

# The Green and Golden Bell Frog Key Population in the Upper Hunter



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**Cover photograph:** Satellite image of the Upper Hunter Region (Courtesy - Google Earth)

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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 (Figure 1). 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 splotched 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*.

As a consequence of being listed as a threatened species under both state and national legislation a draft recovery plan has been prepared for the GGBF (Department of Environment and Conservation 2005). Also, consideration needs to be given to the species when assessing the impacts of developments and activities on populations of the species and its habitats. 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 Upper Hunter Management Plan

This Management Plan relates to the Upper Hunter Key Population located in the Hunter 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*. Recovery Plan Action 11.3.4 and Priority Action Statement (PAS) Action 21 for the GGBF call for the NSW Department of Environment and Climate Change (DECC) to 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, residents and other private land owners) 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 GGBF Recovery Plan, and these are further satisfied by the implementation of this plan.

The Hunter-Central Rivers Catchment Management Authority (HCRCMA) Draft Catchment Action Plan (CAP) identifies Threatened Species, "WM Target 04 -

threatened species conservation”, as a particular priority. The development and implementation of this Management Plan will also contribute to the implementation of the above, and other, CMA CAP targets.

There is also a requirement under the *Local Government Act 1993* for local councils to develop and implement Management Plans, where GGBFs occur on public land under their care, control and management. It is therefore envisaged that this Management Plan will satisfy such a requirement of Singleton and Muswellbrook Shire Councils (with respect to the Upper Hunter key population components that may occur on public land). This Management Plan is also intended to provide guidance, direction and coordination for other stakeholders and/or land owner/managers within the Upper Hunter where the frog and/or its habitat occur.

### **Purpose**

The Upper Hunter GGBF Management Plan has been prepared to ensure that the Upper Hunter key population is successfully managed and monitored such that the species continues to persist at the location 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 in the Upper Hunter.
2. To manage the species in accordance with the strategies outlined within the draft GGBF Recovery Plan.

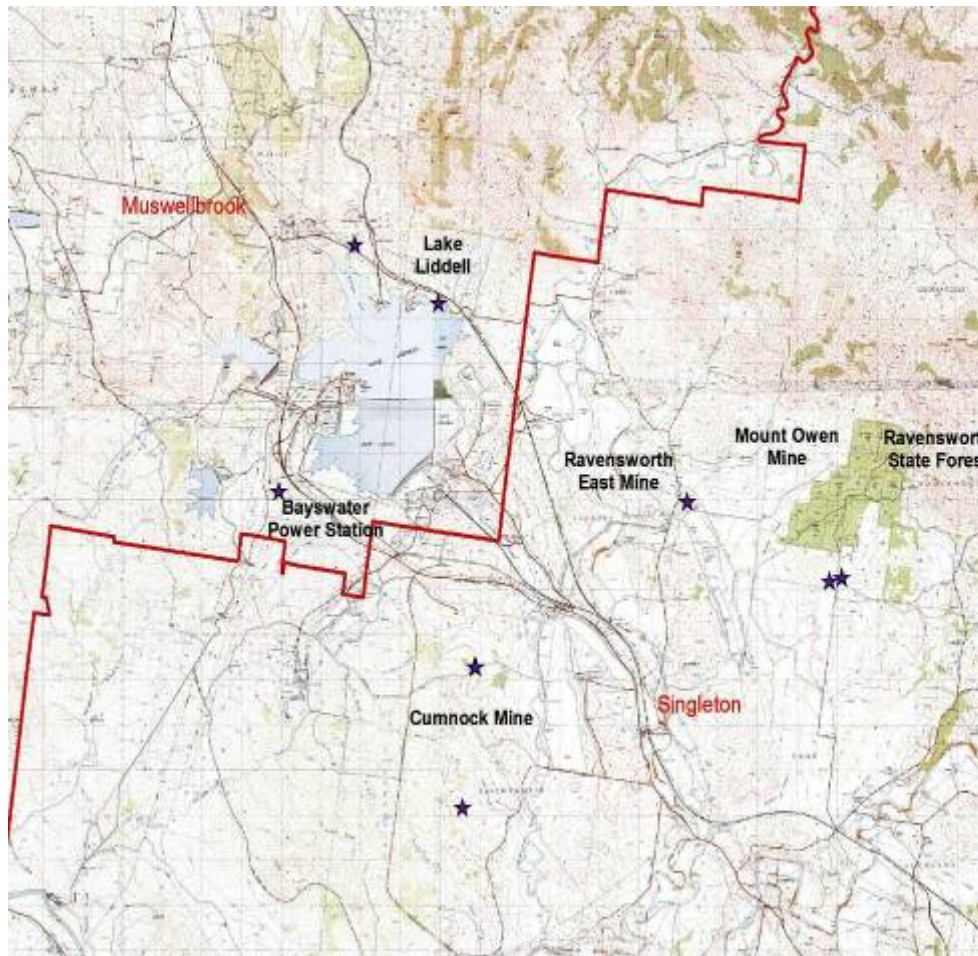


**Figure 1.** *Green and Golden Bell Frog.* Photo ©Garry Daly.

## THE UPPER HUNTER POPULATION

### Location

The Upper Hunter GGBF Key Population is located (see map below) approximately 90 kilometres northwest of the Newcastle CBD, between the settlements of Singleton and Muswellbrook (32° 23' S, 151° 02' E). It is situated in the upper parts of the Hunter River catchment and is one of only two inland populations of the species remaining extant. It consists of one main diffuse population at, or in the vicinity of, the Ravensworth and Liddell areas and also incorporates bordering areas of Muswellbrook and Singleton Shire Councils.



