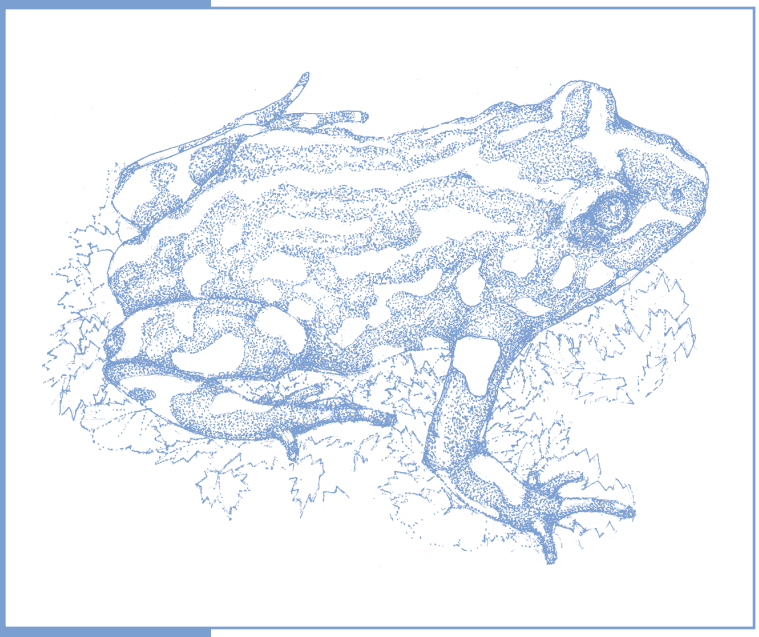
Action Plan No. 6

Northern Corroboree Frog

Pseudophryne pengilleyi

An Endangered species



ACT Government

Action Plan for the Northern Corroboree Frog

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Action Plan No. 6

Second Edition

The northern corroboree frog *Pseudophryne pengilleyi* was declared an endangered species on 8 December 2003 (Determination DI2003-319) in accordance with section 38 of the *Nature Conservation Act 1980*. Section 40 of the Act requires the Conservator of Flora and Fauna to prepare an Action Plan in response to each declaration. This is the Action Plan for the:

Northern Corroboree Frog
Pseudophryne pengilleyi

Preamble

The *Nature Conservation Act 1980* establishes the ACT Flora and Fauna Committee with responsibilities for assessing the conservation status of ACT flora and fauna and the ecological significance of potentially threatening processes. Where the Committee believes that a species or ecological community is threatened with extinction or a process is an ecological threat, it is required to advise the responsible Minister and recommend that a declaration be made accordingly.

Flora and Fauna Committee assessments are made on nature conservation grounds only and in a regional context. They are guided by criteria set out in its publication *Threatened Species and Communities in the ACT: criteria for assessment, July 2008*.

In making its assessment of the northern corroboree frog, the Committee concluded that it satisfied the criteria indicated in Table 1. Accordingly, in 2003, the Committee recommended the northern corroboree frog be declared Endangered. This replaces earlier declarations for the species.

The species had previously been declared vulnerable in 1996 under the species name of *P. corroboree* (Determination DI1996-29 of 15 April 1996), which was subsequently revoked and replaced by a declaration of *P. pengilleyi* as a vulnerable species (Determination DI1998-7 of 12 January 1998) following taxonomic revision of corroboree frogs.

An Action Plan is required in response to each declaration. The Action Plan must include proposals for the identification, protection and survival of a threatened species or ecological community, or, in the case of a threatening process, proposals to minimise its effect. While the legal authority of this Action Plan is confined to the Australian Capital Territory, management considerations are addressed in a regional context.

The first edition of this action plan was prepared in 1997 (ACT Government 1997). The first edition is superseded by this second edition in 2012.

Table 1 Criteria satisfied	
1.1	Species is known or suspected to occur in the ACT region and is already recognised as endangered or presumed extinct in an authoritative international or national listing.
1.2	Species is observed, estimated, inferred or suspected to be at risk of premature extinction in the ACT region in the near future, as demonstrated by one or more of: 1.2.1 Current serious decline in population or distribution from evidence based on: 1.2.1.1 Direct observation, including comparison of historical and current records. 1.2.3 Continuing reduction or unnaturally extreme fluctuations in population, or distribution, for a species currently occurring over a small range or having a small area of occupancy within its range.

Conservation status

The northern corroboree frog *Pseudophryne pengilleyi* is recognised as a threatened species in the following sources:

International
Endangered. IUCN Red List of Threatened Species. IUCN 2011.

National
Vulnerable. *Environment Protection and Biodiversity Conservation Act 1999*.

New South Wales
Critically Endangered. *Threatened Species Conservation Act 1995*.

Australian Capital Territory
Endangered. *Nature Conservation Act 1980*.
Special Protection Status Species. *Nature Conservation Act 1980*.

Species description and ecology

Description and distribution

There are two closely related species of corroboree frog; the northern corroboree frog *Pseudophryne pengilleyi* (Wells & Wellington 1985), and the southern corroboree frog *P. corroboree* Moore (Osborne et al. 1996). Both are in the family Myobatrachidae and are amongst the most distinctive and easily recognised Australian frogs (Cogger 1992) (Figure 1).

Figure 1. Dorsal view of northern corroboree frog. The black and white illustration is two times actual frog size.

