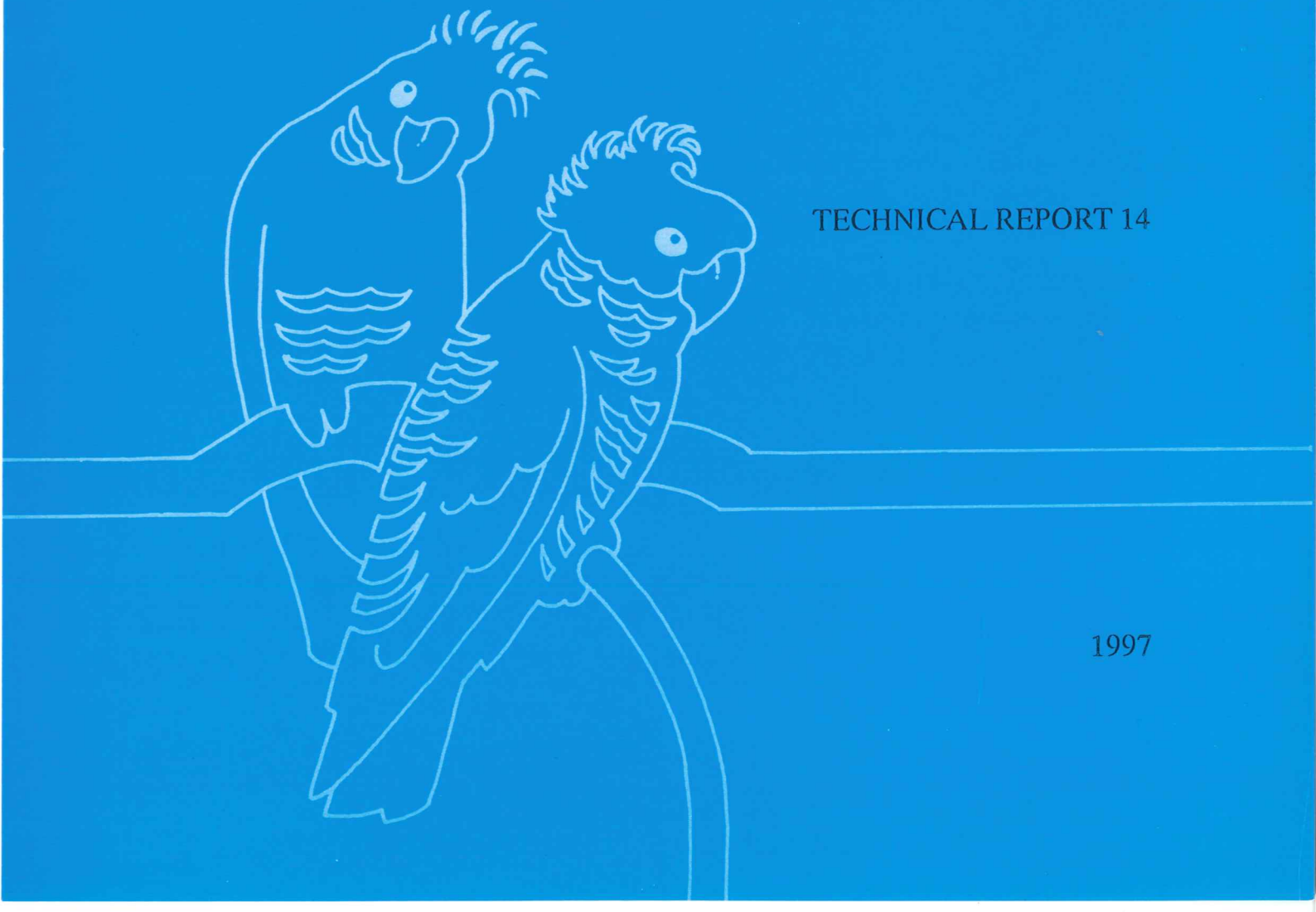
ACT PARKS and CONSERVATION SERVICE

FROG FAUNA OF THE AUSTRALIAN CAPITAL TERRITORY : A REVIEW

M. A. RAUHALA



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A list of other publications produced by the ACT Parks and Conservation Service is on page 64.

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ABSTRACT

Fifteen species of frog are currently recognised to occur naturally in the ACT. A further three species are considered to have become locally extinct. The available information on distribution, abundance and evidence of change for all 18 species is reviewed. Conservation status assigned to each species on a national level are summarised. The status of each species in terms of distribution and abundance in the ACT is evaluated and potential threats, further requirements for survey, monitoring and management are outlined.

Of the 15 species recognised to currently occur in the ACT, eight (including one sub-species) are considered to require a targeted approach in terms of survey and/or monitoring, with some requiring further management oriented research, habitat management and protection. The remaining frogs are considered relatively widespread and common, requiring only a general monitoring approach. A monitoring program for ACT frogs is discussed including guidelines for its conduct in terms of techniques, timing and information requirements.

1. INTRODUCTION

Frogs are an integral part of the Australian terrestrial fauna. The 204 species that are currently formally described (Barker *et al.* 1995), occur in a diverse range of environments including inland deserts, high altitude mountain ranges and tropical rainforests. However, species diversity is greatest around the coastal margins and tropics, with areas of highest diversity on the east coast near the New South Wales - Queensland border and in far north Queensland (Roberts 1993).

It is now widely recognised that amphibian populations in many parts of the world, including Australia, have suffered serious declines (Baringa 1990, Blaustein and Wake 1990, Martin 1990, Tyler 1991). Although the causes of decline are often attributable to human activities which lead to environmental degradation (Ferraro and Burgin 1993), in many others, the causes are not as apparent. Of particular concern are frog declines and extinctions from seemingly pristine environments, where human influences are minimal. For example, in Queensland since 1978, seven species of frogs have disappeared and populations of another four species have seriously declined (Ingram and McDonald 1993). It is noteworthy, that all of these declines have occurred in high altitude rainforest streams. Corresponding high-altitude declines in the Australian Alps of south-eastern Australia, have also been reported in a recent review, in which Gillespie *et al.* (1995) considered nine species to be of conservation concern, including six species which have declined considerably in abundance over the last ten to fifteen years. In the Southern Tablelands of NSW, three species of the *Litoria aurea* complex which were once common, appear to have disappeared entirely from the area in the early 1980's (Osborne *et al.* 1996).

The phenomenon of declining amphibians populations is clearly real, although some authors have suggested that with long term monitoring data generally lacking, it is difficult to ascertain whether declines are actually part of natural population fluctuations (Tyler and Davies 1985, Pechmann *et al.* 1991). Nevertheless, most scientists now believe that many of the declines being witnessed are not merely natural fluctuations and that in a large number of instances the causes of decline are not clearly attributable to climatic variables or currently recognisable human influences. It is most likely that causes of decline vary between species and environments and that combinations of factors, both human induced and "natural" are involved.

In the ACT, several species of frog have been identified as being of conservation concern (Osborne 1990a , 1992). Some causes for frog declines in the Territory have been postulated, with prolonged drought conditions experienced during the early 1980's implicated as one of the possible causes (Osborne 1990a).

Information on frogs in the ACT comes from many sources. Among these are the several general fauna surveys of specific areas which have been conducted by the ACT Parks and Conservation Service (Eberhard and Schulz 1973, Kukolic 1990, Rauhala 1993, Rauhala *et al.* 1995) and pitfall trapping surveys (mainly in grasslands around the urban fringe) targeted at locating the striped legless lizard *Delma impar* (Kukolic 1993, 1994, Kukolic *et al.* 1994, Rauhala *et al.* 1995, Rauhala 1996). A number of other ecological surveys have been carried out by consultants which have added to the knowledge base on frogs in the ACT (Gilmour *et al.* 1987, Helman *et al.* 1988, Barrer 1992). Specific surveys for frogs, however, have generally been carried out on an *ad hoc* basis by personnel of the ACT Parks and Conservation Service, interested individuals and students. The approaches taken in frog surveys and level of detail vary widely and much of this information is not in a readily available form.

Species specific research on frogs in the ACT has been undertaken by several post-graduate students (Pengilley 1966, Woodruff 1972, Lau 1986, Osborne 1990 b). All these studies focused on the genus *Pseudophryne*, and whilst they form the basis of current understanding on species relations and breeding biology in the genus, only Osborne (1990 b) dealt with distribution and abundance in one member of the genus. One notable study of a breeding frog community comprising several species, was conducted near Sutton to the north of the ACT by Humphries (1979)

The Vertebrate Atlas of the ACT data-base, co-ordinated by the ACT Parks and Conservation Service, has been in operation since 1988 (Lintermans 1990). Information contained in it is reliant on input from Service officers and interested community groups and the public. It is anticipated that with increased and sustained support from contributors, this data base will provide some valuable distributional information on frogs, particularly around the urban areas of the ACT. However, the Atlas is not designed to be used as a mechanism for monitoring or analysing the relative abundance of individual species.

World-wide, the need to carry out further work to assess the status of frogs through survey and long term monitoring has been widely recognised (Beiswenger 1986, Baringa 1990, Juterbock 1990, Mahony 1993, Tyler 1993). Recently the need for monitoring programs of the ACT's amphibians has been recommended (Commissioner for the Environment, ACT 1995), along with regional survey of amphibian habitats for more effective management and protection of wetlands.

The ACT is in a strong position to contribute in a significant way to an understanding of frog status and conservation issues in similar climatic and geographical areas of the region. This is possible through the relatively small size of the Territory and the concentration of research institutions and scientific knowledge.

1.1 Objectives of this report

- To collate and assess all relevant available information on the distribution and abundance of each frog species occurring in the ACT and immediate surrounding region.
- To assess whether any changes in abundance and distribution of frog species in the ACT are apparent, and to discuss this in relation to the situation nationally.
- To identify potential threats to individual frog species and frog communities.
- To identify requirements for monitoring and survey of frogs in the ACT.
- To identify the need for ecological information and management actions necessary for the conservation of the ACT frog fauna.

1.2 Definition of the study area

This report focuses on the frog fauna of the ACT. However, where information is available for the immediate surrounding area (for example Googong foreshores), this is incorporated to give a regional perspective.

1.3 Characteristics of the study area

The ACT falls within two separate bioregions (Thackway and Cresswell 1995). The larger proportion of the ACT falls within the South Eastern Highlands bioregion which also extends across southern and eastern Victoria and southern New South Wales. The high altitude areas in the south-western portion of the ACT fall within the Australian Alps Bioregion, an area also extending into NSW and Victoria. All of this area within the ACT is contained within Namadgi National Park.

The ACT lies on the Southern Tablelands of New South Wales, and is characterised by a predominance of relatively high altitudes ranging from 450 to 1910 metres above sea level with the majority of land between 550 and 1100 metres. Geologically the ACT forms part of the Palaeozoic Lachlan Fold Belt which extends from central NSW to Victoria. The underlying rocks are mainly of sedimentary origin which have subsequently undergone metamorphosis. At various times granitic intrusions and volcanic activity have occurred, adding to the variety of rock types seen in the Territory today (Commissioner for the Environment, ACT 1994).

