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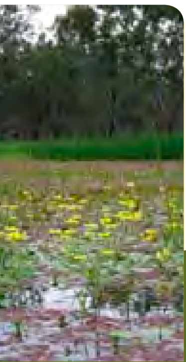
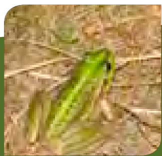




Significant impact guidelines for the vulnerable growling grass frog (*Litoria raniformis*)

Nationally threatened species and ecological communitites
Background paper to the EPBC Act policy statement 3.14

Contents

Introduction

This paper provides background to EPBC Act policy statement 3.14 – Significant impact guidelines for the growling grass frog (*Litoria raniformis*), hereafter referred to as the policy statement. This background paper provides the biological and ecological context to the habitat areas, significant impact thresholds, and mitigation measures defined for the growling grass frog in the policy statement. The information provided in this paper has been prepared based on the best available scientific information and consultations with species experts. Increases in knowledge will be accounted for in future policy revisions.

Conservation status

The growling grass frog is listed as vulnerable under the Australian Government *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). The species is also listed as threatened under the Victorian *Flora and Fauna Guarantee Act 1988*, vulnerable under the South Australian *National Parks and Wildlife Act 1972* and the Tasmanian *Threatened Species Protection Act 1995*, and endangered under the New South Wales *Threatened Species Conservation Act 1995*.

About the growling grass frog

Description

The growling grass frog is also known as the southern bell frog, the green and golden frog, the warty frog, the warty bell frog and the green or warty swamp frog. The growling grass frog is a large frog (females may exceed 100 mm in length) that varies from dull olive to bright emerald-green on the back (dorsum), with large irregular blotches of brown or rich golden-bronze (Barker et al. 1995; Cogger 2000).

Tadpoles of the growling grass frog may attain 110 mm in total length, but more commonly measure around 85 to 90 mm (Antis 2002; DEC 2005). In the later stages of development they have a characteristic green or yellow dorsal colouration (Anstis 2002). The sides of the body, over the gills and abdomen are opaque white with a copper sheen. Tailfins are deeply arched and the entire tail has a yellowish tinge with lightly coloured veins throughout the fins (Antis 2002; DEC 2005).

Distribution and populations

The growling grass frog was formerly distributed across a large area of south-east Australia (Pyke 2002), including New South Wales and the Australian Capital Territory, Victoria, South Australia and Tasmania. The mainland distribution previously extended from the upland areas of the Murray-Darling catchment from Bathurst and the Australian Capital Territory, westward to the Murray River floodplain of South Australia, and extended south through Victoria to about Orbost including cosmopolitan environments around Melbourne (Pyke 2002; Lewis 2008).

Over the past 30 years the growling grass frog has undergone substantial declines across its range (Wassens et al. 2008a). Declines and local extinctions in Tasmania appeared to be the result of wetland degradation with some declines exacerbated by the 1980's drought (Ashworth 1998; Wassens in press). Local extinctions in New South Wales were first described in the early 1990's, although the reasons for these declines were poorly understood (Osborne et al. 1996; Wassens in press). Declines in abundance and distribution in South Australia, Victoria and inland New South Wales have also been reported, although dedicated long-term surveys are mostly lacking (Tyler 1997; Mahony 1999; Pyke 2002; Wassens in press).

New South Wales and the Australian Capital Territory

The growling grass frog occurs in isolated populations in western New South Wales, around Coleambally, Lake Victoria, and scattered locations in the Murray River Valley (DEC 2005). The species remains locally abundant in the Lowbidgee region at the confluence of the Murray and Darling Rivers and down stream along the Murray into South Australia (NPWS database; Wassens in press).

Populations persist in the Wakool region, north of the Murray River within both irrigation infrastructure and natural Black Box wetlands (Wassens in press) and the species has been recorded from six catchment management areas in New South Wales: Lower Murray Darling, Murrumbidgee, Murray, Lachlan, Central West and South East (DEC 2005). Growling grass frog populations persist in the Coleambally Irrigation Area (CIA) south of the Murrumbidgee (AMBS Consulting 2000; Wassens in press)

Debate continues as to whether the growling grass frog remains in the Monaro region at the southern end of the South Eastern Highlands. The species was present in the area in the early 1990's (Mahony 1999; Wassens in press), however surveys of this region in the late 1990's failed to locate the growling grass frog (Wassens in press).

The species has also disappeared from sites in the central and southern highlands (Ehmann & White 1996) and a number of sites along the Murrumbidgee River (Mahony 1999). The disappearance of the species in the southern highlands and the Australian Capital Territory coincided with a period of drought between 1978 and 1980 (Osborne et al. 1996).