**Figure 2.** Map of the Upper Hunter showing the location of all recorded sightings of Green and Golden Bell Frogs (these records include both historic and contemporary observations from the 1970s to the present).

The Hunter River Valley is one of the largest eastern flowing river systems in the state and represents a unique landscape in NSW because the large valley crosses a low and gentle, rather than steep and mountainous, divide. The relatively dry Hunter 'corridor' created by this valley forms a passage from coastal to inland parts of NSW and likely forms (or at least previously formed) a pivotal corridor between coastal and inland populations of the GGBF, as well as for populations of many other species.

The Upper Hunter Key Population incorporates the upper Hunter River and its tributaries and is included within the Singleton and Muswellbrook Local Government Areas (LGA). The known records of this population occur on private lands that

include current coal-mining and pastoral lands as well as state-owned lands such as power generation facilities, council land and NSW Department of Primary Industries (DPI) lands in the now decommissioned Ravensworth State Forest. Previously, GGBFs have been found associated with drainage features of the Hunter Valley and its tributaries as well as farm dams, Sewage Treatment Plants (STPs), bunded areas, on roads next to creek crossings, close to water bodies near open cut coal mines and adjacent to artificial water bodies associated with Power Stations. Owners, managers or operators of lands in the vicinity of where GGBFs or their likely habitat have been found, in the Upper Hunter, include:

- Macquarie Generation (Liddell and Bayswater Power Stations)
- Xstrata Coal (Ravensworth West, Ravensworth East, Cumnock and Mt Owen Coal Mines) – formerly, in part, Hunter Valley Coal Corporation
- Lake Liddell Trust
- Singleton and Muswellbrook Shire Councils
- Hunter-Central Rivers Catchment Management Authority (HCRCMA)
- Thiess (as managers/operators of some of the implicated coal mines)
- NSW Department of Primary Industries (DPI) (Forests NSW) as a former land owner/manager and ongoing stakeholder of Ravensworth State Forest lands and also DPI (Mineral Resources) as lead agency administering mine operations.
- Coal and Allied (Rio Tinto Coal) as owner operator of Hunter Mines
- Hunter Water Corporation (HWC)
- Australian Rail and Track Corporation (ARTC)
- NSW Department of Lands (Crown lands)
- Private rural landowners

The Upper Hunter GGBF Key Population is known from approximately eight verified locations (see Fig 2.) and has an assumed diffuse distribution across lands encompassed by these locations. It is often absent from certain habitat components for several years before it re-appears, probably caused by climatic circumstances and/or seasonal life cycle changes of the species. Consequently, given its declined status and above factors, the population is now only sporadically located at any given site. Hence, there is currently no known 'centre' of distribution, but merely a general area containing various habitat components. However, overall, too little information exists on the status of the species in the Upper Hunter area, and the population is therefore in urgent need of concerted targeted survey efforts and habitat assessment during suitable seasons and climatic conditions.

### **Habitat**

The upper Hunter River catchment is generally a rural landscape, with some urban population centres such as Muswellbrook and Singleton, and numerous towns and hamlets dotting the landscape. As such, much of the land is or at least has been utilised for grazing purposes with some small cropping and timber operations in the general vicinity. A substantial and increasing area is also utilised for electricity generation and open-cut coal mining. Over 20 of the world's largest coalmines and the largest electricity generator in Australia are located in the Hunter Valley.

The composition and structure of the area's native vegetation has been profoundly altered since European settlement. Indeed, 99 per cent of remnant native vegetation on the valley floor between Muswellbrook and Branxton has been removed or altered since pre-European times. Recent efforts to map remnant vegetation provide some insight into these pre-European vegetation patterns. The vegetation communities are primarily open forest, woodland, grassland, floodplain (river red gum and river oak

dominated communities and undulating areas adjacent to the floodplain) and wetland associations. The GGBF population utilises these latter habitats, however it is not confined to these remnants and has survived in the area by using more open grassland vegetation and local features including:

- Breeding habitat e.g. in permanent water bodies such as some of the over 10,000 farm dams present in the vicinity (a portion of which would be ephemeral), or industry waterbodies, such as the Bayswater Power station sewage treatment plant (STP) polishing ponds and the margins of lake Liddell. More ephemeral breeding habitat such as ponds, dams and scrapes in open pastures that fill after heavy rain fulfill this habitat requirement also. Most of these habitat areas are human constructions made for purposes other than as frog habitat. Some 40 years ago, the species mainly used more permanent water bodies for breeding, but today it appears to breed predominantly in ephemeral habitat.
- Foraging habitat: Areas of native or introduced grasses, tussock vegetation and emergent sedges and reeds such Cumbungi (*Typha* sp.) and *Juncus acutus* have been identified as important foraging habitat in the Betty's Creek catchment. Vegetated dams or ponds (farm or industry) and creeks not subject to cattle grazing also provide this habitat element in the Upper Hunter. These areas are vital for the GGBF to feed in relative safety from predators and for basking in the sun by day.
- Shelter habitat, includes similar vegetation to that used for foraging and, most particularly, rock piles, ground timber, tussock forming vegetation and other features that are difficult to categorise (e.g. crevices and earth cracks, around root systems of plants and under ground debris). Rocks and rubble piles have been provided as part of some recently created habitat at the Mount Owen complex. These areas were created as a trial and to offset the loss of substantial areas of potential shelter habitat and much of the Betty's Creek Catchment that are in the process of being removed by the mine's extension.
- Movement habitat, generally typified by wet areas such as creeklines, drains, periodically damp areas, connecting or partially connecting vegetation, easements, and even open areas that do not restrict movement. Movement habitat exists in most areas, but its suitability is often limited due to prevailing drought conditions in the valley. Where the frogs do move within the area, they presumably do so along drainage lines or after rain, using periodically damp areas.
- Over wintering habitat - some of this habitat is most likely similar to shelter habitat, such as rock and rubble piles, ground timbers and logs and dense tussock vegetation. Fallen timbers in the Betty's Creek and adjacent catchments may provide this habitat function. A gravel quarry 3 km southeast of Mount Owen also has extensive strewn rock features that could be selectively utilized as over wintering habitat. There is evidence that males and females may differ in their selection of over wintering habitat and may seek to shelter in differing areas, though this is poorly understood. Habitat features known to be used for over wintering include sites such as amongst boulders, inside logs, amongst overgrown or dense, moist or tussock vegetation and even in sympathetic residential gardens. Note, the species has been previously recorded practicing communal aggregation as an over wintering strategy.

## Species Status

It appears that the Hunter Valley serves as a corridor for GGBF in two ways. First, as a north south coastal connection between populations, and second, as a western connective link (the *'Hunter Corridor'*) between coastal populations and those that, at least historically, occupied habitat further inland on the central tablelands. This assumption is supported by the distribution patterns of a variety of other frog, reptile and other fauna species.

Today, the former widespread Hunter distribution of GGBFs has contracted to only four known areas that are identified in the draft GGBF Recovery Plan as Key Populations of the Hunter Region.

These populations are at:

1. Kooragang Island;
2. Sandgate/Hexham Swamp;
3. Gillieston Heights/Ravensdale, north-west of Newcastle; and
4. Ravensworth/Liddell (the focus of this plan).

Up until the early 1970's the GGBF was a common feature throughout the Hunter Valley region. Vast populations inhabited swamps in areas around Maitland, Singleton, Broke and Lake Liddell. From about the mid to late 1970s, the population declined dramatically with only few records from the north and northwest foreshores of Lake Liddell.

In 1994, GGBFs were 'rediscovered' when several adult males were heard calling within Betty's Creek catchment during fauna surveys undertaken as part of the proposal to commence operations at the Mount Owen coalmine. The species was again detected in 1996, 1997 and 1999 on the same creek system, but none of these surveys detected more than three individuals, and only once was a fully mature specimen observed. Since then, no further records exist from that site. In 1997, three sub-adult specimens were removed from the original 1994 Betty's Creek site for captive breeding purposes, but these later succumbed to infection by frog chytrid.

The last confirmed records in the area are from the Bayswater Power Station STP polishing ponds, where a small colony of 4-5 adults, and some dozen juveniles and tadpoles were observed. In 2000, approximately 10 male GGBF were recorded in a slightly saline dam created by subsidence at Cumnock No.1 underground coalmine.

In addition, two unconfirmed or anecdotal observations exist from Main Creek (east of Betty's Creek on Xstrata Coal land at, Mount Owen) in 2005, and from the north-western shore of Lake Liddell in 2006. Other records also exist for the Ravensworth East coalmine and for the foreshores of Lake Liddell although the number of individuals detected is not known. Verification of all these observations is a high priority.

Above average rainfall during December 2002 and November 2003 did not correlate to GGBF presence in the Betty's Creek catchment and surrounding Mount Owen lands, despite high abundance and diversity of other frog species during this time. This could be taken as a further indication of GGBF decline in the upper Hunter. It may also indicate that, despite the high rainfall, the habitat having suffered extensive degradation during extended rainless periods and simultaneous cattle grazing may not have recovered sufficiently for the GGBF to return.

