Threatened species survey and assessment guidelines: field survey methods for fauna

Amphibians

Department of **Environment & Climate Change** NSW

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1. Introduction

All investigators conducting field surveys for amphibians should be experienced and competent in surveying amphibians and identifying frogs, and be familiar with the target species.

Useful keys for identifying frogs and tadpoles are listed in section 9 and include:

- Anstis M 2002, *Tadpoles of south-eastern Australia: a guide with keys*, Reed New Holland, Sydney.
- Barker J, Grigg GC and Tyler MJ 1995, *A field guide to Australian frogs*, Surrey Beatty and Sons, Chipping Norton NSW
- Cogger HG 2000, *Reptiles and amphibians of Australia*, Reed Books Australia.
- Robinson M 1993 (reprinted 2000), *A field guide to frogs of Australia from Port Augusta to Fraser Island including Tasmania*, Reed New Holland.

Calls can be identified using reference recordings such as *Australian frog calls: subtropical east*, by David Stewart (visit www.naturesound.com.au).

The Department of Environment and Climate Change's (DECC's) threatened species profiles
(visit www.threatenedspecies.environment.nsw.gov.au/tsprofile/home_species.aspx) contain descriptions of and calls for most species.

Alternatively, you may wish to assume a species is present if suitable habitat exists on the site, rather than conduct surveys. See section 7 for more information on habitat assessment.

Accessing local information

Different species have different seasonal and daily peaks of activity based on their biology and the weather. To increase the likelihood of detecting target species, you should conduct surveys at the time of year and day when those species are most likely to be active and during weather conditions favouring activity. Section 8 identifies the months suitable for surveying each threatened species. However, DECC strongly recommends that you contact your local DECC office (National Parks and Wildlife Service) or local Department of Primary Industries office, and local frog groups such as the Frog and Tadpole Study Group of NSW Inc (visit www.fats.org.au/Welcome.html) to see if they have any additional information on the target species in the area of the survey.

You may need to confirm a frog's identity with an expert. For rare species, university researchers may be the best source of information.

These general guidelines are based on the best available knowledge at the time of writing, but you should always seek local information and current literature on the target species, particularly in regard to weather conditions favourable for activity, and then survey during those times. The nature and source of this information should always be included in the report (see section 6).

Times, seasons and weather for surveys

As the probability of detecting frogs is so closely linked to weather conditions, DECC recommends finding a reference site where the species is known to occur which is near the development site, where possible. Use this reference site to determine when frogs

are calling or active, so the proposed development site can be surveyed at that time. If no frogs are calling at the reference site, it is likely that environmental conditions are not conducive to frog activity and surveying the proposed site is likely to be ineffective.

In general, a thorough frog survey will involve a combination of nocturnal searches, call surveys and tadpole surveys conducted in suitable weather conditions and repeated on a number of separate occasions (see sections 2–4).

As most frogs are nocturnal and easily detected by their calls, surveys should generally be undertaken at night in wet, warm weather. Many frogs become less active at lower temperatures, making conditions less suitable for surveys. As surveys are so weather dependent, several potential survey dates should be set aside.

Tadpole surveys are not weather dependent and can be conducted during the day and throughout the entire breeding season for most species (Anstis pers. comm).

For most species, surveys should be undertaken in and around areas containing water (i.e. along streams, dams, intermittent ponds etc), although some species such as the pouched frog (*Assa darlingtoni)* live in leaf litter and under rocks and logs on the rainforest floor (Thumm pers. comm, Ingram et al 1975), not necessarily near water.

Section 8 outlines recommended weather conditions, times of year and methods for surveying each species of threatened frog.

Handling frogs

Frogs must be handled as little as possible to avoid removing skin secretions, and must be kept moist during identification and before release. Do not use insect repellent or hand creams before handling frogs. The *Hygiene protocol for the control of disease in frogs* (visit www.environment.nsw.gov.au/resources/nature/hyprfrog.pdf) must be followed when working with frogs or conducting fieldwork in wetlands or other freshwater environments. This protocol aims to prevent the spread of pathogens, such as chytrid fungus. It covers on-site hygiene issues, including the cleaning and disinfection of footwear, equipment and vehicles; and the handling of frogs in the field.

A recent paper by Cashins et al (2008) suggests certain types of glove, particularly latex and nitrile (synthetic latex) gloves, can be lethal to tadpoles. Their study comparing three commonly-used types of glove (latex, nitrile and vinyl) found using vinyl gloves and rinsing them before use decreased tadpole mortality, but different species appear to react differently. As a precaution, if you must use gloves, avoid using latex or nitrile gloves, and wash all gloves in clean water before handling tadpoles.

2. Nocturnal searches

Also known as visual encounter surveys, headlamp surveys or stream searches, nocturnal searches are surveys for adult frogs conducted at night, and involve experienced surveyors walking through an area of habitat, such as along a stream, and actively looking for exposed or active frogs and eyeshine. They can be conducted along a transect or as a randomised walk. All aspects of the watercourse and adjacent areas should be searched, including under logs and rocks, in shrubs and trees, under bark and in litter or emergent vegetation. Surveys in rainforests and other dense, tall vegetation may require a longer time period to compensate for the greater structural diversity of the habitat.

A nocturnal survey should be conducted with a spotlight or head torch and is generally more successful on nights just following rain.

Diurnal habitat searches in Australia are generally not effective for detecting frogs as most species hide too well. Even in tropical habitats, nocturnal searches generally detect more species than diurnal ones (Pearman et al 1995).

A diurnal survey for basking individuals can be conducted as an *additional* method for some species, including the:

- green and golden bell frog (*Litoria aurea)*
- spotted tree frog *(L. spenceri)* (Hamer et al 2003, Gillespie and Hollis 1996)
- *Philoria spp.* (Anstis pers. comm)
- southern corroboree frog (*Pseudophryne corroboree)*
- northern corroboree frog (*P. pengilleyi)* (Osborne et al 1999)
- pouched frog (*Assa darlingtoni)* (Lemckert pers. comm).

3. Call surveys, including call playback

Call surveys are extensively used to record the presence of species (Lemckert and Mahony 2008), by recording the species-specific calls that males use to advertise their presence. Frog calling is generally restricted to the breeding season and when conditions are conducive to calling. These calling periods can be considered the core calling period for any species (Lemckert and Mahony 2008). Calling may still occur outside this period but is unpredictable (Lemckert and Mahony 2008).

For most species, calling activity decreases throughout the night, so surveys are best undertaken when the target species is most likely to be active. Seek local information when you can.

Section 8 provides information on the calling period and time when calling is most likely to occur for each species. For some species, very little is known about calling behaviour.

Call surveys can be undertaken by:

- **audio strip transect** – listening to and recording calls along a transect. This technique is particularly useful on sites with large or elongated areas of suitable habitat such as along a stream or creek bank and can be conducted while doing a nocturnal search.
- **static or point call survey** – listening to and recording calls at a particular site. This method is suited to areas where species breed in farm dams or small ponds, and can be conducted while doing a nocturnal search.
- **call playback** – attempting to stimulate male frogs to call by imitating or playing their call at probable breeding sites. *Pseudophryne australis*, *P. corroboree* and *P. pengilleyi* may respond to loud shouting at a particular pitch if conditions are suitable, although this should only be conducted by experienced surveyors.