The northern corroboree frog occurs over an altitudinal range of 750 to 1800 m and is confined to the high country of the ACT and adjacent areas in NSW, including the northern Brindabella Range, Fiery Ranges, Bogong Mountains and Buccleuch State Forest (Figure 2). In the ACT, the species occupies a disjunct narrow strip that follows the summit of the Brindabella/Bimberi Range. The southern corroboree frog is found only in the Snowy Mountains of Kosciuszko National Park in NSW (Osborne 1989).

The frogs are small (adults 2.5 to 3 cm in body length) and are characterised by yellow and black dorsal stripes (Pengilley 1966; Cogger 1992). This pattern extends over the limbs and flanks. The ventral surface is broadly marbled with black and white or black and yellow. A large flat femoral gland is present on each limb.

Adults of the northern corroboree frog differ from the southern corroboree frog in having: (1) a pattern of dorsal stripes that are usually yellow with a green or lime-green tinge; (2) mid-dorsal light-coloured stripes that are less than half the width of the adjacent black stripe at mid-body; and (3) a significantly smaller body and tibia length (Osborne et al. 1996). The two species also differ genetically (Roberts and Maxson 1989; Osborne and Norman 1991; Morgan et al. 2008) and in their skin biochemistry (Daly et al. 1990). Another difference, which is less obvious, is the longer first component in the advertisement call of the northern corroboree frog.

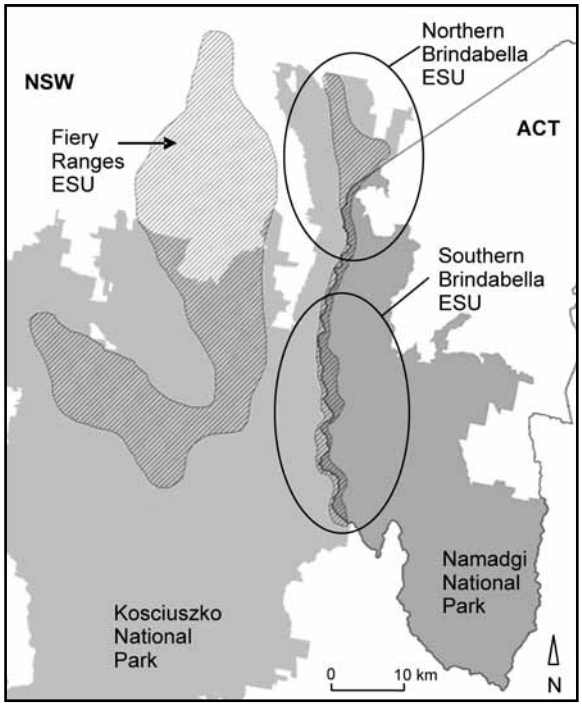

Figure 2. Distribution (hatched area) of the northern corroboree frog, from current and historic records.

Three Evolutionary Significant Units (ESU) have been identified for the northern corroboree frog each represented by populations of frogs that are genetically different (Morgan et al. 2008) (Figure 2). The southern Brindabella ESU occupies the highest elevation of the three ESUs, and is found in the subalpine zone between about 1400 m and 1850 m along the Bimberi Range between Mt Bimberi and Ginini Flats. This ESU occurs within Namadgi National Park (ACT) and to a lesser extent in the adjacent Bimberi Nature Reserve in NSW, with the largest numbers of frogs historically occurring at Ginini Flats and Snowy Flats in the ACT. The northern Brindabella ESU is characterised by frogs having greener stripes and occurs at lower elevations at the northern extent of the Brindabella Range between Bushrangers Creek in the ACT and California Flats in NSW. The Fiery Ranges ESU occurs in NSW and occupies lower elevation areas encompassing the Fiery Ranges, Bogong Mountains and Buccleuch State Forest.

Habitat

The frogs use two distinct habitat types; a breeding season habitat associated with pools and seepages in *Sphagnum* moss (*Sphagnum cristatum*) bogs, wet tussock grasslands and wet heath, and a terrestrial non-breeding habitat in forest, sub-alpine woodland

and heath adjacent to the breeding area (Pengilley 1966; Osborne 1990). During summer, the adult frogs breed in shallow pools and seepages within the breeding area, before returning to the adjacent woodland and tall moist heath at the end of the breeding season. Litter, logs and dense ground cover in the understorey of snow gum woodland and heathland provide over-wintering habitat for subadults and adults (Pengilley 1966).

The breeding pools are characteristically shallow and have relatively large surface areas and low water flow rates, which may allow the water in the preferred pools to become warmer during the day, possibly enhancing tadpole development (Osborne 1990). Pools range from semi-permanent to ephemeral, with the abundance and duration of pools related to amount and timing of rainfall or snowmelt.

Life-history and ecology

Like most frogs, corroboree frogs have a two-stage life cycle; an aquatic tadpole stage and a terrestrial post-metamorphic juvenile and adult stage. However, they differ from most other frogs in that their eggs are laid out of water, in moss or damp, dense vegetation at the edge of the breeding pool. The embryos develop to an advanced stage within the egg capsule before hatching and moving to the nearby pool.

Adult males move into the breeding areas during January and February and call from small terrestrial chambers in moss or other dense vegetation at the edges of the breeding pools. Females only enter the bogs briefly to lay their eggs in the terrestrial oviposition site and then leave the breeding site. The males continue calling for a number of weeks, presumably to continue to attract females. Males may have more than one clutch in their nest. They then leave the bogs during late February and March to return to the over-wintering habitat (Pengilley 1966; Osborne 1988). The eggs are laid in a small clutch of about 25 eggs (range 16–38) (Pengilley 1973). Whilst the number of eggs produced per female is relatively few, the eggs are amongst the largest in the genus (Tyler 1989), being about 3.5 mm in diameter when laid and later absorbing water to swell to about 9 mm diameter.