GGBF tracking conducted by researchers at the University of Newcastle found that the tagged GGBFs did not venture further than Betty's Creek catchment. The pending loss of the three recognised Betty's Creek GGBF habitat sites during the Mount Owen mine extension, adds further cause for concern for the species status in



the Mt Owen area. Habitat creation offset trials may have some success prior to these habitat areas being lost as the mine area extends across Betty's Creek. This element of the population may also make shifts outside Betty's Creek and into the Main Creek catchment to the east.

The primary concern regarding the Ravensworth/Liddell GGBF population in the Upper Hunter is its currently unknown population status and location. However the GGBF is a species that can be difficult to detect. Consequently, there has been regular conjecture as to whether the Upper Hunter population is still extant each time a significant period elapses between observations. The transient nature of appearance and disappearance is a known trait of the species that has been observed at other key population sites. Consequently, and despite the paucity of recent records, it is herein assumed that the population is still extant and merely occupying other components of the extensive potential habitat areas existing in the upper Hunter Valley. The resolution of the status of this population is a high priority.

All confirmed records in recent times detail only low numbers of adult individuals. Also, tadpoles have only been observed in one instance. Consequently, NSW DECC recognises this population as one of high conservation concern and a priority for conservation efforts. The conservation of this population is also important because it is one of only two inland GGBF populations surviving and could thus provide insights into the factors causing decline in other inland populations.

## THREAT ASSESSMENT

The major factors that potentially threaten the Upper Hunter GGBF Key Population are small population size, loss of habitat, habitat degradation, and disease. An outline of all identified threats to the Upper Hunter Key Population are detailed below.

1. Small population size - The current small population size leaves it vulnerable to stochastic and catastrophic events that might otherwise, with more robust population size, be overcome. The lack of genetic diversity, in small or large populations, may also be a significant threat.
2. Loss of habitat - The severe drought prevalent to some extent during the last 15 years and ongoing is placing continued pressure on the GGBF population through loss of vegetation cover. The GGBFs occupy and utilise a wide variety of habitats across varying land tenures in the Upper Hunter. Despite reasonable offsetting measures, the continued expansion of existing coalmines and the opening of new mines is removing further potential and actual GGBF habitat. In previous habitat creation offsets for the species, proving functionality of created GGBF habitat has been difficult although a requirement in recent development related offsetting. Habitats created as a development offset do not equate to totally natural habitat but may nevertheless be utilized by the frogs. Future proposals for rural-residential subdivision and new rail spurs in the upper Hunter have the potential to remove further GGBF habitat.
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 is thought to be widespread in the Upper Hunter population.
4. Habitat degradation - The species is threatened by cattle using its waterbodies. Cattle trample down frog habitat, forage in the frogs' riparian shelter vegetation (such as Cumbungi) and pollute waterbodies with excrement and through increased turbidity.
5. Water quality - Runoff from the largely deforested catchment is likely to be high in phosphorus, sediment and faecal loads. This is further exacerbated after extended periods of drought or near drought conditions when vegetation cover has been lost or reduced. Stormwater, leakages, and spillages may also have an impact on the species due to the GGBFs use of human-created waterbodies or in occupying areas near human activity including heavy industry and STPs. Fall out in suspension or solution from industrial stacks may also pollute GGBF habitat including wetlands and drainage areas. Recent reports of high selenium and sulfuric acid from the Bayswater Power Station could have an influence on the occurrence of GGBF if these substances are entering the environment. Paradoxically they may also be contributing to attenuation of frog chytrid pathogens at the same time, this is indeed an area worthy of further investigation.
6. Introduced predators that include:
  - Plague Minnow – *Gambusia holbrooki* (predation by *G. holbrooki* is listed as a Key Threatening Process) is present in Glennie's Creek catchment and many other water bodies and stream systems in the upper Hunter River catchment. This species feeds on GGBF tadpoles.

- Carp (*Cyprinus carpio*) and Goldfish (*Carassius auratus*) are both regularly released into farm dams. Both species will feed on GGBF tadpoles, metamorphlings and possibly also small adults.
  - The European Red Fox - *Vulpes vulpes* (predation by the European Red Fox is listed as a Key Threatening Process for a number of threatened species) is known to inhabit the entire Hunter Valley. It is also known to feed on adult frogs.
  - Feral and Domestic Cats - *Felis catus* (predation by the Feral Cat is listed as a Key Threatening Process) are also widespread in the area. They too are likely to feed on adult frogs.
7. Native predators - Predation on the GGBF by native predators may also be considered a threat to the species where populations have declined to small size and are no longer robust. Native predators in various locations may include Eels *Anguilla spp.*, Red-bellied Black Snake *Pseudechis porphyriacus*, Eastern Tiger Snake *Notechis scutatus* and Ibis *Threskiornis spp.*, along with other wader bird and snake species that will vary by locality.
8. Anthropogenic climate change (Listed as a Key Threatening Process) - May result in changes to rainfall patterns that would most likely influence the GGBFs ability to utilise certain sites for breeding. For example, drought may prevent the species breeding in ephemeral waterbodies and permanent waterbodies may be unavailable due to other KTPs. Long term reduction of rainfall may therefore reduce recruitment and lead to population decline or collapse at some sites. This may be especially the case where populations are represented only by mature adults due to previous repeated breeding failures and lack of recruitment. Resultant senescent populations may then be unable to recover even when/if conditions do become suitable.