Calls can be recorded manually using a hand held tape recorder with a microphone attached to confirm identification. The microphone needs to be placed as close as possible to the calling frog. This method is recommended for less experienced surveyors or those not familiar with the target species.

Automatic tape recorders can be left in place and programmed to record intermittently throughout the night (Parris et al 1999), to increase survey effort at a site. It can be used for any species with a distinctive call (Lemckert pers. comm), although a loud chorus from a common species can drown out isolated or softer intermittent calls from a threatened species.

In some situations, the call will have to be traced to its source for positive identification. For example, all species of *Philoria* have calls that are virtually indistinguishable (Knowles et al. 2004). Where species are sympatric and have very similar calls (e.g. *P. sphagnicolus* and *P. loveridgei*), frogs should be caught to obtain a positive identification.

To trace a calling frog, position at least two people around the sound of the call. Each person should shine a torch beam in the direction from which the call is coming. The intersection of the torch beams should indicate the approximate location of the frog, which can then be captured and identified.

Surveying at a core calling period does not guarantee that individuals will be calling at the time of the survey. Environmental conditions, such as temperature and recent rainfall, affect the calling activity of frogs and must be considered as well as information on calling periods. Unfavourable climatic conditions may curtail calling activity and could prevent frogs from being detected in an area where they are otherwise common, even if

it is the middle of the core calling period and the survey effort is high (Lemckert and Mahony 2008). Likewise, surveying for frogs in the wrong habitat is also unlikely to detect target species (Lemckert and Mahony 2008).

Call surveys will be most successful when surveyors are familiar with the calls of all frog species, common and threatened, likely to be found in the area.

4. Tadpole surveys

If you are experienced in identifying tadpoles, tadpole surveys can be an effective way of detecting frogs. Tadpole identification is difficult and requires specialist knowledge and experience. Depending on the species and prevailing climatic conditions, tadpole development can take place from ten days to two years (Anstis pers. comm), meaning tadpoles are often present at a site when adults are less active or not active at all. Another advantage of tadpole surveys is that they are not weather dependent.

Tadpole surveys can be conducted by either using a dip net or by using light traps, also known as bait traps, which are available from bait shops. Light traps can be left overnight and can catch both bottom dwelling tadpoles (often Myobatrachidae) and top column swimmers (often Hylidae) (White pers. comm).

Tadpole surveys can be conducted wherever there is enough water to submerge a trap or net. Traps are not effective in very shallow water, whereas dip nets can be used in any depth of water (Anstis pers. comm).

When using a dip net, samples should be taken from different depths (bottom, mid-water and surface) and from both near the bank and further out, using a thorough swooping movement.

In clear water, tadpoles can often be seen, while in turbid water, you will need to examine what comes up after random swooping – both in shallow water near the bank and in deeper water further out (Anstis pers. comm).

One disadvantage of tadpole surveys is that newly hatched tadpoles are more difficult to identify and *Litoria spp.* in particular are difficult to identify until the later development stages (White pers. comm, Anstis pers. comm). However, knowledge of the species likely to occur in an area helps to narrow down the possibilities and some larger hylid tadpoles such as *Litoria littlejohni* and *L. aurea* are more distinctive (Anstis pers. comm). If you cannot identify a tadpole, you should seek the advice of an expert. In this instance, take digital photos of the tadpole in the water. Photos of tadpoles taken out of the water (e.g. on someone's hand) are very difficult to identify (Anstis pers. comm).

Photographing tadpoles

Use a digital camera that takes good macro shots and focuses readily. Place the tadpole in a small shallow container (e.g. rectangular takeaway container) with fine sand on the bottom and clear water. Use photos in Anstis (2002) as a guide.

The tadpole should be in good light as the flash will reflect on the water's surface (you may need to use a higher ISO). The picture must be in focus and reasonably exposed.

When the tadpole stops moving or is moving as little as possible, take several macro shots from above so the camera lens is parallel to the dorsal surface of the tadpole (eye position is crucial in identification, and if the photo is taken at an angle, this is not always clear).

Also record the following information:

- approximate total length, including tail
- approximate body length, excluding tail
- location information

- habitat, including position in the water column, how near to the bank it was found, and whether it was in a flowing stream or pond
- approximate numbers of the type of tadpole – types can often be recognised by their behaviour (e.g. bottom dwellers or surface dwellers) and whether they are together in one particular part of the water body (Anstis pers. comm).

If possible, also try to take a profile picture (side-on view) of the tadpole in a glass container (with sand and water). This is more difficult than getting a dorsal shot and requires patience. A profile shot can help if identification is difficult.

Chytrid fungus can damage the keratinised teeth and jaws of tadpoles. It is often possible to see damage in the mouthparts when the tadpole is turned on its back on your hand, out of the water. If possible, take several macro shots of the mouth. Report incidents of chytrid to DECC by emailing info@environment.nsw.gov.au.

Photos can be emailed to Marion Anstis, who will identify them for a small fee. Email them to info@environment.nsw.gov.au.

Conducting tadpole surveys

Tadpole surveys can also be conducted during the day or at night with a spotlight. Many species of tadpole may occur at low densities and hide under rocks or debris during the day, so are more easily detected at night (Daly pers. comm).

Recommended effort is one trap for each water body on the site. For water bodies more than 50 metres in area (i.e. riparian areas or big dams), two traps per 50 metres should be used (White pers. comm). In general, one trap should be placed in deeper water (though not necessarily the deepest part) and one closer to the bank (Anstis pers. comm).

Tadpole surveys are not suitable for *Assa darlingtoni* as the male keeps the tadpoles in his pouch until they metamorphose, but small white egg masses can sometimes be found before the hatched tadpoles move into the male's pouch. They are also not suitable for *Philoria spp.* which all lay eggs in small moist hollows beneath rocks or leaf litter in seepage areas, where the embryos complete their entire development and metamorphose. The tadpoles do not leave the nest until they emerge as metamorphlings (Knowles et al 2004).

5. Other survey methods

Nocturnal driving surveys

These surveys involve spotlighting from a slow-moving vehicle along roads that intersect areas of suitable habitat. This method can be used to survey large, highly mobile species that cross roads while foraging or moving between areas of habitat. It can be useful for some arboreal species of tree frog during the breeding season when frogs are moving to and from their breeding sites (Lemckert pers. comm). It is not suitable for species with small home ranges, or small or sedentary terrestrial species.

This technique allows large areas to be surveyed in a relatively short amount of time, but only where roads intersect areas of habitat. This method is likely to be successful only after rain (Anstis pers. comm).

Pitfall trapping

Pitfall trapping is generally not recommended for amphibian surveys, but may catch frogs when used as part of a larger survey for reptiles or small mammals.