Victoria

The growling grass frog appears to have undergone a dramatic decline in the northern and north-eastern plains of Victoria (DEC 2005). Significant remnant populations occur in the greater Melbourne area (Robertson et al. 2002; Heard et al. 2004; Poole 2004; Hamer & Organ 2006; Hamer & Organ 2008). The species has also been recently recorded in the south-west, north-west and central regions of Victoria, and from western Gippsland.

South Australia

There are three distinct groups of records of the growling grass frog in South Australia. One group is located in the far south-east of the state (near Keith), adjoining Victorian populations, one group along the Murray River from the Victorian border to the coast, and a small group in the Mt Lofty Ranges (Tyler 1978; DEC 2005). The latter population, however, is now considered extinct (DEC 2005).

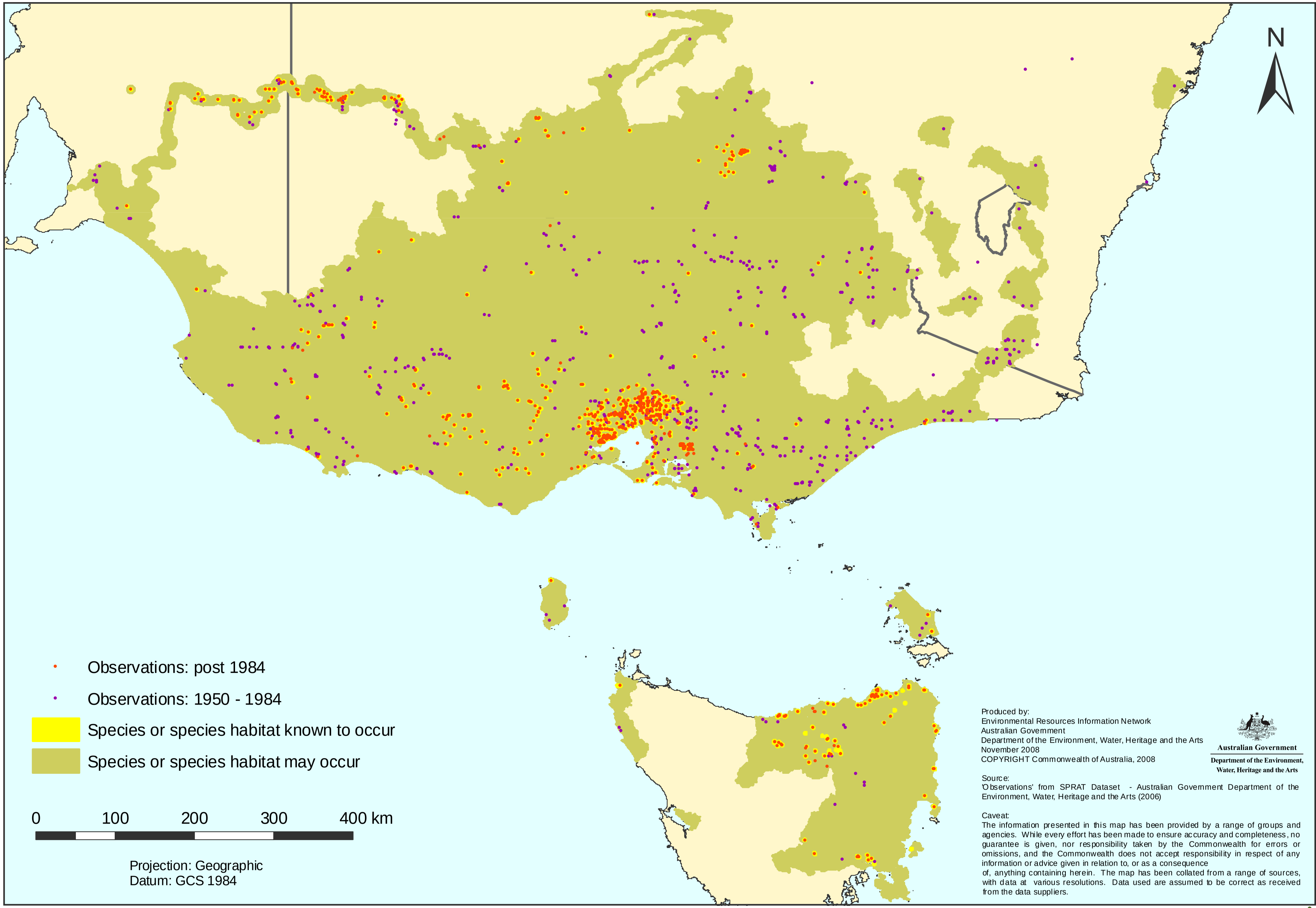
Tasmania

The growling grass frog's range has contracted in north-west, central and south Tasmania since the early 1980's (Tyler 1997). For example, the species has changed from abundant to scarce at Launceston. Populations still occur on Flinders and King Islands, though the species may be close to extinction on King Island due to the expansion of the dairy industry (DEC 2005).

