

The Green and Golden Bell Frog Key Populations in the Lower Hunter



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Cover photograph: Aerial Photograph of the Hunter Estuary including Hexham Swamp and Kooragang Island

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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 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*.

The consequences of being listed as a threatened species under both state and national legislation has been that a draft recovery plan has been 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, the draft NSW recovery plan for this species will be finalised.

The draft Green and Golden Bell Frog Recovery Plan defines Key Populations as important 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 Lower Hunter Management Plan

This Management Plan relates to the Kooragang Island and Sandgate/Hexham Swamp Key Populations located in the Hunter Green and Golden Bell Frog 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 Recovery Plan that was developed in accordance with the *Threatened Species Conservation Act 1995*. Action 11.3.4 calls 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) 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 which are further satisfied in part by the implementation of this plan.

Under the Hunter-Central Rivers Catchment Management Authority (HCRCMA) Draft Catchment Action Plan (CAP) "Threatened Species WM Target 04 - threatened species conservation" is of particular priority. This Management Plan addresses aspects of the above section of the CAP and implementation of this plan will further assist the Hunter-Central Rivers CMA meet this and other related 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 this requirement of Newcastle City Council (with respect to the Lower 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 Lower Hunter where the frog and/or its habitat occurs.

Purpose

The Lower Hunter GGBF Management Plan has been prepared to ensure that the Lower Hunter population is successfully managed and monitored such that the species continues to persist in the Lower Hunter and that 'measures' of the two populations' 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 Lower 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 LOWER HUNTER POPULATION

Location

The Lower Hunter estuary contains two key populations of the endangered GGBF. These populations are contained within an area centred approximately seven kilometres northwest of the Newcastle CBD ($32^{\circ} 52' S$, $151^{\circ} 41' 58 E$) - see circled area in Figure 2 map below. The GGBFs within this area are divided into two Key Populations:

1. Kooragang/Ash Island; and
2. Sandgate/Hexham Swamp

The above populations, whilst separated by only a small distance, are considered separate Key Populations as defined in the draft GGBF Recovery Plan because of the presence of the tidal south arm of the Hunter River as a significant geographic barrier. Future investigations may result in the redefinition of these Lower Hunter Key Populations conservation units.

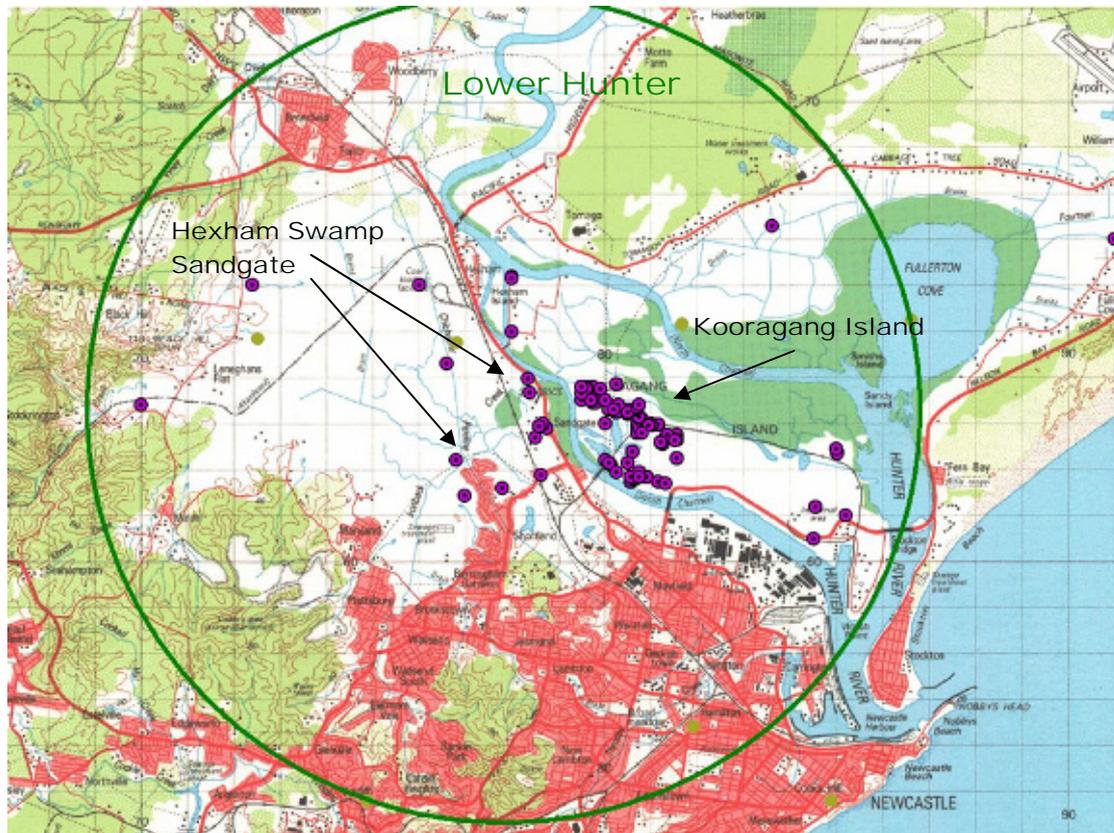


Figure 2 Map of the Lower Hunter showing the location of all recorded sightings of Green and Golden Bell Frogs