Tadpole development initially occurs within the egg and the relatively advanced tadpoles emerge from the egg when they are about 15 mm in length (Pengilley 1966; Osborne 1991). Hatching occurs in autumn and winter during periods of high rainfall or snow-melt that cause pool levels to rise and flood nests. The pre-metamorphic period is critical for reproductive success, because the tadpoles and eggs are vulnerable to desiccation and pool-drying from insufficient rainfall or snow-melt. Corroboree frogs reach reproductive age about four years after metamorphosis and are known to survive for up to nine years in the wild (Hunter 2000). Adult survival is critical to enabling the species to persist through a series of dry years (drought) when there may be little or no recruitment to populations from breeding.

Little is known about the life-history of the frogs after they leave the pools as juveniles. Pengilley (1966, 1973) suggested that they remain in moist vegetation near the breeding pools for several months, before moving into the adjacent non-breeding habitat where it is thought they remain until they are adults. The diet of subadults and adults consists mainly of ants and to a lesser extent other invertebrates (Pengilley 1971b), though to what extent this reflects relative food-type availability or dietary specialisation is unclear.

Population decline

During the 1960s and 1970s the northern corroboree frog was quite common in suitable habitat. Many breeding aggregations in the ACT region were reported to be very large, often consisting of many hundreds of individuals (Pengilley 1966; Osborne 1988). The frogs present at Ginini Flats have been monitored regularly since the mid-1980s and other sites have been monitored since the mid-1990s (Osborne 1989; Osborne et al. 1999; M. Evans, ACT Conservation Planning and Research, unpubl. data). The results indicate that northern corroboree frog populations have suffered severe and widespread decline since the early 1980s, and that the decline is still occurring. In the western section of Ginini Flats (commonly referred to as Ginini West) there was estimated to be 500 to 1000 male northern corroboree frogs calling in 1986; three years later the figure had dropped to about 50 males calling (Osborne et al. 1999). At the time of writing there are estimated to be less than 100 adult northern corroboree frogs remaining in the wild across the species' range in the ACT. The actual number remaining is possibly as low as 50 individuals. The most severe decline has occurred in the Brindabella and Bimberi ranges in and near the ACT, though particularly within the higher elevation ACT Southern Brindabella ESU (M .Evans, ACT Conservation Planning and Research, unpubl. data). Numbers in the NSW Fiery Ranges ESU have also declined, though

apparently not as severely as in the two Brindabella ESUs (R. Pietsch and D. Hunter, NSW Department of Climate Change and Water, unpubl. data). The southern corroboree frog has shown a similar catastrophic decline across its range in the Snowy Mountains (Hunter et al. 1999; Osborne et al. 1999).

Threats

Threats to corroboree frogs include disease, fire, drought, climate change, feral animals and weeds. Such threats rarely act in isolation and when more than one threat acts against a population the effects are often synergistic (magnifying) (Brook et al. 2008). For example, warmer temperatures and less rainfall due to climate change might modify corroboree frog breeding habitat. These conditions might also increase the frequency of fire in Alpine environments, which in turn will also modify breeding habitat. Drought causes failed recruitment, the effect of which may be compounded by fewer breeding adults due to amphibian chytrid fungus, and both threats might increase the species susceptibility to the inherent risks faced by small populations. Effective management of threats will require consideration of risks and potential synergies.

Disease

Recent evidence points to disease caused by an introduced fungal pathogen as the main reason for decline in corroboree frogs. The amphibian chytrid fungus *Batrachochytrium dendrobatidis* has only recently spread around the world and the disease it causes (Chytridiomycosis) has resulted in mass amphibian declines and extinctions (Berger et al. 1998; Skerratt et al. 2007). Frog species vary in their susceptibility to the disease; corroboree frogs are highly susceptible, whereas the sympatric common eastern froglet *Crinia signifera* is apparently relatively unaffected and can act as a reservoir host for the disease (Hunter 2007). Field sampling for chytrid fungus indicates that it is present in all key corroboree frog habitats in the ACT (Hunter 2007). Chytrid fungus can infect tadpole and frog stages but not eggs as they do not contain keratin, which is required by the fungus. The main method of disease transmission amongst populations of corroboree frogs is likely to be from adult-adult contact during breeding and by corroboree frog tadpoles contracting the disease from tadpoles or adults of common eastern froglets using the same pools.

Reducing the impact of the disease will require (a) eradicating or controlling amphibian chytrid fungus in the environment or (b) improving resistance of frog populations to the disease. Eradication of amphibian chytrid fungus from the Australian continent, or even the Australian Alps, appears unlikely given no introduced organism has been eradicated once it has become established in the Australian environment. There is no known method to control the pathogen on a broad geographic scale, though maintaining disease-free 'refuge' sites (particularly sites that are isolated by natural barriers to animal movement) might be achievable. However, there are no known disease-free sites for corroboree frogs in the ACT.

Improved disease resistance in wild populations may arise through attenuated virulence of the pathogen and/or increased defences of amphibian hosts. There is some evidence that populations of other frog species that have suffered declines from Chytridiomycosis have developed resistance to this pathogen (Retallick et al. 2004; McDonald et al. 2005), probably through intense genetic selection. Corroboree frogs have persisted with amphibian chytrid fungus in their habitats for at least two decades (albeit at perilously low population levels) and thus the remaining individuals are likely to represent the most disease-resistant genes.