The landscapes of the ACT can be divided into three groups: uplands, rolling country and plains (Commissioner for the Environment, ACT 1994). The uplands (above 800 metres) occur mainly to the west of the Murrumbidgee River and consist of a series of parallel ridges separated by several stream valleys. The soils of the uplands tend to be shallow, stony and sandy of generally low fertility. This combined with steep slopes, makes the soils easily erodible once disturbed. Much of the uplands are covered by native forests and woodlands. Major land uses include nature conservation, agriculture and plantation forestry.

A rolling terrain of gentle hills occupy the north-eastern part of the ACT and along the eastern side of the Murrumbidgee River. Altitudes in this landscape type range from about 600 to 900 metres. Soils are generally deeper and more fertile than in the uplands and although not as readily erodible, still have the potential to erode and cause degradation in the quality of the waterways due to the more intense land use practices, characterised by agriculture and to a lesser degree nature conservation and urban development.

Large areas in the north of the ACT are within a relatively low lying plain (550 to 600 metres), which is interspersed with higher hills and ridges. The soils of the plain tend to be deeper and better drained and support a mixture of native and exotic grasslands and open woodlands. However, a large part of the plain is now under urban development and agriculture. A small proportion of this landscape in the ACT is set aside for nature conservation purposes.

The climate of the ACT has been described as continental (Commissioner for the Environment, ACT 1994), typically experiencing marked variations in temperatures between seasons with warm to hot summers and cold winters. Rainfall is fairly evenly distributed throughout the year with a slight peak in late winter and spring. Rainfall, however, is not evenly distributed in a geographical sense, with the ranges in the western part of the territory experiencing substantially higher falls including regular snow, whilst the lower altitude areas in the east receive the lowest rainfall. A characteristic feature of rainfall in Canberra district is the high variability of rainfall from year to year, droughts being a periodic feature of the local and regional climate.

The ACT is not unique in its landscape, geology, climate and vegetation, and the patterns of distribution and abundance of fauna in space and time also reflect trends in the immediate region.

In the ACT, frog breeding habitats are provided by a wide range of aquatic and semi-aquatic situations. These can be broadly grouped as Rivers and Creeks, Lakes and Ponds, and Wetlands (NCDC 1984). A wide range of conditions exist within each of these categories, which influence their suitability as breeding sites for different frog species. These conditions

include altitude, water flow and stability, water quality, nature of adjacent non-breeding habitat, land use and disturbance factors.

A common perception among people generally, is that frogs live in ponds, swamps and streams. This is only partially accurate, because whilst frogs do spend a part of their life cycle as an egg or aquatic tadpole, it is only during the breeding season that adult frogs congregate around water bodies for breeding. The majority of a frogs life may be spent some distance away from the breeding sites in surrounding vegetation where they forage and over-winter. It is, therefore, important not to disregard the significance of the areas surrounding the breeding sites as an essential component of frog habitat.

2. METHODS

Information compiled into this report comes from many sources. These include published and un-published reports of fauna surveys undertaken in the ACT, records from the ACT Vertebrate Atlas database, records of the Australian National Wildlife Collection (CSIRO), as well as information and opinions acquired through personal communication with local naturalists and herpetologists.

This information is arranged into a format which outlines some aspects of general biology and habitat utilisation of local frog species. Distribution throughout the species range and limited information on abundance of individual species is given. Distributional information for the ACT region is not intended to provide an exhaustive list of occurrence records but an indication only of the variety of areas where the species has been found. Where applicable, changes in distribution and abundance are discussed. Requirements for survey and monitoring are outlined, as are other specific management actions where appropriate.

Conservation status of species is reviewed in terms whether it is regarded as threatened nationally in any recent authoritative listing. The following authoritative listings are used;

- **IUCN (1994)** - International Union for the Conservation of Nature - Red list of threatened animals.
- **ANZECC (1991)** - Australian and New Zealand Environmental Conservation Council. List of Endangered Vertebrate Fauna.
- **ANCA (in prep.)** - Australian Nature Conservation Agency. The Action Plan for Australian Frogs (Draft).

The status of species in terms of distribution and abundance only is reviewed for the ACT, with the following references cited.

- **NCDC (1984).** - The Ecological Resources of the ACT. NCDC Technical paper No. 42.
- **Hogg (1990).** - The Ecological Resources of the ACT. A review of recent information. Report to the National Capital Planning Authority.

Where the author is of the strong opinion that the distribution and abundance status assigned for the ACT by these sources does not accurately reflect the current situation, a suggestion for an alternative category is given. This recommendation should be regarded as an indication of the state of current knowledge on distribution and abundance only, and not as an official listing of conservation status. Threatened species can only be assigned a conservation status for the ACT, by declaration by the Minister following a recommendation from the ACT Flora and Fauna Committee. As of November 1996, only one species (the corroboree frog *Pseudophryne corroboree*) has been listed through this process.

2.1 Nomenclature

Scientific names used in this report are after Cogger (1992). In addition, where common names are provided by Cogger (1992) they are used in this report. However, where they are not, other frequently used common names are adopted.

3. RESULTS

3.1 Family: Myobatrachidae (the Southern Ground Frogs)

This family represents a morphologically and ecologically diverse group of ground dwelling frogs which usually have cylindrical fingers lacking expanded and flattened discs (Barker *et al.* 1995). 21 genera are recognised throughout Australia with five genera and ten species occurring in the ACT.

Crinia	2 species
Neobatrachus	1 species
Limnodynastes	3 species
Pseudophryne	3 species
Uperoleia	1 species

Taxonomic status of *Pseudophryne bibronii* and *P. dendyi.*

A considerable amount of uncertainty exists regarding the specific status of these two species in southern NSW, and the nature of the relationship between them. A number of herpetologists are of the opinion that *P. dendyi* is a subspecies or geographic race of *P. bibronii* (Barker *et al.* 1995).

Pengilley (1971a) examined the calls of these two species in south-eastern NSW and the ACT and found them to be very similar, to the extent that he suggested hybridisation could occur. In addition he proposed that the similarity in calls may indicate that the two species are synonymous. Subsequent work in the ACT and region by Woodruff (1972), indicated that *P. dendyi* occurs on the Brindabella Ranges whilst *P. bibronii* is found on the plains to the north and east of Canberra with a zone of full contact and hybridisation between these two areas. He further suggested that sites used by Pengilley (1971a) to characterise *P. bibronii* calls were actually inhabited by hybrids and that based on this, Pengilley's suggestion that the two species may be synonymous, required re-assessment.

Woodruff's assertion that sites in the ACT were inhabited by toadlets of intermediate phenotypes (Woodruff 1972) was not widely recognised, and considering the subtle nature of the morphological differences between the two species, most records of toadlets at lower altitudes in the ACT continued to be regarded as *P. bibroni* (Kukolic 1990, Rauhala 1995, *Vertebrate Atlas of the ACT* Records). Whether any sites in the ACT are currently inhabited by true *P. bibronii* is unknown, mainly because so few recent sightings of the species have

been made in recent times and because call alone is not a reliable means of distinguishing between the species.

Despite the current difficulty of establishing whether any pure *P. bibronii* populations occur in the ACT, the recognition of the Territory as a zone of hybridisation between the two species is of significance in itself. Littlejohn (1989) considers hybrid zones to be of considerable biological interest :

- as indicators of the level of genetic divergence reached during speciation processes;
- as evolutionary interactions representing dynamic aspects of speciation and fusion of taxa; and
- as biological phenomena in their own right.

Littlejohn and Watson (1993) assert that whilst hybrid zones *per se* may be recognised, the zonal interactions including their geographic locations, currently lack any effective protection under existing legislation. They further maintain that hybrid zones clearly fit within the criteria of the Australian Heritage Commission for placing onto the Register of the National Estate, and that state and federal Governments should act to ensure recognition of the phenomenon, support research to delineate and describe the interactions, and ensure the protection of significance locations.

Although the uncertainty concerning the specific status of these two frogs is acknowledged, they are currently regarded as separate species (Cogger 1992) and accordingly, in this document will be dealt with as such.

3.1.1. *Crinia parinsignifera* (Plains Froglet)

Other common names.

- Eastern Sign-bearing Froglet (Tyler 1992, Barker *et al.* 1995).

Biology and habitat

This species is found in a variety of habitats within its range. Breeding sites include swamps, artificial dams, seepage areas, slow flowing creeks and temporary inundated areas in woodland and grassland where it calls from grasses within, and fringing the water. In south-eastern Australia the calling season extends from about mid August to the end of November (Osborne 1985). A minimum tadpole development period of 79 days has been reported (Watson and Martin 1973 in Tyler 1994).

Distribution, abundance and evidence of change

This species occurs from the Murray River valley to south eastern Queensland, through the central west of New South Wales (Cogger 1992). McNally (1985) investigated the distribution of *C. parinsignifera* and *C. signifera* in relation to habitat and microhabitat in southern central Victoria. He found *C. parinsignifera* to be restricted to low elevation sites (below 380 m) that are not underlain by quaternary volcanic soils. In the ACT the association of this species with geology and soils has not been examined, however, the upper altitudinal limit of the species in the region appears to be around 800 metres, and several surveys at higher altitudes have failed to record the species (Eberhard and Schulz 1973, Gilmour *et al.* 1987, Helman *et al.* 1988). The species is known to occur in parts of the Murrumbidgee River Corridor (Rauhala 1993, 1995), however, it is probably more widespread at lower altitudes and is particularly common on the plains to the north of Canberra. Rauhala (1995, 1996) has found this species to be far less common and widespread in the grasslands of the Jerrabomberra and Majura valleys compared with similar habitats in the Gungahlin area. Kukolic (1990), in a 1975-76 study of the Mt Ainslie-Majura and Black Mountain Reserves rarely encountered this species.

Some evidence is available to suggest that the species shows wide fluctuations in abundance from year to year (Rauhala *et al.* 1995, Rauhala 1996), although no consistent longer term trend of decline is suggested.

Although no specific monitoring regime is in place to evaluate changes to the distribution and abundance of this species in the ACT, there is no evidence or opinion available to suggest that the species has declined in this region.

National Conservation Status

Not regarded as threatened in any recent authoritative listing.

ACT status

NCDC (1984) - Widespread, common.

Hogg (1990) - Widespread, common.

This species can be regarded as widespread and very common in part of the ACT

Potential threats

- Activities such as urban and infrastructure development, siltation, pollution or destruction of breeding sites will affect populations at a local scale. However, despite these disturbances being most likely in areas where the species appears to be most abundant, the widespread and adaptable nature of the species will probably ensure its survival.

Requirements for survey, monitoring and management

- Incorporate the species in a long term monitoring program of frog populations in the ACT to detect any changes in its distribution and abundance.

Some conservation reserves where the species has been recorded

- Canberra Nature Park
  - Mulligans Flat Nature Reserve
  - Mt Ainslie
  - Mt Majura
  - Gungahlin Grassland Reserve
- Jerrabomberra Wetlands Nature Reserve
- Murrumbidgee River Corridor
  - Stony Creek Nature Reserve
  - Gigerline Nature Reserve
- Lower Molonglo River Corridor
- Googong Foreshores (NSW)

3.1.2. *Crinia signifera* (Common Eastern Froglet)

Other common names.