In the Lower Hunter, GGBFs are found on publicly and privately owned lands. Kooragang Nature Reserve occupies the north and north-east of the island, whilst Hexham Swamp Nature Reserve lies directly west of the island on the mainland. The Department of Environment and Climate Change (DECC) manages both nature reserves. The majority of the GGBF population on Kooragang Island occurs on land managed by either the Kooragang Wetland Rehabilitation Project (KWRP), HCRMA, Regional Land Management Corporation (RLMC) or DECC. Significant areas of known or potential GGBF habitat are also located on lands owned and/or

managed by a number of other organisations. These private companies, government authorities or groups with a controlling or regulating interest include:

- BHP Billiton
- Orica & Incitec Pivot
- Port Waratah Coal Services (PWCS)
- Roads and Traffic Authority (RTA)
- 2HD Broadcasters
- Broadcast Australia Pty Ltd
- Alinta/AGN
- Energy Australia
- Newcastle Coal Infrastructure Group (NCIG)
- Hunter Central Rivers CMA (HCRCMA)
- Kooragang Wetland Rehabilitation Project (lease holder)
- Department of Commerce/Crown Portfolio
- Australian Rail Track Corporation (ARTC)
- Kooragang Coal Loader Ltd
- Hunter Water Corporation (HWC)
- NSW Department of Environment and Climate Change (DECC)
- Newcastle City Council
- Hunter Wetland Centre
- Regional Land Management Corporation

Habitat

The lower Hunter estuary has typical delta geomorphology with estuary islands and a surrounding wetland mosaic. Much of the area has undergone major changes over the past 60 years brought about by activities such as timber cutting, grazing, dredging, channel construction, spoil and waste disposal, major flood mitigation works (diversions and flood gating) and industrial development (summary in Williams *et al.* 2000). As a result, the current landscape is a series of wetland fragments interspersed with industrial developments, pasture and suburban development. Nevertheless, GGBFs have survived by using such local features as:

- Breeding habitat associated with permanent water bodies such as ponds that have been formed for other purposes or even by accident or that may form along sections of roads, causeways and in the vicinity of other linear infrastructure features such as railway lines and access tracks. Other ephemeral breeding habitat is provided after heavy rain when grassy swale areas, ponds, drainage depressions and culverts are temporarily filled or through poor drainage retain water for extended periods. Some of these habitat areas may currently go unrecognised. Many of these features are human constructions made for flood mitigation or other purposes and often by accident and result in portions of a site becoming suitable in either a permanent or transient way for the GGBF.
- Foraging habitat, includes areas of native or introduced grasses, tussock vegetation and emergent sedges and reeds bordering water features. These areas are vital for the GGBF to feed in relative safety from predators and to bask in the sun by day. Researchers from Newcastle University have determined that in particular such plant species as *Juncus kraussi*, *Schoenoplectus subulatus*, and *Sporobolus virginicus* are indicators of habitat suitability for GGBFs. These plants are usually indicators of brackish conditions, and further research thus needs to establish the levels of salinity tolerated by GGBF in this type of habitat.

- 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 (crevices in the ground, around root systems of plants and ground debris).
- Movement habitat, generally typified by wet areas such as creek lines, drains, periodic damp areas, connecting or partially connecting vegetation, easements, laneways and even open areas that do not restrict movement.
- Over wintering habitat. Some of this habitat is probably in common with shelter habitat such as rock and rubble piles, ground timbers, logs, in deep earthcracks and amongst 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 even in residential gardens.

Before substantial vegetation change in the nineteenth century, the Lower Hunter, including Kooragang Island, had extensive areas of saltmarsh and swamp forest communities (both saline and fresh/brackish) with the highest ground supporting patches of littoral rainforest (Winning 1996). The original swamp forest and littoral rainforest have been almost completely eliminated; the areas of saltmarsh have been significantly reduced, either by mangrove encroachment or conversion to agricultural land. Areas of freshwater wetland associated with floodplain features as well as an outer fringe to the fluctuating margins of more saline wetlands have also been dramatically reduced by development and these other modifying landuses. These areas would have formed a more significant area of habitat for the GGBF at earlier times.