Corroboree frog populations might recover if given the opportunity for ongoing selection for disease resistance, as has apparently occurred for some other frog species. Selection for disease resistance could occur naturally in the wild or artificially in captive populations, though the latter will require research into the response of the frog immune system to infection with the amphibian chytrid fungus.

There have been significant recent developments in the effectiveness of treating frogs that have Chytridiomycosis, including the use of elevated temperatures and fungicides such as Chloramphenicol (Woodhams et al. 2003; Bishop et al. 2009). There is also some evidence to suggest that frogs exposed to Chytridiomycosis and then 'cured' may acquire lasting resistance to the disease (Woodhams et al. 2003), though such resistance is not conferred to offspring. This type of acquired resistance may be useful for managing disease outbreaks in captivity and for boosting survival rates of individuals released from captivity to the wild.

Fire and drought

Wildfires and planned (prescribed) fires have the potential to impact on the frogs by burning vegetation and peat in breeding and non-breeding areas (Clark 1986). Wildfire can severely damage peat and bog areas, causing erosion and decreasing the capacity of the bogs to hold water (Good 1973; Clark 1986). In January 2003, wildfires burnt most of Namadgi National Park (and much of the Australian Alps) and severely burnt corroboree frog breeding sites and their heath/woodland over-wintering habitat. All breeding sites were affected, with the proportion of each site burnt ranging from 70% to 95% (Carey et al. 2003). Corroboree frogs were killed in the fires (D. Hunter pers. com.), though breeding still occurred in unburnt areas. The recovery of breeding habitat has been variable, with some areas taking less than three years post-fire to provide suitable conditions (vegetation and pools), whereas other areas are still recovering after eight years. In some areas, *Sphagnum* moss or wet heath have been converted to wet grassland (a less favourable breeding habitat for corroboree frogs). Some smaller bogs have not recovered their functionality due to the peat becoming hydrophobic and these areas are now dry grassland (M. Evans pers. obs.), which is unsuitable as breeding habitat. It is possible that these areas may not revert to bogs for decades, if ever. Most breeding sites, particularly the larger sites such as Ginini Flats and Snowy Flats, now appear to be suitable breeding habitat for corroboree frogs.

Whilst the short-term effects of fire are loss of habitat and potentially loss of frog individuals, the long-term effects on the ecology or abundance of corroboree frogs are not well understood. Osborne (1991) considered that autumn fires burning through woodland and heath surrounding breeding sites had the greatest potential influence. At this time adult and subadult frogs have moved into these areas to feed and to find suitable over-wintering sites. Regular burning of understorey litter and grass cover in these areas, such as occurs during prescribed burns, is likely to reduce the shelter available to the frogs and make them more vulnerable to predation, dehydration or freezing.

Drought presents a broader scale threat and has been observed to prevent breeding or to prevent recruitment when pools that contain developing tadpoles prematurely dry (Pengilley 1966; Osborne 1988, 1989). Prolonged drought that results in lack of recruitment for several years is likely to have widespread and significant impacts on corroboree frog populations.

Feral animals and weeds

Feral pigs (*Sus scrofa*) are a threat as they disturb breeding areas by rooting up *Sphagnum* moss and other vegetation in their search for food (M. Evans, pers. obs.), which includes insect larvae and tubers (Alexiou 1983). Pigs also wallow in the bog pools and can disturb the breeding pools at the time they are being used by the frogs (D. Hunter, W. Osborne, pers. obs.). However, the actual extent of impact on the ecology of the frogs requires further research.

Sambar deer (*Cervus unicolour*) and fallow deer (*Dama dama*) have the potential to damage corroboree frog habitat, and whilst their abundance in the ACT is low, there is some evidence that their numbers are increasing.

In NSW trampling by feral horses (*Equus equus*) has caused extensive damage to some breeding sites (W. Osborne and D. Hunter pers. obs.) through incision of the bogs and altering drainage patterns (see comments by Dyring 1992). There is no known permanent population of feral horses in the ACT, and it is important for the protection of corroboree frog habitat that horses moving into the ACT from NSW continue to be trapped and removed.

Blackberry (*Rubus fruticosus*) is a serious threat to corroboree frog habitat. Breeding sites that have been invaded by this weed in NSW appear to be no longer suitable for corroboree frogs (W. Osborne, R. Pietsch, D. Hunter, pers. obs.). In the ACT, blackberries are present in Namagi National Park, including some of the smaller corroboree frog breeding sites, and ongoing control is required. Pine wildings are occasionally found and removed from corroboree frog breeding sites, particularly Snowy Flats where the source is the arboretum near Pryors Hut. Exotic grasses such as sweet vernal grass (*Anthoxanthum odoratum*) are present at the margins of some corroboree frog breeding sites, though what effect this might have on corroboree frog habitat is unknown.

Habitat disturbance and degradation

Localised human impacts are known to have had a deleterious effect on some breeding sites (Osborne 1991). Erosion from poorly maintained roads has damaged some sites (mostly in NSW) where the species occurred (Osborne 1988). Livestock grazing and trampling may also have caused habitat deterioration, particularly in NSW. Trampling by livestock, including horses, increases erosion and causes incision of bogs (Dyring 1992; Wimbush and Costin 1979).

