Green and Golden Bell Frog

Litoria aurea (Lesson, 1829)

Other common names: Bell Frog, Swamp Frog, Smooth Swamp Frog, Growling Grass Frog

The following information is provided to assist authors of Species Impact Statements, development and activity proponents, and determining and consent authorities, who are required to prepare or review assessments of likely impacts on threatened species pursuant to the provisions of the *Environmental Planning and Assessment Act* 1979.

These guidelines should be read in conjunction with the NPWS *Information Circular No. 2: Threatened Species Assessment under the EP & A Act: The '8 Part Test' of Significance* (November 1996), the draft Green and Golden Bell Frog Recovery Plan (December 2002) and the species information profile (NPWS 1999).

Proponents, consent and determining authorities when considering development or other activity proposals must asses direct and indirect impacts on the Green and Golden Bell frog and/or its habitat. Direct impacts can include harm to individual frogs and loss/damage to breeding or other habitat components. Indirect impacts can include actions that increase or exacerbate threats (see threats section below) as a result of a development or activity.

Survey

The Green and Golden Bell Frog can be surveyed for using standard frog survey techniques. These should include:

- Nocturnal surveys using spot light/head lamp search techniques. This should be undertaken amongst emergent and fringing vegetation in the natural and artificial wetland habitat likely to be frequented by the species as well as areas of potential shelter and foraging habitat in the vicinity;
- Aural surveys to call playback response;
- Diurnal visual searches of ground cover (debris, rocks and logs) and for basking individuals, usually amongst emergent vegetation; and
- Dip-netting surveys for tadpoles (this may prove difficult and will require the use of a good identification guide [Anstis 2002] unless the surveyor has had considerable experience with tadpole identification).

Determining the adequacy of survey effort required is difficult. Factors that need to be considered in determining the amount of search effort required includes: the size of the wetland and any surrounding ancillary habitat present, its accessibility, the prevailing weather conditions, the amount of ground cover, the extent of fringing and emergent vegetation as well as the seasonal timing of the survey to be undertaken.

Experienced surveyors tend to gain a 'feel' for the suitability of a site even if frogs are not located on a single visit. It is likely that several visits to a site will be required to detect the species (ideally each survey separated by 2-4 weeks). Surveys must be undertaken during favourable seasonal and climatic conditions. Such surveys may need to be conducted over several activity-breeding seasons to be successful. The ideal timing of survey should be in the warmer activity period of the year usually between the months of August and March. The activity period begins later in the southern and more elevated portions of the species distribution and continues well into autumn in the north (G. Daly; M. Parsons pers. comm.). It is possible to observe the species outside the main activity period if warmer weather breaks torpor early. The species is most likely to be detected during and after heavy rainfall but this should not be taken to mean that the frogs definitely become active after a single rainfall event.

Small areas of habitat (< 0.3 Ha) should be surveyed for a minimum of one hour on three separate occasions during the species activity period. Larger areas, that may include whole wetlands and lagoon margins, are more difficult to survey and require a minimum of 3 separate four hourly searches during the species activity period.

Surveyors should be mindful that the species has a somewhat nervous disposition and will often attempt to evade detection. They are known to actively avoid torch-light and at such times will readily dive or swim off to another location.

Males mainly call between September and January however frogs will take advantage of favourable conditions outside these times and be heard calling. Eliciting a call response to tape playback can be a successful way of detecting the species and even a well rehearsed imitation call by experienced surveyors can have the same result.

Males normally call while floating in water and this can be useful in helping to confirm the identity of a calling frog (G. Pyke pers. comm.). However the call is extremely distinctive and should not be mistaken for any other species except perhaps in areas where other "Bell Frog" species may co-occur (central and southern tablelands Osborne *et al.* 1996; White and Pyke 1999). An absence of their call cannot be taken as an absence of the species without undertaking substantial site survey over several activity seasons.

During inactivity periods, Green and Golden Bell Frogs may also be found taking refuge under or inside objects (both natural and 'man-made') in the vicinity of their habitat. When searching care should be exercised not to excessively disturb or destroy these important refuge sites particularly when the frogs may be aestivating over winter (sometimes collectively) and in a state of torpor.