Species status

Historically, the GGBF was a common and prolific feature of the various floodplain wetlands of the lower Hunter River estuary and its tributaries. The GGBF was commonly recorded in the areas around Shortland and in Hexham Swamp. The Hexham population has most recently manifested itself in a peripheral area to Hexham Swamp on the 2HD radio transmitter tower lands at Sandgate and the nearby former waste disposal facility lands. This population is not always detectable and there has been some conjecture as to whether it is still extant. Based on the somewhat transient nature of appearance and disappearance of the species at other sites it is herein assumed that the population is still extant and merely occupying other components of the extensive potential habitat comprising parts of the Hexham Swamp wetland. The resolution of the status of this population is a high priority.

A population is also known to have existed to the south in the Lake Macquarie LGA around Jewell's Wetland, Red Head Lagoon and Belmont Swamp, however none of the available anecdotal records are recent enough to suggest that this population is extant. To the north, an extensive area of potential habitat exists from Fullerton Cove and Tomago to Raymond Terrace and the Grahamstown Reservoir. Anecdotal records exist for various locations in this area. The only confirmed recent records are from Moffat's Swamp to the north of the area covered by this Management Plan. Other extensive areas of potential habitat also exist to the north of this management area at Racecourse Swamp and the Karuah wetlands. These areas fall outside the scope of this management plan.

Before more recent range contraction, the Hunter region, in addition to acting as a north south coastal connection between populations, is also thought to have acted as a western connective link (the '*Hunter Corridor*') between coastal populations and those further inland on the central tablelands.

This former distribution of GGBFs has now contracted to only four known centres of distribution that are identified in the draft GGBF Recovery Plan as Key Populations in the Hunter Region.

These populations are at:

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

In 1981, the GGBF was considered to be one of the most common frogs in the Lower Hunter Region. Twenty six years later only two populations remain, one at Kooragang Island and the other at Sandgate/Hexham Swamp. Considerable research has been conducted on the GGBF population on Kooragang Island and more recently at Sandgate on the edge of Hexham Swamp. Other GGBF populations may exist in what appears to be suitable habitat to the immediate north in the Tomago Wetlands area; however records of GGBF from this region are sparse, irregular or old. The extent of systematic survey effort is unknown and the area is worthy of further investigation.

The GGBFs oldest formal 'record' from Kooragang Island was in 1971 by Gosper (1975). However in the late 1960s and early 1970s, the GGBF was known to be very common in the eastern *Typha* swamp in the Kooragang Nature Reserve and the area where the 'BHP ponds' now occur. With the reduced frequency of major flood events due to flood mitigation structures and storage dams this population is now geographically isolated. Today, the tidal South and North arms of the Hunter River likely preclude interconnection and migration with the populations at Sandgate and any to the north in the Tomago wetlands. Furthermore, given the small size and poor measures of viability of the other remnant populations in the Hunter catchment, the GGBF population on Kooragang Island by comparison is much larger and more robust and so of major conservation significance to the species.

In the Lower Hunter, the GGBF also displays a trend, observed at other Key Population sites where the species manages to survive, occupying what appears to be less than 'ideal' habitat. Kooragang Island swale areas north of Creek 3 have become fresh or less frequently brackish due to reduced tidal flushing through restrictive narrow pipes at the mouth of the creek. During time of high rainfall, the swale areas are colonised by the GGBF and these swale areas are considered to be a critically important breeding habitat area for the GGBF on the island. It is possible that a similar situation may exist for parts of the Hexham Swamp area due to the flood gating and reduced tidal flushing of Ironbark Creek and areas of Hexham Swamp. The areas most likely to have become adaptively suitable for the GGBF due to the gating that has been in place since the early 1970s are at the peripheral margins of Hexham Swamp and/or along areas modified by roads, tracks, rail lines or other infrastructure development traversing the wetland.

On Kooragang Island research undertaken by Andrew Hamer during 2000-2002 found over 20 water bodies on Kooragang Island supporting GGBF colonies but with four of these designated active breeding sites. Three of these are on RLMC lands and another on private land – formerly BHP ponds (potentially affected by the proposed NCIG Coal Loading facility). Hamer's study found that generally the more ephemeral water bodies were the most successful breeding habitat after heavy rain, that the northern swale area was most often utilised after heavy rain events; and that protection of these breeding areas was fundamental to the species continued survival on Kooragang Island.

THREAT ASSESSMENT

The major factors that potentially threaten both the Kooragang Island and Sandgate/Hexham populations of the Green and Golden Bell Frog are habitat loss/modification, increased salinity from changed inundation frequency, predation by introduced pests, disease, and water quality.