Almost all habitat for the northern corroboree frog in the ACT is contained within Namadgi National Park, which is a relatively undisturbed environment. Nevertheless, activities that may pose a threat in catchments with corroboree frog habitat include earthworks and road construction, which may damage soil, peat or vegetation and alter flows of water into bogs and other wet areas. Road construction without adequate environmental safeguards risks sedimentation of corroboree frog habitat, especially during unforeseen storm events.

Climate change

Global warming (IPCC 2007; Lawler 2009) has particular significance for the conservation of cool-adapted species such as the northern corroboree frog (Bennett et al. 1991). Due to its restricted high-altitude distribution, the species is likely to be particularly susceptible to climate change (Osborne and Davis 1997). Climate change modelling suggests that higher elevation areas of the Australian Alps, including the Brindabella Range, will experience warmer temperatures and a decrease in precipitation (both as rainfall and snow) (Hennessey et al. 2003). Higher temperatures might be expected to result in a contraction of the lower altitudinal limit for the species, whereas higher temperatures and less precipitation, combined with an expected higher fire frequency, might result in a change in the hydrological functioning of wetlands and a reduction of suitable breeding habitat (such as *Sphagnum* moss communities becoming wet sedgeland, grassland or heathland).

The most immediate effect on the species is likely to be less reliable annual recruitment to the population due to less frequent 'good' breeding seasons. The long development times for corroboree frogs as eggs and tadpoles (several months) means that both species of corroboree frog are particularly susceptible to low precipitation that results in ephemeral pools not forming (loss of eggs) or pools drying before tadpoles reach metamorphosis (Osborne 1990, Hunter et al. 2009).

Whilst climate change can be speculated to have some impact on corroboree frogs, it is still uncertain whether the magnitude of such changes will be sufficient to cause the extirpation of these species. In addition to *Sphagnum* moss, corroboree frogs are able to use a range of other wet areas for breeding, including wet grassland and wet heathland. Depending on the rate and magnitude of climate change, it is possible that its effect on the species may be ameliorated to some extent though behavioural or genetic adaptation.

Small population size

Whilst not often regarded as a threat per se, very small populations face a higher probability of extinction simply because of their small size (Caughley and Gunn 1996). For small populations, the effects of environmental stochasticity (random environmental disturbances such as drought and fire) are magnified. In addition, small populations risk genetic problems such as loss of genetic diversity and random genetic drift, which can result in individuals being less genetically 'fit' for their environment. Very small populations may also not be able to maintain a social structure, such as calling aggregations in frogs that attract females and enable sexual selection. A key recovery action for species whose populations have been reduced to small size is to increase the size of the population to overcome the 'small population paradigm' (Caughley and Gunn 1996). This is particularly applicable to low fecundity species such as corroboree frogs. The use of a captive population to produce individuals for release back to the wild can be an effective (in some cases the only) method to increase the size of wild populations.

The northern corroboree frog faces considerable inherent risk due to its specialised life history. It has a very low clutch size, each female breeds only once each year, and the tadpoles are slow-growing, spending three months or more in the shallow pools. Whilst this life history has evolved in response to a relatively stable, cold, low nutrient environment, it also reduces the ability of the species to recover quickly during favourable seasons and places it at risk from any long-term disturbance or change that affects the breeding sites.

Captive population

In response to ongoing declines of corroboree frogs in the ACT, and in particular a sharp decline through 2001 and 2002, the decision was made to collect eggs to establish a captive assurance population in a biosecure (free of chytrid fungus) facility to safeguard against the loss of the Southern Brindabella ESU in the event that the species becomes extinct in the wild.

Northern corroboree frog eggs were collected from the wild in April 2003 to establish the captive population at Tidbinbilla Nature Reserve.

The egg stage was collected because the eggs are naturally free of chytrid fungus, most eggs in the wild are unlikely to survive to become a frog and survivorship of eggs can be markedly increased under controlled (captive) conditions, enabling a rapid increase in the size of the captive, and potentially wild (through reintroduction), populations.

Around one-third of eggs in each nest were collected from all nests found at key monitoring sites, which is estimated to have been less than half of all nests in the ACT. The number taken was considered to be sufficient to establish a captive population yet not to have a major impact on recruitment in the wild.

A similar project had begun three years earlier for the southern corroboree frog, whose catastrophic declines preceded those of the northern corroboree frog. By 2007 the number of nests in the wild was insufficient to continue egg collections for northern corroboree frogs. Northern corroboree frogs take five years from eggs to reach breeding age, and were bred in captivity for the first time in 2008.

The captive population currently contains over 800 individuals, with around half of the population at breeding age. The establishment of this captive assurance population is consistent with the recommendations of the National Threat Abatement Plan for Chytrid Fungus (DEH 2006) and the draft National Recovery Plan for the Northern and Southern Corroboree Frog (NSW DECCW in prep.).

Major conservation objective

The objective of this Action Plan is to:

- Maximise the survival, in the long-term, of viable, natural populations of northern corroboree frogs at sites across the geographic range of the species in the ACT. This includes the need to maintain the natural evolutionary development of the species in the wild.

The objective is to be achieved through the following strategies:

Protection

- Protecting sites and vegetation communities that are critical to the survival of the species. This includes habitat that is listed as threatened under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (Alpine *Sphagnum* Bogs and Associated Fens), and the Ramsar-listed Ginini Flat Subalpine Bog Complex in the ACT.
- Managing activities in the catchments of breeding sites and surrounding woodlands to minimise or eliminate any threat to frog populations.
- Increasing community awareness of the need to protect the frogs and their habitat.