6. Information to be included in the final report

The following information should be included in the final report to the consent authority. See www.environment.nsw.gov.au/threatenedspecies/surveymethodsfauna.htm for more information on the final report:

- names of all species detected and the number of individuals of each species
- for all threatened species, an estimate of the local and regional abundance of those species; a full description of the type, location, size and condition of their habitat; and the dates and times of the surveys, including start and finish times
- the names, qualifications and experience of the surveyors, including any experts who provided identification
- weather conditions for each survey, including the air temperature, relative humidity (particularly important for calling behaviour), the time since it last rained and water temperature
- a description of the habitat in the survey area, particularly the proximity to and the nature of riparian features
- a description of the survey method including the location and length of the transects, the dimensions of the total area searched, and the number of simulations used and the spacing between them (call playback).

7. Survey effort

As many threatened amphibians have a patchy distribution, low population sizes and cryptic habits, the survey effort, including the size of the area to be searched and the number of repeat surveys that must be conducted, generally must be high to ensure results are accurate. Even under ideal survey conditions, few animal species are so visible that they are detected with absolute certainty (Wintle et al 2005). As a result, one-off, low-intensity surveys of small areas are generally inadequate for detecting threatened species. Generally, you should visit a site more than once and use a number of sampling techniques in combination (Parris et al 1999). Section 8 outlines the minimum effort required for each threatened species, but always use your professional judgement, and provide a justification for this based on the conditions at each site.

You may wish to assume a species is present if suitable habitat exists on the site, rather than conduct surveys.

You can survey for more than one species at a time if the survey methods and effort are the same, although the recommended level of effort needs to be met for each species.

A generic level of effort is difficult as each site is unique. While a small pond may be easily checked by one person in 10–15 minutes, a dam or stream may require an hour or more to survey. Effort for nocturnal searches should involve surveyors walking slowing along the transect or survey site at a slow enough pace to thoroughly search the area, looking for eyeshine and individuals. Unlike other types of scientific studies, surveys for impact assessments do not need to be for a pre-determined length of time, nor do they need to be consistent between sites, as the aim of the survey is to determine if a threatened species is present, rather than to compare or monitor sites.

You should spend enough time at each site to thoroughly survey the area of suitable habitat. For large development sites which contain large water bodies or long sections of stream or river, or for planned developments which are likely to have downstream impacts, more than one survey site should be set up along the water course and be targeted with a transect. In the report, justify the level of effort employed, and include information on the size of the area and the amount of time spent searching.

Transects should be targeted to areas containing suitable habitat for the target species. The number of transects required for large sections of rivers or streams will depend on the area of suitable habitat present.

As an example, a study by Gillespie and Hollis (1996) of the spotted tree frog (*Litoria spenceri*) in Victoria and parts of NSW which detected the frog in streams in which it was previously unrecorded, searched a minimum distance of 500 metres at each site with most transects at least one kilometre long. Sites were chosen based on the presence of suitable habitat rather than the location of historical records alone, and an effort was made to survey inaccessible areas.

Where there is a species profile, environmental impact assessment guidelines or a recovery plan prepared for a species, these documents should be considered when designing surveys and assessing impacts. These documents also contain detailed information on habitat requirements.

DECC's threatened species website (visit www.threatenedspecies.environment.nsw.gov.au/tsprofile/home_species.aspx) will provide links to the above documents for the species you are interested in, if they are available.

8. Recommended survey methods and effort for each species

Key

EIA guidelines = environmental impact assessment guidelines

EPBC Act = *Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth)

TSC Act = *Threatened Species Conservation Act 1995*

To read the species profile for each species, visit www.threatenedspecies.environment.nsw.gov.au/tsprofile/profile.aspx

Habitat and habits	Survey methods and effort	Time of year suitable for survey	Additional notes
***Assa darlingtoni* (pouched frog) Status**: Vulnerable (TSC Act)			
Found in Antarctic Beech forest and rainforest in mountainous areas. Does not need free water to breed as eggs are laid on the ground (Robinson 1993). Spends most of its time in damp leaf litter, or under rocks and fallen logs on the rainforest floor (NPWS 2000). Males call from secreted positions on the ground under leaf litter, logs or rocks (Anstis 2002).	Nocturnal call surveys in suitable habitat and weather conditions. As this species shelters under cover, surveyors will need to listen for calls. Calling position during daylight is usually concealed, but at night is generally fully or partly exposed (Ingram et al 1975). Minimum of one 200-metre transect, repeated on a minimum of two separate nights. This species can be very difficult to detect when it is not calling (Parris et al 1999). During the breeding season, searches should include looking for eggs, which are white and distinctive (Anstis pers. comm). Tadpole surveys are not suitable for this species as the male keeps tadpoles in his pouches until they emerge as tiny froglets.	October–May (Lemckert and Mahony 2008) Males call during spring and summer (Anstis 2002). Calling intensifies during early morning (dawn) and late afternoon (dusk) (Anstis 2002). Surveys should be undertaken from late afternoon to about 9 p.m. (Anstis pers. comm) and are more successful after rain (Daly pers. comm). Extreme care should be taken when rolling rocks and logs to minimise damage to habitat.	Read the species profile

Habitat and habits	Survey methods and effort	Time of year suitable for survey	Additional notes
***Adelotus brevis* (tusked frog) Status:** Endangered population in the Nandewar and New England Tablelands Bioregions (TSC Act)			
Usually associated with water bodies in rainforest, wet sclerophyll forest, or grassland which is sometimes flooded. Most frequently found under cover beside large dams or stream pools, ponds or ditches (Robinson 1993, Daly pers. comm, Anstis pers. comm). Often shelters under leaf litter, logs or stones, and in cavities or crevices beside puddles or streams (Cogger 2000). Males call from the water, hidden among vegetation or behind logs and rocks in the water, and can sometimes be hard to locate (Robinson 1993). Males construct nests in concealed sites under leaf litter, vegetation or logs in shallow water at the edge of ponds or stream pools. Nests may also be in water-filled depressions such as those made by yabbies or cattle (Anstis 2002). Eggs are white (Anstis pers. comm). Tadpoles are most often observed among leaf litter on the substrate but range throughout the water body (Anstis 2002).	Combination of tadpole surveys, call surveys and nocturnal searches in suitable habitat and weather conditions. As this species shelters under cover, surveyors need to listen for calls and search rolling rocks and fallen logs (taking care not to destroy habitat) in areas of suitable habitat. Minimum of one 200-metre transect per water body repeated on a minimum of two separate nights.	October–February (Lemckert and Mahony 2008) Calling occurs during spring and summer and often continues day and night. Intensity increases after rain. Peak periods of breeding may occur in late spring (Anstis 2002).	Extreme care should be taken when rolling rocks and logs to minimise damage to habitat. Care needs to be taken with tadpole identification as tadpoles may be confused with those of *Crinia signifera* or smaller specimens of *Litoria pearsoniana* (Anstis 2002). Tadpoles at many sites have a white spot on their nose (Daly pers. comm). Read the species profile