- Common Froglet (Tyler 1992, Barker *et al.* 1995, Hero *et al.* 1991)

Biology and habitat

This small frog occurs in a wide range of habitats within its range. It utilises ephemeral and permanent situations for breeding including seepage areas, culverts, farm dams and slow flowing creeks. Throughout much of its geographic range, including the ACT region, some breeding activity occurs throughout the year provided that adequate moisture is available. During dry periods the frogs shelter in thick vegetation or beneath rocks and logs and emerge from these retreats after rain (Cogger 1992) when they are particularly active and vocal. A minimum tadpole development period of 49 days has been reported (Watson and Martin 1973 in Tyler 1994).

Distribution, abundance and evidence of change

The species is widely distributed along the east coast, ranges and adjacent western slopes and plains of Queensland, New South Wales and Victoria. It also extends into south-eastern South Australia and occurs in Tasmania (Cogger 1992).

Most surveys conducted in the ACT region have found the species to be common and widespread, often being recorded in very large numbers, particularly at breeding sites. In the uplands (areas generally above 800 metres), several surveys have been conducted which support this general conclusion. For example, Eberhard and Schulz (1973) found the species to be widespread and abundant throughout the Cotter River Catchment in the ACT. Similarly, Helman *et al.* (1988) who investigated the Upper Cotter River Wilderness area, considered *C. signifera* to be the most abundant species, with large choruses heard in association with pools and marshes along the entire length of the Cotter Valley floor and in bogs and wet heaths and seepages along the ridge tops. Gilmour *et al.* (1987) also found the species to be abundant throughout the Mt Tennent- Blue Gum Creek area.

Crinia signifera is similarly common and widespread in the rolling terrain to the east of the Murrumbidgee River and the plains in the northern part of the ACT. Surveys here, (Kukolic 1990, Rauhala 1993, Rauhala 1995, 1996, Rauhala *et al.* 1995) all further support the suggestion (NCDC 1984, Hogg 1990) that the species is widespread and common in the ACT, although (Rauhala *et al.* 1995 and Rauhala 1996) suggest that the species may be more abundant in grasslands in the Gungahlin area than in similar habitat in the Majura and Jerrabomberra Valleys.

Whilst no specific monitoring regime is in place to evaluate changes to the distribution and abundance of this species in the ACT, there is no evidence or opinion available to suggest that the species has declined in this region.

National Conservation Status

Not regarded as threatened in any recent authoritative listing.

ACT status

NCDC (1984) - Widespread, common.

Hogg (1990) - Widespread, common.

This species can be regarded as widespread and very common in the ACT

Potential threats

- Although activities such as urban and infrastructure development, siltation, pollution or destruction of breeding sites undoubtedly affects populations at a local scale, the widespread and adaptable nature of the species is likely to ensure that these disturbances do not result in large scale declines in its distribution and abundance.

Requirements for survey, monitoring and management

- Incorporate the species in a long term monitoring program of frog populations in the ACT to detect any changes in its distribution and abundance.

Some conservation reserves where the species has been recorded

- Canberra Nature Park
  - Mulligans Flat Nature Reserve
  - Mt Ainslie
  - Black Mountain
  - Mt Majura
  - Gungahlin Grassland Reserve
- Jerrabomberra Wetlands Nature Reserve
- Murrumbidgee River Corridor
  - Stony Creek Nature Reserve
  - Gigerline Nature Reserve
- Lower Molonglo River Corridor
- Namadgi National Park
- Tidbinbilla Nature Reserve
- Googong Foreshores (NSW)

3.1.3. *Limnodynastes dumerilii* (Eastern Banjo Frog)

Other common names.

- Eastern Pobblebonk (Robinson 1993)
- Four-bob Frog (Tyler 1992)
- Bullfrog (Barker *et al.* 1995), Pobblebonk(Hero *et al.* 1991)
- Pobblebonk, Banjo Frog

Biology and habitat

This large burrowing frog is found in forests, woodland, grassland, heathland and farmland where it utilises a large range of aquatic situations for breeding including swamps, dams, ditches and slow flowing streams. Calling period in south-eastern Australia extends from around August to April, with peak activity generally around October and November (Osborne 1985). Male frogs call from hidden positions in water, under overhanging vegetation or from cavities in the pond or stream bank (Humphries 1979). Eggs are laid in a foam nest and in warm water tadpole development takes around 4-5 months, however in cooler climates it can take up to 15 months (Barker *et al.* 1995). Following breeding, frogs forage widely away from breeding sites and over-winter in burrows dug by the frog.

Distribution, abundance and evidence of change

The Eastern Banjo Frog occurs in Tasmania, south-eastern South Australia, Victoria and through eastern New South Wales to south-eastern Queensland (Cogger 1992). In the ACT, the species is widely distributed and regularly encountered. However, two recent surveys in lowland grasslands around Canberra (Rauhala *et al.* 1995, Rauhala 1996) found it to be one of the most uncommon species caught in pitfall traps. Kukolic (1990) found the species to be present in moderate numbers on the Mt Ainslie and Black Mountain Reserves but did not record it from Mt Majura. This frog is also known from the Murrumbidgee River Corridor, where it is found in association with some of the major creek lines, farm dams and slow flowing sections of the river (Rauhala 1993, Rauhala 1995). The species occurs at altitudes up to around 1200 metres in the ACT (Gilmour *et al.* 1987, Lintermans 1993, Vertebrate Atlas of the ACT).

National conservation status

Not regarded as threatened in any recent authoritative listing.

ACT status

NCDC (1984) - Widespread, common

Hogg (1990) - Widespread, common

Potential threats

- Activities such as urban and infrastructure development, siltation, pollution or destruction of breeding sites undoubtedly affects populations at a local scale.

Requirements for survey, monitoring and management

- Incorporate the species in a long term monitoring program of frog populations in the ACT to detect any changes in its distribution and abundance.

Some conservation reserves where the species has been recorded

- Canberra Nature Park
  - Mulligans Flat Nature Reserve
  - Mt Ainslie
  - Black Mountain
- Murrumbidgee River Corridor
  - Stony Creek Nature Reserve
  - Gigerline Nature Reserve
- Namadgi National Park
- Tidbinbilla Nature Reserve
- Googong Foreshores (NSW)

3.1.4. *Limnodynastes peronii* (Brown-striped Frog)

Other common names.

- Striped Marsh Frog (Robinson 1993, Barker *et al.* 1995, Hero *et al.* 1991)

Biology and habitat

This species is most often found in association with permanent water, including slow moving streams, swamps, marshes, dams and ponds (Cogger 1992). During the day it hides under logs, rocks and leaf litter and is capable of burrowing effectively (Barker *et al.* 1995). In south-eastern Australia the main calling season extends from about August to January, with possible extensions to April during wet years (Osborne 1985).

Distribution, abundance and evidence of change

This adaptable frog, which is considered one of the most common and widespread within its range (Barker *et al.* 1995) is found in Tasmania and along the coast and ranges of eastern Australia (Cogger 1992).

In the ACT most records are from the north of the Territory, particularly the Belconnen and Gungahlin area as well as the Jerrabomberra Wetlands and associated backwaters (Vertebrate Atlas of the ACT). Although the species has been previously regarded as common and widespread (NCDC 1984), a more recent review of the ecological resources of the ACT (Hogg 1990) recognised the species as uncommon. This view is supported by many surveys conducted in the ACT in recent years. For example, during extensive pitfall trapping surveys of lowland grasslands in the ACT (Rauhala *et al.* 1995, Rauhala 1996) the species was recorded on two occasions only, represented by two individuals. Similarly, fauna surveys of parts of the Murrumbidgee River Corridor (Rauhala 1993, Rauhala 1995), the Mount Tennent-Blue Gum Creek area (Gilmour *et al.* 1987), the Ainslie, Majura and Black Mountain Reserves (Kukolic 1990) have not recorded the species.

The information available on the total geographic range of the species in Australia (Cogger 1992), and its seemingly limited distribution in the ACT, suggest that the species is probably at or near the western limits of its range in this region. This could be interpreted to mean that its relative contribution to the biological diversity of the ACT is therefore unimportant, however, it is also recognised that populations near the limits of their range are significant in themselves, for their potential role in the species evolutionary development.

National Conservation Status

Not regarded as threatened in any recent authoritative listing.

ACT status

NCDC (1984) - Widespread, common

Hogg (1990) - Uncommon

The species should be regarded as being localised and uncommon in the ACT.

Potential threats

- The restricted distribution of the species in the ACT, renders it more vulnerable to local extinction resulting from disturbance and destruction of its breeding habitats.

Requirements for survey, monitoring and management

- Identify areas where the species occurs in the ACT.
- Regularly monitor sites to determine changes in abundance and relate these to changes in habitat.
- Safeguard its breeding and non-breeding habitat.
- Provide information and advice to land managers in areas where the species occurs to ensure protection of the species and its habitat through management practices compatible with its survival.

Some conservation reserves where the species has been recorded

- Canberra Nature Park
  - Gungahlin Grassland Reserve
  - Mt Pleasant Nature Reserve
  - O'Connor Ridge Nature Reserve
- Jerrabomberra Wetlands Nature Reserve

3.1.5. *Limnodynastes tasmaniensis* (Spotted Grass Frog)

Other common names.

- Spotted Marsh Frog (Robinson 1993, Hero *et al.* 1991)

Biology and habitat

This species is associated with a wide range of habitats including open forest, woodland, shrubland, grassland, including open disturbed areas (Hero *et al.* 1991). Within these habitats frogs breed in farm dams, flood plains, swamps, streamside ponds and other temporary, semi-permanent and permanent water. It is an adaptable species, which is often one of the first to take advantage of newly formed habitat such as farm dams (Robinson 1993). By day, frogs shelter under logs, rocks and debris, generally close to breeding habitat (Barker *et al.* 1995) Within its geographic range, breeding can occur throughout the year provided adequate rain has fallen (Barker *et al.* 1995). In south-eastern New South Wales, calling season extends from about August to mid January, with possible extensions of breeding thereafter during wet years (Osborne 1985). Tadpole development takes from 3 to 5 months (Barker *et al.* 1995).

Distribution, abundance and evidence of change

A widely distributed and common species, occurring throughout Tasmania, Victoria, New South Wales, most of Queensland and parts of the Northern Territory and South Australia (Cogger 1992).

In the ACT region it is similarly widespread and common, being particularly abundant in grasslands at lower altitudes around Canberra, where pitfall trapping surveys (Rauhala *et al.* 1995, Rauhala 1996), have found it to be one of the most abundant and widespread amphibian species captured. It is also moderately common along parts of the Murrumbidgee River Corridor in the ACT (Rauhala 1993, 1995), where it is usually associated with farm dams and some of the more substantial creek lines. Although occasional records of the species at higher altitudes (above 900 m) exist, (Vertebrate Atlas of the ACT), the species is generally recorded at lower altitudes. For example a survey of the Upper Cotter River Catchment in the ACT (Helman *et al.* 1988) did not record the species in the study area which ranges from 960 to 1912 metres.