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

1. Loss of habitat. The GGBFs occupy and utilise a wide variety of habitats across varying land tenures in the Lower Hunter. Proposed developments such as the \$800 million Newcastle Coal Infrastructure Group (NCIG) coal export terminal on Kooragang Island or the RTA upgrade of State Highway 23 between Shortland and Sandgate could affect both Key Populations. The SEPP 74 (Newcastle Fort and Employment Lands), in place over parts of Kooragang Island, and the fact that some GGBF habitat is zoned as industrial is a possible constraint to a number of potential GGBF conservation initiatives and available/possible offsetting initiatives. Developments in the future will continue to place pressure on the remaining GGBF habitat and connectivity between habitat areas.
2. Saline inundation. Increased salinity levels can pose a serious threat to GGBF populations. Current wetland rehabilitation projects have the objective of increasing available mangrove and saltmarsh habitat for marine life through removal or modification of flood mitigation and other structures. All necessary measures should be taken to ensure that GGBF is not negatively impacted upon by such activities. For example, the overflow of saltwater from Creek 3 during king tide events and potentially into the GGBF northern swale habitat adjacent to the creek, could pose a direct threat to this population and the critically important breeding habitat if current flow controls were removed. It is the intention of the plan developed by KWRP/CMA, RLMC and DECC that tidal flows not be increased until bunding between the northern and southern swales is in place to protect GGBF habitat (WBM 2004). These and all other measures taken in the future need to be conducted in a way that saline inundation of GGBF habitat is avoided at all costs.
3. Introduced predators that include:
 - Plague Minnow – *Gambusia holbrooki* (Listed as a Key Threatening Process). Kooragang Island is one of a few locations where Plague Minnow and GGBF coexist rather than result in complete disappearance of the resident GGBF population;
 - Feral and Domestic Cats - *Felis catus*;
 - The Red Fox *Vulpes vulpes* (listed as a Key Threatening Process for a number of threatened species).
4. Disease. Frog Chytrid 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 widespread on Kooragang Island and Hexham Swamp. The disease may be confounding positive outcomes from other conservation initiatives. Also it is emerging that occasional exposure to saline influences and/or certain contaminants may be attenuating the effects of the Frog Chytrid at certain locations. However, hypotheses supporting this scenario are presently being tested by M. Stockwell and M. Mahoney from the University of Newcastle.

5. Introduced plants. Ironically, possible removal of invasive plant species such as *Juncus acutus* coupled with the absence of appropriate native plantings to replace/offset the lost habitat these plants provide could result in loss of GGBF population elements, as may have occurred in GGBF habitat at Scott's Point in 1999.
6. Water quality. Stormwater and leakages, spillages, fall out in suspension or solution from industrial stacks from urban and industrial areas may pollute GGBF habitat such as wetlands and drainage areas. The dumping of waste in the vicinity of the Sandgate/Hexham population may also be affecting GGBF habitat.

MANAGEMENT ACTIONS

Strategic considerations

Coupled with the need to minimise the direct threats to the Lower Hunter populations is the challenge to increase connectivity within and around each population.

The Kooragang Island population extends across lands leased by the KWRP/HCRCMA, the Kooragang Nature Reserve and various lands owned by private stakeholders as discussed above. Each landholder maintains diverse management and development agendas with little or no co-ordination of activities that may affect the GGBF populations. Discussion and liaison amongst public landholders (DECC, KWRP/CMA, DOP), utilities (RTA, Alinta, ARTC) and industry (PWCS, NCIG/RLMC, BHP/Billiton, Orica etc) should be promoted as a matter of urgency and NSW Planning and NSW DECC should liaise to resolve approval requirements for pending developments (eg Lot 122 DP 874949 former BHP site).

A strategic and cooperative approach by various agencies could provide beneficial GGBF outcomes without compromising development outcomes. It is almost certain that some major developments will likely proceed in some form (despite conflicting with conservation concerns) via the pathway of 'state significance' or via mechanisms that place an onus on land owner/managers to negotiate appropriate concessions for offsetting or other compensation for the local GGBF population and its habitat.

In August 2003 the NSW Government gazetted *State Environmental Planning Policy No. 74 – Newcastle Port and Employment Lands* (SEPP 74). This SEPP was introduced with the stated aims of:

- (a) promoting and coordinating the orderly and economic development of certain land in the local government areas of Port Stephens and Newcastle;
- (b) promoting the economic development of the Port of Newcastle while promoting the conservation of natural and cultural heritage in the lower Hunter;
- (c) facilitating the carrying out of certain types of industrial and infrastructure development of State Significance with a strong commitment to sustainable environmental performance; and
- (d) enabling public involvement and participation in the assessment of applications for consent to carry out this development.

The SEPP 74 vests approval powers to the NSW Minister for Planning, and is administered and managed by the Department of Planning (DOP) and the Regional Lands Management Council (RLMC) that control the SEPP 74 corridor. The corridor consists of land on Kooragang Island and includes a corridor of width up to 0.7km, stretching from about 2km east of the Tourle Street Bridge westward along the shore of the south arm of the Hunter River to 4km west of the bridge and northward across

Ash Island, over the north arm and incorporating the Tomago buffer land. There has been controversy regarding the introduction of the SEPP and the perceived potential for its operation to negatively impact on environmental values of the Lower Hunter estuary and Kooragang Island.