Habitat and habits	Survey methods and effort	Time of year suitable for survey	Additional notes
***Crinia sloanei* (Sloane's froglet) Status**: Vulnerable (TSC Act)			
Found in woodland, grassland and open or disturbed areas, usually associated with inundated areas (Robinson 1993). Males call after rain while afloat in temporary ponds, flooded grassland, ditches and swamp areas (Anstis 2002) and the upper laterals of non-perennial creeks (Daly pers. comm).	Combination of call surveys and nocturnal searches in suitable habitat after rain. Minimum of one 200-metre transect per water body or inundated area, repeated on a minimum of two separate nights. Tadpole surveys are not suitable for this species as they are unable to be distinguished from *Crinia parinsignifera* or *C. signifera* when these species are sympatric (Anstis pers. comm).	Autumn, winter and spring, after rain (Anstis pers. comm) Breeding has been observed late winter to spring (Anstis 2002) and calling appears to be from at least mid-winter to early spring (Lemckert pers. comm) This species requires enough rain to flood temporary pools and wetlands (Lemckert pers. comm). It is probably an opportunistic breeder, as rain is often unpredictable throughout its range (Anstis pers. comm). A cryptic species found usually only after rain when males start calling (Cogger 2000).	Lemckert and Mahony (2008) were unable to establish a core calling period for this species. Read the species profile
***Crinia tinnula* (wallum froglet) Status**: Vulnerable (TSC Act)			
This species appears to be confined to acid paperbark swamps in the wallum country (Robinson 1993). Males call from secluded positions either beside water or while afloat among emergent vegetation (Anstis 2002). Tadpoles are bottom dwellers (Anstis 2002).	Combination of tadpole surveys, call surveys and nocturnal searches in suitable weather conditions around swamps, dams and flooded roadside ditches. Minimum of one 200-metre transect per water body or inundated area, repeated on a minimum of two separate nights.	November–May (Lemckert and Mahony 2008). Breeding occurs in autumn and late winter, and possibly spring and late summer (Anstis 2002). Weather conditions are likely to be more important than the time of year for this species (Anstis pers. comm). Males call at any time of the year, especially after heavy rain, and can sometimes be heard during the day after rain.	Read the species profile

Habitat and habits	Survey methods and effort	Time of year suitable for survey	Additional notes
***Heleioporus australiacus* (giant burrowing frog) Status:** Vulnerable (TSC Act and EPBC Act) Read the EIA guidelines – visit www.environment.nsw.gov.au/resources/nature/Giantburrowingfrogeia0501.pdf			
Appears to exist as two distinct populations in the north and south of its range, both with slightly different habitat preferences. Has been associated with yabbie burrows and has been known to call while buried. Spends most of its time in non-breeding habitats up to 500 metres from water (Lemckert and Brassil 2003, Penman et al 2008). Individuals move from these sites to breeding sites within ten days of heavy rains (Penman et al 2008). Tadpoles are generally sedentary and slow moving and mostly frequent the bottom of small pools (Anstis 2002) although their long lifespan means they need semi-permanent to permanent water to survive (Lemckert pers. comm).	Call surveys have occasionally been successful when they coincide with an explosive breeding event, but are generally not effective (Lemckert pers. comm, EIA guidelines). This species calls irregularly (Lemckert pers. comm) but has a distinctive call. The call generally does not carry far (less than 10 metres) so many sites must be included when conducting call surveys. Tadpole surveys and nocturnal searches in suitable habitat and weather conditions are more effective than call surveys. Minimum of one 200-metre transect per water body repeated on a minimum of two separate nights All available water bodies, including rainwater pools, ephemeral swamps, slow flowing creeks and rock pools in non-perennial water courses should be examined for tadpoles (EIA guidelines). Nocturnal driving surveys can be used if roads dissect areas of suitable habitat. Surveys should be undertaken either during or following storms, when the species becomes active. These frogs rarely jump so surveyors will need to drive slowly and look for frogs on and adjacent to the road (Lemckert pers. comm).	September–May. After heavy rain is preferred. While most activity occurs following periods of thunderstorm activity in summer, specimens have been found active at temperatures ranging between 10° and 23°C and at all hours of the night. Most activity on the surface takes place well after sunset, with high levels of activity between 10 p.m. and 1 a.m. having been observed (EIA guidelines). Tadpoles are distinctive (for the specialist) and can be found throughout the year (Anstis 2002).	Lemckert and Mahony (2008) were unable to establish a core calling period for this species. Read the species profile

Habitat and habits	Survey methods and effort	Time of year suitable for survey	Additional notes
***Litoria aurea* (green and golden bell frog) Status:** Endangered (TSC Act) Vulnerable (EPBC Act) Read the EIA guidelines – visit www.environment.nsw.gov.au/resources/nature/GAndGbellfrogEia0703.pdf Read the draft recovery plan – visit www.environment.nsw.gov.au/recovery/GreenGoldBellFrogRecoveryplanDraft.htm			
Occurs in large permanent swamps and ponds with plenty of emergent vegetation, especially bulrushes (*Typha spp*.) or spikerushes (*Eleocharis spp.).* Also inhabits ornamental ponds and farm dams near the preferred habitat. Males call while afloat among vegetation, usually in larger permanent dams, swamps and lagoons (Anstis 2002). Tadpoles often bask in shallow water at the edge of dams among vegetation and dart to deeper water when disturbed. They mostly swim in midwater to the surface, and often feed at or near the surface (Anstis 2002).	Combination of tadpole surveys, call surveys (this species has a distinctive call) and active searching both during the day and night. Small areas of habitat (less than 0.3 hectares) should be surveyed for a minimum of one hour on three separate occasions during the species' activity period. Larger areas, which may include whole wetlands and lagoon margins, are more difficult to survey and require a minimum of three separate four-hourly searches during the species' activity period (EIA guidelines). Surveyors should be aware this species is known to actively avoid torchlight and at such times will readily dive or swim off to another location (EIA guidelines). This species has been known to respond to call playback or a well-rehearsed imitation call (by an experienced surveyor) (EIA guidelines).	August–February (Lemckert and Mahony 2008), preferably after rain. Breeding often peaks after heavy rains in January to February (Anstis 2002). Males mainly call between September and January, although frogs will take advantage of favourable conditions and can be heard calling outside these times (EIA guidelines). Larval life span of between 2.5 and 11 months (average 3 months) (Anstis 2002).	Read the species profile

Habitat and habits	Survey methods and effort	Time of year suitable for survey	Additional notes
***Litoria booroolongensis* (booroolong frog) Status:** Endangered (TSC Act and EPBC Act)			
This species is almost always associated with rocky flowing streams in mountainous regions (Robinson 1993). Males call from exposed rocks in shallow, flowing sections of mountain streams (Anstis 2002) especially when there are rock outcrops in the stream (Daly pers. comm). Tadpoles are strong swimmers and have been seen darting across a strong current in flowing water. They adhere to rocks with their mouths (Anstis 2002).	Combination of tadpole surveys, call surveys and nocturnal searches in suitable habitat (i.e. along flowing streams) and weather conditions. Minimum of one 200-metre transect per stream repeated on a minimum of two separate nights. Diurnal searches of rocky streams can also detect this species, which have been found under rocks on the edges of streams (Lemckert pers. comm). Tadpoles can be difficult to distinguish from *L. lesueuri* where the two species are sympatric, and at some sites the two can hybridise (Anstis pers. comm). Refer to Anstis (2002).	December–February Males call during spring and summer (Anstis 2002). Males have been heard calling in December, even when there has been no recent rain (Daly pers. comm).	Lemckert and Mahony (2008) were unable to establish a core calling period for this species. If tadpoles of this species are suspected, surveyors should confirm their identification with M. Anstis (see section 4) Read the species profile
***Litoria brevipalmata* (green-thighed frog) Status:** Vulnerable (TSC Act)			
A ground-dwelling frog that inhabits coastal forest and bushland. Calling males gather around temporary or semi-permanent ponds and flooded ditches after heavy rain. Egg masses are often laid in temporary ponds (Anstis 2002). Tadpoles are predominately surface dwellers, but feed throughout the water body (Anstis 2002).	Combination of tadpole surveys, call surveys and nocturnal searches in suitable habitat after heavy rain. Minimum of one 200-metre transect per water body repeated on a minimum of two separate nights.	November–February (Lemckert and Mahony 2008) after heavy rain. Breeding is highly dependent on intense/ heavy summer rains, when calling males gather around temporary ponds (Anstis 2002). This species appears to call on only a few nights in any given year after very heavy rains so there are very few chances of finding them (Lemckert pers. comm). They have been heard calling from September to May, but the warmer months appear to be better (Lemckert pers. comm).	Read the species profile