Although no specific monitoring regime is in place to evaluate changes to the distribution and abundance of this species in the ACT, there is no evidence or opinion available to suggest that the species has declined in this region.

National Conservation Status

Not regarded as threatened in any recent authoritative listing.

ACT status

NCDC (1984) - Widespread, common.

Hogg (1990) - Widespread, common.

This species can be regarded as widespread and very common in much of the ACT

Potential threats

- Although activities such as urban and infrastructure development, siltation, pollution or destruction of breeding sites undoubtedly affects populations at a local scale, the widespread and adaptable nature of the species is likely to ensure that these disturbances do not result in large scale declines in its distribution and abundance.

Requirements for survey, monitoring and management

- Incorporate the species in a long term monitoring program of frog populations in the ACT to detect any changes in its distribution and abundance.

Some conservation reserves where the species has been recorded

- Canberra Nature Park
  - Mulligans Flat Nature Reserve
  - Mt Ainslie
  - Black Mountain
  - Gungahlin Grassland Reserve
  - Jerrabomberra Wetlands Nature Reserve
- Murrumbidgee River Corridor
  - Stony Creek Nature Reserve
  - Gigerline Nature Reserve
- Namadgi National Park
- Tidbinbilla Nature Reserve
- Googong Foreshores (NSW)

3.1.6. *Neobatrachus sudelli* (Spotted Burrowing Frog)

Other common names.

- Sudell's Frog (Tyler 1992, Barker *et al.* 995)
- Painted Burrowing Frog (Gillespie *et al.* 995)
- Common Spadefoot Toad (Hero *et al.* 1991)

Biology and habitat

This species is reported to inhabit open grasslands and lightly wooded country (Barker *et al.* 1995). Within its habitat it breeds in ponds, swamps and temporarily filled pools and soaks (Gillespie *et al.* 1995). It is a burrowing species which spends most of its time underground, and is believed to only come to the ground surface on warm nights following heavy rain (Osborne 1986). In south eastern Australia, the species breeds intermittently from mid August to mid April (Osborne 1985), presumably in response to episodes of adequate rain. The minimum tadpole development period has been documented as 4.5 to 7 months (Martin 1965 in Tyler 1994), however, such a long period of tadpole development seems at odds with the temporary nature of many of its breeding sites which would not be conducive to high levels of successful recruitment to the population.

Distribution, abundance and evidence of change

Occurs in southern Queensland, throughout much of New South Wales, Victoria and the extreme south-eastern corner of South Australia (Barker et al 1995), however, there are suggestions (Cogger 1992) that the distribution of this species is unclear due to its overlap with the distribution of the closely related *N. pictus*.

In the ACT, records of this species are confined mainly to altitudes below 700 metres (Vertebrate Atlas of the ACT), although one record exists from Gudgenby Station at 980 metres (Lintermans 1993). It has been suggested (NCDC 1984), that the physical properties of the soil may be a factor determining the species distribution.

Although previously considered as uncommon in the ACT (NCDC 1984, Hogg 1990), the species has more recently found to be widespread and moderately abundant throughout the grassland plains around Canberra, including the Gungahlin area and the Majura and Jerrabomberra valleys (Rauhala *et al.* 1995, Rauhala 1996). The concentration of records from lowland grasslands around Canberra, to a large extent reflects the extensive pitfall trapping that has been conducted in this area over the last six years by the ACT Parks and

Conservation Service in response to urban development pressures. However, these grasslands at lower altitudes are in fact likely to comprise the preferred habitat of the species in this region, as many surveys in other areas have failed to record the species (Eberhard and Schulz 1973, Gilmour *et al.* 1987, Helman *et al.* 1988, Kukolic 1990, Rauhala 1993, 1995). The paucity of records away from the grassland plains around Canberra should be regarded with a degree of caution, however, due to the fact that the species can be easily missed due to its burrowing habits.

Although no specific monitoring regime is in place to evaluate changes to the distribution and abundance of this species in the ACT, there is no evidence or opinion available to suggest that the species has declined in this region.

National Conservation Status

Not regarded as threatened in any recent authoritative listing.

ACT status

NCDC (1984) - Uncommon

Hogg (1990) - Uncommon

Results of recent surveys indicate that this species is common, particularly the lowland grasslands of the ACT, but that its distribution is insufficiently known.

Potential threats

- Activities such as urban and infrastructure development, siltation, pollution or destruction of breeding sites are likely to affect populations at a local scale. This is particularly relevant as the species appears to be most abundant in the lowland grasslands in the ACT where development pressure is greatest.
- Improving drainage can lead to degradation of breeding sites through premature drying of pools and soaks leading to egg and tadpole mortality.
- Ploughing and cropping of grassland areas

Requirements for survey, monitoring and management

- Incorporate the species in a long term monitoring program of frog populations in the ACT to detect any changes in its distribution and abundance.

Some conservation reserves where the species has been recorded

- Canberra Nature Park
  - Mulligans Flat
  - Gungahlin Grassland Reserve
- Googong Foreshores (NSW)

3.1.7. *Pseudophryne bibronii* (Brown Toadlet)

For a discussion on the taxonomy of this species, please refer to page 7.

Other common names.

- Bibron's Toadlet (Tyler 1992, Robinson 1993, Gillespie *et al.* 1995, ANCA in prep.)

Biology and habitat.

Like most members of its genus, *P. bibronii* lays its eggs on land, usually in a burrow in soil, amongst moss or other damp vegetation, leaf litter or other debris in areas subjected to inundation as a result of winter rain (Pengilley 1971a). Most species of *Pseudophryne* breed during late summer to late autumn or early winter (Pengilley 1973), and the calling season of *P. bibroni* in south-eastern NSW has been identified broadly as February to the end of May (Osborne 1985). Male frogs move to the breeding areas before females and establish a calling site. Females are attracted to the calling sites, where they deposit eggs and then disperse. The males, however, remain with the clutch for varying lengths of time, and continue to call during this period (Pengilley 1971a). The emergence of tadpoles is delayed pending the onset of sufficient rain in winter to inundate of the deposition site and release the tadpole from its capsule (Tyler 1992). Pengilley (1973) found the breeding success of three *Pseudophryne* species in the Southern Tablelands and Highlands to be affected by drought. Similarly, Humphries (1979) observed complete embryonic mortality, due to desiccation in nests of *P bibronii* resulting from severe drought period experienced in the Canberra region during the winter of 1976. In the non-breeding season this species can be found under logs and rocks in forest and woodland, up to 150m away from the breeding areas (Gillespie *et al.* 1995). The diet of *P. bibronii* is similar to that of *P. corroboree* and *P. dendyi*, with ants comprising the greater majority of food by weight, followed by spiders and termites (Pengilley 1971b). Tadpole development is reported to take from 120 to 210 days (Woodruff 1976a).

Distribution, abundance and evidence of change.

The species is widely distributed through south-eastern Queensland, the eastern half of New South Wales, Victoria and south-eastern South Australia, as well as Tasmania (Cogger 1992). It was considered the most common and widespread member of the genus (Barker *et al.* 1995), but populations appear to have declined in some areas and its current distribution now requires redefinition (ANCA in prep., Gillespie *et al.* 1995).

In the ACT, most records of the species are from lower altitudes (below 800m), with only one or two exceptions. The species was studied in 1964-65 at Uriarra, Tidbinbilla and to the north

of the ACT border near Yass and Mountain Creek Road (Pengilley 1971a, 1973). It has also been documented as occurring on the plains north and east of Canberra, including Bungendore (Woodruff 1972), and at New Chums Rd Brindabella Range in 1978 (Australian National Wildlife Collection, unpublished data). In 1975-76 the species was common in the Ainslie-Majura and Black Mountain Reserves (Kukolic 1990), and as late as the early 1980's was generally considered common and widespread in the ACT (NCDC 1984). By 1986, this species had suffered a reduction in their populations, and was no longer considered common in the Canberra region (Osborne 1986). Many searches for this species in the mid to late 1980's failed to record any individuals (Osborne 1990) and it was suggested that the species may be considered rare (Hogg 1990) or have become locally extinct in the region possibly as a result of the drainage of wetlands as well as droughts (Osborne 1990). Since this time, however, the species has been recorded at several scattered locations in the ACT and immediate region (*Vertebrate Atlas of the ACT*, Rauhala 1995, M. Rauhala and D. Roso unpublished data, D. Roso pers. comm., pers. obs.). Gillespie *et al.* (1995) regard the species as poorly known within the Australian Alps and that there is evidence of decline in south-eastern Australia.

National Conservation Status

IUCN (1994)	Insufficiently known
(ANCA in prep)	Insufficiently known

ACT status

NCDC (1984)	Widespread, common
Hogg (1990)	Rare

Evidence is available to suggest that the species has declined in this region. It should be regarded as rare and its distribution as insufficiently known in the ACT, with more survey and monitoring urgently required.

Potential threats

- Prolonged drought conditions (particularly during winter) are likely to affect the breeding success of this species which is reliant on adequate winter rains to inundate breeding site, allowing hatching and tadpole development
- Improved drainage of breeding sites and erosion can lead to loss of egg deposition sites, or the premature drying of deposition sites, leading to egg desiccation and mortality. Woodruff (1976b) and Humphries 1979 found evidence of mass embryonic mortality caused by desiccation in *Pseudophryne*. In addition, improved drainage can lead to loss of pools for tadpole development.

- Removal of ground debris, rocks and logs, leading to loss of sheltering sites.
- Frequent fires may lead to loss of sheltering sites and increased vulnerability to predation or desiccation.
- Modification of breeding sites, such as invasion by plant species which shade breeding pools.
- Disturbance to breeding sites by heavy machinery or by animals such as livestock, or feral pigs.

Requirements for survey, monitoring and management.

- Survey sites in the ACT and region, where the species has been recorded historically.
- Survey additional habitat likely to support the species.
- Regularly monitor sites where the species is currently known to occur to determine changes in abundance and relate these to changes in habitat.
- Identify and protect sites of hybridisation between *P. bibronii* and *P. dendyi*
- Provide information and advice to land managers in areas where the species is known to occur to ensure protection of the species and its habitat through management practices that are compatible with its survival.
- Gillespie *et al.* (1995) recommend resolution of the taxonomy of the species in the zone where it hybridises with *P. dendyi.*

Some conservation reserves where the species has been recorded

- Canberra Nature Park
  - Black Mountain
  - Mt Ainslie
  - Mt Majura
- Murrumbidgee River Corridor
  - Gigerline Nature Reserve
  - Bullen Range Nature Reserve
  - Woodstock Nature Reserve
- Tidbinbilla Nature Reserve
- Googong Foreshores (NSW)

3.1.8. *Pseudophryne dendyi* (Southern Toadlet)

For a discussion on the taxonomy of this species, please refer to page 7.

Other common names.

- Dendy's Toadlet (Robinson 1993, Gillespie *et al.* 1995, Hero *et al.* 1991)

Biology and habitat.