Connectivity between Kooragang Island and the Sandgate/Hexham populations is considered unlikely given the significant migration barrier of the tidal south arm of the Hunter River. Historically, extensive freshwater flushing provided in times of flood is likely to have supplemented the Kooragang population and allowed natural exchange between mainland and island GGBF populations. Given the critically reduced populations elsewhere in the Hunter this interconnectivity between the two key populations is currently improbable. Unless genetic analysis shows the two populations are of a single 'evolutionary unit' and that artificial exchange is warranted, interconnectivity between populations is outside the scope of this management plan and should be addressed under the state-wide recovery plan.

The existence of suitable GGBF habitat (notably Scott's Point and various Sandgate and Hexham areas) scattered across parts of the Lower Hunter suggests an improvement in habitat connectivity could be beneficial. The creation of a habitat 'mosaic' between such areas to facilitate migration between populations, between populations and assisting expansion of the species into currently unoccupied areas should be considered.

Large areas of potential, and likely historical, habitat exist in the areas to the north and south of the Kooragang Island key population. To the north, in the Tomago Wetlands and to the south and west in the Hexham Swamp small GGBF populations are either known or considered likely to continue to persist. Systematic surveying of these areas to determine status of GGBF deeper into these large reserves could prove fruitful for resolving actual population status and also possibly identify areas for possible reintroduction opportunities.

The absence of GGBFs in seemingly suitable habitat is a continuing conundrum, debate continues as to why this is so. Creation of suitable frog habitat could result in false confidence that this habitat will be used. Factors unable to be managed at the moment such as disease could be confounding what might otherwise be successful habitat creation initiatives. Ultimately, all the reasons for the continued decline of the GGBF in the Lower Hunter are unknown thus further research into actual habitat requirements at each stage of the frogs development should be continued.

Planning process

This Plan builds upon a range of past and current actions to manage the GGBF populations and habitat.

Local actions to manage the species have included:

- University of Newcastle conducts ongoing research into the local GGBFs, in partnership with HCRCMA. This has included research into the general biology of GGBF and aspects of the ecology of the species on Kooragang Island.
- Port Waratah Coal Services, during construction of its major coal loader, provided an offset of substantial funding for research into habitat enhancement and creation initiatives. This funding and associated actions was facilitated by the KWRP.
- Hunter Wetland Centre (HWC) constructed breeding ponds and reintroduced GGBFs to its site (a former GGBF site of occurrence). Additionally display tanks and information panels were constructed inside the HWC visitor centre,

with assistance from SOFAR (Society of Frogs and Reptiles - community herpetological interest group), for educational purposes.

- An expert panel was established to make recommendations regarding GGBF conservation following controversy associated with perceived impacts of wetland rehabilitation works. This resulted in an expert panel report and a subsequent Creek 3 rehabilitation plan by consultants WBM Oceanics on behalf of KWRP/CMA, RLMC and DECC.
- KWRP with assistance from SOFAR and Kooragang Landcare, and with advice from the Australian Museum, installed/created habitat components for the GGBF in the Scott's Point area. This included plantings to enhance a created 'chain of ponds'.
- Feral predator control measures have been implemented on parts of Kooragang Island by NSW DECC, the CMA and Newcastle City Council.
- Researchers at the Australian Museum have been undertaking monitoring of the GGBF population at Sandgate.
- GGBF were monitored as part of the Hexham Swamp Rehabilitation Project, in the channel leading from the 2HD ponds (WBM 2004).
- "Stepping stone" frog ponds were created as part of the Kooragang Wetland Rehabilitation Project, midway between Creek 3 and Scott's Point.

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, in accordance with the draft GGBF Recovery Plan. The workshop was held on 31 January 2007 with representation from:

- Newcastle, Maitland and Gosford City Councils
- Industries (Incitec/Pivot, Orica, Energy Australia, Alinta)
- Kooragang Wetland Rehabilitation Project (KWRP)
- Road and Traffic Authority (RTA)
- Department of Environment and Climate Change (DECC)
- Hunter-Central Rivers Catchment Management Authority (HCRCMA)
- Researchers (University of Newcastle, Australian Museum)
- Environmental groups (SOFAR) and Wetlands Centre
- Regional Land Management Corporation (RLMC)
- Consultants for Newcastle Coal Infrastructure Group (NCIG) – Resource Strategies Pty Ltd

This plan was then distributed in draft form for comment to these and other stakeholders including the Commonwealth Department of Environment and Water Resources (DEW), 2HD Radio Newcastle, other industries and the Australian Rail and Track Corporation (ARTC).

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 three objectives of the Lower Hunter GGBF Management Plan are as follows:

1. To maintain the two existing GGBF key populations;
2. To enhance existing GGBF habitat and thus measures of population viability for these two Key Populations; and
3. To increase connectivity within and, if possible, between the Key Populations.

Strategies

The following six strategies, arising out of the draft Recovery Plan, will be used to achieve these objectives:

1. Further development 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 Lower Hunter GGBF populations; and
6. Coordination and communication between the various stakeholders, land managers and the community.