Habitat and habits	Survey methods and effort	Time of year suitable for survey	Additional notes
***Litoria castanea* (yellow-spotted tree frog/yellow-spotted bell frog) Status**: Endangered (TSC Act and EPBC Act) This species is possibly extinct (Lemckert pers. comm, Scientific Committee Preliminary Determination).There have been no reliable records of this species since the 1970s (recovery plan) Read the recovery plan – visit www.environment.nsw.gov.au/resources/nature/castaneaPiperataApproved.pdf.			
Found in large permanent ponds, lakes and dams with an abundance of bulrushes and other emergent vegetation (Robinson 1993). Males call while floating in the water (Robinson 1993) and breeding has been observed in large permanent ponds with emergent vegetation (Anstis 2002).	Combination of call surveys and searches in suitable habitat. Minimum of one 200-metre transect per water body repeated on a minimum of two separate nights.	September–May Breeding thought to occur during the warmer months usually following rainfall (recovery plan). Males call during spring and summer (Anstis 2002).	Lemckert and Mahony (2008) did not establish a core calling period for this species. Read the species profile
***Litoria daviesae* (Davies tree frog) Status**: Vulnerable (TSC Act)			
Previously thought to be *L. subglandulosa* and the two species have similar habitat requirements (Mahony et al 2001). Found at sites with streams above 400 metres. Adults are found adjacent to permanently flowing streams, which usually consist of sections of large pools with a gentle flow interspersed with faster flowing shallow sections with cascades and waterfalls (Mahony et al 2001). Has also been found in small, permanent streams, suggesting that large pools are not essential but permanent water may be (Lemckert pers. comm) Breeds in various habitats including rocky creeks where teatree shrub dominates and in creeks with beech (*Northofagus moorei*) and teatree shrubland (Daly pers. comm).	Combination of tadpole surveys, call surveys and nocturnal searches in suitable habitat and weather conditions. Minimum of one 200-metre transect per stream repeated on a minimum of two separate nights.	September–March (Lemckert and Mahony 2008) Calling has been observed during spring irrespective of rainfall (Daly pers. comm). Tadpoles are mainly present from late October to February (Anstis pers. comm)	This species has been recently identified and taxonomically separated from *L. subglandulosa* Tadpoles are distinctive although very similar to *L. subglandulosa* (Anstis pers. comm) Read the species profile

Habitat and habits	Survey methods and effort	Time of year suitable for survey	Additional notes
***Litoria littlejohni* (Littlejohn's tree frog/heath frog) Status:** Vulnerable (TSC Act and EPBC Act)			
Appears to be restricted to sandstone woodland and heath communities at mid to high altitude. Forages both in the tree canopy and on the ground, and has been observed sheltering under rocks on high exposed ridges during summer (Scientific Committee Determination). Males call from elevated positions on branches beside semi-permanent or permanent dams, ponds or creeks (Anstis 2002). Appears to breed in wet forest margins, which may be wet heath or ephemeral wet areas (Scientific Committee Determination). Tadpoles frequent the surface of still ponds or pools of smaller creeks. Large groups have been observed schooling (Anstis 2002).	Combination of tadpole surveys, call surveys and nocturnal searches in suitable habitat and weather conditions. Minimum of one 200-metre transect per water body repeated on a minimum of two separate nights. The tadpole of this specie is distinctive (Anstis 2002). It is black and has a high tail fin (Daly pers. comm). Tadpoles can take between 3 and 12 months to complete development (Daly pers. comm) and are usually present in late winter, spring and summer (Anstis pers. comm). If using a dip net to survey for tadpoles, both a nocturnal and diurnal survey are recommended.	July–April (Lemckert and Mahony 2008) Breeding is unusual, being mostly in autumn, but the species will also breed after heavy rainfall in spring and summer (Scientific Committee Determination). Daly and Craven (2007) observed breeding in early spring in the Shoalhaven region, irrespective of rainfall.	Read the species profile
***Litoria olongburensis* (olongburra frog/sharp-snouted reed frog) Status:** Vulnerable (TSC Act and EPBC Act)			
Occurs in coastal foredune swamps and lagoon systems (Lewis and Goldingay 2005). Usually found associated with acidic, tannin-stained water (Robinson 1993). Males call from emergent reeds above water level (Anstis 2002). This species requires areas of habitat frequently inundated with water (Lewis and Goldingay 2005). Tadpoles mainly frequent midwater to surface regions and may be well camouflaged in peat-stained water (Anstis 2002).	Combination of tadpole surveys, call surveys and nocturnal searches in suitable habitat (swamp) and weather conditions. Minimum of one 200-metre transect per water body repeated on a minimum of two separate nights. Tadpole searches should not be relied on for this species as they are difficult to distinguish from *Litoria fallax.* Surveyors can confirm tadpoles with M. Anstis if unsure. (see section 4)	October–March Males call from late afternoon in spring and summer, especially after rain (Anstis 2002). Lewis and Goldingay (2005) suggest higher counts in winter. Lewis and Goldingay (2005) found rainfall the previous day had a negative effect on adults while rainfall the previous week had a positive effect. Lewis and Goldingay (2005) suggest starting a survey 30 minutes after dark.	Lemckert and Mahony (2008) were unable to establish a core calling period for this species. Read the species profile