The biology and habitat is similar to that of the closely related *P. bibroni* (see above). The breeding season has been described as extending from February to the end April (Osborne 1985).

Distribution, abundance and evidence of change

The species is confined to south-eastern New South Wales and eastern Victoria (Cogger 1992). Although within its range the species occurs from near sea level to altitudes of 1700 metres (Gillespie *et al.* 1995), in the ACT it is usually only recorded at altitudes above 800 metres. A survey of the Cotter River catchment in the ACT (Eberhard and Schulz 1973) found the species to be common and widespread at higher altitudes, and likewise Helman *et al.* (1988) in a study of the upper Cotter River catchment, found it to be relatively common, with large numbers recorded in association with seasonal pools and seepages in the upper Cotter valley. Gilmour *et al.* (1987) in their study of the Mt Tennent-Blue Gum Creek area, considered this frog scarce and confined to sites above 1000 metres. Although there is no documented evidence available to suggest that the species has declined in this area, no specific evaluation of its distribution and abundance has been undertaken.

National Conservation Status

Not regarded as threatened in any recent authoritative listing.

ACT status

NCDC (1984)	Uncommon.
Hogg (1990)	Localised, common.

The species should be regarded as insufficiently known in the ACT, with more survey and monitoring required.

Potential threats

The same as those for *P. bibronii* (see above)

Requirements for survey, monitoring and management

- Regular monitoring of a selection of sites where the species is known to occur in the ACT to assess any changes in abundance and relate these to changes in habitat.
- Identify and protect sites of hybridisation between *P. bibronii* and *P. dendyi.*
- Provide information and advice to land managers in areas where the species is known to occur to ensure protection of the species and its habitat through management practices that are compatible with its survival.
- The ACT Parks and Conservation Service should encourage the resolution of the taxonomy of *P. bibronii* and *P. dendyi* in the area where the two hybridise, as recommended by Gillespie *et al.* (1995).

Some conservation reserves where the species has been recorded

Namadgi National Park

3.1.9. *Pseudophryne pengilleyi* (Northern Corroboree Frog)

Taxonomic status

Two distinct forms of Corroboree Frog have been recognised (Pengilley 1966, Woodruff 1975) and subsequent work (Roberts and Maxon 1989, Osborne and Norman 1991) has indicated that significant genetic differences exist between them. Osborne (1989) further established that the northern and southern forms are geographically isolated from each other. Zentelis (1992) detected significant divergence between the two forms in morphology, advertisement call characteristics and the physiological characteristic of critical thermal minimum, as well as some evidence of genetic divergence. Formal recognition of the two forms as separate species has been recommended (Wells and Wellington 1985, Zentelis 1992, Osborne *et al.* in press). The southern form is confined to the Snowy Mountains, whilst the northern form comprises two geographically separated populations; one in the Fiery Range and Bogong Mountains, and the other in the Brindabella and Bimberi Ranges (Osborne 1991). It has been proposed by Wells and Wellington (1985) that the specific name of *P. pengilleyi* be adopted for the northern form and that the southern form retain the name *P. corroboree*. In a detailed recent analysis of geographic variation in morphology and calls (Osborne *et al.* in press) recommended that the name *P. pengilleyi* Wells and Wellington be used for the northern form. Given that this recommendation is likely to be accepted, the population in the ACT will be referred to here as the Northern Corroboree Frog *Pseudophryne pengilleyi.*

Biology and habitat.

During the breeding season the species utilises areas with shallow pools and seepages among mainly bog, wet-heath, wet-herbfield and tall wet-grassland (Osborne 1990). Male calling activity extends broadly from January to April (Pengilley 1973). Frogs call from chambers among vegetation at the edge of pools and seepage areas and attract females which then deposit eggs within the nest. The male frog usually remains with the eggs and may continue calling (Pengilley 1971a), presumably to attract other mates. The well-advanced tadpoles emerge from the egg with the onset of winter rains which inundate the nest sites. During winter and spring the tadpoles complete their development within the pools from which they emerge as metamorphs in early summer (Pengilley 1966, Osborne 1991). After breeding is complete, adult frogs move into adjacent heath and woodland where they over-winter under logs, rock, vegetation and litter (Pengilley 1966, Osborne 1988). Adults and sub-adults feed mainly on ants and termites (Pengilley 1971b).

Distribution, abundance and evidence of change.

The Brindabella Range-Bimberi Range population of the Northern Corroboree Frog has a restricted range of about 60 km^2, at altitudes ranging from 1090m to 1840 metres (Osborne 1989). The distribution of the species in the ACT is confined to the Brindabella and Bimberi Range, where it occurs along a narrow strip along the mountain range (Osborne 1991) and includes areas in the vicinity of Ginini Flats, a site listed in 1996 as a wetland of international importance under the Ramsar agreement. This frog has also been recorded in adjacent areas of NSW including Coree Flats (Pengilley 1979a), Rolling Ground Gap and Leura Gap (Helman *et al.* 1988).

Osborne (1989), indicated that whilst the Snowy Mountain populations of the corroboree frog has suffered a reduction in abundance and that it had disappeared from some sites where it occurred previously. However, he considered the northern form to still be common and widespread in the Fiery and Brindabella Ranges and that most local breeding groups in this area were relatively large (20 % of sites with frogs had more than 50 calling males, and five sites with several hundred individuals recorded). He did, however, note that at some sites in the Brindabella Range the numbers of calling males had declined considerable from 20 years ago, and estimated the adult male population to be 2000-3000 in the Brindabella Range in 1988. However, over the last few years, numbers have declined significantly in the Brindabella Range, to the extent that there is now serious concern over its continued survival in this area (Osborne pers. comm.). Gillespie *et al.* (1995) also suggest that there is evidence for decline in this species in south-eastern Australia.

National Conservation Status.

Most references to the conservation status of Corroboree Frogs refer only to the composite species *P. corroboree* and not separately to the two forms now believed to represent two distinct species. However, in New South Wales *P. pengilleyi* is listed as vulnerable in NSW on Schedule 2 of the NSW Threatened Species Conservation Act 1996.

IUCN (1994)	Vulnerable
ANZECC (1991)	Vulnerable
ANCA (in prep.)	Vulnerable

ACT status

Nature Conservation Act 1980

Vulnerable; Special Protection Status

In terms of distribution and abundance, the species should be regarded as restricted and rare in the ACT.

Potential threats

The potential threat to the species have been examined by Osborne (1991) and his main concerns are :

- Prolonged dry conditions and droughts affecting breeding success.
- Hydro-electrical and ski-resort developments.
- Any major construction or works affecting drainage of breeding sites or their siltation
- Fire.
- Weed infestation of habitat.
- Physical disturbance to habitat, and disruption to breeding activity through people searching for frogs.
- Feral pigs damage to habitat.
- Climate change, including changes in precipitation, temperatures UV radiation .

Requirements for survey, monitoring and management

- Identify all sites where the species has been recorded in the ACT.
- Implement a long-term monitoring program for key sites, including monitoring breeding and non-breeding habitat.
- Protect breeding and non-breeding habitat (ANCA in prep.)
- Analyse long-term climatic data to determine whether declines can be attributed to weather patterns (Gillespie *et al.* 1995).

Some conservation reserves where the species has been recorded

- Namadgi National Park

3.1.10. *Uperoleia laevigata* (Smooth Toadlet)

Other common names.

- Orange-groined Toadlet

Biology and habitat

This frog exists in a wide range of habitats within its range, occurring in closed forests, woodland and grasslands (Robinson 1993, Barker *et al.* 1995). It has been described as cryptozoic (Cogger 1992), emerging from retreats to breed in temporary inundated grasslands during spring and summer. Further breeding habitats have been listed as ponds, lagoons, dams and lakes (Hero *et al.* 1991). In south-eastern New South Wales the calling season has been described as extending from September to early January (Osborne 1985).

Distribution, abundance and evidence of change

The species occurs from eastern Victoria, through coastal and central regions of New South Wales (including the Great Dividing Range) to south-eastern Queensland (Davies and Littlejohn 1986, Cogger 1992).

In the ACT the species has been described as common and widespread (NCDC 1984, Hogg 1990). It appears to be less common at higher altitudes in the ACT, being recorded only infrequently in the Mt Tennent-Blue Gum Creek area (Gilmour *et al.* 1987) and the Upper Cotter River Catchment (Helman *et al.* 1988). Similarly, Kukolic (1990) recorded the species on Mt Majura on the basis of only one individual, but did not record the species on Black Mountain or Mt. Ainslie. At lower altitudes, and particularly on the grassland plains around Canberra, the species has been found to be moderately widespread and present in low to moderate numbers (Rauhala *et al.* 1995, Rauhala 1996). Along the Murrumbidgee River Corridor in the ACT, Rauhala (1993) found the species to be very uncommon in the Stony Creek Nature Reserve, however, in the following year, the species was found to be very widespread and common in the Gigerline Nature Reserve, where it was the most abundant frog found in pitfall traps (Rauhala 1995). It appears that the species is generally widespread in suitable habitat in the ACT, but only locally abundant.

Although no specific monitoring regime is in place to evaluate changes to the distribution and abundance of this species in the ACT, there is no evidence or opinion available to suggest that the species has declined in this region.

National conservation status

Not regarded as threatened in any recent authoritative listing.

ACT status

NCDC (1984) - Widespread, common

Hogg (1990) - Widespread, common

Potential threats

- Activities such as urban and infrastructure development, siltation, pollution or destruction of breeding sites are likely to affect populations at a local scale.

Requirements for survey, monitoring and management

- Incorporate the species in a long term monitoring program of frog populations in the ACT to detect any changes in its distribution and abundance.

Some conservation reserves where the species has been recorded

- Canberra Nature Park
  - Mulligans Flat
  - Mt Majura
  - Gungahlin Grassland Reserve
  - Tuggeranong Hill
  - Farrer Ridge
  - Rob Roy Range
- Murrumbidgee River Corridor
  - Stony Creek Nature Reserve
  - Gigerline Nature Reserve
- Namadgi National Park
- Tidbinbilla Nature Reserve
- Googong Foreshores (NSW)

3.2 Family: Hylidae (Tree Frogs)

Although generally referred to as tree frogs, members of this family exhibit arboreal, ground dwelling and burrowing habits. The burrowing hylids lack the expanded and flattened discs on their fingers and toes which are characteristic of most other hylids (Barker *et al.* 1995).

Three genera of hylid frogs occur in Australia, however, only one (*Litoria*) is found in the ACT. Five species of *Litoria* are currently known to occur in the ACT, with three other species believed to have become locally extinct.

3.2.1. *Litoria latopalmata* (Broad-palmed Frog)

Other common names.

- Günther's Frog (Tyler 1992)

Biology and habitat

This frog has been described as a species of open forests which breeds in temporary, summer rain-filled pools (Davies *et al.* 1983). It is also known to occur near permanent and semi-permanent pools and billabongs near open forest (Barker *et al.* 1995). In the ACT the species is most commonly associated with the Murrumbidgee River and larger creek systems of the river where it breeds in pools along rocky sections of stream (Rauhala and Osborne 1994). Habitat at most known breeding sites in the ACT are in open pastures, well away from tree cover.

