

# The Green and Golden Bell Frog Key Population at Kurnell



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**Cover photograph:** Satellite image of Kurnell Peninsula, looking north.

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## INTRODUCTION

### The Green and Golden Bell Frog

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

The colouration of the back is quite variable, being a vivid pea green splotted with almost metallic brass brown or gold. The backs of some individuals may be almost entirely green whilst in others the golden brown markings may almost cover the whole back.

The Green and Golden Bell Frog was formerly distributed from the NSW north coast near Brunswick Heads southwards along the NSW coast to Victoria, where it extends 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 known range.

The Green and Golden Bell Frog is listed as an Endangered Species under Schedule 1 of the NSW *Threatened Species Conservation Act 1995*. At the national level, the species is listed as Vulnerable under Schedule 1 Part 2 of the *Environment Protection and Biodiversity Conservation Act 1999*.

The consequences of being listed as a threatened species under both state and national legislation has been that a recovery plan will be prepared and considerations given to the species when assessing the impacts of developments and activities on populations of the species and its habitats. Whilst preparation of recovery plans has been made optional under the most recent legislation changes, a NSW recovery plan has been drafted for this species. The actions within the Recovery Plan are also listed as Actions within the DECC Priorities Action Statement for amphibians -

[http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/pas\\_speciestype\\_details.aspx?type=Amphibians&kingdom=Animal](http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/pas_speciestype_details.aspx?type=Amphibians&kingdom=Animal)

The draft Green and Golden Bell Frog Recovery Plan defines Key Populations as conservation management units and gives recognition and focus for conservation to 43 such populations across the former extent of the species almost state-wide distribution.

### The Kurnell Management Plan

This Management Plan relates to the Kurnell key population located in the Sydney Green and Golden Bell Frog (GGBF) Management Region as identified in the draft NSW GGBF Recovery Plan.

This plan has been prepared to satisfy Action 11.3.4 of the draft GGBF Recovery Plan that was developed in accordance with the *Threatened Species Conservation Act 1995*. Action 11.3.4 of the Recovery Plan and Priority Action Statement (PAS) Action 21 for the GGBF requires that the NSW Department of Environment and Climate Change (DECC) prepare and implement a GGBF Management Plan for each key population on its own land and liaise with other landowners as necessary (e.g. local councils, industry and residents) to prepare and implement site specific Management Plans across the extent of the species distribution in NSW. The implementation tables of this Management Plan further identify links to other actions, within the draft Green and Golden Bell Frog Recovery Plan and PAS, and which are further satisfied in part by the implementation of this plan.

Under the Sydney Metropolitan Catchment Management Authority (SMCMA) Draft Catchment Action Plan (CAP) there are a number of Catchment Targets that specifically relate to this management plan, these are Catchment Targets B3, B4, B5, W1 and W2. These actions primarily relate to biodiversity (threatened species)

conservation, native vegetation retention and connectivity and wetland retention and rehabilitation. This Management Plan interlinks with the above sections of the CAP and therefore implementation of this plan will also assist the SMCMA meet these and other related CAP targets.

There is also a requirement under the Local Government Act for local councils to develop and implement Management Plans for threatened species, where they occur on public land under their care, control and management. It is therefore envisaged that this Management Plan will satisfy the requirement of Sutherland Shire Council (with respect to the Kurnell GGBF key population components) that may occur on public land within their jurisdiction/responsibility. This Management Plan is also intended to provide guidance, direction and coordination for other stakeholders and/or land owner/managers within Kurnell and its surrounds where the frog and/or its habitat occurs.

### **Purpose**

The Kurnell GGBF Management Plan has been prepared to ensure that the Kurnell population is successfully managed and monitored such that the species continues to persist in the locality and measures of the population's viability are maintained or improved over time.

There are two aims of the Management Plan.

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



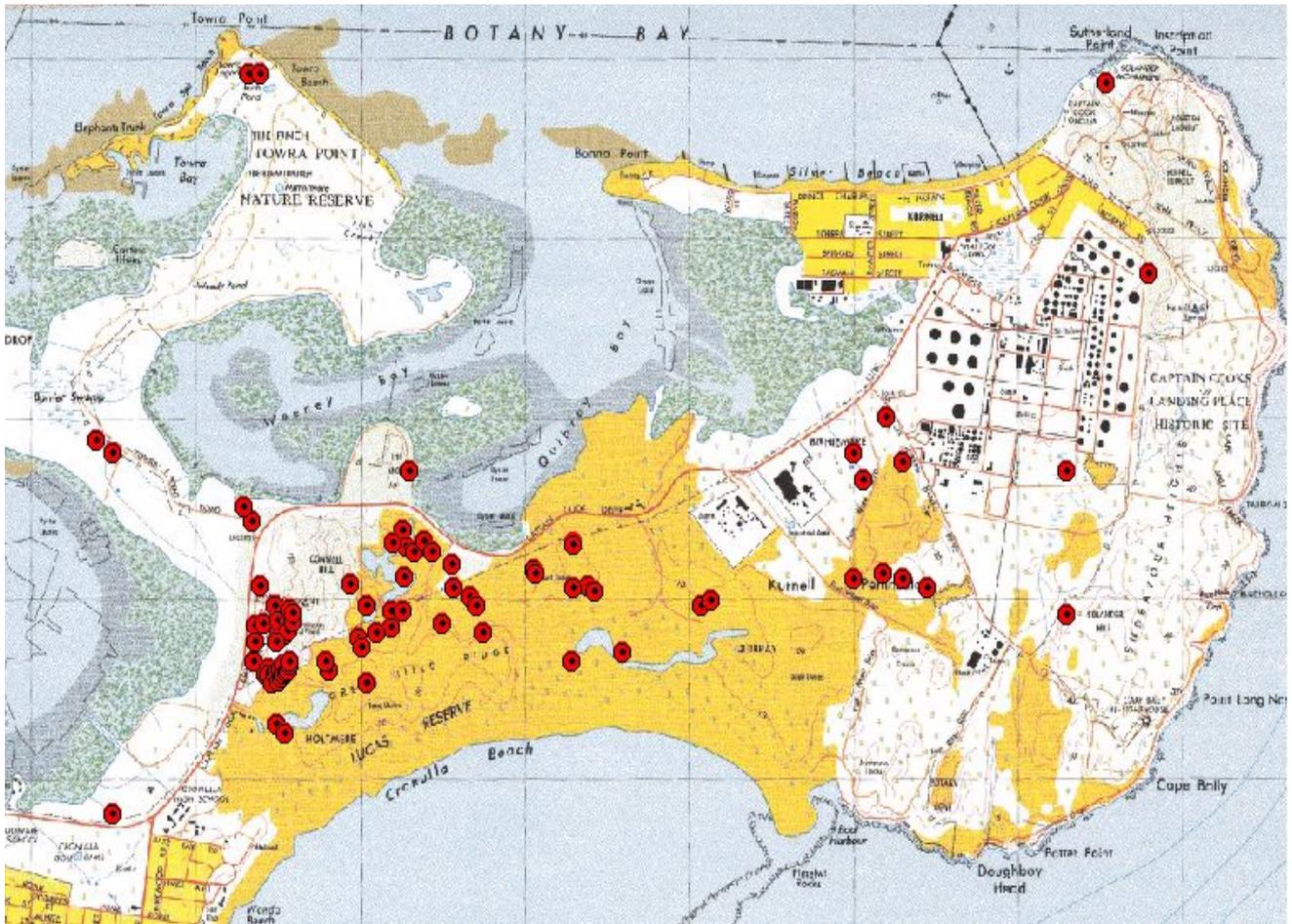
**Figure 1** *Green and Golden Bell Frog*. Photo ©Garry Daly.