Distribution map

Figure 1 highlights the known and potential distribution of the growling grass frog. The map aims to provide a guide to areas where the growling grass frog may occur based on records and landscape characteristics, and should not be taken as prescriptive or exhaustive.

Figure 1: Known and potential distribution of the growling grass frog (*Litoria raniformis*)



Habitat

The growling grass frog inhabits a wide range of still waterbodies across its range, including lagoons, swamps, lakes, ponds, farm dams, irrigation channels and quarries (DEC 2005). It also occupies slow-flowing sections of streams and rivers.

In the more mesic (moderately moist) areas of Tasmania and most of Victoria, the frogs are typically found among vegetation within or at the edges of permanent water such as slow-flowing streams, swamps, lagoons and lakes (Clemann & Gillespie 2004). In disturbed areas it commonly occurs in artificial waterbodies such as farm dams, irrigation channels and disused quarry holes, particularly where natural habitat is no longer available (Clemann & Gillespie 2004).

In contrast, populations from semi-arid and riverine areas in the north of the species' range currently occupy irrigated rice crops and swamps (Clemann & Gillespie 2004). Typical features of these habitats are that they are large, continuous areas containing both permanent and ephemeral waterbodies that undergo regular flooding, and are surrounded by areas containing suitable refugia (Clemann & Gillespie 2004).

Within these habitats, the growling grass frog utilises a range of microhabitats. Important microhabitats for nocturnal activity such as calling and foraging include floating and submergent vegetation, emergent vegetation (such as *Typha* spp. and *Eleocharis* spp.), bank-side rocks, open pasture and bare-ground (Heard et al. 2008b). These microhabitats may also be used during diurnal basking activities, which the species is well known for (Pyke 2002).

The growling grass frog shelters under rocks, logs, and other debris close to waterbodies, as well as in soil cracks and crayfish burrows (Wassens 2005).

Overwinter aestivation (hibernation) within dense vegetation is common amongst members of the bell frog complex (Osborne et al. 1996; Wassens et al. 2008). It has been suggested that the growling grass frog hibernates during winter in warm moist areas, such as under logs, rocks and beneath thick vegetation (Cree 1984; Ayers 1995; Ashworth 1998; Pyke 2002)

Habitat connectivity and dispersal corridors

Recent studies have found that the spatial arrangement (matrix) and level of connectivity among water bodies within the landscape is one of the most important factors influencing the presence of the growling grass frog at a given site (Robertson et al. 2002; Heard et al. 2004; Hamer & Organ 2008). This finding indicates that these frogs, like many others, display metapopulation dynamics (Heard et al. 2004) and require a matrix of aquatic and terrestrial habitat in order to persist in the landscape. The long-term viability of individual populations is dependant on dispersal corridors allowing movement to and from local breeding sites (Robertson in prep; Clemann & Gillespie 2004). Consequently, alterations to the landscape that decrease connectivity between habitat patches (for example: roads, residential developments, pipelines, fences, changed agricultural landuse etc) are likely to have an impact on the viability of individual populations, and can ultimately cause a break-down of the species' regional metapopulation dynamics.

Breeding

There is growing evidence that particular features of water-bodies influence their suitability for growling grass frogs. Occupied wetlands and breeding habitat consistently display diverse aquatic vegetation communities, including floating, submerged and emergent species (Robertson et al. 2002; Heard et al. 2004; Poole 2004; Wassens 2005; Hamer & Organ 2006; Hamer & Organ 2008; Heard et al. 2008). These are important microhabitats for frogs (as described above), but also likely represent substrates for egg deposition and foraging and shelter sites for tadpoles. Permanent wetlands are more likely to be occupied by the species and provide important core breeding habitat, but seasonally flooded sites also provide high-quality breeding habitat in high-rainfall years or during annual flooding events (Heard et al. 2004; Wassens 2005). In some areas, breeding occurs in waterbodies dominated by lignum and nardoo, and submerged aquatic vegetation like watermilfoil (Wassens et al. 2008a). Whilst some exceptions occur, it is generally the case that wetlands that are free of predatory fish, particularly exotic species, are of higher quality given the susceptibility of tadpoles to fish predation.