Habitat and habits	Survey methods and effort	Time of year suitable for survey	Additional notes
***Litoria piperata* (peppered tree frog) Status**: Vulnerable (TSC Act and EPBC Act) This species is possibly extinct (Lemckert pers. comm, Scientific Committee Preliminary Determination). There have been no reliable records of this species since the 1970s (recovery plan). The call of this species and its breeding habits have not yet been recorded and tadpoles of this species have not yet been described. Read the recovery plan – visit www.environment.nsw.gov.au/resources/nature/castaneaPiperataApproved.pdf			
Very little is known about this frog's ecology. Adults are active in bushes or on rocks at the edge of creeks (recovery plan).	Combination of call surveys and nocturnal searches in likely habitat and weather conditions. Minimum of one 200-metre transect per water body repeated on a minimum of two separate nights.	October–February	Lemckert and Mahony (2008) did not establish a core calling period for this species Read the species profile
***Litoria raniformis* (southern bell frog) Status:** Endangered (TSC Act), Vulnerable (EPBC Act) Read the draft recovery plan – visit www.environment.nsw.gov.au/resources/nature/recoveryplanDraftSouthernBellFrog.pdf			
Males call while afloat among vegetation such as bulrushes and tall reeds in permanent ponds, dams, lagoons or lakes (Anstis 2002). Breeding usually occurs in still or slow moving water (draft recovery plan). Most breeding sites found in recent surveys in NSW were overflow areas, for example, levee swamps, oxbows or billabongs, which were excessively disturbed by grazing from sheep and cattle, or pollution from agricultural run-off and irrigated crops (draft recovery plan). Tadpoles hide among vegetation at the warmer, shallower edges of larger water bodies (Anstis 2002). During the day in summer, the frog is often found basking on grassy banks near water (draft recovery plan).	Combination of tadpole surveys, call surveys and nocturnal searches in suitable habitat (including disturbed areas) and weather conditions. Minimum of one 200-metre transect per water body repeated on a minimum of two separate nights. Diurnal searches for basking animals may also be undertaken as an additional method for this species.	September–May Breeding generally occurs from November to March following local flooding and a marked rise in water levels, from rain or other sources, which triggers calling in breeding males (draft recovery plan). This species has a larval life span of 12–15 months (Anstis 2002).	Lemckert and Mahony (2008) did not establish a core calling period for this species. Read the species profile

Habitat and habits	Survey methods and effort	Time of year suitable for survey	Additional notes
***Litoria spenceri* (Spotted tree frog) Status:** Endangered (TSC Act and EPBC Act) Read the recovery plan – visit www.environment.nsw.gov.au/resources/nature/approvedLitoriaSpenceri.pdf			
Found in rock habitats along streams, sheltering under or basking on rocks and stones less than one metre from the main stream (Gillespie and Hollis 2005). Males call from boulders or low overhanging branches in and beside streams (Anstis 2002). Read the recovery plan for a more detailed habitat description. Tadpoles often frequent backwaters and streamside pools which may or may not be connected to the main water flow. Tadpoles are difficult to find and frequently have shortened tails (Anstis 2002).	Combination of tadpole surveys, call surveys, and nocturnal and diurnal searches in suitable habitat and weather conditions. Minimum of one 200-metre transect per stream repeated on a minimum of two separate nights.	December–February Males call during spring and summer. Breeding occurs between October and December (Gillespie and Hollis 1996). At Bogong Creek, adults and juveniles are mainly diurnal. Elsewhere, adult animals may be nocturnal (recovery plan). Gillespie and Hollis (1996) did diurnal surveys only. Larval life span likely to be about three months (Anstis 2002).	Lemckert and Mahony (2008) did not establish a core calling period for this species. Read the species profile
***Litoria subglandulosa* (glandular frog) Status:** Vulnerable (TSC Act)			
Associated with permanent streams and rivers in rainforest, montane areas or wet sclerophyll forest above about 300 metres. Males call from low vegetation just above the edge of the stream or further away. Breeding occurs in shaded pools where water flow is less (Anstis 2002). Tadpoles frequent the bottom of shallow, slowly flowing sections of a stream, where they are well camouflaged and appear to have distinctive feeding behaviour not seen in other species (Anstis 2002).	Combination of tadpole surveys, call surveys and nocturnal searches in suitable habitat and weather conditions. Minimum of one 200-metre transect per stream repeated on a minimum of two separate nights.	September–March (Lemckert and Mahony 2008) Males call in a variety of weather conditions during early spring and summer (Anstis 2002). The frog has been heard calling from October to November (Robinson 1993). Calling increases in intensity during and after light rain and breeding occurs from spring to early summer (Anstis 2002). Larval life span is likely to be about three to four months, with tadpoles being present from early September to early February (Anstis 2002).	*L. daviesae* has recently been separated from *L. subglandulosa.* Read the species profile

Habitat and habits	Survey methods and effort	Time of year suitable for survey	Additional notes
Alpine tree frog *(Litoria verreauxii alpina)* **Status:** Endangered (TSC Act); Vulnerable (EPBC Act)			
A ground dwelling tree frog, this high altitude subspecies is confined to the southern Alps in the Snowy Mountains region (Smith et al 2003). It is associated with alpine ponds and still pools of creeks or streams in alpine forests, or on moorland or partly cleared land (Anstis 2002). Males call from the ground, sitting among grass tussocks or sedges beside water or while afloat (Anstis 2002). Frogs can be found under logs and rocks beside creek swamps (Daly pers. comm) This species has also been associated with artificial water bodies ranging from small dams to reservoirs (Osborne et al 1999). Tadpoles frequent mid-water to surface regions and prefer shallow, warmer water or bask in the sun in upper levels of the water body (Anstis 2002).	Combination of tadpole surveys, call surveys and nocturnal searches in suitable habitat and weather conditions. Minimum of one 200-metre transect per water body repeated on a minimum of two separate nights.	September–February Males call during spring, summer and early autumn. Breeding occurs during spring and summer, often after rain (Anstis 2002). At higher altitudes, breeding activity occurs mostly from spring to mid-autumn (Smith et al 2003). Larval life span is likely to be about three months (Anstis 2002).	Lemckert and Mahony (2008) did not establish a core period for this subspecies. The core period for *Litoria verreauxii* was July–March. Read the species profile

Habitat and habits	Survey methods and effort	Time of year suitable for survey	Additional notes
***Mixophyes balbus* (stuttering barred frog) Status:** Endangered (TSC Act), Vulnerable (EPBC Act)			
Usually associated with flowing streams, often in rainforest or wet sclerophyll forest. Males call from beside streams, often well-camouflaged on leaf litter, under banks, or on dry parts of the stream floor or logs just above flowing water midstream (Anstis 2002). Tadpoles are bottom-dwellers and graze among stones in pools of streams (Anstis 2002). This species has a long larval lifespan and therefore needs streams with permanent water, even if these are just the occasional larger pool (Lemckert pers. comm). Outside the breeding season, *M. balbus* may travel hundreds of metres away from the stream in which they breed. Adults bury themselves under leaf litter during cool or dry periods and are difficult to detect (NPWS 2002).	Combination of tadpole surveys, call surveys and nocturnal searches along flowing streams in suitable weather conditions. Minimum of one 200-metre transect per water body repeated on a minimum of two separate nights. This species may respond to call playback or a good imitation of their call.	September–April (Lemckert and Mahony 2008). Males call during spring and summer (Anstis 2002), but can call as late as March and April (Lemckert pers. comm) Tadpoles are likely to be present for most of the year. Tadpoles collected from Barrington Tops had a minimum larval lifespan of 15 months in captivity (Anstis 2002).	Read the species profile
***Mixophyes fleayi* (Fleay's barred frog) Status:** Endangered (TSC Act and EPBC Act)			
Associated with flowing streams often in rainforest or wet sclerophyll forest. Males call from beside streams, often well camouflaged on leaf litter, under banks, or on dry parts of the stream floor or logs just above flowing water midstream (Anstis 2002). Tadpoles are bottom-dwellers, grazing over rocks, leaf litter and the substrate in pools and shallow eddies at the sides of streams (Anstis 2002).	Combination of tadpole surveys, call surveys and nocturnal searches along flowing streams in suitable weather conditions. Minimum of one 200-metre transect per stream repeated on a minimum of two separate nights. This species may respond to call playback or a good imitation of their call.	October–May Males call during spring and summer (Anstis 2002). Tadpoles from eggs laid in November or December are likely to be present over winter and metamorphose the following spring or summer (Anstis 2002).	Lemckert and Mahony (2008) were unable to establish a core calling period for this species. Read the species profile