It is difficult to define the habitat requirements and/or preferences for this species but the various types of habitat utilised has been documented (see Pyke and White, 1996; 2001). In any case when assessing the suitability of habitat it should always be considered in the event of rainfall. A site when dry may appear unsuitable but this may change with moderate rains and so consideration should also be given to the species propensity to turn up to breed in ephemeral locations that are more often dry than wet. Quarries, brickpits, mining sites, STPs, bunded or otherwise 'retained' areas, detention basins, drains, scrapes, depressions and farm dams along with the more natural coastal or floodplain wetland features such as swamps, ponded areas of intermittent creeklines, lagoons, billabongs and dune swales are all candidate sites for occupation by this species (White 1995; Pyke and White 1996; 2001; Hamer *et al*. 2002). Such sites are occupied and used mainly as breeding habitat.

Foraging habitat requirements include tall, dense, grassy vegetation and tussock forming vegetation is known to be used for foraging and shelter (A. Hamer pers. comm.; A. White pers. comm.).

Over-wintering sites are another important habitat component that requires consideration in any site assessment. Such habitat provides protection from disturbance during the cooler months of the year when individuals enter a period of quiescence/inactivity and become torpid. Such sites include the bases of dense vegetation tussocks, beneath rocks, timber, within logs or beneath ground debris including human refuse such as sheet iron etc (Pyke and White 2001; R. Wells pers. comm.; A. Hamer pers. comm.). Such sites may be adjacent to the breeding sites but may also be some distance away. The full range of possible habitat used for this purpose is not well understood and so assessments should be mindful of this information gap.

The congregation of large numbers of individuals at some breeding sites followed by a dwindling in number of observed animals during non-breeding stages suggests that individuals move off to seek other non breeding habitat where this is absent in situ. Consequently other 'potential' habitat attributes must be considered during any assessment of an area and not just the extent of breeding habitat. The sometimes skewed sex ratios of individuals found around breeding sites indicates there are sexual differences in the spatial and temporal use of various habitat components (M. Bannerman pers. comm.). Therefore the timing of any proposed disturbance to potential habitat may differ significantly in its direct impact on a local population of the species.

In some areas heavy urbanisation and other development has encroached on the species habitat. *Litoria aurea* is a species that has high tolerance to varying levels of certain physical and chemical factors in the environment (T. Penman pers. comm.). This 'colonising' capability appears to have pre-adapted the species to establish itself in the altered habitats it often utilises. The species strong dispersal ability also means it may be

able to satisfy its various habitat requirements, even when these are located some distance apart, provided suitable corridor connections are retained. Examples of this include over-wintering in household gardens and then breeding in wetlands or dams, quarries and other human constructions, considerable distances away.

Life cycle of the species

The general biology and ecology of *Litoria aurea* is described in the referenced literature (see Pyke and White 2001 for a review) and is summarised in the Draft Recovery Plan (NPWS 2003).

The Green and Golden Bell Frog is considered highly dependent on its breeding sites for long term survival at the various remnant population sites. The species is known to be highly fecund (5000+ eggs/spawn mass) and is therefore considered potentially capable of reproductively 'bouncing back' from population "bottleneck" situations provided threatening processes are removed or ameliorated.

Tadpoles develop over an approximate three month period but this can vary depending on prevailing conditions. Some ephemeral breeding locations are prone to drying out before tadpoles have reached metamorphosis. This is considered critical for some of the remnant populations and is believed to be a limiting factor at those sites where recruitment appears to be poor (P. Gray pers. comm.). At other sites tidal inundation of breeding sites can be a factor affecting breeding success (A. Henderson pers. comm.; G. Pyke pers.comm.).

Metamorphlings are highly susceptible to predation and need to forage successfully soon after transformation to improve their chances of survival during the first over-wintering period. To this end, it is important that vegetation for foraging is retained around the breeding sites as well as connecting corridors of vegetation that enable movement away from breeding sites to other areas of habitat. Metamorphlings that remain in the vicinity of breeding sites where a resident population of adults remain are often cannibalised (A. White pers. comm.).

Threatening processes

Key Threatening Processes (KTPs) that have been listed under Schedule 3 of the Threatened Species Conservation Act 1995 and which have known or likely implications for the Green and Golden Bell Frog include:

- *Predation by* Gambusia holbrooki *(Plague Minnow or Mosquito Fish).*

The presence of *Gambusia* in known or potential breeding sites is a matter of concern as *Gambusia* is known to feed on eggs and early stage tadpoles and to strip tail fins and limb buds at later stages of tadpole development. The density of fish, size of the water body, availability of other food sources and extent of emergent vegetation for shelter, all appear to be factors in the extent of impact *Gambusia* has on *Litoria aurea* breeding efforts (Morgan and Buttemer 1996; Webb and Joss 1997; A. White pers. comm.).