Variations in biology

Clemann and Gillespie (2004) outline the geographic variations in the biology of the growling grass frog. Throughout the growling grass frogs distribution there are two apparently distinct biogeographical groups:

- For the group in the semi-arid north of the species' range (semi-arid New South Wales and part of Victoria and South Australia bordering the Murray River) breeding is triggered by spring/summer flood events and the larval period can be as short as two months. In this area the frogs are concentrated in permanent waterbodies (such as irrigation canals, wetlands and dams) during the non breeding season and they then spread out randomly to seasonally flooded waterbodies during the spring and summer (Clemann & Gillespie 2004; Wassens et al. 2007).
- The second group occurs on the southern slopes of the Monaro district and the central southern tablelands of New South Wales, extending to the plains near Omeo in Victoria, across most of Victoria, far south-eastern South Australia and much of Tasmania (Atlas of Victorian Wildlife database; White & Pyke 1999; Clemann & Gillespie 2004). Breeding is again seasonal within this group (occurring in spring and summer) but the larval stage may last up to 15 months (Antis 2002; Clemann & Gillespie 2004). It appears that the spatial organisation of many populations within this group conform to a metapopulation structure (Robertson et al. 2002; Clemann & Gillespie 2004; Heard et al. 2004).

Diet

The growling grass frog is considered an opportunistic feeder (Ayers 1995; Pyke 2002). The diet of the growling grass frog is varied and it is known to feed on tadpoles and other frogs (including members of the same species) (Thomson 1922; Barker & Grigg 1977; Martin & Littlejohn 1982; Hero et al. 1991; Pyke 2002), as well as other vertebrates such as lizards, snakes, small fish (Martin & Littlejohn 1982; Pyke 2002), and invertebrates (Pyke 2002).

Key threats and recovery priorities

Loss and degradation of habitat

The loss, modification, degradation and fragmentation of aquatic and adjacent terrestrial habitats are likely to have had a considerable negative influence on growling grass frog populations (Clemann & Gillespie 2004). The majority of the growling grass frog's range has been subject to widespread clearing of native vegetation, grazing by exotic herbivores, agricultural enterprises (Graetz et al. 1995; Clemann & Gillespie 2004) and/or development of industrial or residential infrastructure (Clemann & Gillespie 2004).

Altered hydrological regimes have substantially modified natural processes around extant populations of growling grass frogs. In particular, Clemann and Gillespie (2004) identified three key aspects of the natural hydrological (flood) regimes that have been altered: timing – flooding now frequently occurs at times of the year that do not coincide with the growling grass frog breeding season; frequency – flood events may not occur as frequently, or at all in some areas, due to water being diverted away from the floodplains; and extent – areas are not being flooded as extensively, or at all, due to lack of water and diversion of all available water to irrigation and agriculture (Clemann & Gillespie 2004; Wassens et al. 2007; Wassens et al. 2008b).

Similarly, draining and degradation of coastal wetlands is a major threat to the growling grass frog in Tasmania (Ashworth 1998; Clemann & Gillespie 2004).

Clemann and Gillespie (2004) state that grazing by domestic stock occurs over much of the growling grass frog's former range. Grazing, particularly at high densities, can cause considerable damage to the margins of water bodies. Apart from clearing native vegetation and ground debris to create grazing land, grazing may affect frog habitat by:

- compacting soil and creating pugging in damp areas, which leads to the destruction of soil cracks used by sheltering frogs
- directly removing vegetation that is used by frogs for shelter and as movement corridors, and seed predation by stock can prevent regeneration of habitat (Meeson et al. 2002)
- removing vegetation which in turn affects the microclimate, including humidity levels at ground level, and
- trampling of breeding habitat and pollution of water at the margins of water bodies by domestic stock incursion.

Barriers to movement

Barriers to growling grass frog movement between water bodies (for example roads, footpaths, buildings, railways and fences) are likely to compromise the ability of populations of the frog to respond to periodic drought, changed hydrological regimes and fluctuations in water levels of local systems of water bodies (Robertson et al. 2002; Clemann & Gillespie 2004; Heard et al. 2004). There is mounting evidence that the growling grass frog, in most landscapes, is dependant upon movement between particular water bodies (permanent and seasonally flooded), and between breeding and non-breeding habitats (Clemann & Gillespie 2004; Heard et al. 2004; Wassens et al. 2008a). The construction of barriers around wetlands across the range of the growling grass frog has the potential to compromise the viability of many populations (Clemann & Gillespie 2004), and limits the species ability to recolonise an area after localised extinctions.