Monitoring, research and experimental management

- Supporting and participating in monitoring, research and experimental management aimed at understanding and mitigating the causes of population decline.

Captive Breeding and Release

- Establishing and maintaining captive assurance population(s) while the species is under immediate threat of extinction in the ACT.
- Reintroducing captive bred individuals to the wild to allow selection for disease resistance through maintenance of wild populations, either by increasing the size of small populations or re-establishing extirpated populations.

Conservation issues and intended management actions

Monitoring

Populations of corroboree frogs have declined to low numbers in the ACT (estimated to be less than 100 individuals remaining in the wild) and the decline is continuing. The species has become locally extinct at a number of breeding sites. The current monitoring program identified the sharp decline in 2001 and 2002, which triggered the establishment of the captive assurance population (located at Tidbinbilla Nature Reserve). Continued monitoring is essential to track the trend in the species population size and to evaluate the effectiveness of conservation, research and land management actions.

Annual monitoring will be expanded to include an assessment of pool and bog characteristics that may be impacted from climate change, fire and feral animals. Monitoring will be conducted by suitably experienced personnel, and will follow procedures agreed by the Corroboree Frog National Recovery Team to allow for consistency of techniques across the region.

Monitoring Action 1

Objective

Trends in abundance are known for corroboree frogs in the ACT.

Action

Monitor corroboree frog abundance and habitat (bog and pool characteristics) at key sites in the ACT.

Indicator

Annual monitoring of corroboree frog abundance is undertaken. Monitoring includes characteristics of pool and bog habitat.

Research and experimental management

There is considerable existing information on the biology and ecology of corroboree frogs. Distribution (Osborne 1989), breeding biology and demography (Pengilley 1966, 1973; Hunter 2000), diet (Pengilley 1971a), population genetics (Osborne and Norman 1991; Morgan et al. 2008), habitat use (Osborne 1990) and causes of decline (Berger et al. 1998; Skerratt et al. 2007) are reasonably well known.

Amphibian chytrid fungus is a key factor causing the decline of corroboree frog populations and remains the most significant impediment to the species recovery. This pathogen is well established in the Australian environment and is likely to remain so. Facilitating greater resistance to this pathogen at the population level should be a major goal of research and experimental management. A key step will be to understand how the frog immune system responds to infection with the amphibian chytrid fungus. This knowledge would provide the basis for a captive breeding program to select for specific traits. Research investigating the immune response of corroboree frogs to this pathogen requires specialised laboratory facilities, and is currently being undertaken at James Cook University (Townsville) and Taronga Zoo (Sydney). The captive population of northern corroboree frogs at Tidbinbilla is likely to be an important (perhaps the only) source of northern corroboree frogs for such research.

Other key research aspects relate to the landscape processes that influence metapopulations, which is of particular importance in the conservation of this patchily distributed species. Research is required on the extent of movement between breeding sites by individuals and the effect of catchment hydrology on population persistence, particularly with respect to long-term survival during droughts. It is still not clear why the frogs choose particular breeding pools, and in what way hydrology and vegetation interact in the formation of pools.

Climate change has the potential to alter the habitat of corroboree frogs, such as the hydrology (timing and persistence) of the ephemeral breeding pools, and the growth and dynamics of vegetation in the breeding habitat.

Since 1996 the Corroboree Frog National Recovery Team has played an important role in coordinating, advising and obtaining funding for recovery actions (including research and habitat management) for both species of corroboree frog. The recovery team is composed of experts on corroboree frogs, representatives of all agencies responsible for management of land with corroboree frog habitat, and other stakeholders such as zoos and research agencies.

Research Action 1

Objective

The short-term objective is to attain a greater understanding the ecology of corroboree frogs, particularly with respect to interaction with chytrid fungus and potential effects of climate change. The long-term objective is to mitigate threats to the species to enable viable, wild populations to survive.

Action

Support and participate in research and experimental management, including research by universities and other organisations.

Indicator

Research is undertaken and supported that provides a greater understanding of the ecology of corroboree frogs (especially in relation to chytrid fungus) and the mitigation of threats to the frogs and their habitat.

Research Action 2

Objective

The Corroboree Frog National Recovery Team continues to play a key role in the provision of expert advice and coordination of recovery actions for both species of corroboree frogs.

Action

Represent the ACT on the Corroboree Frog National Recovery Team and provide expert advice.

Indicator

Continued representation on the Corroboree Frog National Recovery Team and provision of expert advice and progress updates to the team on the conservation of the Northern Corroboree frog in the ACT.

Captive breeding and release

Action 2.1.6 of the National Threat Abatement Plan (TAP) for Chytrid Fungus (DEH 2006) is to 'Restock species that are under severe threat from infection with Chytridiomycosis using captive-raised and captive-bred stock. Implement this under an adaptive management framework that heeds relevant state, national and international (IUCN) standards on translocations and monitor the outcome'. Other actions in the TAP relate to coordinating captive husbandry, breeding and restocking programs across states and territories (Action 2.1.1); expanding knowledge of, and infrastructure for, captive breeding of amphibians that are particularly vulnerable to Chytridiomycosis (Action 2.1.3); and assessing the value of reintroduction programs over significant timeframes in terms of increased abundance, range and prevalence of Chytridiomycosis (Action 3.4.3). A major goal of the draft National Recovery Plan for the Corroboree Frog (NSW DECCW 2010) is the establishment of captive assurance population(s) and undertaking reintroductions.