Duration

The duration of this plan will be three years, starting mid-2007 and ending 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 for each strategy, links to the draft Recovery Plan, 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 this plan.

IMPLEMENTATION PLAN

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

ACTION	RECOVERY PLAN LINKS	RESPONSIBILITY	COST*	FUNDING SOURCES	TIMEFRAME
1.1 Identify land parcels, tenure and zoning for lands considered to be of strategic importance for GGBFs.	Action 11.3.4	DECC, Newcastle City Council, Hunter Central Rivers CMA	In-kind		2007-2008
1.2 Develop a (staged/costed) conceptual estuary-wide 'masterplan' for creating a GGBF habitat mosaic on Kooragang Island to increase potential habitat areas, enable the species to colonise areas currently not utilised as well as provide community opportunities.	Actions 10.3.1, 11.3.3	University of Newcastle, Hunter Central Rivers CMA	\$15,000	NHT, Hunter-Central Rivers CMA devolved grant, TSN Grants	2007-2009
1.3 On the basis of systematic surveys undertaken for Hexham Swamp (Action 5.1), develop a (staged/costed) conceptual 'masterplan' for creating GGBF habitat components around the peripheral parts of Hexham Swamp.	Actions 10.3.1, 11.3.3	University of Newcastle, Hunter Central Rivers CMA	\$15,000		2008-2009
1.4 Key landowner and stakeholder groups to meet and discuss possible initiatives that could be implemented across strategically important lands. Link to Action 1.2.	Actions 10.3.1, 11.3.4	DECC, Industries, other stakeholders	\$1,500 (venue, facilitation)		2007-2008
1.5 Develop guidelines for the creation and enhancement of frog-friendly habitat components. This information should target gardens and other landscaping and maintenance opportunities.	Actions 11.3.3, 14.3.1	DECC, University of Newcastle, consultants	\$5,000 (outsource to consultants)	TSN Grants	2008

* Costs are indicative only and subject to available funding

ACTION	RECOVERY PLAN LINKS	RESPONSIBILITY	COST*	FUNDING SOURCES	TIMEFRAME
1.6 DECC and HCRCMA to meet with key industry and agency groups regarding the use of and access to easements and corridors as GGBF movement habitat.	Action 10.3.1	DECC, HCRCMA, University of Newcastle, HWC, RTA, ARTC, Transgrid, Energy Australia, Alinta	In-kind		2007-2008

IMPLEMENTATION PLAN (continued)

Strategy 2: Improvement of habitat within the GGBF key populations

ACTION	RECOVERY PLAN LINKS	RESPONSIBILITY	COST*	FUNDING SOURCES	TIMEFRAME
2.1 Creation of further GGBF habitat components at Scott's Point will be encouraged as a component of other habitat creation and enhancement initiatives.	Actions 10.3.1, 11.3.3	HCRCMA, KWRP	\$2,000	HCRCMA, Env. Trust	2008
2.2 DECC will meet with land use consent authorities to discuss SEPP 74 limitations and opportunities with regard to GGBF habitat enhancement, connectivity and offset initiatives projected to occur in the area.	Action 10.3.1	DECC, DOP, Premiers Dept, Newcastle City Council, HCRCMA	In-kind		2007-2008
2.3 Funding opportunities for implementing and monitoring the estuary-wide 'masterplan' will be sought (links to Actions 1.2, 1.4).	Action 10.3.1	DECC, HCRCMA, DOP	In-kind	Envirofund, Env.Trust, CMA small grants, TS grants	2008-2009
2.4 The development and management of GGBF habitat across various industry lands to be promoted and initiated through appropriate regulatory and voluntary means. Where possible this will be strategic and linked to the GGBF estuary-wide 'masterplan' to be developed in 1.2 (link to Actions 1.2, 1.4).	Actions 10.3.1, 11.3.3	DECC, Newcastle City Council, industry	to be determined as part of Action 1.2	HCRCMA, NHT, Env.Trust, industry, various development offsets	2008-2010
2.5 Relevant landowner managers to develop site plans that give consideration to GGBF and the intent of actions arising out of this plan.	Action 11.3.4	Industries, Newcastle City Council, DECC	In-kind	Internal sources or external grants eg NHT TSN	2007-2010

* Costs are indicative only and subject to available funding

IMPLEMENTATION PLAN (continued)

Strategy 3: Community education to build GGBF awareness and encouragement of coordination of various stakeholders in land management or development activities