## THE KURNELL POPULATION

### Location

The Kurnell key population is located seventeen kilometres south of the Sydney CBD (34° 01' 38 S, 151° 10' 47 E) in the Sydney Region of NSW. The population resides on the Kurnell Peninsula (Figure 2) which is situated between Botany and Bate Bays and the Tasman Sea. The GGBF population on the Kurnell Peninsula is considered to currently exist as two sub-populations that include:

1. Kurnell West; and
2. Kurnell East



**Figure 2** Map of Kurnell Peninsula - showing the location of some of the recorded sightings of Green and Golden Bell Frogs (these records include both historic and contemporary observations from the 1970s to the present and are meant to provide an indicative distribution of the species and its habitat at Kurnell).

The Kurnell Key population incorporates the Kurnell Peninsula and is included within the Sutherland Local Government Area (LGA). The GGBF population is currently spread across several private and public land tenures, albeit a major portion inhabits private lands. Some individuals are occasionally detected within Towra Point Nature Reserve and Botany Bay National Park (managed by the Department of Environment and Climate Change {DECC}) and on other publicly owned lands such as the Cronulla Sewage Treatment Plant (STP), Crown Land and Council Reserves.

The various private and public entities that own or manage land that GGBFs either inhabit or have the potential to inhabit at Kurnell include:

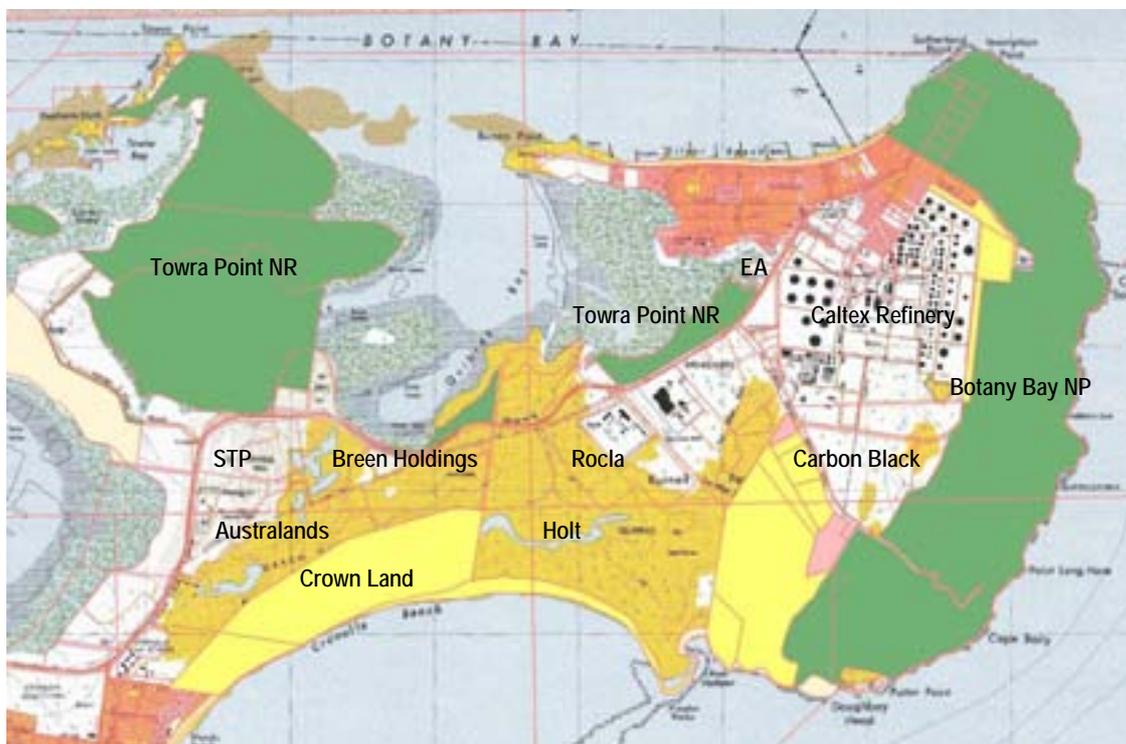
- Australand Holdings
- Sydney Water – Cronulla STP and proposed desalination plant sites
- Breen Holdings (Kurnell Land Fill Company)
- Rocla
- Continental Carbon
- Besmaw (part of the Holt Group)
- Department of Planning (former Hookers 1 site, soon to be transferred to DECC for addition to Towra Point Nature Reserve)
- Serenity Cove Business Park
- NSW Department of Environment and Climate Change (DECC)
- Department of Lands
- Sutherland Shire Council (SSC)
- Caltex Oil
- Energy Australia

### Habitat

Historically the peninsula supported a mosaic of forest, woodland, littoral rainforest, heath and wetlands on a largely stable (vegetated) sand dune system. However there is some debate regarding evidence that part of the peninsula consisted of mobile dunes, even at the time of European colonisation. Since then the landscape of the Kurnell peninsula has been vastly modified by a combination of grazing, timber getting, sandmining, land filling and other industrial as well as residential developments. Sand extraction began in the 1930s and continues to this day. As a result the peninsula currently supports (to some extent ever since sand mining commenced) a series of semi-permanent freshwater lakes that are currently more extensive due to more recent subterranean sandmining methods; these lakes can often reach depths of at least 12 metres and at times, on some sites, have extended to bedrock. Various human-made ponds and retention basins also dot the landscape. The shape and extent of these water-bodies experience ongoing change from development and natural sand migration. Additionally, vegetation that includes the Endangered Ecological Communities (EECs) Kurnell Dune Forest, Swamp Sclerophyll Forest, Littoral Rainforest, Swamp Oak Floodplain Forest as well as other freshwater wetlands occur across the peninsula. GGBFs have survived by using various components of this habitat and more specifically such local features as:

- Breeding habitat, including permanent water bodies such as ponds in and around secure breeding habitat on Australand property, at Keegan's Basin and in purpose built ponds on the Cronulla STP (Sydney Water) land. As well as other more ephemeral breeding habitat that fills after heavy rain including grassy swale areas, ponds and drainage depressions. Such ephemeral swale habitat is often indicated by plant species such as *Juncus* spp., *Schoenoplectus* spp., *Isolepis* ssp. and *Baumea* spp. Some of these habitat areas may currently go unrecognised across the otherwise exposed sandy areas that at least today typify the Kurnell dunal landscape. When dry these areas are easily overlooked and dismissed as habitat. However, after significant rainfall the somewhat impervious 'crust' or aquitard lining such depressions may allow water to be retained and the waterbody to be used for breeding purposes (not always successfully). Many of these features are of either human construction, as a vestige of earlier sand extraction/mining, or the result of aeolian processes that subsequently become naturalised and then colonised in the absence of further or ongoing human disturbance.

- Foraging habitat, including areas of native or introduced grasses, tussock vegetation and emergent sedges and reeds bordering water features. Examples of suitable foraging habitat are evident around the Australand and Cronulla STP sites and in scattered locations elsewhere on the peninsula. These areas are vital for the GGBF to feed in relative safety from predators and/or to bask in the sun by day.
- Shelter habitat, includes similar vegetation to that used for foraging and also, most particularly, rock piles, ground timber, tussock forming vegetation and other features that are difficult to categorise (crevices in the ground, around root systems of plants and ground debris). Significant areas of shelter habitat are found at the Australand site, but may also be present elsewhere.
- Movement habitat, generally typified by wet areas such as creek lines, drains, periodically damp areas, connecting or partially connecting vegetation, easements, laneways and even open areas that do not restrict movement. Movement habitat is apparent between the Australand site and the STP and was factored into these developments. Elsewhere such habitat is either sparse or remains ill defined and often unrecognised.
- Over wintering habitat - Some of this habitat is probably in common 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. In some locations this may even include residential gardens that are sympathetic to the frogs' requirements, but at Kurnell, this is likely to be limited to the somewhat restricted residential interface areas of Kurnell, North Cronulla and Woolooware at either end of the peninsula.



**Figure 3** *Property Boundaries and Land Tenure for some important Kurnell Peninsula Lands*

## Species Status

The Kurnell Key Population is believed to be the second largest in the Sydney Region (the Homebush Bay key population being recognised as the largest).

The species was 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. This former distribution of GGBFs has contracted to only eight known locations identified in the draft GGBF Recovery Plan as key populations in the Sydney Region. These populations are located at:

- Homebush Bay/Sydney Olympic Park
- Kurnell (the focus of this plan)
- Greenacre
- Clyde/Rosehill
- Merrylands
- Arncliffe
- St Marys/Mt Druitt/Riverstone; and
- Hammondville

Apart from the first sighting by Cooks party in 1770 the GGBF was again officially recorded on the Kurnell peninsula in 1946, but no abundance or distribution data exist for this time period. Whilst the GGBF was probably detected at other times regularly by visitors to the peninsula few records exist due, most likely, to the species' then common status. However, extensive surveys were conducted in the early 1990s across the peninsula. These indicated that the species was widely distributed on the peninsula and it was identified at a further fourteen locations there. It was reported by Arthur White (Biosphere Consultants) that sightings of the GGBF in the eastern part of Kurnell Peninsula had decreased markedly since 1993/94. White's studies indicated that sightings had become less regular for the eastern sub-population while larger populations existed in the western part of the peninsula. Furthermore, a component of the eastern sub-population, that existed at least as recently as 1992 in part of Botany Bay National Park, may now be locally extirpated.

The total Kurnell West sub-population was recorded as 500 adult frogs in the late 1990s based on studies at the Australand and STP sites. Another study carried out in 2000, as part of the pre-development studies of the Australand site, estimated the GGBF population in the two main habitat ponds on that site to be between 460 and 790 frogs. Importantly, of the possible habitat ponds mapped for that site, the two exhibiting the highest GGBF abundance had the lowest Plague Minnow (*Gambusia holbrooki*) abundance (one pond being completely free of this species), albeit no scientific investigations were conducted then to quantify this trend. Surveys on Rocla-owned lands in the east of the peninsula resulted in GGBFs being recorded in 1996 and 2001 but absent most other years. This site is likely to be used primarily as movement and foraging habitat, however extensive swale areas also exist on this site that may provide ephemeral breeding habitat during wet episodes.

GGBF researcher Michelle Christy, during her PhD research at Sydney University, conducted much of her field work on the Kurnell Landfill Company Lands. During studies there she recorded many GGBF for the site and reported an upward trend in numbers during the years 2000-2002. Under her direction habitat creation initiatives provided a cyclic pattern of habitat creation in response to advancing sand mining and landfill process operations. In 2002, conservative estimates of the population size on this site indicated the adult GGBF population was greater than 400 individuals. These numbers were considered over and above those detected contemporaneously on adjacent Australands and STP sites.

Various consultants and GGBF experts have undertaken surveys and monitoring across properties at Kurnell from the mid 1990s to the present. These observations have been undertaken for various purposes including research, required assessment works and as conditioned routine monitoring. Lands implicated have included the Cronulla STP site, lands transected by the ocean outfall sewer pipeline duplication, Australands - H6 site (tourist resort, residential, industrial and mixed use proposals), Kurnell Land Fill (Breen lands) – research site, and Besmore (Holt lands, Lot 2 DP 559922), Rocla, Continental Carbon and surrounding lands. Observations have been variously recorded/documentated by Dr Allen Greer, Dr Michelle Christy, Dr Arthur White, Associate Professor Michael Mahony, Mr Eric Le Provost, Mr Dominic Fanning, Mr Ian Drinnan, Mr Geoff Ross and Ms Marion Traynor. These individuals have noted GGBF sightings including auditory records of calling males on a number of occasions from all of the above properties. These collective observations confirm that these areas function as GGBF habitat (but see also White, 1996, Christy, 2002).