Male frogs call from the edge of water and in the ACT have been found to utilise solid rock bars and rock slabs within or adjacent to water (Rauhala and Osborne 1994). Calling season in the ACT extends broadly from November to January, and the duration of tadpole development in this region is thought to take between 8 and 12 weeks (Rauhala and Osborne 1994).

Distribution, abundance and evidence of change

Cogger (1992) described the distribution of this species as extending from central Queensland to Central New South Wales, on the coast, ranges and in the interior. However, more recently, the species has been recorded in the ACT (Rauhala and Osborne 1994), and subsequently in the Carabost State Forest, 130 km south-west of the ACT site (Lemckert *et al.* 1995).

The species was first recorded in the ACT in 1985 on the basis of one individual found in a farm dam on the Cotter Road about 1.5 kilometres from the Murrumbidgee River. A subsequent fauna survey in Stony Creek Nature Reserve, Murrumbidgee River Corridor (Rauhala 1993), and other observations have located several additional sites supporting the species. In the ACT, it seems to be strongly associated with the Murrumbidgee River, its larger tributary creeks and some nearby farm dams (Rauhala and Osborne 1994). The northern -most record of the species locally is from Wallaroo Road, just north of the ACT border, with the southern-most occurrence recorded at Pine Island (Rauhala and Osborne 1994).

National Conservation Status

Not regarded as threatened in any recent authoritative listing.

ACT status

NCDC (1984) - Not recognised

Hogg (1990) - Not recognised

In the ACT the species should be regarded as uncommon, and its distribution localised. In addition it must be recognised that the distribution remains insufficiently known, with more survey and monitoring required.

Potential threats

- At least two breeding populations of this species in the ACT, are located adjacent to areas used for pine plantation forestry. Impacts from this adjacent land use may include increased sedimentation of streams following logging operations, as well as potential chemical contamination from use of herbicides and fertilisers. Similarly, livestock grazing within or near breeding sites may lead to increased erosion, siltation, trampling and nutrient input. It is not understood how significant these factors are for the survival of the species in these areas.

- Farm dams supporting breeding populations of the species may be subject to modification or destruction as part of farm management practices.

Requirements for survey, monitoring and management

- Regularly monitor sites where the species is currently known to occur to determine changes in abundance and relate these to changes in habitat.

- Survey additional areas to gain a better understanding of the distribution of the species in the ACT.

- Where forestry and grazing are land uses conducted within the immediate catchment of known breeding streams, a number of safeguards should be adopted to protect the species and its habitat. These include;

    1. effective erosion control measures
    2. careful and directed application of chemicals
    3. conservative livestock grazing rates

Some conservation reserves where the species has been recorded

- Lower Molonglo River Corridor
- Murrumbidgee River Corridor

  Stony Creek Nature Reserve

  Bullen Range Nature Reserve

  Pine Island Special Purpose Reserve

3.2.2. *Litoria lesueuri* (Lesueur's frog)

Other common names.

- Lesueur's Tree Frog (Gillespie *et al.* 1995)
- Stony Creek Frog (Barker *et al.* 1995)
- Rocky River Frog (Hero *et al.* 1991)

Biology and habitat

Although living in a variety of habitats and sometimes found long distances from water (Cogger 1992), this frog is most commonly associated with rocky streams. Calling activity in south-eastern Australia extends from September to January (Osborne 1985) with male frogs calling on the ground or from rocks adjacent to, or within the stream. Eggs are deposited in a quiet section of stream in a gelatinous mass which adheres to the substrate or to submerged rocks (Barker *et al.* 1995)

Distribution, abundance and evidence of change

It is thought that at least two separate species are currently grouped under this name (Cogger 1992, Barker *et al.* 1995, Tyler 1992). The composite species is widely distributed along the coast, ranges and slopes of eastern Australia, extending from northern Queensland to Victoria (Cogger 1992).

In the ACT this riverine frog occurs along the length of the Murrumbidgee River, with hybridisation between two forms of the species identified at Uriarra Crossing (S. Donellan, South Australian Museum pers. comm.). Eberhard and Schulz (1973) in a survey of the vertebrate fauna of the Cotter River catchment found the species to be abundant along the length of the Cotter River, as well as some major tributary creeks, however, other work (Helman *et al.* 1988, Lintermans pers. comm.) in the Upper Cotter Catchment has found it to be uncommon at higher altitudes. The highest documented occurrence of this species in the ACT appears to be on the Cotter River at about 990 metres (Vertebrate Atlas of the ACT), however it is particularly abundant in the river above Bendora Reservoir (pers. obs.) and around the edges of the impoundment (M. Lintermans pers. comm.). The species is also known to occur along the Murrumbidgee River in the ACT (Rauhala 1993, 1995), the Queanbeyan River particularly above Googong reservoir, and the Naas River (Vertebrate Atlas of the ACT). Isolated records exist from the Lower Molonglo River (Hogg 1990) and the Gudgenby River (M. Littlejohn unpublished data).

Although no specific monitoring regime is in place to evaluate changes to the distribution and abundance of this species in the ACT, there is no evidence or opinion available to suggest that the species has declined in this region.

National Conservation Status

IUCN (1994) - Insufficiently Known

ACT status

NCDC (1984) - Widespread, common

Hogg (1990) - Localised, uncommon

The species should be regarded as widespread in suitable habitats but generally uncommon.

Potential threats

- Disturbances to riverine processes, including drastic alteration of flows, increased siltation or other pollutants.
- Large scale removal of streamside rock and cobble would affect populations on a local scale.
- Predatory fish.

Requirements for survey, monitoring and management

- Regularly monitor sites where the species is currently known to occur to determine changes in abundance and relate these to changes in habitat.
- Further surveys for this species, including the two forms, have been recommended (Osborne 1992).
- Identify and protect sites of hybridisation between the two forms of the species (For a discussion on the significance of hybrid zones, refer to page 8).

Some conservation reserves where the species has been recorded

- Lower Molonglo River Corridor
- Murrumbidgee River Corridor
  - Stony Creek Nature Reserve
  - Gigerline Nature Reserve
  - Point Hut Special Purpose Reserve
- Namadgi National Park
- Googong Foreshores (NSW)

3.2.3. *Litoria peronii* (Peron's Tree Frog)

Biology and habitat

This species is usually found in wooded and forested habitats, where it shelters amongst vegetation and under loose bark, coming to the ground to forage. Breeding takes place in rivers, creeks, lagoons, dams and swamps, however, eggs are usually deposited in still water situations. Calling season in south-eastern Australia extends from September to February (Osborne 1985) and a tadpole life of around 190 days has been reported (Tyler 1992).

Distribution, abundance and evidence of change

This species extends from southern Queensland, throughout New South Wales to northern Victoria and south-eastern South Australia (Cogger 1992).

In the ACT, this frog appears to be associated mainly with wooded areas where it is usually recorded calling at farm dams. It is known to occur in the lowlands around Canberra with the highest altitude record in the immediate region at 850 metres on the Burra Road in NSW (Vertebrate Atlas of the ACT). The species has also been recorded from the Cotter River (Vertebrate Atlas of the ACT) and the Murrumbidgee River Corridor where it has been heard calling in backwater pools of the river as well as farm dams (Rauhala 1995). The species is regularly recorded in dams at Googong Foreshores and Tidbinbilla Nature Reserve.

Distribution records of this species are probably underestimated to some extent due to the fact that this frog is not readily caught in pitfall traps due to its climbing ability. Surveys using calling are the most effective technique for this species because of its characteristic call which is not likely to be confused with any other frog occurring in the region.

Although no specific monitoring regime is in place to evaluate changes to the distribution and abundance of this species in the ACT, there is no evidence or opinion available to suggest that the species has declined in this region.

National Conservation Status

Not regarded as threatened in any recent authoritative listing.

ACT Status

NCDC (1984) - Widespread, common.

Hogg (1990) - Widespread, common

The species should be regarded as widespread and common in parts of the ACT.

Potential threats

- Activities such as urban and infrastructure development, siltation, pollution or destruction of breeding sites are likely to affect populations at a local scale.

Requirements for survey, monitoring and management

- Incorporate the species in a long term monitoring program of frog populations in the ACT to detect any changes in its distribution and abundance.

Some conservation reserves where the species has been recorded

- Canberra Nature Park
  - Gungahlin Grassland Reserve
  - Mt Ainslie
  - Mulligans Flat
  - O'Connor Ridge
- Lower Molonglo River Corridor
- Murrumbidgee River Corridor
  - Gigerline Nature Reserve
- Namadgi National Park
- Tidbinbilla Nature Reserve
- Googong Foreshores (NSW)

3.2.4. *Litoria* species affin. *phyllochroa* (Cotter River Frog)

This frog was first recorded in 1975 when it was collected between the Bendora and Corin reservoirs by an officer of the ACT Parks and Conservation Service (Osborne *et. al.* 1994). At that time it was identified as the Leaf-green Tree Frog *Litoria phyllochroa*, a species which has a wide geographic distribution along coastal and adjacent areas of New South Wales, south-eastern Victoria and Queensland, and is known from Kosciusko National Park some 80 kilometres from this isolated site.

In 1993 a further examination of the preserved specimen and photographs by a number of herpetologist and further field survey in 1994 led to suggestions that the frog may be the endangered spotted tree frog *Litoria spenceri* (Osborne *et. al.* 1994). Subsequent work (Gillespie and Osborne 1994), including preliminary genetic analysis (Donellan in Gillespie *et al.* 1995) indicated that this frog may have been a separate taxon from both *L. phyllochroa* and *L spenceri* , however, more genetic analyses are currently being undertaken (S. Donellan, S. A. Museum, pers. comm.) to further clarify its taxonomic status. The most recent information available indicates that this frog is likely to be a form of the Leaf-green Tree Frog *Litoria phyllochroa* (W. Osborne pers. comm.).

Biology and habitat

Very little is known of the biology and habitat requirements of this riverine frog, however, preliminary survey indicates that The species inhabits densely vegetated montane forest and riparian habitat and that breeding habitat is confined to areas of pebble and shingle banks and probably relies on backwater pools for egg and tadpole development. The species has been heard calling in December, with metamorphs observed in April along exposed pebble (cobble) banks of the stream (Gillespie *et al.* 1995). Calling position has been noted to include dense fern banks and other vegetation overhanging the water as well as flood debris adjacent to large, deep pools along the river (Gillespie *et al.* 1995).

Distribution, abundance and evidence of change

Currently this species is only known from two sites. One in the ACT, along the Cotter River above Bendora Reservoir in Namadgi National Park and the other, along the Goodradigbee River in NSW, approximately 10 kilometres from the Cotter River site (D. Hunter pers. comm.).

National Conservation Status

Not recognised by any recent authoritative listing

ACT Status

NCDC (1984) - Not recognised

Hogg (1990) - Not recognised

Prior to the discovery of the Goodradigbee River site, Gillespie *et al.* (1995) describe the status of this species in the Australian Alps as highly restricted. Although the additional site has subsequently been identified, this frog should continue to be regarded as rare with its distribution localised and insufficiently known.