ACTION	RECOVERY PLAN LINKS	RESPONSIBILITY	COST*	FUNDING SOURCES	TIMEFRAME
3.1 Increase level of regional and local knowledge and awareness of the GGBF through local community workshops.	Actions 14.3.1, 14.3.2	SOFAR, DECC, HWC, HCRCMA, other stakeholders	\$4,000 (venue facilitation, advertising)	TSN Grants, local sponsorship	2007-2009
3.2 University of Newcastle and other researchers to monitor local populations with assistance from community and students and enter data into Wildlife Atlas and a database available to the community (GIS?).	Actions 12.3.1, 14.3.2	University of Newcastle, SOFAR, AM researchers	\$10,000	TSN Grants, Env. Trust Grants, local sponsorship	2007-2010
3.3 Establishment of a Lower Hunter GGBF website where background information, habitat, photos, recordings, reports and documents are available. This site will be a community website and could provide event information; a survey/monitoring timetable, new achievements or observations and opportunities to participate.	Action 14.3.1	DECC, SOFAR, University of Newcastle, HCRCMA	\$10,000 (website construction and maintenance)	TSN Grants, Env. Trust Grants, local sponsorship	2007-2010
3.4 Development of a community survey and information proforma distributed to residents and businesses surrounding Hexham Swamp and Kooragang Island.	Action 14.3.2	University of Newcastle, DECC, HCRCMA, SOFAR	\$3,000	TSN Grants, Env. Trust Grants, local sponsorship	2007-2008

ACTION	RECOVERY PLAN LINKS	RESPONSIBILITY	COST*	FUNDING SOURCES	TIMEFRAME
3.5 Construction of interpretive signs for community benefit, where public access is allowed.	Action 14.3.1	Newcastle City Council, DECC, HCRCMA, SOFAR	\$30,000	HCRCMA, Env. Ed. Grant, Sponsorship	2008-2010
3.6 Develop a newsletter (hardcopy/electronic) to report on new sightings, event outcomes, status reports and trends etc.	Action 14.3.1	HCRCMA, SOFAR	\$5,000	HCRCMA, Env. Ed. Grant Sponsorship	2007-2010
3.7 Development of best practice guidelines to deal with maintenance and access issues associated with infrastructure maintenance across GGBF habitat areas.	Action 11.3.1, 11.3.3	DECC, Energy Australia, Alinta, Transgrid, RTA, HWC, RailCorp/ARTC	\$10,000	Env Trust, NHT, CMA	2007-2010
3.8 A compilation of all previous records and survey findings will be created and recorded as a GIS layer. All data to be entered into Wildlife Atlas.	Action 14.3.1, 14.3.2	DECC, University of Newcastle, other researchers	<\$5,000	CMA, DECC, NHT, Env. Trust	2007-2008
3.9 Develop maps depicting important areas of known and potential habitat in relation to property, zoning, SEPP and other relevant information and incorporate as appended map to this plan.	Action 11.3.1, 11.3.2, 11.3.3, 11.3.4	DECC, University of Newcastle, local herpetologists, HCRCMA	<\$2000	DECC, NHT, CMA, consultants	2007

IMPLEMENTATION PLAN (continued)**Strategy 4: Reduction of external threats to GGBFs**

ACTION	RECOVERY PLAN LINKS	RESPONSIBILITY	COST*	FUNDING SOURCES	TIMEFRAME
4.1 Ensure that tidal intrusion into 2HD ponds does not occur, as per HSRP EIS/approvals.	Action 11.3.2	HCRCMA, HSRP, NCC, DECC, NSW DPI - Fisheries	To be determined	HCRCMA, NHT	Approval dependent
4.2 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	All stakeholders	In-kind		2007-2010
4.3 Survey of what GGBF habitat <i>Gambusia holbrooki</i> occupies and, in accordance with the <i>Gambusia</i> Threat Abatement Plan, prevent further spread to unoccupied GGBF habitat.	Action 11.3.2	Newcastle University, SOFAR, KWRP, DECC NSW DPI Fisheries	\$5,000	NHT, HCRCMA devolved grants	2008-2009
4.4 Installation of security cameras, signage or increased surveillance to deter dumping at Sandgate/Hexham sites.	Action 11.3.2	Newcastle City Council, DECC	In-kind	Recurrent funds	2007-2010
4.5 Continuation of feral predator control (e.g. trapping, fox baiting) in land leased by KWRP and on public and industrial lands to be coordinated with baiting in Hexham and Kooragang Nature Reserves.	Actions 10.3.1, 11.3.2	DECC, HCRCMA, NCC, industries, other stakeholders	> \$10,000	Fox TAP, HCRCMA, NHT	2007-ongoing
4.6 Promote responsible cat ownership in relation to GGBFs through education. (Link with Action 3.3)	Actions 11.3.2, 14.3.2	DECC, HCRCMA, NCC	<2,000		2007-2010