Disease and predation

The disease chytridomycosis, caused by the fungal pathogen chytrid fungus (*Batrachochytrium dendrobatidis*), has been implicated in the rapid declines of amphibians in several parts of the world. Chytrid fungus is known to infect the growling grass frog, as well as other members of the bell frog complex (Berger et al. 1999; Clemann & Gillespie 2004). It is reportedly wide spread in frog populations of eastern Australia and has been recently detected in the growling grass frog and the closely related green and golden bell frog (*Litoria aurea*) (Berger et al. 1999; Lewis 2008).

The growling grass frog is threatened by a number of feral species. Feral pests such as cats and fox's will readily prey on juvenile and adult frogs whilst rabbits, goats and domestic livestock will reduce vegetative cover through over grazing leading to degradation of surrounding habitats (Lewis 2008). Feral pigs also pose as a potential threat to the species through damage to wetland and riparian habitats (Lewis 2008).

Predation of eggs and/or tadpoles by introduced fish, particularly mosquitofish (*Gambusia holbrooki*), have been implicated in the decline of the *L. aurea* complex (Morgan & Buttemer 1996; White & Pyke 1996; Clemann & Gillespie 2004), particularly the green and golden bell frog, a species which is ecologically similar to the growling grass frog (Clemann & Gillespie 2004). Mosquitofish, and other introduced fish species such as redfin (*Perca fluviatilis*), trout (*Salmo* spp.), goldfish (*Carassius auratus*) and european carp (*Cyprincus carpio*), are common throughout the range of the growling grass frog (Clemann & Gillespie 2004).

High densities of european carp are thought to have a significant negative impact on recruitment levels (Wassens et al. 2008b). Studies on the impact of introduced fish species have tended to be circumstantial and the role of introduced fish in the decline of the growling grass frog remains unclear. However in other frog species fish have been shown to reduce frog recruitment via direct predation of eggs (Holomuzki, 1995; Hamer et al. 2002; Teplitsky et al. 2003; Wassens et al. 2008b), refusal of females to deposit eggs (Holomuzki 1995; Wassens et al. 2008b), and changes in tadpole behaviour and fitness (Teplitsky et al. 2003; Wassens et al. 2008b). European carp also reduce water quality and damage vegetation (Roberts et al., 1995, Pinto et al. 2005; Wassens et al. 2008b) which can impact on tadpole survival (Wassens et al. 2008b).

Biocides

Amphibians are particularly susceptible to pollutants due to their semi-aquatic lifestyle and semi-permeable skin. A large proportion of growling grass frog habitat occurs in areas where the application of biocides is a common practice. Consequently, the use of these chemicals may represent a considerable threat to the species (Clemann & Gillespie 2004). Further research is required to asses the influence chemicals such as herbicides have on bell frogs (Lewis 2008).

Recovery priorities

A national recovery plan (Clemann & Gillespie 2004) for the growling grass frog has been produced. The recovery plan aims to manage and protect the growling grass frog and its habitat, and to promote its recovery. The specific objectives of the recovery plan include the following:

- Secure all known extant populations of the growling grass frog.
- To improve the viability of growling grass frog populations (increased population sizes and/or areas of occurrence throughout its range).
- To improve understanding of the biology and ecology of the growling grass frog so effective management and sustainable use of natural resources within its habitat can be achieved.
- To identify causes for the observed decline of the growling grass frog across its geographic range.
- To address known or predicted threatening processes to the growling grass frog, and change or implement appropriate management practices where possible.
- To ensure that land use activities do not threaten the survival of the growling grass frog.
- To increase public awareness of the growling grass frog, and engender widespread support for its recovery amongst landowners and the community.

The objectives of the recovery plan will be achieved through the following recovery actions:

- Create and maintain a growling grass frog recovery team.
- Document interim habitat management prescriptions.
- Conduct surveys to ascertain current distribution and status.
- Monitor selected populations, and all translocated populations.
- Increase public awareness of the status and threats to the species, through the development of a brochure and information sheets for landowners.

The recovery plan also identified the following research priorities:

- Investigate movement patterns at selected sites across the growling grass frog's geographic range.
- Investigate differences in the genetics, ecology and life history traits of selected populations across the species' geographic range.
- Further research into disease, specifically the contemporary chytrid infection status of representative populations.
- Investigate the relationships between predation by exotic and native fish, and habitat complexity on recruitment.
- Investigate responses of all growling grass frog life-history stages to various relevant water parameters and pollutants.
- Investigate the response of the growling grass frog to translocation and/or the creation, recreation or rehabilitation of suitable habitat.
- Investigate the impact of fox and cat predation on selected populations.