Habitat and habits	Survey methods and effort	Time of year suitable for survey	Additional notes
***Mixophyes iterates* (Giant barred frog) Status:** Endangered (TSC Act and EPBC Act)			
Associated with flowing streams, often in rainforest or wet sclerophyll forest. Generally lives in large streams or rivers with a width of at least 5 metres (Lemckert pers. comm). Males call from beside streams, often well-camouflaged on leaf litter, under banks, or on dry parts of the stream floor or logs just above flowing water midstream (Anstis 2002). Unlike other species in this genus, *M. iteratus* does not travel large distances from the breeding stream when not breeding and remains almost exclusively within 20 metres of the stream throughout the year (Lemckert pers. comm). Tadpoles are bottom dwellers, grazing over rocks and the substrate in still or slowly flowing pools or on the sides of streams (Anstis 2002).	Combination of tadpole surveys, call surveys and nocturnal searches along flowing streams in suitable weather conditions. Minimum of one 200-metre transect per stream repeated on a minimum of two separate nights. This species may respond to call playback or a good imitation of their call.	September–March (Lemckert and Mahony 2008) Males call during spring and summer (Anstis 2002). Tadpoles are present for most of the year and can take up to 14 months to reach metamorphosis (NPWS 2000). Surveys should be undertaken when air temperature is above 18°C (Koch & Hero 2007).	Eggs can be easily confused with those of *Mixophyes fasciolatus*. Read the species profile

Habitat and habits	Survey methods and effort	Time of year suitable for survey	Additional notes
***Neobatrachus pictus* (painted frog) Status:** Endangered (TSC Act) Read the recovery plan – visit www.environment.nsw.gov.au/resources/nature/pbfrog.pdf			
Breeds in grassy marshes, lagoons, flooded claypans and temporary roadside pools (Cogger 2000). Males call while afloat in waterholes, dams or still pools of watercourses (Anstis 2002).	Search intermittent puddles and other water sources in the nights following heavy rain for two nights. Searches for tadpoles in permanent water sources at other times of the year. One light trap per water source for water bodies less than 50 metres in area, or one dip net sweep from each water body. Tadpoles are easy to recognise when not sympatric with the more common *Neobatrachus sudelli* (Anstis pers. comm) Refer to live photos of *N. sudelli* in Anstis (2002) as the two are very similar. Confirm with M. Anstis (see section 4) if unsure.	Any time of the year after heavy rain. Breeding only occurs after heavy rain (usually more than 25 millimetres in 24 hours) and probably at all times of the year (recovery plan). Breeding periods last for a few days. Tadpoles are usually present from late summer or autumn to late spring, for about four and a half to seven months (Anstis 2002).	Lemckert and Mahony (2008) did not establish a core calling period for this species. Read the species profile

Habitat and habits	Survey methods and effort	Time of year suitable for survey	Additional notes
***Philoria kundagungan* (mountain frog) Status:** Endangered (TSC Act)			
All species of *Philoria* have similar habitat requirements and reproductive biology. Adults are usually found beneath saturated leaf litter and mud in soaks or small creek beds (Anstis 2002), shallow burrows in mud, moss or leaf-litter along the edges of constantly flowing streams or around permanent soaks in highland forest (NPWS 2002). Breeding pairs of all species mate in well-covered sites such as in small chambers excavated in mud and under rock or leaf litter, under the banks of small creeks, or in the sphagnum mat of bogs. All species seem to favour breeding habitats with a saturated substrate (Knowles et al 2004) and have been found hiding under large rocks, in rocky scree or in holes in the ground (Lemckert pers. comm).	Listen for calling males in areas of suitable habitat during the day. Minimum of one 200-metre transect per water body, repeated on a minimum of two separate days. Tadpole surveys in water bodies are unsuitable for *Philoria sp*. All species lay their eggs in nests in the ground, where the tadpoles remain throughout entire development until they emerge post metamorphosis (Knowles et al 2004).	September–February Males call from nest sites under rocks or leaf litter in water-filled cavities from late August to mid-February (Anstis 2002). Diurnal surveys are best for detecting this species, preferably in the morning or late afternoon (Anstis pers. comm).	Lemckert and Mahony (2008) were unable to establish a core calling period for this species. Knowles et al (2004) provide a key to the genus *Philoria*. Read the species profile
***Philoria loveridgei* (Loveridge's frog) Status:** Endangered (TSC Act)			
Males call from smooth walled chambers in the ground anywhere on the forest floor, especially along creeks (Knowles et al 2004). Also see '*P. kundagungan* (mountain frog)' for habitat requirements.	Conduct call surveys for calling males around the headwaters of small streams and soaks where groundwater is continually present and close to the surface. Listen for calling males in areas of suitable habitat during the day. Minimum of one 200-metre transect per water body, repeated on a minimum of two separate days. Tadpole surveys in water bodies are unsuitable for *Philoria sp*.	September–February Breeds from November to January when males can be heard calling (Knowles et al 2004). Calling has been heard in late August and may continue as late as April (Lemckert and Mahony 2008). Diurnal surveys are best for detecting this species, preferably in the morning or late afternoon (Anstis pers. comm).	Lemckert and Mahony (2008) were unable to establish a core calling period for this species. Knowles et al (2004) provide a key to the genus *Philoria*. Read the species profile

Habitat and habits	Survey methods and effort	Time of year suitable for survey	Additional notes
Philoria pughi **Status:** Endangered (TSC Act)			
This species has only recently been described, and little is currently known about it. Males call from or near small excavated burrows. See '*P. kundagungan* (mountain frog)' for more information on habitat requirements.	Conduct call surveys for calling males around the headwaters of small streams and soaks where groundwater is continually present and close to the surface. Listen for calling males in areas of suitable habitat during the day. Minimum of one 200-metre transect per water body, repeated on a minimum of two separate days. Once a calling male has been detected, the frog should be located to ensure a positive identification.	October–January Breeding occurs from at least October–December (Scientific Committee Determination). Diurnal surveys are best for detecting this species, preferably in the morning or late afternoon (Anstis pers. comm)	Due to insufficient records, Lemckert and Mahony (2008) were unable to establish a core calling period. Knowles et al (2004) provide a key to the genus *Philoria*. Tadpole surveys in water bodies are unsuitable for *Philoria sp*. Read the species profile
Philoria richmondensis **Status:** Endangered (TSC Act)			
This species has only recently been described, and little is currently known about it. Males call from or near small excavated burrows. These frogs often call from well beneath rocks in seepage areas and their habitat can be easily destroyed if rocks are removed or dislodged. See '*P. kundagungan* (mountain frog)' for more information on habitat requirements.	Conduct call surveys for calling males around the headwaters of small streams and soaks where groundwater is continually present and close to the surface. Listen for calling males in areas of suitable habitat during the day. Minimum of one 200-metre transect per water body, repeated on a minimum of two separate days. Survey by call only, as *P. richmondensis* is not sympatric with other *Philoria* spp. and the call of this species is distinctive (Anstis pers. comm). Tadpole surveys in water bodies are unsuitable for *Philoria sp*.	Breeding occurs from at least October–December (Scientific Committee Determination). Diurnal surveys are best for detecting this species, preferably in the morning or late afternoon (Anstis pers. comm)	Knowles et al (2004) provide a key to the genus *Philoria*. Lemckert and Mahony (2008) did not establish a core calling period for this species. Read the species profile