## MANAGEMENT ACTIONS

### Strategic considerations

The primary strategic issue that needs to be considered when managing the GGBF in the Upper Hunter is the unknown population status and its extent. As discussed previously, no confirmed records exist for the upper Hunter River past the year 2000 despite habitat creation initiatives and some above average rainfall years. However, the three sites where GGBF were recorded most consistently in recent years, all within Betty's Creek catchment, are to be lost through mine extension. Other areas have not been surveyed sufficiently, and it is also important to take into account the large area of potential habitat in the Upper Hunter Valley. Hence, while current records indicate that the species has declined seriously in the area, further surveys are necessary to confirm this presumed trend. As a consequence, all future management activities are dependant on determining population status and location. That is, there is little point in, for example, creating large areas of additional habitat or conducting expensive community education programs if the population is not extant in the area.

Despite the best of intentions to create or enhance habitat for GGBF it seems such endeavours can also be victims of drought, which leaves waterbodies dry for large parts of the year. For example, the habitat ponds created as an offset to the Mount Owen mine extension were dry for a period of 12 months after their construction. Thus it would be prudent to ensure that the creation of GGBF habitat is followed by adequate provisioning of water, even human-sourced if needs be.

GGBF habitats at Cumnock No. 1 coalmine and at Bayswater Power Station have not been professionally surveyed in recent years. It is known that a breeding event did occur in the polishing ponds of the Bayswater Power Station's STP and thus at some point, if not currently, this habitat was suitable for breeding. Survey of historic and recent GGBF habitat is imperative in any future management actions.

The certain continuation of coal mining operations, including mine expansion and opening of new mines, in the Upper Hunter could provide further opportunities for GGBF conservation initiatives. In addition, towards the closing stages of mining operations, mining companies are required to produce some rehabilitation initiatives in their 'Mine Closure Plan'. Given that much of the floodplain and wetland features associated with the upper Hunter River and its tributaries were former GGBF habitat, and numerous coal mines are at different stages of development or rehabilitation in the area, it would be useful and desirable to incorporate some form of GGBF habitat creation as part of these mine closure plans.

At this stage, captive breeding and reintroductions cannot be considered, due to the lack of local provenance specimens to be reintroduced. Frogs removed from Betty Creek (Mt. Owen) in 1997 did not survive in captivity. As the "*Mount Owen Coal Mine Fauna Monitoring*" report states, the captive breeding program is suspended due to lack of frogs. Thus any captive breeding efforts, of local provenance stock, are solely reliant on determining the Upper Hunter GGBF population status and extent. If the population is of sufficient size to extract individuals or to collect tadpoles then captive breeding efforts should recommence. Such captive breeding and reintroduction, either as part of mine consent or as additional research trials, would require extensive liaison and associated licensing from DECC.

The absence of GGBFs in seemingly suitable habitat is a continuing conundrum, and debate continues as to why this is so. Researchers at the University of Newcastle propose 'sensitive endpoint' studies to confirm what is actually 'wrong' with the large areas of potential habitat, i.e. why aren't GGBF inhabiting an area that was formerly their habitat? The re-introduction of GGBF into an area (if no local population is found) and subsequent experiments could help to explain why GGBF have disappeared from the Upper Hunter. Such studies could potentially be outside the scope of this site-specific management plan but indeed are worthy of further research perhaps at a state-wide level.

### **Planning process**

This Plan builds upon a range of past and current actions to manage the GGBF populations and habitat in the Upper Hunter Valley. Such actions listed below are not usually coordinated or integrated in any particular fashion. This plan aims to coordinate and integrate further actions to most effectively use time and resources available for GGBF conservation.

Local actions to manage the species include:

- Xstrata Coal has constructed exploratory GGBF habitat leading up to the excavation and diversion of the original Betty's Creek catchment which contains GGBF habitat in the Mount Owen Coalmine extension area. This was done to 'coax' GGBFs to sites where they can be detected as well as a compensatory habitat measure being part of the development consent for the mine upgrade. Soaks, scrapes and dams supporting emergent reed vegetation were constructed, with surrounding rubble/logs as foraging, shelter and possibly over wintering habitat. Construction of this new habitat has only just been completed, and it is yet too early to determine whether this will be successful but may require a water provision strategy.