In addition, the Department of Environment and Climate Change (NSW) has developed a draft recovery plan for *L. raniformis* (DEC 2005).

Significant impact assessment

Whether or not an action may have a significant impact depends upon the sensitivity, value and quality of the environment which is impacted and upon the intensity, duration, magnitude and geographic extent of the impacts. The potential for an action to have a significant impact will therefore vary from case to case. The following thresholds have been developed to provide guidance in determining the likely significance of impacts on the growling grass frog.

Significant impact thresholds

There is a real chance or possibility of a significant impact on the species if the action occurs in an area which supports an important population of the growling grass frog as shown on page 14.

The thresholds outlined on page 14 were developed in consultation with experts to provide guidance in determining the significance of impacts on the growling grass frog. However, decisions on significance will always need to be made on a case by case basis with consideration for the context of the action.

Ecological element affected	Habitat degradation in an area supporting an important population
Impact threshold	• Permanent removal or degradation of terrestrial habitat (for example between ponds, drainage lines or other temporary/permanent habitat) within 200 m of a water body in temperate regions, or 350 m of a water body in semi-arid regions, that results in the loss of dispersal or overwintering opportunities for an important population. • Alteration of aquatic vegetation diversity or structure that leads to a decrease in habitat quality. • Alteration to wetland hydrology, diversity and structure (for example any changes to timing, duration or frequency of flood events) that leads to a decrease in habitat quality. • Introduction of predatory fish and/or disease agents.
Comment	Habitat is a connected area that supports one or more key ecological functions for this species. These functions may include, but are not limited to: foraging, breeding, dispersal, shelter. Any action that results in the degradation of habitat such that the recruitment, survival or dispersal rates of an important population are lowered could have a significant impact on the species. Habitat quality increases with: • increasing wetland area, • water permanence, and • aquatic vegetation cover. Habitat quality decreases with: • the degree of development in the terrestrial zone (ie. Roads, buildings, fences etc) and • the presence of predatory fish.
Ecological element affected	**Isolation and fragmentation of populations**
Impact threshold	• Net reduction in the number and/or diversity of water bodies available to an important population. • Removal or alteration of available terrestrial or aquatic habitat corridors (including alteration of connectivity during flood events). • Construction of physical barriers to movement between water bodies, such as roads or buildings.
Comment	Habitat connectivity could be provided by a linear water body (for example creekline) or by suitable terrestrial habitat between waterbodies. Individuals may use a range of terrestrial and aquatic habitats as movement corridors between water bodies, including floodways or grassy fields. Any isolation of water bodies, through destruction of habitat, or creation of a barrier such that movement or migration between waterbodies is less likely could have a significant impact on the species.

Notes:

The elements and thresholds in the table above give guidance to the level of impact that may be significant for the species at a site. They are not intended to be exhaustive or prescriptive, but rather to highlight the need to maintain the ecological function of the habitat area.

Habitat and/or populations may, and usually will, extend beyond the site boundaries. Failure to consider impacts beyond the limits of the site may lead to indirect negative impacts on significant populations.

Mitigation Measures

Mitigation activities are generally undertaken on the site of the development to avoid or reduce impacts. Ideally, mitigation measures should be incorporated into the design of a development so that significant impacts do not occur.

Care should be taken to ensure that any mitigation and/or management actions implemented for the growling grass frog do not have a negative impact on other matters of national environmental significance present at a site. The mitigation and management proposed at a site needs to take into account the needs of all matters of national environmental significance in a project area.

The following measures may assist in minimising impacts on the growling grass frog. They should be used with the aim of reducing the impact of an action to below the thresholds laid out in this document. Avoidance measures should be considered the priority, followed by measures to reduce the level of impact. In many cases, a combination of mitigation measures may give the highest benefit.

Examples of mitigation measures for the growling grass frog

Avoiding impacts

- Retain habitat known or likely to contain the growling grass frog, and manage for the species.
- Retain terrestrial habitat and dispersal corridors:
  – incorporate buffer zones of at least 200 m, and 350 m around water bodies in temperate and semi-arid zones respectively
  – maintain dedicated terrestrial habitat corridors, of a minimum of 100 m in width, and
  – maintain existing hydrological regimes.

Minimising impacts

- Maintain existing management regime if the site currently supports a breeding population of *L. raniformis* (for example current grazing intensity).
- Maintain existing water quality.