Habitat and habits	Survey methods and effort	Time of year suitable for survey	Additional notes
***Philoria sphagnicola* (sphagnum frog) Status:** Vulnerable (TSC Act)			
Forms breeding congresses closely associated with creeks (Knowles et al 2004). Burrows in loose moist soil, moss or leaf litter, often in soaks or seepages. May also use cracks and cavities behind and beside waterfalls where the environment remains saturated with moisture (NPWS 2002). Also see '*P. kundagungan* (mountain frog)' for habitat requirements.	Conduct call surveys around the headwaters of small streams and soaks where groundwater is continually present and close to the surface. Listen for calling males in areas of suitable habitat during the day. Minimum of one 200-metre transect per water body, repeated on a minimum of two separate days. Tadpole surveys in water bodies are unsuitable for *Philoria sp*.	September–December (Lemckert and Mahony 2008) Breeding occurs in November and December in the northern localities, and October and January in the mid-northern coastal ranges (Anstis 2002). Males call during the day from established nest sites (Knowles et al 2004). They call mainly in spring and summer, often just before dusk. Diurnal surveys are best for detecting this species, preferably in the morning or late afternoon (Anstis pers. comm).	Knowles et al (2004) provide a key to the genus *Philoria*. Read the species profile

Habitat and habits	Survey methods and effort	Time of year suitable for survey	Additional notes
***Pseudophryne australis* (red-crowned toadlet) Status:** Vulnerable (TSC Act) Read the EIA guidelines – visit www.environment.nsw.gov.au/resources/nature/RedcrownedtoadletEia0501.pdf			
Restricted to Hawkesbury sandstone and may be found beside temporary creeks, gutters and soaks and under rocks and logs. Breeding occurs in damp leaf litter (Robinson 1993). Tadpoles are bottom-dwellers in still, small pools, either among leaf litter or quite exposed (Anstis 2002).	Call detection is the most common method used to locate this species. Surveys should commence with an aural survey to detect any calling males in suitable habitat and weather conditions. Minimum of one 200-metre transect per water body, repeated on a minimum of two separate nights. Males will sometimes respond to a loud shout if conditions are suitable for breeding (Thumm pers. comm) Surveys for the species when call detection is not successful should include active searching of microhabitat features such as beneath rocks, logs and amongst leaf litter. Pools of water in any suitable drainage lines in the vicinity should be targeted for tadpoles (EIA guidelines)	July–March (Lemckert and Mahony 2008), after rain. May call both day and night and in any month of the year, although most calling occurs during the late afternoon and early evening and most often just after periods of heavy rainfall, so surveys are recommended at this time. Commonly heard calling during the day after good rain (Anstis pers. comm). Highest activity occurs after thunderstorms in summer but the species is regularly heard calling between late August to April under appropriate weather conditions. Ambient temperatures recorded during calling have ranged from 5°C to 30°C, but 17°C to 25°C are more usual conditions (EIA guidelines). As breeding can occur in any month, tadpoles may be present year round (except in dry periods), although tadpoles have rarely been found at breeding sites (Thumm pers. comm).	Tadpoles may be confused with those of *Pseudophryne coriacea* and *P. bibroni* and *Crinia signifera* (Anstis 2002). Read the species profile

Habitat and habits	Survey methods and effort	Time of year suitable for survey	Additional notes
***Pseudophryne corroboree* (southern corroboree frog) Status:** Endangered (TSC Act and EPBC Act) Read the recovery plan – visit www.environment.nsw.gov.au/resources/nature/approvedSouthernCorroboreeFrog.pdf			
Occurs at high altitudes (1300–1760m) in subalpine and montane areas that are subject to a winter covering of snow. The species uses two distinct habitats: a breeding site occupied for a few weeks in midsummer by adults and for a longer period by tadpoles and juveniles; and an adjacent non-breeding habitat used by subadults and adults. Refer to species profile for more details on habitat preferences. Nests are hollowed out among the roots of sphagnum clumps near small pools or dry bog pans which will be inundated (Anstis 2002). After breeding, adults can disperse up to 300 metres from the breeding site into the surrounding woodland (recovery plan). Tadpoles are primarily bottom-dwellers, often burrowing into the dark brown peat-based silt on the substrate where they are well-camouflaged (Anstis 2002).	Combination of tadpole surveys and call surveys and searches during the day or early evening. *Pseudophryne corroboree* and *P. pengilleyi* both respond to a loud human shout (Osborne et al 1999). Minimum of one 200-metre transect per water body repeated on a minimum of two separate days.	January– February Males call from early December to late February and eggs are found in January to March (Anstis 2002). Males call during the day in suitable weather after rain (Anstis pers. comm). Do not survey during cold or very wet weather (Osborne et al 1999). This species has a relatively narrow period (usually only 2–3 weeks of the year) when calling and breeding takes place. During this period they call consistently and will respond to shouting (Lemckert pers. comm). Surveying within this period is critical for detecting this species, as they do not call outside these times (Lemckert pers. comm) The larval lifespan averages nine months and tadpoles remain in suspended development for at least two months during winter, before resuming growth after the snow has melted (Anstis 2002).	Lemckert and Mahony (2008) were unable to establish a core calling period for this species due to insufficient records. Read the species profile

Habitat and habits	Survey methods and effort	Time of year suitable for survey	Additional notes
***Pseudophryne pengilleyi* (northern corroboree frog) Status:** Vulnerable (TSC Act and EPBC Act)			
Males call from hidden burrows among the roots of clumps of sphagnum in boggy areas associated with montane and subalpine heathland (Anstis 2002). Tadpoles are sedentary bottom-dwellers grazing and burrowing among the silt and plant matter in bog pools where they are well camouflaged (Anstis 2002).	Combination of tadpole surveys and call surveys during the day or early evening. *Pseudophryne corroboree* and *P. pengilleyi* both respond to a loud human shout (Osborne et al 1999). Minimum of one 200-metre transect per water body, repeated on a minimum of two separate days.	January–February (Lemckert and Mahony 2008) Males call mainly during December and through to early March (Anstis 2002), calling during the day in suitable weather after rain (Anstis pers. com.). Eggs are mostly laid from mid-January to early March (Anstis 2002). This species has a relatively narrow period (usually only 2–3 weeks of the year) when calling and breeding takes place. During this period they call consistently and will respond to shouting (Lemckert pers. comm). Surveying within this period is critical for detecting this species, as they do not call outside these times (Lemckert pers. comm).	Read the species profile

9. References and further reading

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