The aim of maintaining captive assurance population(s) is to provide a source of individuals for conservation research and re-establishment of the species in the wild, in the event that wild populations become unviable or extinct. A key aim of reintroduction is to maintain the species in the wild with a functional social structure to allow for ongoing selection of disease resistance in frog populations. Disease-resistant genes in wild populations will need to be incorporated back into the captive breeding program, otherwise the reintroduction of 'less fit' captive-bred individuals to the wild may act against the selection process. This can be achieved by regularly introducing wild-bred individuals (either as eggs, tadpoles or frogs) to the captive breeding program.

Captive breed/release Action 1

Objective

Prevent complete loss of northern corroboree frogs from the ACT if wild populations become extinct.

Action

Establish and maintain captive assurance population(s) of northern corroboree frogs whilst the species is under immediate threat of extinction in the wild.

Indicator

Captive assurance population(s) are maintained whilst the species is under immediate threat of extinction in the wild.

Captive breed/release Action 2

Objective

Augment existing, or re-establish extirpated, wild populations of northern corroboree frogs in the ACT.

Action

Develop a plan to captive breed and release corroboree frogs to the wild. Implement a breed/release program that is (a) within a scientific monitoring framework, (b) consistent with the National Recovery Plan for the species and (c) takes account of advice and direction provided by the National Recovery Team for corroboree frogs.

Indicator

A captive breeding and release plan is developed that is consistent with the National Recovery Plan for the species. Corroboree frogs are released to the wild and a scientific monitoring framework established.

Protection

Almost all of the known breeding sites for the northern corroboree frog in the ACT occur within Namadgi National Park. The largest populations occur in sub-catchments of the Cotter River above Bendora and Corin dams. Public access and camping are restricted and these areas are managed primarily for conservation and water catchment protection.

General guidelines for the conservation management of the northern corroboree frog and its habitat in the ACT have been included in the *Namadgi National Park Plan of Management* (ACT Government 2010). Protection includes controlling activities such as construction of access tracks and fire management/suppression in the vicinity of corroboree frog habitat, controlling feral animals (horses, pigs, deer) and weeds (pine wildings, blackberry), and avoiding the spread of diseases that could affect frogs.

Fire can severely impact corroboree frog habitat, particularly *Sphagnum* moss bogs where the effect of intense fire can be long-term. Planned and unplanned fire should be excluded from breeding habitat (bogs) and overwintering habitat (surrounding woodland). Fire suppression activities (such as use of heavy machinery and chemical retardants) can also cause impacts to habitat. Undertaking such activities in or near corroboree frog habitat should only be considered if habitat is under threat of severe impact from fire. Guidelines for fire management in areas where corroboree frog habitat is known or suspected

to occur have been included in the Fuel and Fire Suppression Guidelines for ACT Declared Threatened Species and Endangered Ecological Communities (ACT Government 2008) and in Bushfire Operational Plans. Specifically the plans provide for:

- Preparation of maps of sensitive sites including all known corroboree frog breeding sites in the ACT. These maps are available for use in fire emergencies and prescribed burns.
- Excluding planned (prescribed) burns in the area within 300 metres of identified corroboree frog breeding habitat.
- Avoiding the use of heavy machinery in the immediate catchment of *Sphagnum* moss bogs and corroboree frog habitat where this is likely to result in sediment flows into the bogs.
- Avoiding the use of chemicals and fire retardants in and near bogs.

Protection Action 1

Objective

Corroboree frog habitat in Namadgi National Park is protected from the impacts of construction and maintenance of access tracks.

Action

New vehicle access tracks are not constructed in corroboree frog habitat. Measures are taken to avoid impacts (such as sediment movement into bogs) from tracks in the vicinity of habitat, both during and after construction.

Indicator

No impacts on corroboree frog habitat from construction and maintenance of access tracks. No new vehicle access tracks constructed in corroboree frog habitat.

Protection Action 2

Objective

Corroboree frog habitat is protected from fire and from impacts of fire management and suppression activities.

Action

Include guidelines for fire management in or near corroboree frog habitat in Bushfire Operational Plans and other relevant fire planning/management documentation.

Indicator

No planned fires in corroboree frog habitat or within 300 m of identified breeding habitat. No fire suppression activities undertaken in corroboree frog habitat (unless threat of severe impact by fire).

Protection Action 3

Objective

Corroboree frog habitat is protected from the impacts of feral animals and weeds.

Action

Manage feral animals and weeds so that their impacts do not threaten the viability of northern corroboree frog populations or their habitat.

Indicator

Impacts from feral animals and weeds do not pose a threat to the viability of northern corroboree frog populations or their habitat.

Protection Action 4

Objective

Prevent the spread of pathogens amongst wild corroboree frog populations.

Actions

- Promote and provide advice to researchers, land managers and the public on appropriate quarantine measures (such as sterilisation of footwear and equipment) to reduce the possibility of spreading pathogens between catchments and frog populations.
- Screening for pathogens in captive corroboree frogs prior to release to the wild is consistent with best practice risk assessment guidelines such as Pessier et al. (2010).

Indicators

- Advice on appropriate quarantine measures provided to persons intending to visit areas in or near corroboree frog habitat, including researchers, land managers and the public.
- Agency staff (including researchers and land managers) undertake appropriate quarantine measures when working in or near corroboree frog habitat.
- Appropriate quarantine measures included as a condition on relevant scientific licences issued by the ACT government.
- Screening for pathogens in captive corroboree frogs prior to release to the wild has been undertaken according to best practice risk assessment guidelines such as Pessier et al. (2010).