Managing habitat

- Enhance habitat quality
  – carefully remove weeds and replace with indigenous submergent, floating and emergent vegetation in and around water bodies. In weedy areas that support growling grass frogs, weeds need to be gradually removed and replaced by natives. Any drastic and sudden removal of weeds in areas supporting growling grass frogs is likely to have a negative effect on the species.
  – maintain open (unvegetated) areas within water bodies, potentially by increasing water depth in some sections.
  – remove or manage exotic fish (for example mosquitofish, carp and redfin). If required, drainage of water bodies to eliminate fish should occur during times of the year when there are few or no tadpoles present.
  – improve terrestrial habitat through provision of logs, rocks and riparian vegetation etc., to provide a diversity of overwintering habitat.
  – manage terrestrial weeds (manually, and without chemicals).

Experimental measures

A number of measures have been proposed or tried in an attempt to mitigate the impacts of an action. As yet, these measures have not demonstrated substantial success and should be considered experimental. Some experimental measures include:

- Habitat creation – Artificial water bodies, such as storm-water ponds, may appear successful in the first year or two, but their occupancy and productivity often declines in subsequent years. The reasons for these declines are varied, but pollution from storm-water, weed invasions and the introduction of predators appear key factors.
- Frog fencing and underpasses – Frog fences have been implemented in an attempt to channel frog movements towards suitable movement corridors. Underpasses have been installed under roads to prevent movement across roads. There is currently no evidence that growling grass frogs follow frog fences or utilise underpasses. In addition, evidence that frogs use these structures from time to time would not constitute evidence that they satisfactorily mitigate the impacts of a particular action. The lack of evidence of success of such measures has often been attributed to poor monitoring and maintenance following implementation. Any proposed use of these or other experimental measures must utilise the best available information and be accompanied by an adaptive management strategy which clearly specifies:
  - the criteria for identifying success (for example existing occupancy rate maintained after five years), and
  - identifies thresholds at which management intervention will occur.

Ongoing monitoring should collect data which allows the reason behind any decline to be identified, and to inform any adaptive management undertaken.

Despite being experimental, habitat creation and connective measures such as underpasses have the potential to play an important role in increasing available habitat and maintaining or increasing habitat connectivity. Artificial habitat should be positioned to create new links between otherwise unconnected water bodies (due to distance or unsuitable corridors), and its creation timed so that it is suitable for occupation at the time individuals are dispersing (spring–summer for temperate, post-flooding for semi-arid).

Translocation

Translocation does not reduce the impact of an action below the significance threshold. Translocation of growling grass frogs is not considered to mitigate the impact of an action. However, salvage translocation may be considered as part of the conditions of approval.

Survey Guidelines

A guide to conducting surveys for the growling grass frog is given below. Surveys should be designed to maximise the chance of detecting the species, and should also be used to determine the context of the site within the broader landscape. Consideration should be given to the timing, effort, methods and area to be covered in the context of the proposed action. If surveys are conducted outside recommended periods or conditions, survey methods and effort should be adjusted to compensate for the decreased likelihood of detecting the species.

Habitat use by the growling grass frog is dynamic; within and between years the species' abundance in certain habitats, its choice and use of different habitats can vary markedly (Clemann & Gillespie 2004). Similarly, the likelihood of detecting the species relies heavily on the frog's behaviour. Growling grass frogs may be detected relatively easily when calling or basking but difficult to detect when silent or inactive (Clemann & Gillespie 2004). Detectability also varies between different habitat types and the species behaviour in different areas can be quite different. Consequently, surveys for growling grass frogs should be conducted across a spectrum of habitat types available in the landscape, and not restricted to habitats considered likely to contain the species (Clemann & Gillespie 2004). Surveys should attempt to determine habitat occupancy and incorporate repeat visits to all survey sites (Clemann & Gillespie 2004; Heard et al. 2006).

The EPBC Act protected matters search tool will provide a good starting point for determining the likelihood of having growling grass frog habitat in your area. Survey results should be lodged with the Commonwealth and relevant state or territory authority.

Is the habitat suitable?

Prior to carrying out surveys, it is important to assess whether a site supports habitat that is suitable for the growling grass frog. The following characteristics should be assessed, as they are indicators of the likely presence of the species at a site and the quality of the habitat:

- within known range of the species
- presence of water bodies, including slow flowing streams and rivers, or off-stream wetlands, which contain water at least periodically
- records of growling grass frogs in the local area, and
- presence of other frog species.