Potential Threats

- Alteration of water flows. The imposed water flow regime in the Cotter River between Corin and Bendora reservoirs has potential to adversely affect the population of the frog at this location through effects on breeding success. However, the recently developed draft Environmental Flow Guidelines for the ACT, when implemented, will assist in the protection of this species from the potential harmful effects of human controlled flow extremes.
- Large scale removal of streamside rock and cobble.
- Increased sedimentation and other pollutants.
- Predatory fish, e.g. trout.

Requirements for survey, monitoring and management

(The following are modified from the actions suggested by Gillespie *et al.* 1995.)

- Further surveys to establish the distribution of the species in the region. A co-ordinated approach with the NSW National Parks and Wildlife Service is suggested.
- Monitoring of the populations at the known sites of occurrence.
- Detailed work on the habitat requirements and ecology of the species.
- Investigation of the potential impacts of predatory fish.
- Investigation on the influence of the imposed river flow regime on breeding biology of the species.
- Encourage work on determining the taxonomic status of this frog.

Some conservation reserves where the species has been recorded

- Namadgi National Park

3.2.5. *Litoria verreauxii* (Whistling Tree Frog)

Other common names.

- Verreaux's Tree Frog (Robinson 1993)

This species is currently recognised to consist of two sub-species, the Whistling Tree Frog *L. verreauxii verreauxii* and the Alpine Tree Frog *L. verreauxii alpina*. There is considerable uncertainty as to whether the alpine subspecies occurs in the ACT.

Biology and habitat

Litoria verreauxii is found in a variety of habitats within its range including wet and dry sclerophyll forest, woodland and grassland. It breeds in swamps, lagoons, ponds, dams and streams (Cogger 1992), where males call from the ground, low vegetation or floating in the water (Hero *et al.* 1991). In the ACT calling extends from January to October (Hone *et al.* 1992).

Distribution, abundance and evidence of change

Litoria verreauxii has a distribution extending from south-eastern Queensland, northern tablelands of NSW to central and south coast and ranges of New South Wales and eastern Victoria (Cogger 1992).

The species is widely distributed on the plains around Canberra, the Tidbinbilla valley, Naas valley, Orroral valley and the Cotter River catchment.). In a survey of the Cotter River Catchment, Eberhard and Schulz (1973) found *L. verreauxii* (recorded as *Hyla ewingi*) to be abundant and widespread in swamps, springs and creeks in the vicinity of Mts. Ginini and Gingera and at Murray's Gap. Helman *at al.* (1988) recorded the species to be relatively common along the valley floor as far south as Rolley's Flats, where it was found breeding in temporary water filled depressions and shallow marshes along the valley floor.

There is considerable concern for the continued survival of the alpine sub-species of this frog throughout its restricted range, with some evidence to suggest that it has disappeared from the alpine zone and declined in the sub-alpine zone (Gillespie *et al.* 1995). There has also been the suggestion (Osborne 1990), that breeding aggregations of *L. v. verreauxii* have been substantially reduced from their former abundance, however, consistent long term information is not available. Recent field observations by W. Osborne and E. Guarino (University of Canberra) indicate that lowland populations of *L. verreauxii* in the Gungahlin

region have fully recovered from the very low numbers found in the late 1980's by W. Osborne and K. Kukolic (unpublished data) (W. Osborne pers. comm.).

National conservation status

Litoria verreauxii
IUCN (1994) - Insufficiently Known
Litoria v. alpina
ANCA (in prep.) - vulnerable .

ACT status

NCDC (1984)		
	Litoria v. alpina	Uncommon
	Litoria v. verreauxii	Widespread, common
Hogg (1990)		
	Litoria v. alpina	Uncommon
	Litoria v. verreauxii	Widespread, uncommon

Litoria v. verreauxii has a widespread distribution in the ACT and can generally be regarded as uncommon. The status of *Litoria v. alpina* is insufficiently known.

Potential threats

- Activities such as urban and infrastructure development, siltation, pollution or destruction of breeding sites are likely to affect populations at a local scale.
- The restricted alpine sub-species is likely to be susceptible to climate change and in parts of its range (Victoria and NSW) may be threatened by construction and operation of hydro-electric facilities and ski resort development (Gillespie *et al.* 1995). However, these are not foreseen to constitute major threats in the ACT.

Requirements for survey, monitoring and management

- Incorporate the species in a long term monitoring program of frog populations in the ACT to detect any changes in its distribution and abundance.
- Determine the distribution and status of the alpine sub-species in the ACT.

Some conservation reserves where the species has been recorded

- Canberra Nature Park
  - Gungahlin Grassland Reserve
  - Mt Ainslie Nature Reserve
  - Mulligans Flat Nature Reserve
  - Pinnacle Nature Reserve
- Namadgi National Park
- Tidbinbilla Nature Reserve
- Googong Foreshores (NSW)

3.2.6. The *Litoria aurea* complex in the ACT region

Litoria aurea (Green and Golden Bell Frog)
Litoria raniformis (Warty Swamp Frog)
Litoria castanea (Yellow-spotted Tree Frog)

Other common names.

L. aurea

- Green and Golden Grass Frog (Hero *et al.* 1991)
- Green and Golden Swamp Frog (Robinson 1993)

Litoria raniformis

- Southern Bell Frog (ANCA in prep, Tyler 1992)
- Growling Grass Frog (Hero *et al.* 1991)
- Warty Marsh Frog (Gillespie *et al.* 1995)

Litoria castanea

- New England Swamp Frog (Robinson 1993)

Although three members of the *Litoria aurea* complex are believed to have occurred in the ACT and region (Thomson *et al.* 1996), extensive searches for these species in the Southern Tablelands of New South Wales and the ACT between 1985 and 1995 indicate that all are now locally extinct (Osborne *et al.* 1996).

Biology and habitat

The biology and habitat of these three species appear to be broadly similar. All breed in permanent, still water situations such as dams, lagoons and swamps with abundant bordering vegetation such as reeds and rushes (Barker *et al.* 1995). These frogs are frequently active during the day when they may be observed basking on vegetation or logs within the water. Breeding activity in the ACT region has been reported to occur between October and December (Humphries 1979), and metamorphosis is completed from late summer to autumn, although some may over-winter (Gillespie *et al.* 1995). Frogs over-winter mainly close to the breeding site and have been observed under logs, ground debris (Cogger 1992) and the base of *Carex* tussocks (Humphries 1979).

Distribution, abundance and evidence of change

Litoria aurea has been described to occur in eastern NSW and far eastern Victoria (Cogger 1992), where it is mainly confined to low altitudes. *Litoria castanea* was thought to be confined to the northern tablelands of NSW (Cogger 1992), however, there is now evidence to suggest that a southern form of this species had a restricted distribution between Canberra and Bombala (Osborne *et al.* 1996). The third species, *Litoria raniformis*, is distributed on the south-eastern slopes and plains of NSW, throughout Victoria to south-eastern South Australia and Tasmania (Cogger 1992). The former distribution of these species in the ACT region is reviewed by Osborne *et al.* (1996).

Litoria aurea is recognised to have undergone a considerable decline in distribution throughout a large part of its former range, with extensive populations declines reported throughout New South Wales, including the ACT (Osborne 1990, 1992, Mahony 1993, Lemckert 1996, White and Pyke 1996, Osborne *et al.* 1996). The species is believed to be extinct in the ACT region (Osborne *et al.* 1996). A corresponding decline in Victoria, however, is not evident (Gillespie 1996).

There is also grave concern for the continued survival of *L. castanea* throughout its former range, where surveys in the New England Tablelands of New South Wales have failed to locate the species (ANCA in prep.). This frog is also considered to no longer occur within its former range in the Southern Tablelands, including the ACT (Osborne *et al.* 1996).

Litoria raniformis has also disappeared from part of its former range. The species was formerly present throughout the Southern Tablelands up to altitudes of around 1300 metres, however, searches between 1985 and 1995 in an extensive area of the Southern Tablelands centred on Canberra, have failed to record this species (Osborne *et al.* 1996). There are some indications that the species has also experienced declines and local extinctions in areas of south and central Victoria, however, it is still considered common in parts of Melbourne (ANCA in prep.).

The disappearance of these frogs in the region apparently occurred relatively suddenly between 1978 and 1981 (Osborne *et al.* 1996). Some causes of frog decline in general, and which are also applicable to these species, have been postulated. Habitat destruction, modification and drainage of wetlands are overt in their impact on frog populations. However, other causes which may contribute to these declines include prolonged periods of drought (Osborne *et al.* 1996), global climatic change, increased ultraviolet radiation (Carey 1993, Blaustein *et al.* 1994), impact of the introduced predatory fish *Gambusia holbrooki* (Mahony 1993, Daly 1995, Morgan and Buttemer 1996), and disease. It is likely that a

combination of these factors in different situations, and possibly a yet undetermined causal agent are at work.

National Conservation Status

IUCN (1994) - All three species listed as Insufficiently Known

ANCA (in prep.)

L. aurea - Endangered

L. castanea - Endangered

L. raniformis - Vulnerable

ACT Status

NCDC (1984) - Widespread, common.

Hogg (1990) - Rare

In the ACT, all three species are now regarded as extinct.

Potential threats

- Destruction, disturbance and modification of wetlands.
- Pollutants
- Herbicides (surfactants)
- Droughts
- Mosquito fish, *Gambusia holbrooki*
- Increased levels of ultra-violet radiation

Requirements for survey, monitoring and management

- Encourage studies being conducted into the ecology, habitat requirements and underlying causes of decline in these species.

Some conservation reserves where species of the *L. aurea* complex were formerly recorded

- Namadgi National Park
- Murrumbidgee River Corridor
- Jerrabomberra Wetlands Nature Reserve

4. MONITORING

4.1 The need for monitoring

Long-term ecological monitoring is recognised as a fundamental requirement for responsible conservation and management of our biological diversity. Early detection of changes, especially declines in species populations, communities and habitats, and appropriate early intervention is highly desirable both ecologically and economically, as recovery will be less costly and infinitely more successful if problems are detected and acted upon before declines become critical. Due to the sensitivity of frogs to environmental pollutants, monitoring of frog populations in some situations has the added potential of indicating contaminants in water systems thereby also alerting to possible human health hazards.

4.2 Aims of frog monitoring

- Provide information on ACT distribution and abundance of individual frog species, and detect changes.
- Provide base-line, and subsequently long-term information on the species composition and relative abundance of individual species within breeding communities at selected sites.
- Determine if any changes in distribution and abundance can be attributed to natural population fluctuations, or to habitat change, degradation or other causes.
- Provide information to ACT land managers which can be applied to conservation management of frog species, communities and habitats.

Two types of frog monitoring are recommended:

1. General frog monitoring.

This program is intended to encompass species which are currently considered common and widespread as well as those for which information for such an evaluation is generally lacking. Whilst more specific survey and monitoring programs will be undertaken for species of particular conservation concern (see below), some such species will also be covered by the general program where they occur at general monitoring sites.