Efforts to control or eradicate the fish should be considered in accordance with the Draft *Gambusia* Threat Abatement Plan but timing, scale and likelihood of reinfestation should be major considerations (NPWS 2002). The presence of *Gambusia* in a waterway is not to be taken as meaning that the Green and Golden Bell Frog is absent or that the habitat is rendered unsuitable. Some sites with *Gambusia* are still utilised by *L. aurea*, but with a likely reduced reproductive success rate, such sites may in any case provide vital foraging or shelter habitat for adults.

- *Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands.*

The Draft Recovery Plan identifies the destruction and alteration of wetlands and stormwater pollution as a major threat to the species and a significant contributor to its current conservation status.

Developments and other activities have the potential to have obvious direct and not so obvious indirect impacts on these processes and include, among others, artificial opening regimes for coastal lagoons, deposition of fill to floodplain areas, diversions, water extraction, flood mitigation works and culvert construction in wetland areas that lower the watertable.

- *Clearing of native vegetation (as defined and described in the final determination of the Scientific Committee to list the key threatening process);*

Alteration of habitat associated with grazing by stock, development or other land use

activities that clear native vegetation results not only in direct loss of habitat but also isolation of habitat through creation of 'barriers' to movement between populations.

- *High frequency fire resulting in the disruption of life cycle processes in plants and animals and loss of vegetation structure and composition;* and

This process is likely to result in direct losses as well as removes shelter/cover exposing the species to greater predation and eliminates food reserves.

- *Predation by the European Red Fox* Vulpes vulpes *(Linnaeus 1758).*

Predation by feral animals such as foxes is another likely threat particularly where populations are already stressed by impacts of other threatening processes.

Other threats include:

- *Chytridiomycosis*, a disease that has been recently listed as a KTP under the Commonwealth EPBC Act and has also been listed as a KTP in NSW under the TSC Act.

Recent research has identified an important frog pathogen, an exotic frog chytrid fungus, known to cause chytridiomycosis, a usually fatal condition (L. Berger pers. comm.), and also known to be impacting on many other frog species as well as *Litoria aurea* (Berger *et al.* 1999; Mahony 1999; Mahony and Werkman 2001). This may ultimately prove to be the major causative factor in the recently reported wide scale decline in frogs generally in this country.

- *Broad scale application of herbicides*

Weed control activities involving the broad scale application of herbicides needs to be considered for their potential to impact on this species (Bidwell and Gorrie 1995; Mann and Bidwell 1998; 1999). Such impacts may be the direct result of the toxicity of the herbicides on frogs and tadpoles, as well as indirectly through broad scale ground cover loss.

- *Road Mortality*

At some sites, particularly where populations are impacted by a number of threats, road mortality can be an additional and quite significant mortality factor (Daly 1996).

Viable local population of the species

It is difficult to determine what constitutes a viable local population however in the absence of a detailed specific local population study all populations should be considered significant and viable unless shown otherwise. The draft recovery plan for the Green and Golden Bell Frog has identified 44 key populations across its overall NSW distribution and these are considered viable populations based on current information (NPWS 2002). The key populations have been subdivided across 9 management regions that incorporate the species state-wide distribution. At most of these sites available information indicates that population sizes are generally small with breeding events infrequent. However at six key sites substantial populations have been found and regular breeding events recorded (NPWS 2002). Implementation of the recovery plan will attempt to address the data gaps for the other key populations where viability indicators (calling males, amplexus, spawning, tadpoles, metamorphlings and recruitment) are presently unavailable. At all sites little information is available about levels of successful recruitment from emergent metamorphling to adult.

Consequently to accurately determine viability of a particular population several seasons of intensive survey and monitoring is necessary. The difficulty of assessing viability is best illustrated via the example of several sites where populations were initially assumed, from the information available, to be in imminent danger of extinction. These were later revealed to be much larger and viable when further survey was completed (R. Porter; M. Bannerman; G. Pyke, R. Wright all pers. comm.). Clearly this illustrates the need for the precautionary principle to be applied in the absence of adequate information.

Additional populations not currently categorised as key populations within the draft recovery plan may be detected in the future. These populations, even when detected as low numbers of individuals, may have high conservation value and are to be considered significant and viable until shown otherwise.

A significant area of habitat

The Green and Golden Bell Frog is most frequently detected in or around its breeding habitat. Such sites are of critical importance to the species and its availability appears to be a limiting factor in many locations. The species tends to congregate at breeding sites during the warmer months (August-March) and during these events aggregations of individuals may represent a substantial proportion of the total population from the surrounding area. Breeding habitat should therefore be afforded the highest level of protection and likely disturbances, during the breeding period in particular, should be totally avoided. However the breeding habitat cannot be considered in isolation from the other habitat components known to be essential for the species to complete its life cycle.