Habitat has also been created on the North Cronulla STP site as a requirement of development consent for that site because GGBFs had been recorded making use of Keegan's Basin (Lake) as an area of breeding and foraging habitat. The two habitat ponds subsequently created functioned initially with a single breeding event recorded for one of the ponds. However, drought conditions, and limited active management since, are likely to have contributed to the apparent ongoing failure of this habitat to be occupied regularly. Active management might have, but didn't, provide a consistent supply of water to the created ponds and should be a consideration for future ongoing active management at that site. Sporadic records of GGBF are still recorded from around the facility. Development approval at the Australand site also requires significant GGBF habitat creation, enhancement and maintenance works and performance criteria have been placed on the conditioned habitat creation works.

### Historical Significance

The population on Kurnell has been evident on the peninsula since Cooks party first detected it upon landing at Migurrung Beach in 1770. This gives the GGBF population at Kurnell immense historical significance with the species being the first Australian frog detected by Europeans and subsequently one of the first illustrated from specimens sent back to England. An illustration depicting the frog appears in the publication by John White "*Journal of a Voyage to New South Wales*". This book documents the field observations made by the naturalists aboard 'Endeavour', including Solander and Banks, at Kurnell and at other locations explored. The naturalists' field notes were transcribed by George Shaw and then published in White's Journal with illustrations by J. Merritt based on the descriptive field notes provided along with the preserved specimens. The specimens were lodged in the 'Hunterian Museum' at the Royal College of Surgeons in London. Unfortunately the specimens were destroyed during an air raid in WWII when the building was bombed and consumed by fire and so the identity of the Type specimen is in some doubt and can no longer be verified.

The treatment of the matter by Tyler and Dobson in 1973, where they suggest that the specimen is a Green Tree Frog *Litoria caerulea (sensu lato)*, is one possible interpretation and is based on the tendency of preserved *L. caerulea* to often have a blue tinge and hence the name for the illustration. There is also another motive for favouring this interpretation and that is preserving the nomenclatural stability of the two well known frog species (*Litoria aurea* and *L. caerulea*) that are implicated. With no intention or desire to destabilise the existing nomenclatural arrangement of either species, it is however, still important to give appropriate recognition to such an important historical discovery of the first frog for Australia. The illustration provided in White (Figure 4) shows a specimen of what is almost certainly a GGBF with its reduced toe pads, elongate phalanges, pointed snout and pictured habit of calling

from wetland/pond margins. Furthermore the GGBF is also well known for its 'electric' blue thighs and groin area that would no doubt have been mentioned in field notes at the time of collection. The 'Blue Frog' notation could therefore have been in reference to this leg colouration rather than the whole frog as alluded to by Tyler and Dobson (1973). The location illustrated also bears a strong resemblance to the wetland and spring still present today a short distance from Cooks landing place that was, in all likelihood, the original site of the specimens collection. This area is recorded on the register of the National Estate and is a National Environmental Significance (NES) matter protected by the Commonwealth Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act).



**Figure 4** *Illustration from Whites Journal depicting what appear to be Green and Golden Bell Frogs at Kurnell*

### THREAT ASSESSMENT

The major factors that potentially threaten the Kurnell GGBF key population are loss of habitat, predation by introduced pests, disease, habitat degradation, and poor water quality.

The identified threats to the Kurnell key populations of the Green and Golden Bell Frog that are known to be operating include:

1. Loss of habitat. Currently, there are several developments proposed that could affect the GGBF key population. Whilst some proposed developments may not directly affect important permanent breeding habitat they may result in loss of other transiently used or strategically important habitat including foraging habitat, ephemeral breeding habitat or linkage corridors between population elements. Given the importance of the Kurnell GGBF key population it would be prudent for current/future proposals to be required to provide adequate and proven offsetting/compensation for any losses of GGBF habitat in the local area. In addition, aeolian migration of the Australand dune will invariably result in the loss of the most consistent GGBF breeding habitat ponds in recent years (ponds 1 and 2) on that site and contingencies for

replacing this habitat should be considered. Other aeolian sand movements also have the potential to threaten significant habitat areas on other sites. Ideally habitat creation initiatives that are proposed as offsets to development need to demonstrate functionality in accordance with DECC EIA Guidelines.

2. Introduced Predators that include:
  - The Plague Minnow – *Gambusia holbrooki* (Listed as a Key Threatening Process [KTP]) is present in most permanent water bodies inhabited by the GGBF on the Kurnell Peninsula.
  - Carp - *Cyprinus carpio* present in various waterbodies.
  - The Red Fox *Vulpes vulpes* (listed as a Key Threatening Process for a number of threatened species) is known to inhabit the peninsula.
  - Feral and Domestic Cats - *Felis catus*
3. Disease - Frog Chytrid fungus (*Batrachochytrium dendrobatidis*) is listed as a Key Threatening Process at state and national levels. This disease is rapidly emerging as possibly the single biggest threat to the species (as well as to many other species of frogs). Frog Chytrid fungus has been found to be present on the peninsula but purportedly, and importantly, is now not present in the Australand habitat areas according to recent swab screenings undertaken.
4. Habitat degradation - Weed invasion of foraging and breeding areas has been recognised as a potential threat in monitoring reports (Arthur White at the STP site). In particular, Bitou Bush (*Chrysanthemoides monilifera*), listed as a KTP primarily for its impacts on native vegetation communities and threatened flora species, occupies large swathes of the peninsula and could be reducing overall GGBF habitat area. Vegetation overgrowth, in various artificial habitat ponds particularly, can reduce the habitat value of these ponds by reducing open water areas. Lack of water as a result of drought or imperfect artificial habitat construction (leakage through pond liners) can result in habitat degradation or loss in severe cases. Intentional mechanised ripping (tining) of the impervious lining (aquitarde) of ephemeral swales and/or infilling of these swale areas is an example of important habitat loss or modification that has occurred in addition to the losses caused generally by development and changes to land use.
5. Water quality - Many of the freshwater bodies on the peninsula are highly groundwater dependent. Landfill operations have the potential for movement of pollutants off-site, via groundwater, to the various waterbodies inhabited by GGBF. Previous offsite movement of organic pollutants has been reported as occurring from current or former landfill operations towards the Towra Point wetlands and also from the STP site adjacent to the Australands H6 site.
6. Herbicide Spraying - Sutherland Shire Council conducts integrated weed and pest management with landholders that includes aerial herbicide spraying of parts of the the peninsula and includes *C. monilifera* as a targeted species. Whilst recognising the value of controlling this weed it must also be recognised that herbicide control measures need to consider that glyphosate compounds, used in weed control, are acutely toxic to a closely related species the Western Bell Frog (*Litoria moorei*) and therefore also likely to be toxic to the endangered GGBF. Broad aerial applications of glyphosate need to be mindful of the potential to impact on the species. Biactive® formulations of glyphosate compounds that are often proposed as an alternative to RoundUp® are not necessarily less toxic to frogs (see page 40 of the Draft GGBF Recovery Plan).
7. Predation of GGBF from native predators - There are a number of native predators that could now be considered a threat to the species given the cumulative effect of other threats listed above. These include:

- The Australian White Ibis (*Threskiornis molucca*) that now congregate around GGBF habitat, and potentially the Silver Gull (*Larus novaehollandiae*).
  - The native Red-bellied Black Snake (*Pseudechis porphyriacus*) which is known to inhabit the peninsula in large numbers.
8. Inappropriate recreational use - The peninsula is a popular area for off-road motor vehicle (dirt bikes and 4WD) recreation in the remaining areas of the peninsula's sand dunes. Such activities have the potential to threaten GGBF habitat, particularly ephemeral swale areas.

## MANAGEMENT ACTIONS

### Strategic considerations

The Kurnell GGBF population is likely isolated from all other known GGBF key populations in the Sydney Region. Historically, the Kurnell population was most likely connected to populations fringing Botany Bay and along the Georges River and perhaps into the Hacking River catchment further south and west. Today, however, precluding the unlikely migration across the Georges River in times of flood, the Kurnell Key Population is likely to be effectively genetically and physically isolated, which increases its conservation significance.

The possible loss of elements of the eastern peninsula population from parts of Botany Bay National Park circa 1992 and the subsequent apparent decline in GGBF occurrence in the east of the peninsula in recent years could be some cause for concern. Though recent records do exist on the eastern peninsula (1996 and 2001 on Rocla lands; 2000 at Alpha Farm Botany Bay NP and in the area of the Sydney Water Desalination Plant site during 1993-96), a concerted effort to definitively locate GGBF on the eastern peninsula and identify any potential habitat would prove beneficial in delineating the sub-population's status. Improved interconnection between the eastern and western sub-population components should be viewed as a high priority.

Most of the population resides on privately owned lands, with the Cronulla STP site being the primary publicly owned land that supports GGBFs, albeit older records exist from Towra Point Nature Reserve and also more recently from Crown Land and Botany Bay NP. The peninsula has been used for over 70 years and still is utilised as a significant source of fine sand for the construction industry. Though such activities are declining due to resource depletion, or are being phased out due to planning considerations (SREP17), there remains significant economic value attached to the land, either through existing sand extraction, land fill or industrial, commercial, infrastructure and/or possible residential development. The Kurnell Peninsula is hence ultimately useful for non-conservation purposes, which has implications for GGBF conservation initiatives and for site access when conducting studies or determining GGBF presence.

Significant developments are underway on the Kurnell Peninsula and seemingly this will continue in the coming years. Australand Holdings has gained approval for the industrial subdivision of its site and GGBF habitat areas have been incorporated into the development design. Subsequent developments, adjacent to the Australand site and further afield (e.g. Kurnell desalination plant), will need to take into account GGBF movement corridors that are necessary to increase connectivity within and between the eastern and western sub-populations (e.g. collaboration between Australand Holdings and Sydney Water in relation to efforts at forming GGBF movement corridors), a stated objective of this management plan. Thus it is desirable to identify and map areas of GGBF habitat, potential areas for interconnection between sites and mechanisms within future developments to ensure that areas set aside for GGBF are

appropriately managed and maintained for this purpose and with due consideration of previous efforts.

It is important that any habitat unavoidably lost to development is compensated by the creation of habitat that meets functionality performance criteria as set out in the DECCs Environmental Impact Assessment Guidelines for the Green and Golden Bell Frog (see references). That is, any habitat creation initiatives proposed as an offset to a development must be tested on a performance basis prior to removal of any existing habitat. Performance with respect to breeding habitat is measured by successful breeding and subsequent recruitment that demonstrates that two full life cycles have been completed in the created habitat. Thus F<sub>1</sub> female progeny need to reach sexual maturity (~ 2 years), breed successfully and any resulting progeny, in turn, need to reach sexual maturity and successfully breed. Habitat creation initiatives proposed as an offset to development on the peninsula but that do not meet these requirements would otherwise result in a net loss of GGBF habitat and be contra an objective of the Draft Recovery Plan.

Furthermore, the creation or rehabilitation of artificial human-made waterbodies should not be considered as habitat offset to a development when the structures primary purpose is for some other aspect of a development eg infiltration, storm water detention or water quality treatment. Whilst such areas can, and frequently do, serve as ancillary GGBF habitat, they are preferentially managed to serve the primary engineering purpose that may be inconsistent with long term GGBF utilisation.

Sutherland Shire Council, in consultation with peninsula landholders, is working on an integrated weed management program that is targeting major weeds such as Privet (*Ligustrum* spp.), Lantana (*Lantana camara*) and Bitou Bush (*Chrysanthemoides monilifera*) through the use of aerial spraying, hand removal and biological control agents. Such laudable conservation efforts however must be undertaken mindful of the potential conflicts with GGBF conservation due to the toxicity of the herbicides containing glyphosate compounds to tadpoles and adults of the GGBF. The hand removal or use of non-residual chemical spraying of *C. monilifera* (a KTP), and other weed infestations that overlap with GGBF habitat, should be considered particularly in the vicinity of water bodies. Aerial spraying of glyphosate herbicides was identified as a threat to the GGBF in the Draft GGBF Recovery Plan (page 40). It was also identified that end users have a practice of adding additional surfactants to reportedly less toxic Bio-Active formulations of Round Up™ to improve their weed killing effects but also rendering the sprays again toxic to frogs. Use during the inactivity period of the frogs may reduce impact on the GGBF but may be a less effective spraying period for some of the target weed species. These issues need to be addressed when weed control measures are being planned.