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

ACTION	RECOVERY PLAN LINKS	RESPONSIBILITY	COST*	FUNDING SOURCES	TIMEFRAME
5.1 Conduct a systematic survey in the Tomago and Hexham Swamp Wetlands, and surrounding areas, to ascertain GGBF status and extent of potential habitat. Obtain collate and review any existing GGBF assessment data for the Tomago Smelter, the State Highway 23 upgrade and the Wetland Rehabilitation projects. Continue the HCRCMA survey on HSRP land.	Action 12.3.1	DECC, University of Newcastle, SOFAR, HCRCMA	\$10,000	NHT, HCRCMA devolved grants	2007-2008
5.2 Undertake water quality/salinity monitoring within 2HD ponds post-Ironbark Ck floodgate opening.	Action 12.3.1	DECC, University of Newcastle, Australian Museum, HCRCMA	\$5,000	NHT, HCRCMA devolved grants	2007
5.3 Maintain existing monitoring regime of (GGBF) populations to detect any further decline and status.	Action 12.3.1	University of Newcastle, Australian Museum, SOFAR	\$20,000	NHT, HCRCMA devolved grants	2007-2010
5.4 University of Newcastle continue to undertake research into population dynamics and actual GGBF habitat requirements at each stage of the species life cycle.	Action 12.3.2	University of Newcastle, DECC	\$20,000	University of Newcastle, ARC	2007-2010
5.5 Adoption of DECC created performance indicators for created habitat to benchmark functional habitat criteria for offsetting or other compensatory mechanisms.	Action 12.3.1	DECC (EIA Guideline), NCC, DOP, RLMC	In-kind		2007-2010
5.6 Maintenance of Hunter Wetland Centre GGBF reintroduction trial including further releases, if appropriate, and monitoring of performance.	Actions 12.3.1, 13.3.2	HWC, University of Newcastle, SOFAR	\$10,000	Env. Trust, NHT, HCRCMA devolved grants	2007-2010
5.7 Undertake independent assessment of genetic data on GGBF populations in the Hunter to ascertain direction for future management of significant conservation units and provenance related reintroduction issues.	Action 12.3.2	Macquarie University	\$5000	DECC, NHT, Env. Trust, HCRCMA	2007-2008

IMPLEMENTATION PLAN

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

ACTION	RECOVERY PLAN LINKS	RESPONSIBILITY	COST*	FUNDING SOURCES	TIMEFRAME
6.1 DECC to meet with land use consent authorities regarding interpretation of SEPP 14, particularly with respect to sand bagging trials. Such trials can reduce instances of inundation, e.g. of the Creek 3 swales from breaches of low points in the creek bank or back/overland flows from adjoining creek catchments.	Action 10.3.1	DECC, Newcastle City Council, DOP	In-kind		2007
6.2 DECC will liaise with RTA over appropriate offsets/compensatory measures for State Highway 23 construction, such as strategic habitat creation.	Action 10.3.1	DECC, RTA, NCC	In-kind		2007
6.3 Infrastructure organisations will be consulted to facilitate the incorporation of habitat components into areas along line easements and into track/trail construction and maintenance requirements. Factor into any memorandum of understanding, environmental management plan or other codes and licensing requirements.	Action 10.3.1	Transgrid, ARTC, Alinta, DECC, University of Newcastle	In-kind		2007
6.4 Establishment of a Lower Hunter GGBF working group, e.g. "Friends of GGBF" group (link to Action 1.2).	Action 14.3.2	DECC, SOFAR, University of Newcastle, CMA	\$5,000	DECC	2007-2008
6.5 Annual or half yearly stakeholder meetings with respect to implementation of the plan and developments/issues	Action 10.3.1	DECC, HCRCMA	In-kind, \$2000 (venue and facilitation)	DECC, HCRCMA	2007-2010
6.6 Maintenance of GGBF Lower Hunter contacts/stakeholder list.	Action 14.3.1	DECC, HCRCMA	In-kind	DECC, HCRCMA	2007-2010

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 and, without implementing the hygiene protocol, may be cause for the spread of the chytrid disease. 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, to 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>

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

	<p>Photo 1. Frog Exclusion fencing at Shortland Wetlands Centre (photo J. Clulow and M. Mahony)</p>
	<p>Photo 2. GGBF habitat on the western side of the Kooragang rail line (that is to be expanded as part of the proposed coal export terminal development) Kooragang Island (photo J. Clulow and M. Mahony)</p>
	<p>Photo 3. GGBF habitat at Hexham Swamp, Sandgate (photo J. Clulow and M. Mahony)</p>

	<p>Photo 4.</p> <p>GGBF habitat on the western side of the Kooragang rail line (that is to be expanded as part of the proposed coal export terminal development), Kooragang Island (photo J. Clulow and M. Mahony)</p>
	<p>Photo 5.</p> <p>Middle swale on the northern side of Creek 3, Kooragang Island (photo R. Parker-Wright)</p>
	<p>Photo 6.</p> <p>Creek 3 tree line showing evidence of salt invasion, looking towards Bell Frog Road, Kooragang Island (photo R. Parker-Wright)</p>



Photo 7.

Corner pond, GGBF habitat looking south (railway 4mtrs on left), Kooragang Island (photo R. Parker-Wright)