A range of breeding habitat types in both flowing and still water should be selected e.g. river, creek, stock watering dam, pond, swamp/wetland, lake edge. Provided below are general principles for the selection of sites;

- Select a number of sites in each of the above categories as appropriate, incorporating urban, rural and "natural" environments.
- The range of sites should also broadly cover the ACT geographically and altitudinally.
- The range of sites should encompass the habitats of as many species as possible.

2. Targeted survey and monitoring.

The review of the status of frogs in the ACT indicates that for a number of species, distribution, abundance and status are poorly known, and that for some there is evidence of population declines. A targeted approach to survey and monitoring is therefore required for the following species;

Pseudophryne bibronii
Pseudophryne dendyi
Pseudophryne pengilleyi
Limnodynastes peronii
Litoria latopalmata
Litoria lesueuri
Litoria sp. affin. *phyllochroa*
Litoria verreauxii alpina

For targeted monitoring and survey, sites will be selected where the target species is known or suspected to occur, and that will best provide information on pre-determined questions.

4.3 Recommended technique for monitoring

One of the most cost effective techniques of monitoring frogs is aural surveys at breeding sites during the appropriate season. The majority of the general and targeted monitoring program should be carried out using this technique.

This method is designed to estimate abundance of breeding males, but cannot be used to evaluate distribution and abundance of females, juveniles or silent males (Heyer *et al.* 1994). The underlying assumption with this method is that the number of breeding males will reflect the total number of individuals of both sexes in the population at a particular location.

Although this technique is widely and successfully used, some of its inherent difficulties are acknowledged. For example, the number of calling males at a location varies depending on the weather conditions at the time of the sampling, as well as the relative stage of the calling season. This problem is hard to overcome entirely, as it is rarely possible to visit each

location during the optimal time, especially when many locations over several months must be sampled. Another factor to consider is that some species are only reliably detected following a period of heavy rain and again, it may not be possible to visit every potential site in the period immediately following appropriate rainfall. Some strategies to moderate these biases should be adopted, including multiple visits and rotation of visits so that as many sites as possible are sampled during ideal condition

4.4 Timing of frog monitoring

For the majority of species occurring in the ACT, breeding activity extends from spring, through summer to early autumn. It is possible, therefore, to undertake much of general and targeted monitoring during this period. However, the onset of calling activity and its intensity varies between species and locations and also according to the weather conditions at the time of monitoring. For this reason, it is generally advised that monitoring should be conducted on more than one occasion at each site during this period and to draw conclusions based on the combination of data collected from each visit. Where this is clearly not practical or possible, the monitoring episode should at least be carried out at times during which species expected or suspected of being present would be detected.

4.5 Information to be recorded

The level of detail recorded will vary according to the species, community or habitat being considered. However, for monitoring to be most valuable, it is necessary to collect information in a consistent and methodical manner. Four categories of information should be collected for each monitoring site.

4.5.1 Site description

Details about the location of the monitoring site should be documented at the beginning of the monitoring program. Although it is obviously not necessary to record these details at each monitoring session, where significant longer-term changes become apparent, these should be noted.

- Description of physical location, grid reference, altitude and aspect if applicable.
- Broad vegetation classification e.g. dry sclerophyll forest, natural temperate grassland, pine plantation etc.
- Dominant species of the canopy, understorey and ground cover
- Land use and an indication of the degree of disturbance or modification

- Substrate features of area surrounding the water body up to about a fifty metre radius e.g. presence of logs, rocks etc.
- A description of the type of breeding site e.g. pond, lake edge, creek, swamp etc.
- Relative duration of habitat - e.g. permanent, ephemeral etc.
- Nature of substrate e.g. silt, sand, leaf pack etc.
- Evidence of organisms other than frogs, using water body. e.g. kangaroos, livestock, pigs, waterbirds, tortoise etc.
- Whether site is open above or covered by canopy.

4.5.2 Condition of the habitat at the time of the monitoring.

This is required to enable assessment of long term changes in habitat and relate these to changes in the community or individual species.

It is sufficient if this information is collected on the day of the monitoring episode, however, uniformity in methods used and equipment for measuring various parameters is important.

- Date, name/s of persons taking the records.
- Percentage of water surface open or occupied by emergent or surface vegetation, and what kind of vegetation.
- Vegetation fringing the water body (type and extent).
- Features of the shoreline e.g. vegetated, bare, rocky etc.
- Size - surface area or length and width.
- Depth, water level (at 50 cm and 1 metre from waters edge).
- Flow (visual assessment and categorised as still, slow, moderate or fast).
- pH.
- Conductivity.
- Turbidity.
- Weather conditions up to a week prior to monitoring (precipitation, maximum and minimum temperatures) should be obtained.
- A photographic record is recommended.

4.5.3 Conditions under which monitoring is undertaken.

This is considered vital for evaluating the effects of variables on the results. This information should be recorded at the time of the frog monitoring.

- Date
- Time of day
- Duration of monitoring episode
- Names of persons conducting monitoring, including information on expertise and experience.
- Weather conditions at time of monitoring

  Temperature (air and water as a minimum, in some instances substrate or vegetation temperature is also appropriate)

  Relative humidity

  Sky Condition (after Heyer *et al.* 1994)

  (1) Clear or a few clouds
  (2) Partly cloudy or variable
  (3) Cloudy (broken) or overcast
  (4) Fog
  (5) Drizzle
  (6) Showers

  Wind (modified from Heyer *et al.* 1994)

  (1) Still - smoke rises vertically
  (2) Light breeze - wind direction shown by smoke drift
  (3) Light wind - wind felt on face, leaves rustle
  (4) Windy - leaves and branches in motion

4.5.4 Species richness and relative abundance of each species present at a site.

- Number of different species detected at the breeding site (either by call or by observation)
- An index of the number of individuals of each species heard calling. With some experience, the number of calling males can be carefully estimated and grouped into the following categories.

  1-5 calling
  5-20 calling
  20-50 calling
  50-100 calling
  more than 100 calling

- For species not detected by call, the number of individuals observed
- Evidence of breeding activity (other than calling) e.g. amplexus, egg masses, tadpoles.

5. GENERAL RECOMMENDATIONS

- An annual, long-term frog monitoring program should be prepared as part of an ACT wide Flora and Fauna Monitoring Program. (An outline of the 1996/97 Frog Monitoring Program is provided in Appendix 2).
- It is expected that the level of detail recorded during frog monitoring and other specific aspects of the program will be modified during the development and implementation of the program. It is important that all refinements are documented.
- To obtain maximum consistency of approach and technique over the medium to long term and taking staff turn-over into account, there is a need for accurate and detailed documentation of the location of survey sites, transect positions, length, width etc.
- Any personnel carrying out the frog monitoring should be appropriately trained and experienced in both frog and frog call identification.
- The efficiency and effectiveness of automatic frog call recorders for monitoring needs to be evaluated.
- In the medium to long term, data needs to be scientifically evaluated. Therefore, from the outset sufficient thought should be given to adequate replication and standardisation of techniques.
- The results of the frog monitoring program should be reported regularly in written form. A brief report should be produced regularly, as well as less frequent and more analytical reports combining the longer term information.
- Results of monitoring should be incorporated into the ACT Vertebrate Atlas data base.

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APPENDIX 1. Summary of distribution and abundance within the ACT for each frog species and recommended actions.

Species	Common name	ACT Status		Survey and monitoring requirements	Other required actions by the ACT Parks and Conservation Service
		Distribution.	Abundance.		
Crinia parinsignifera	Plains Froglet	W	VC	General monitoring	
Crinia signifera	Common Eastern Froglet	W	VC	General monitoring	
Limnodynastes dumerilii	Eastern Banjo Frog	W	C	General monitoring	
Limnodynastes peronii	Brown-striped Frog	L	U	Targeted survey and monitoring	Habitat management & protection
Limnodynastes tasmaniensis	Spotted Grass Frog	W	VC	General monitoring	
Neobatrachus sudelli	Spotted Burrowing Frog	IK	C	General monitoring	
Pseudophryne bibronii	Brown Toadlet	IK	R	Targeted survey and monitoring	Habitat management & protection
Pseudophryne dendyi	Southern Toadlet	IK	IK	Targeted monitoring	Habitat management & protection
Pseudophryne pengilleyi	Northern Corroboree Frog	Re	R	Targeted monitoring	Habitat management & protection
Uperoleia laevigata	Smooth Toadlet	W	C	General monitoring	
Litoria aurea	Green and Golden Bell Frog	E	E		Encourage conservation work in NSW
Litoria castanea	Yellow-spotted Tree Frog	E	E		Encourage conservation work in NSW
Litoria latopalmata	Broad-palmed Frog	L, IK	U	Targeted survey and monitoring	Habitat management & protection
Litoria lesueuri	Lesueur's Frog	W	U	Targeted monitoring	
Litoria peronii	Peron's Tree Frog	W	C	General monitoring	
Litoria sp. affin. *phyllochroa*	Cotter River Frog	L,IK	R	Targeted survey and monitoring	Investigate biology/ecology
Litoria raniformis	Warty Swamp Frog	E	E		Encourage conservation work in NSW
Litoria verreauxii verreauxii	Whistling Tree Frog	W	U	General monitoring	
Litoria verreauxii alpina	Alpine Tree Frog	IK	IK	Targeted survey and monitoring	

Distributional and abundance categories modified from NCDC (1984) and Hogg (1990).

Distribution

(W) Widespread (widespread distribution in suitable habitat)

(L) Localised (localised ocurrence despite wider distribution of seemingly suitable habitat)

(Re) Restricted (restricted availability of suitable habitat)

(IK) Insufficiently Known (Information not adequate for assessment)

(E) Extinct (no longer exists in the area)

Abundance

(VC) Very common (very large populations

(C) Common (relatively large populations)

(U) Uncommon (relatively small populations)

(R) Rare (very small populations, rarely encountered)

(E) Extinct (no longer exists in the area)

(IK) Insufficiently Known (Information not adequate for assessment)

APPENDIX 2

FROG MONITORING PROGRAM FOR 1996/97

Activity	Timing	Responsibility
Monitoring the Cotter River frog *Litoria sp. affin. phyllochroa*	December 1996	WRU, with NNP
Monitoring the Northern Corroboree Frog *Pseudophryne pengilleyi*	January 1997	WRU, with NNP
Monitoring populations of the Broad-palmed Frog *Litoria latopalmata*	December 1996 - January 1997	WRU, with MRC
Selection of monitoring sites for General Monitoring Program, with a limited amount of field work carried out	February - March 1997	WRU with assistance from Reserves staff
Monitoring the brown toadlet *Pseudophryne bibronii* and the southern toadlet *P. dendyi*	February-March 1997	WRU with assistance from Reserves staff
Monitoring selected general monitoring sites for *L. verreauxii*	June-August 1997	WRU with assistance from Reserves staff

Abbreviations :

WRU - Wildlife Research Unit (Conservation and Land Management)
MRC - Murrumbidgee River Corridor
NNP - Namadgi National Park

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