### **Planning process**

This Management Plan builds upon a range of past and current actions to manage the species. Past efforts at managing the species on private land have largely been development driven. Several large landowners (Australand Holdings and Sydney Water) have developed operational site specific management plans as a result of their development Conditions of Consent related to identified GGBF populations or habitat elements on their respective lands. These developments were required to undertake measures to ensure that the species survived in the area and populations were monitored. Kurnell Landfill (Breen Holdings) allowed PhD student Michelle Christy to undertake studies and provide advice that would enable sand extraction and landfill activities to co-exist. With an existing consent for its operations Kurnell Landfill had no requirement to undertake mitigative measures for the GGBF. Management at the time considered it was prudent to do such works to maintain the species and enhance its habitat wherever possible with the view to a more favourable final development outcome for that site if the GGBF were given adequate consideration.

These actions along with other measures undertaken at Kurnell include:

- The Kurnell Land Fill Company has established the concept of a species conservation area on their lands that was endorsed by the NSW NPWS (now DECC). A land restoration management plan has been produced and includes a wetland conservation area that will incorporate long term species management, for the GGBF and other species. Current management should ideally endeavour to continue these previous management efforts.
- Australand Holdings, as part of their development conditions of consent, is required to maintain in good order and repair GGBF ponds and associated habitat components, and to carry out monitoring and surveying of the GGBF and their habitat. Australand has undertaken GGBF research and monitoring work on site over several years. Specifically, information such as population estimates, frog movements, identification of habitat areas and ways to improve and reduce the effects development has on GGBF habitat have been studied. Other efforts include: pest and weed control, erection of frog exclusion fences around identified habitat (to exclude or contain frogs during construction phases of the development), rehabilitation of foraging areas and protocols to be put in place during construction works that will further minimise disturbance to the frogs and their habitat.
- Sydney Water has prepared and currently implements an Operations Environmental Management Plan (OEMP) developed as a requirement of the conditions of approval for the upgrading of the Cronulla STP and outfall pipeline duplication. GGBF monitoring occurred during the upgrading of the STP in 2000 and again in the summer of 2003-04. Two new frog ponds were created as replacement breeding habitat due to earthworks associated with the construction of Keegans Basin. The OEMP outlines rigorous GGBF management objectives and targets that include bush regeneration, stipulations not to use herbicides in the vicinity of frog ponds, active habitat management, and frog protocols during STP maintenance works among others. Contingency actions to respond to ongoing failure of the habitat ponds require development along with a renewed reporting requirement.
- Sydney Water as part of their Environmental Assessment for construction of the Kurnell Desalination Plant and its associated infrastructure, has been required to consider impacts on the Green and Golden Bell Frog. As such impacts were considered possible and s5A tests of significance were conducted for the GGBF as well as for other Threatened Species. The assessment for the GGBF concluded that the proposal would not have a significant impact on that threatened species. However, the NSW Department of Planning recommended the preparation and implementation of a comprehensive Conservation Area Management Plan and to minimise and manage impacts on the conservation area during construction and operational phases of the plant.
- Sutherland Shire Council manages Charlotte Breen Park and also Marton Park wetlands, the latter in conjunction with Caltex Oil. No recent reports of GGBF records exist for either reserve, though the sites have high probability of being occupied from time to time by GGBF.
- Sutherland Shire Council in conjunction with landholders, Department of Lands - Soil Conservation Service of former DNR and possibly other contracted bush regenerators conducts integrated weed management that may involve aerial herbicide spraying of invasive plants. This activity could be improving GGBF habitat but may also act as a potential threat via the toxicity of glyphosate compounds to tadpoles and adult GGBFs, if applications are not limited to confined areas during ideal weather and seasonal conditions.

- Caltex Oil is involved with SSC in managing the Marton Park wetlands, and also conducts fox baiting and weed management activities on their lands. Components of the refinery site in all likelihood operate as GGBF habitat from time to time. The refinery occupies a strategic position but access restrictions make habitat and GGBF population status assessment difficult.
- Energy Australia, as part of its current proposal to upgrade electricity supply infrastructure to Kurnell, has undertaken to construct GGBF habitat components into the landscaping required as part of Kurnell STS modifications opposite the Caltex Refinery (see Molino Stewart, 2007).

A stakeholder workshop was facilitated by consultants Molino Stewart Pty Ltd to identify these and other possible management initiatives as a basis for preparing this plan as an action of the draft GGBF Recovery Plan. The workshop was held on the 1<sup>st</sup> of May 2007 with representation from:

- Australand Holdings
- Rocla
- NSW Department of Environment and Climate Change
- Sutherland Shire Council
- Botany Bay and Catchment Alliance
- Sydney Water (Cronulla STP)
- Energy Australia
- Besmaw (Holt Group)
- Breen Holdings
- Caltex Oil
- Continental Carbon

This plan was then distributed in draft form for comment to these and other stakeholders including: the Sydney Metropolitan Catchment Management Authority, Biosphere Ecological Consultants, Abbott Australasia, Kurnell Precinct Residents Association, La Perouse Local Aboriginal Land Council, Dr Michelle Christy, Mr Eric Le Provost, Dr Allen Greer and Dr Michael Mahony.

Further comments by any interested parties are encouraged as the plan is implemented. These comments should be sent to DECC (see details in Contacts section).

### **Objectives**

The three objectives of the Kurnell GGBF Management Plan are as follows:

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

### **Strategies**

The following six strategies will be used to achieve these objectives:

1. Further development, where appropriate, of GGBF breeding and other habitat components on public and private lands
2. Improvement of habitat within the GGBF key populations
3. Education and communications to build 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 Kurnell GGBF population and
6. Coordination and communication between the various stakeholders, land managers and the community.

**Duration**

The duration of this plan will be three years i.e. start mid 2007 to mid 2010.

**Implementation plan**

The following implementation plan provides a framework for management actions related to the above strategies, the draft GGBF Recovery Plan and PAS actions. It describes Management Plan actions for each strategy, linked to the draft Recovery Plan and PAS, responsibilities for the management actions, a cost estimate for the actions and possible sources of funding. A time frame for undertaking the various tasks is also provided. This plan should be read and actioned with appropriate further reference to the draft GGBF Recovery plan and PAS.

It should be noted that some management actions are relevant to more than one strategy in the plan.