- Xstrata Coal, as part of an additional offset, has undertaken enhancement of dams and riparian areas through the placement of rock rubble and timber to provide diurnal shelter for frogs.
- Xstrata Coal, as another part of their development consent, have employed environmental consultants to conduct ongoing research and monitoring of the local GGBFs since 1996. This has included providing direction to Xstrata Coal on the creation of suitable GGBF habitat and enhancements as described above.
- Xstrata Coal initiated a captive breeding program when three juvenile GGBF (one female, two males) were obtained from the Betty's Creek catchment during October 1997 and were raised to adults. However, breeding was unsuccessful and all three frogs died in captivity from chytrid infection. Since then the captive breeding program has been suspended due to a lack of source frogs and would require more expansive facilities and management if continued in the future.
- Macquarie Generation has adapted their maintenance schedule at Bayswater Power Station so as to clean their ten polishing ponds one at a time. This should minimise disturbance to possible GGBF individuals and the habitat being utilised.
- The National Parks and Wildlife division of the DECC conducts annual fox baiting programs in all its Hunter reserves. However, efforts to coordinate fox baiting programs on public and private lands, as has occurred to some extent in the past, should continue and aim to extend the areas of fox management.

A stakeholder workshop was facilitated by consultants Molino Stewart Pty Ltd to identify the above and other possible management initiatives as a basis for preparing this plan. The workshop was held on 20 March 2007 with representation from:

- Singleton and Muswellbrook Councils
- Department of Environment and Climate Change (DECC)
- Macquarie Generation
- Xstrata Coal
- University of Newcastle (Researchers)
- Hunter Environment Lobby
- Hunter Region Landcare Network
- Lake Liddell Trust

This plan was then distributed in draft form for comment to these and other stakeholders including the Hunter-Central Rivers Catchment Management Authority (HCRCA), Roads and Traffic Authority (RTA), Dungog, Singleton and Muswellbrook Councils, the Department of Primary Industries Forests and Minerals and Petroleum Divisions, Ecotone Consultants, Thiess/Xstrata, the Australian Rail and Track Corporation (ARTC) and representatives of relevant community/environment groups including Hunter Environment Lobby and Hunter Region Landcare Network.

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

## Objectives

The four objectives of the Upper Hunter GGBF Management Plan are as follows:

1. To determine GGBF population status and location;
2. If required, maintain existing GGBF key population elements and enhance existing GGBF habitat and thus the likely measures of population viability for this Key Population;
3. If required, to increase connectivity within the Key Population; and
4. If/when individuals are located from this population develop a captive breeding program at a recognised facility for the purposes outlined herein and within the draft recovery plan.

## Strategies

Given the unknown population status the following six strategies will be used to achieve these objectives:

1. Monitoring and research to better understand the extent and dynamics of the Upper Hunter GGBF population;
2. Further development of GGBF breeding and other habitat components on public and private lands;
3. Improvement of habitat within the GGBF key populations;
4. Education and communications to build awareness of the GGBFs and encourage further on-ground actions and observation/detection of the species;
5. Reduction of external threats to GGBFs; 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 end mid 2010

## Implementation plan

The following implementation plan provides a framework for management actions related to the above strategies and the draft GGBF Recovery Plan. It describes the actions in a priority-based order, linked to the draft Recovery Plan and GGBF Priority Action Statement (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 reference to the draft GGBF Recovery Plan.

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

## IMPLEMENTATION PLAN

ACTION	RECOVERY PLAN LINKS	PAS LINKS	RESPONSIBILITY	COST*	FUNDING SOURCES	TIMEFRAME
1.1 Systematic survey of historic and recent GGBF habitats, including Bayswater Power Station lands, Cumnock No. 1 coalmine, Betty's Ck catchment and surrounds, Ravensworth East coalmine, and Lake Liddell foreshores.	Action 12.3.1	11, 31	University of Newcastle, Macquarie Generation Xstrata Coal/Thiess, NSW DECC	< \$20,000	NHT, Sponsorship, Industry, Research funding	August 2007 – March 2008; August 2008 – March 2009; August 2009 March 2010
1.2 Community surveys in the form of circulated brochures to supplement expert GGBF surveys in Action 1.1. Brochures to include a sighting hotline number, GGBF descriptions and photos, expert contacts, and details of an official reporting mechanism. To be implemented in warmer months when GGBF are active.	Action 14.3.2	25, 31	Singleton and Muswellbrook Councils, Hunter Region Landcare, NSW DECC	< \$10,000	NHT, Environmental Trusts, CMA, TSN	Mid 2007 distributed at beginning of each activity season.
1.3 A community reporting mechanism to be developed (link with Action 1.2). This could be the DECC Enviroline 1300 361 967 or <a href="mailto:Info@environment.nsw.gov.au">Info@environment.nsw.gov.au</a> but forwarding procedures would need to be established internally by DECC and with instructions on the data/info to be recorded.	Action 14.3.2	4	Singleton and Muswellbrook Councils, NSW DECC, Community Groups	< \$3000	DECC In-kind	2007
1.4 Further opportunistic surveying based on sightings originating from community surveys (link with Action 1.2) and likely habitat such as that at Lake St Clair.	Action 12.3.1	8	University of Newcastle	< \$8000	Sponsorship, TSN, Research funding	August 2007 seasonally ongoing