Where it is not possible to conduct surveys in the manner recommended the precautionary principle should be used (that is, failure to detect the growling grass frog should not be considered indicative of its absence).

Conditions

Research from southern Victoria suggests that night time surveys are preferable to day time surveys and that ideal survey conditions include warm and windless nights in spring and summer (Heard et al. 2006):

- daytime air temperatures greater than 15 degrees celsius, with moderate to no wind, and
- night time air temperatures greater than 12 degrees celsius, with moderate to no wind.

Survey guidelines for detecting the growling grass frog

Aim	To maximise the chance of detecting the growling grass frog at the local site, and in the surrounding landscape.
Timing	At the time of peak activity for the species*: **Temperate southern regions:** Between November and March (calling takes place primarily between November and December however the frogs may still be active until March). **Semi-arid regions:** within one month of flooding (generally October–February).
Effort and methods	• Over at least two nights, under ideal conditions: • using a combination of call playback and night time visual encounter surveys (Heard et al. 2006) • covering a range of stream structures, billabong, farm ponds and dams, swamps and irrigation channels • accompanied by habitat assessment, and • undertaken by appropriately experienced personnel. **Important:** Chytrid fungus is readily transported between sites (e.g. on boots) and suitable precautionary measures must be taken whilst surveying. Please see the threat abatement plan for chrytrid fungus and/or refer to relevant state publications.
Area to be covered **1) Study site** **2) Local area**	1) Small water bodies (<50 metres at greatest length) should be covered in a period of about one hour. Searching banks and emergent vegetation. Larger water bodies (>50 metres) should be searched by sampling subsets of the whole waterbody in a systematic manner. 2) Local area study should include waterbodies surrounding the survey area to place observations at target site in context.

* As the timing of the peak activity and calling varies annually and geographically, the best indicator of key survey period is the presence of active growling grass frogs at known local sites. Reference sites should be monitored during the expected seasonal period of high frog activity and used to guide survey timing at target site.

See Heard et al. (2006) for further detail on survey techniques and detection probabilities for the growling grass frog. Note that Heard et al. (2006) have stressed that the detection probabilities reported are unlikely to apply over the entire growling grass frog range, and that differing survey methods and observer skill/experience could affect detection probabilities.

Where it is not possible to conduct surveys in the manner recommended the precautionary principle should be used, that is failure to detect the growling grass frog should not be considered indicative of its absence.

Survey methods

Call detection, call playback and visual encounter surveys may be useful in detecting the growling grass frog.

Call detection and call playback

- only useful during the breeding period, and only when conditions are conducive to calling
- requires the observer to learn to identify the species-specific call, or to record any calls heard for subsequent analysis and to use appropriate equipment (microphones) suitable for different circumstances
- care should be taken when utilising these techniques in areas of strong or fast running water, as calls can go unheard because of noise pollution, and
- call playbacks should be conducted every 100 m along the edge of the water body.

Visual Encounter Surveys

- best carried out between 20:30 and 03:00 hours
- a standard period of ten minutes should be spent listening for frog calls at the beginning of each survey
- call playback should be conducted in an attempt to stimulate production of advertisement calls by males
- sites should be systematically searched for active frogs following general procedures outlined by Crump and Scott (1994), and
- use spotlights to scan all surfaces of the water body while traversing its length, focusing on inspection of aquatic vegetation (Heard et al. 2006).

Habitat assessment

- In addition to undertaking surveys for the growling grass frog, the following habitat characteristics should be assessed. Surveys should endeavour to determine the potential connectivity of water bodies on site to neighbouring water bodies, even if growling grass frog individuals are not detected on site. Because the growling grass frog uses a series of water bodies, not all of which will be permanently occupied, the presence of the species in neighbouring water bodies provides an indicator of the likely use of on-site water bodies. The following questions should be asked during habitat assessment to determine whether a site contains habitat for a population of growling grass frogs:
- How close is the nearest water body?
  - In the semi-arid zone, individuals are unlikely to move further than five kilometres between water bodies in the absence of major flood events.
  - In temperate areas, individuals are unlikely to move further than one to two kilometres between water bodies.
- How many water bodies occur within ten kilometres (for example from topographic maps)?
- Is there habitat connectivity (terrestrial or aquatic) between water bodies on site and between water bodies on site and those on neighbouring sites?

Additional data

Surveys for growling grass frog should be accompanied by a detailed description of the habitat present on the site, its history of management, and the context of the site in the surrounding landscape. Where surveys cannot be conducted outside of the site, other aids such as aerial photographs, historical records, and vegetation datasets can be useful in giving context to the site.

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