## IMPLEMENTATION PLAN

### Strategy 1: Further development of GGBF breeding and other habitat components on public and private lands

ACTION	RECOVERY PLAN LINKS / PAS LINKS	RESPONSIBILITY	COST*	FUNDING SOURCES	TIMEFRAME
1.1 Establish secure breeding habitat areas with a complete suite of habitat components, where possible, in the east of the peninsula on public or private land (e.g. Sydney Water Desalination Plant site, Botany Bay NP) with the intention of 'luring' to and maintaining GGBF at the relevant sites.	Action 11.3.3 / PAS 9, 18	Sydney Water, other landowners, DECC, SSC	To be determined	Stakeholder sponsorship, NHT	2007- 2010
1.2 Creation of movement and shelter habitat as a result of studies/planning of GGBF movement corridors (link with Actions 5.4 & 6.1).	Action 11.3.3 / PAS 9	Landholders, DECC	To be determined	Landholders, NHT, SMCMA, Env. Trust	2008 - 2010
1.3 Ensure losses of habitat resulting from future landfill/sandmining operations are accompanied by appropriate offsetting and existing landfill/sandmining sites are rehabilitated and include habitat creation initiatives. Any habitat creation initiatives linked to development approvals need to exhibit functionality prior to destruction of any original habitat.	Actions 10.3.1, 11.3.1, 11.3.3 / PAS 1, 5, 30	DECC, SSC, DoP	In-kind	Recurrent funding of agency staff	2007 - 2010

\* Costs are indicative only and subject to available funding

**IMPLEMENTATION PLAN (continued)****Strategy 2: Improvement of habitat within the GGBF key populations**

<b>ACTION</b>	<b>RECOVERY PLAN LINKS / PAS LINKS</b>	<b>RESPONSIBILITY</b>	<b>COST*</b>	<b>FUNDING SOURCES</b>	<b>TIMEFRAME</b>
2.1 Ongoing active management of key habitat areas on Australand, Kurnell Landfill Company and Sydney Water lands.	Action 11.3.3 / PAS 21	Kurnell Landfill Company, Australand Holdings, Sydney Water	Undetermined	Stakeholder/landowner	2007 - 2010
2.2 Investigate possibility of sourcing water to supply Cronulla STP habitat ponds in times of drought, e.g. installation of water tanks or supply of treated water (link with Action 2.1).	Action 10.3.1 / PAS 9	Sydney Water	<\$10,000	Sydney Water	2007 - 2009
2.3 Specific hand removal or 'cut and paint' herbicide application, using only non-residual chemical spray, to weed infestations (e.g. <i>C. monilifera</i> ) in proximity to GGBF habitat components (link to Action 4.4).	Action 11.3.3 / PAS 9	SSC, DoL (Soil Conservation), contracted bush regenerators, other relevant stakeholders	Undetermined	SSC, Coastcare/Bushcare, SMCMA	2007 - 2010

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\* Costs are indicative only and subject to available funding

**IMPLEMENTATION PLAN (continued)****Strategy 3: Education and communications to build awareness of the GGBFs and encourage further on-ground actions**

<b>ACTION</b>	<b>RECOVERY PLAN LINKS / PAS LINKS</b>	<b>RESPONSIBILITY</b>	<b>COST*</b>	<b>FUNDING SOURCES</b>	<b>TIMEFRAME</b>
3.1 Raise community awareness of local GGBF issues through incorporation of GGBF content in Discovery Tours and at the Botany Bay NP Environmental Education Centre.	Action 14.3.1 / PAS 32, 33	DECC, DET - EEC	Minimal	In-kind	2007 - 2010
3.2 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, SSC, GGBF 'Friends' Group when established	Minimal	In-kind	2007 - 2010
3.3 Establishment of a Kurnell GGBF 'Friends' Group with encouragement for community involvement in surveying and/or monitoring for GGBF this group may be linked with or a subgroup of the 'Adopt Kurnell Historic Drive' Group (link to Actions 5.1 & 5.2)	Action 14.3.2 / PAS 7, 32	DECC, existing group members, landowners, other stakeholders	Minimal	In-kind	2007

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\* Costs are indicative only and subject to available funding

## IMPLEMENTATION PLAN (continued)

### 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	2007 - 2010
4.2 Survey of GGBF habitat for presence of Plague Minnow <i>Gambusia holbrooki</i> and, with reference to the <i>Gambusia</i> Threat Abatement Plan (TAP), and where possible remove Plague Minnow from sites as well as reduce further spread to unoccupied GGBF habitat.	Action 11.3.2 / PAS 6	DECC, SSC, other stakeholders, DPI - Fisheries	<\$5,000	DECC, NHT, SMCMA	2007-2008
4.3 Revegetation of the Australand dune in an attempt to halt any further loss of on-site GGBF habitat through dune migration.	Actions 10.3.1, 11.3.3 / PAS 14	Australand Holdings, DoP, SSC	Undetermined	Development Offset, In-Kind	2007 - 2010
4.4 Liaise with SSC and DoL (Soil Conservation) regarding exclusion of aerial weed spraying in and around GGBF habitat, with possible hand removal of weeds in these areas (link with Action 2.3).	Action 11.3.3 / PAS 14	DECC, SSC, DoL, other stakeholders	Nil	N/A	2007

\* Costs are indicative only and subject to available funding

ACTION	RECOVERY PLAN LINKS / PAS LINKS	RESPONSIBILITY	COST*	FUNDING SOURCES	TIMEFRAME
4.5 Investigate likely impacts from pest numbers of the White Ibis at GGBF sites and seek DECC support for implementation of control measures as necessary (to run jointly with investigations conducted for Port Kembla GGBF population).	Action 11.3.2 / PAS 3, 14	DECC, SSC, Wollongong University	Dependent on findings	NHT, DECC, SMCMA, Research Grants	2007-2008
4.6 Signage and/or some form of surveillance with regard to illegal recreational use and dumping in GGBF habitat areas (link to Action 5.2).	Action 11.3.2 / PAS 14	SSC, DECC	In-kind	Recurrent funds	2007-2010
4.7 Survey of potential GGBF habitat that <i>Cyprinus carpio</i> occupy and examine opportunities to eradicate and prevent further spread to unoccupied habitat (in conjunction with Action 4.2).	Action 11.3.2 / PAS 14	DECC, SSC, Landowners, DPI Fishing	<\$5,000	NHT, SMCMA, sponsorship	2008
4.8 Investigate Fox control initiatives being undertaken by DECC and explore possible collaborative efforts to extend Fox control measures onto Council and private land. (link to Action 6.4).	Action 11.3.2, 11.3.6 / PAS 3	DECC, SSC, other landowners	Undetermined	DECC recurrent funding, Fox TAP, NHT, SMCMA, SSC	2007 - 2010

**IMPLEMENTATION PLAN (continued)****Strategy 5: Monitoring and research to better understand the extent and dynamics of the Kurnell GGBF population**