\* Costs are indicative only and subject to available funding

ACTION	RECOVERY PLAN LINKS	PAS LINKS	RESPONSIBILITY	COST*	FUNDING SOURCES	TIMEFRAME
1.5 Encourage Councils to require surveys in areas of known or potential habitat (e.g. Lake Liddell and Clifftleigh areas) as part of the development assessment process in the upper Hunter	Action 12.3.1	11, 31	Muswellbrook Shire Council, NSW DECC, University of Newcastle, ARTC	< \$7000	Development driven, in-kind; statutory responsibility	As required in appropriate season/weather
1.6 Community education program, through existing media (local newspapers, newsletters, industry circulars) or brochures that highlight GGBF significance (link to 1.2).	Action 14.3.1	33	Singleton and Muswellbrook Councils, NSW DECC, HCRCMA	< \$3000	In-kind	2007 and just before each activity season
1.7 Guidelines for the creation of GGBF habitat are to be developed. These should be formulated from existing trials and other information, and supplied to relevant stakeholders when needed. Where possible regionally specific requirements/considerations should be included in the guidelines.	Action 11.3.3	20	University of Newcastle, HCRCMA, NSW DECC, consultants	< \$5000	DECC, NHT, CMA, Env. Trust	2008
1.8 Lake Liddell Trust to liaise with University of Newcastle regarding provision of advice/guidance on habitat creation for the GGBF and habitat rehabilitation activities on their land (in the interim period before completion of Action 1.7).	Action 11.3.3	9	Lake Liddell Trust, HRLN, University of Newcastle, Dept. of Lands	Minimal	In-kind	
1.9 GGBF monitoring to occur at Bayswater Power Station STP before future maintenance of polishing ponds proceed and in accordance with Macquarie Generations DECC scheduled premises licence.	Action 12.3.1	21	Macquarie Generation University of Newcastle NSW DECC	minimal	Macquarie Generation	2007-ongoing



<b>ACTION</b>	<b>RECOVERY PLAN LINKS</b>	<b>PAS LINKS</b>	<b>RESPONSIBILITY</b>	<b>COST*</b>	<b>FUNDING SOURCES</b>	<b>TIMEFRAME</b>
1.10 To ensure that maintenance or modifications of STP ponds at Bayswater Power Station continue to adopt a minimal disturbance policy in regards to GGBF habitat.	Action 10.3.1	21	Macquarie Generation NSW DECC University of Newcastle	< \$3000	Macquarie Generation	Ongoing
1.11 DECC will encourage DPI (Mineral Resources) to incorporate GGBF habitat creation initiatives into Mine Closure Plans in the Upper Hunter.	Action 11.3.3	9	NSW DECC, NSW DPI Minerals and Petroleum			
1.12 Construction of interpretive signs on Lake Liddell Trust land and at Lake St Clair. Signs to include 'to scale' GGBF photos and descriptions, and a hotline phone number to call for suspected sightings see Action 1.3).	Action 14.3.1	33	Singleton and Muswellbrook Councils, HRLN	< \$5000	HCRCMA, Councils, TSN	2008
1.13 Landholder education program to be targeted at graziers in and around Betty's and Main Ck catchments, and Lake Liddell, regarding reduction in cattle grazing of riparian zones (link to Action 1.6)	Action 14.3.1		DPI Agriculture, HCRCMA	Negligible	Recurrent funding salaries of extension/field officers	2008 - 2010
1.14 To ensure that GGBFs are included in development assessments in the Upper Hunter through appropriate information flows within the Council. The DECC will provide information to Councils to raise awareness of GGBFs and their management requirements in the upper Hunter	Action 11.3.1	5	Muswellbrook and Singleton Councils; DECC	Negligible	Statutory requirement	Ongoing