Mitigating Impacts

The basic principles of protecting threatened species is to:-

1. Avoid direct impacts and retain habitat;
2. Minimise impacts where ever possible;
3. Mitigate or ameliorate impacts; and as a last resort
4. Compensate or offset for any unavoidable impacts.

Consequently consideration must be given to retention of all habitat components including foraging, shelter and over-wintering habitat that may be at some distance from the more readily identified breeding habitat.

Under some circumstances, consent and determining authorities may be required to give consideration to habitat enhancement and perhaps habitat creation initiatives as a means of mitigating possible degradation to habitat or offsetting unavoidable habitat losses. In such circumstances an in-situ conservation outcome is paramount and there must be no net loss of habitat. Any habitat creation initiatives that are proposed as an offset to a development must be on a tested performance basis. Performance is to be measured by two successful breeding events that demonstrate that the life cycle has been completed in any created/enhanced habitat. Monitoring and mark recapture studies over an extended period would be required to demonstrate this and might reasonably be expected to take a minimum of 4 years ie the time taken for F_1 female progeny to reach sexual maturity (2 years), breed successfully and any resulting progeny, in turn, to reach sexual maturity and breed (see Semlitsch 2002). Under exceptional circumstances consideration might be given to captive breeding initiatives that could assist with amplification of a local, at threat, population.

Isolation/Fragmentation

The Green and Golden Bell Frog has undergone considerable fragmentation of its once almost continuous state-wide distribution. Most of the remaining key populations are isolated by large distances from other key populations. Many of the remaining key populations also appear to exhibit meta-population structure being comprised of several semi-discreet, variably isolated, sub-populations with an assumed restricted gene flow between them.

Maintenance of the migration/movement paths between various sites is therefore essential if the existing pattern of decline of the species is not to continue. Such movement corridors may include stream lines, other drainage features, swales and depressions as well as built structures and naturally vegetated areas. The species does however exhibit strong migration tendencies, is known to be capable of moving several kilometres and will, when necessary, move across 'hostile' ground, such as roads and cleared land to reach its desired habitat.

Regional Distribution of Habitat

The Green and Golden Bell Frogs historic distribution and hence habitat is contained within the NSW North Coast (8), Sydney Basin (29), South East Corner (5 - NSW) and South Eastern Highlands (1) Bioregions (Thackway & Cresswell 1995). The numbers of key populations identified within each of these bioregions (in parentheses) indicates that there has been an uneven pattern of decline with most severe decline being evident in the South eastern Highlands bioregion whereas the Shoalhaven area of the Sydney Basin has the greatest number of remnant key populations. The Recovery Plan for the Green and Golden Bell Frog places high conservation significance on all remaining key populations and its objective is to prevent any further losses of them. Considerable suitable habitat still occurs across all regions of the species distribution and so other remnant populations may still

exist in this habitat. There is therefore a need for targeted surveys in these potential habitat areas when developments in such areas are being considered.

Limit of Known Distribution

The distribution of the Green and Golden Bell Frog is currently limited to 44 key populations across its distribution (NPWS 2002). The majority of these key populations are near coastal and most are widely disjunct. Consequently the loss of any of these remaining key populations will increase fragmentation and widen existing disjunction. Therefore consideration of individual key populations should be in the context of its distributional limits at the regional level as well as at its northern most or southern most distributional limit to be consistent with the draft Recovery Plan.

Adequacy of representation in conservation reserves or other similar protected area.

The Green and Golden Bell Frog is known to occur within the following reserves: Yuraygir NP (2); Hat Head NP; Lake Innes NR; Myall Lakes NP (3); Kooragang Island NR; Seven Mile Beach NR; Meroo NP; Towra Point NR; Jervis Bay NP; Narawallee NR; Ben Boyd NP and Nadgee NR. A key population also occurs within Commonwealth Booderee NP and on Department of Defence land on Beecroft Peninsula both at Jervis Bay.

Whilst the species occurs within these reserves only in 11 of 44 (25%) of these cases does the major portion of the species key population habitat occur within that conservation reserve. Consequently the species is not adequately protected within the reserve system because the majority of the species habitat occurs on other tenures.

Critical Habitat

Critical habitat has not been declared for this species but may be reconsidered for declaration during the implementation of the recovery plan.

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