<b>ACTION</b>	<b>RECOVERY PLAN LINKS / PAS LINKS</b>	<b>RESPONSIBILITY</b>	<b>COST*</b>	<b>FUNDING SOURCES</b>	<b>TIMEFRAME</b>
5.1 Peninsula-wide GGBF monitoring program that focuses on population numbers, location and finding new GGBF locations. With prior reviews of previous and current monitoring to avoid duplication and more widely report on findings.	Action 12.3.1 / PAS 11, 31	Consultants, Post Graduate University Students	<\$60,000	NHT, SMCMA	2007-2008
5.2 Targeted surveys of areas that have furnished recent and historic GGBF records in the east of the peninsula.	Action 12.3.1 / PAS 31	DECC, Post Graduate University Students, Consultants	<\$15,000	NHT, SMCMA	2007-2008
5.3 Formulation of an updatable conceptual map that highlights key habitat areas, future developments, key threats, and potential movement corridors (link to Action 5.4).	Action 12.3.1 / PAS 4	DECC, SSC	<\$5,000	DECC, In-kind	2007
5.4 GGBF movement corridors to be identified and independently mapped (link to Action 5.3).	Actions 11.3.3, 12.3.2 / PAS 26	Consultants, DECC, SSC	<\$8,000	SMCMA, NHT, Env. Trust	2007-2008
5.5 Scientific investigations into the apparent decrease in GGBF occurrence in the eastern peninsula (subsequent to Action 5.2). Could involve reintroduction experiments and include sensitive endpoint studies.	Action 12.3.2 / PAS 26	Post Graduate University Students, DECC	Undetermined	Research Grants, sponsorship	2009 - 2010
5.6 An independent auditing process that aims to evaluate implementation of GGBF management plans active on private lands of the peninsula. (nb. There may be interrelationships here between consent authority and Commonwealth DEW re Bilateral Agreement re NES matters).	Action 11.3.4	DECC, Consultants, SSC, relevant landowners, DEW	Undetermined	Various funding opportunities	2008 - 2010

\* Costs are indicative only and subject to available funding

**IMPLEMENTATION PLAN (continued)****Strategy 6: Coordination and communication between the various stakeholders, land managers and the community**

<b>ACTION</b>	<b>RECOVERY PLAN LINKS / PAS LINKS</b>	<b>RESPONSIBILITY</b>	<b>COST*</b>	<b>FUNDING SOURCES</b>	<b>TIMEFRAME</b>
6.1 DECC to continue to liaise with large landholders in relation to GGBF conservation concerns on private lands.	Action 10.3.1 / PAS 1, 9, 18	DECC	Negligible	Recurrent funding	2007 - 2010
6.2 DECC to continue to liaise with SSC regarding future development proposals at Kurnell. This will ensure that GGBF is adequately considered in any future development proposals.	Actions 10.3.1, 11.3.1 / PAS 1	DECC, SCC	Negligible	Statutory requirement, recurrent funding	2007 - 2010
6.3 DECC will work cooperatively with landholders to ensure the linkage and creation of habitat through the drafting of a peninsula-wide GGBF habitat concept plan. This will build on and/or incorporate site by site GGBF property management plans (link to Action 6.1).	Actions 10.3.1, 11.3.1 / PAS 1	DECC, Landholders, SCC, DoL	Undetermined	In-kind and operational expense	2007 - 2010
6.4 DECC will liaise with DoP and SSC with respect to any revision of SREP 17. DECC will also provide input to any planning decisions under Part 3A of the EP&A Act that may have impact on the important GGBF population at Kurnell and liaise with DEW on EPBC Act matters.	Action 11.3.1 / PAS 1	DECC/DEW/DoP	Undetermined	In-kind, recurrent funding	2007 - 2010
6.5 DECC will examine license provisions for scheduled premises at	Action 11.3.2 / PAS 1	DECC, relevant licensees	Minimal	In-kind, operational	2007 - 2010

\* Costs are indicative only and subject to available funding

ACTION	RECOVERY PLAN LINKS / PAS LINKS	RESPONSIBILITY	COST*	FUNDING SOURCES	TIMEFRAME
Kurnell. Those scheduled premises with GGBFs/habitat will be considered for site GGBF MPs or other initiatives as part of License conditions, where appropriate and nexus established.				costs	
6.6 DECC to contact relevant landholders, using existing SSC networks, in relation to synchronisation of fox baiting programs that are currently in place (see Action 4.8).	Action 10.3.1 / PAS 3	DECC, SSC, other stakeholders	Undetermined	Existing funding, recurrent funding and Fox TAP	2007 - 2010
6.7 Establish a GGBF 'Friends' group/committee, utilising existing interested groups/individuals, for the purposes of assisting coordination of MP implementation and wider education/awareness raising (includes Action 3.3).	Action 14.3.2 / PAS 7	DECC	Minimal	In-Kind	2007
6.8 Creation of an electronic email/web forum/site that will facilitate coordination of GGBF as in Action 6.7 above.	Action 14.3.2 / PAS 24	DECC, SSC, CMA	Minimal	In-Kind	2008

## REVIEW

A meeting of stakeholders will be organised to occur following the activity period each season where results and trends will be discussed and recommendations for adding to and modifying management actions in the plan made.

A review of the plan is required after 2.5 years as a basis for its next iteration after three years.

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 below.

## THE 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>

## 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 for investigation. Whilst captive breeding and reintroduction/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/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 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 eg 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 eg 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 understanding and future proposals.

### ACKNOWLEDGEMENTS

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*Ian Drinnan, Brendon Graham and Stewart Harris – Sutherland Shire Council*

*Philip Holt and Darren Floyd – Besmaw (Holt Group)*

*Pat McCue - Rocla*

*Nethan Kana – Kurnell Landfill Company (Breen Holdings)*

*Toni Worthing – Continental Carbon Australia*

*Michele Cassidy – Sydney Water*

*Ross Blancato – Australand Holdings*

*Gary Blaschke – Botany Bay and Catchment Alliance*

*Amy Lehoczky and Rod McCulloch – Energy Australia*

*Matt Gencur – Caltex Oil*

*Dr Michelle Christy – GGBF researcher - Kurnell*

*Mr Eric Le Provost – former Manager Kurnell Landfill*

*Associate Professor Michael Mahony – University of Newcastle*

*Dr Allen Greer – former Head Herpetology and Principle Research Scientist - Australian Museum*

*Dr Ann Goeth, Louise Feltus, Debbie Andrew, Geoff Ross and Marion Traynor – Department of Environment and Climate Change*

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