ACTION	RECOVERY PLAN LINKS	PAS LINKS	RESPONSIBILITY	COST*	FUNDING SOURCES	TIMEFRAME
1.15 Research to be conducted into evolutionary significance of Upper Hunter GGBF population eg its relationship to Lower and Middle Hunter populations. This would inform consideration of potential reintroductions from these populations if that proved necessary.	Action 12.3.2	26	University of Newcastle, Macquarie University	< \$4000	NHT, Env Trust	As required
1.16 Pending the redetection of the GGBF population at Mount Owen a captive breeding program will be re-established. Consideration should be given to utilising specimens from any upper Hunter GGBF population sub unit detected, for this purpose. (links to Actions 1.1-1.6 and 1.15 in particular).	Action 13.3.1	27	University of Newcastle; Australian Reptile Park, Taronga Zoo	To be determined	Xstrata as a condition of development consent.	As Required
1.17 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	15	All stakeholders	Negligible Cost	Stakeholder	Ongoing
1.18 Survey of GGBF habitat to identify where <i>Gambusia holbrooki</i> occurs and implement <i>Gambusia</i> Threat Abatement Plan to prevent further spread to unoccupied GGBF habitat and employ steps to eradicate where possible.	Action 11.3.2	6	Newcastle University, NSW DECC NSW DPI Fisheries	< \$10000	DECC/TAP, NHT, Env Trust, CMA	2008 -2009
1.19 Survey of potential GGBF habitat that <i>Cyprinus carpio</i> and/or <i>Carassius auratus</i> occupy and prevention of further spread to unoccupied habitat. (link to simultaneous action 1.18)	Action 11.3.2	3, 14	Newcastle University, NSW DECC NSW DPI Fisheries	See Action 1.18	DECC/TAP, NHT, Env Trust, CMA	2008-2009

ACTION	RECOVERY PLAN LINKS	PAS LINKS	RESPONSIBILITY	COST*	FUNDING SOURCES	TIMEFRAME
1.20 Control of feral predators (eg trapping and fox baiting) on Lake Liddell Trust (LLT) land and that owned by coal mining, power generation companies and rural land owners. Coordinate with baiting in NSW DECC Reserves.	Actions 10.3.1, 11.3.2	3	NSW DECC, DoL (LLT), HCRCMA, Macquarie Generation, Xstrata Coal and other landowners	Undetermined	DECC, NHT, Councils	2007-2010
1.21 In the case of no detection of an extant population in the upper Hunter by the end of 2010, consideration be given to reintroduction of GGBF into recent former habitat (fenced). This should be undertaken as an endpoint experimental process, to determine, the cause of disappearance. Provenance of stock to be used will be instructed by genetic study outcomes if possible (Action 1.15).	Action 12.3.2	26	University of Newcastle, Macquarie University DECC, appropriate site landowner(s).	\$15,000	Sponsorship, Industry, Research Grants, CMA	2010
1.22 Xstrata Coal and University of Newcastle to make gathered flora and fauna survey data available for interpretation of re ongoing management options.	Action 10.3.1		Xstrata Coal, University of Newcastle	Minimal	In-kind	2007
1.23 Explore possibilities of Upper Hunter GGBF content/link on an existing website/s (eg Landcare, Mining, NSW DECC and Amphibian Research Centre websites).	Action 14.3.1	24	NSW DECC, HRLN, HCRCMA	< \$5,000	NHT, CMA, Sponsorship or 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 provided in the inside cover of this plan.

## 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. The detailed procedures and measures 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 includes: 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.

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*Dr Michael Mahony and Dr John Clulow - University of Newcastle*

*Rodney Parker-Wright – Hunter Region LandCare Network and herpetologist*

*Pierre Louys - Hunter Region LandCare Network*

*Garry Daly - Consultant (Gaia Research), herpetologist*

*Neil McElhinney - Herpetologist*

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*Sean Trebley – Environmental Officer, Bayswater Power Station - Macquarie Generation*

*Jan Davis – Hunter Environment Lobby*

*Richard Wells – Herpetologist*

*Glenn Lyons – Hunter-Central Rivers Catchment Management Authority*





*Dr Ann Goeth, Dr Nick Sheppard – Department of Environment and Climate Change*


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### Appendix 1 - - Photos of some of the locations referred to in this Management Plan

	
<p>Mac. Gen. STP polishing ponds at Bayswater (photo S. Trebley )</p>	<p>Mac. Gen. STP polishing pond at Bayswater (photo S. Trebley)</p>
	
<p>Site of unconfirmed GGBF record in Main Creek Catchment, 2005 (photo J. Clulow &amp; M. Mahony)</p>	<p>Site of 1999 GGBF record in Betty's Creek catchment (photo J. Clulow &amp; M. Mahony)</p>
	
<p>Strata Pond '2 in northern offset zone prior to habitat enhancement (photo J. Clulow &amp; M. Mahony)</p>	<p>Xstrata habitat pond 2 in northern offset zone following modification (photo J. Clulow &amp; M. Mahony)</p>

	
<p>Xstrata Pond 1 in southern offset zone prior to habitat enhancement (photo J. Clulow &amp; M. Mahony)</p>	<p>Xstrata habitat pond 1 in southern offset zone following modification (photo J. Clulow &amp; M. Mahony)</p>
	
<p>Created habitat showing more extensive aquatic vegetation (Pond 2) (Photo J. Clulow &amp; M. Mahony)</p>	<p>Close up of rock/rubble piles on Xstrata created GGBF habitat (Pond 3) (photo J. Clulow &amp; M. Mahony)</p>
	
<p>View of the Cumnock coal mine showing general site features (Narawan Williams)v</p>	<p>GGBF specimen photographed at Cumnock coal mine (Narawan Williams)</p>