Legislative provisions

The following legislation applies to the conservation of flora and fauna in the ACT:

ACT legislation

Nature Conservation Act 1980

The *Nature Conservation Act 1980* provides for the protection of native plants and animals (including fish and invertebrates), the identification of threatened species and communities, and management of Public Land reserved for nature conservation purposes. Specified activities are managed via a licensing system.

Native animals and plants may be declared in recognition of a particular conservation concern and increased controls and penalties apply. Species declared as endangered must be declared as having special protection status, which is the highest level of statutory protection under this Act.

Other Relevant Provisions

The *Nature Conservation Act 1980* provides authority for the Conservator to manage Public Land reserved for conservation of the natural environment. Activities that are inconsistent with management objectives for nature conservation are controlled. Special measures for conservation of a species or community of concern can be introduced in a reserved area, including restriction of access to important habitat.

Planning and Development Act 2007

The object of this Act is to provide a planning and land system that contributes to the orderly and sustainable development of the ACT. The Act establishes the Territory Plan; provides for the identification, reservation and management of Public Land; and outlines requirements for environmental impact assessment.

Heritage Act 2004

This Act establishes a system for the recognition, registration and conservation of natural and cultural heritage places and objects. A list of these places is maintained on the ACT Heritage Register.

Commonwealth Legislation

Environment Protection and Biodiversity Conservation Act 1999

The *Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) is the primary Commonwealth legislat*ion for environment protection. Under the EPBC Act, an action will require approval from the (Commonwealth) Environment Minister if the action has, will have, or is likely to have a significant impact on a matter of national environmental significance and it is not subject to certain specified exceptions.

Matters of national environmental significance are: World Heritage and National Heritage properties, Ramsar wetlands of international importance, nationally listed threatened species and ecological communities, migratory species protected under international agreements, Commonwealth marine environment and nuclear actions.

International Agreements

Ramsar Agreement

The Convention on Wetlands (Ramsar, Iran, 1971) is an intergovernmental treaty aimed at achieving the conservation and wise use of wetlands. The Ginini Flats Wetlands in Namadgi National Park, which provide important habitat for the northern corroboree frog, are listed as wetlands of international importance under the Ramsar Agreement. This Action Plan for the northern corroboree frog when read in association with the *Nimadgi National Park Plan of Management (2010)* and the *Ginini Flats Wetlands Ramsar Site Plan of Management* (2001) (ACT Government 2001) provides the basis for ongoing management of Ginini Flats. (At the time or writing the Ginini Flats plan was under review.)

Consultation and community participation

The Conservation, Planning and Research section within the ACT Government is a member of the National Recovery Team that covers both species of corroboree frog (*P. corroboree* and *P. pengilleyi*). This Recovery Team was established in January 1996 to direct and facilitate surveys, monitoring, research, captive husbandry and regional conservation efforts. The membership also includes representatives from the NSW Department of Climate Change and Water, State Forests of NSW, organisations involved in research on corroboree frogs (University of Canberra, Australian National University), and organisations involved in captive husbandry of corroboree frogs (Tidbinbilla Nature Reserve, Amphibian Research Centre (Melbourne), Taronga Zoo, Healesville Sanctuary).

Where appropriate, community participation with activities assisting the conservation of the northern corroboree frog will be encouraged through groups such as the ACT Herpetological Association.

Implementation and review

The ACT Government (Land Management and Planning Division; Department of Climate Change Energy and Water) has responsibility for coordinating implementation of this Action Plan. Some actions will involve collaboration between government agencies, research organisations, zoos and the community.

The Flora and Fauna Committee will review implementation of this Action Plan after three years. The review will comprise an assessment of achievement of the objectives of the Action Plan. The timeframe for achieving some objectives (such as re-establishing wild populations from captive breeding and release) are necessarily longer than the duration of this Action Plan. Assessment of progress will be based on achieving the relevant indicator for each Action.

The review will provide an opportunity for both the Flora and Fauna Committee and relevant section(s) of the ACT Government to assess progress; take account of new knowledge of the species and threats; consider new developments in policy and administration; and review directions and priorities for future conservation actions.

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List of Action Plans

In accordance with Section 23 of the *Nature Conservation Act 1980*, the following Action Plans have been prepared by the Conservator of Flora and Fauna:

No. 1: Natural Temperate Grassland—an endangered ecological community.

No. 2: Striped Legless Lizard (*Delma impar*)—a vulnerable species.

No. 3: Eastern Lined Earless Dragon (*Tympanocryptis lineata pinguicolla*)—an endangered species.

No. 4: A leek orchid (*Prasophyllum petilum*)—an endangered species.

No. 5: A subalpine herb (*Gentiana baeuerlenii*) —an endangered species.

No. 6: Corroboree Frog (*Pseudophryne corroboree*)—a vulnerable species.

No. 7: Golden Sun Moth *(Synemon plana*) —an endangered species.

No. 8: Button Wrinklewort (*Rutidosis leptorrhynchoides*)—an endangered species.

No. 9: Small Purple Pea (*Swainsona recta*) —an endangered species.

No. 10: Yellow Box-Red Gum Grassy Woodland—

an endangered ecological community.

No. 11: Two-spined Blackfish (*Gadopsis bispinosus*)—a vulnerable species.

No. 12: Trout Cod (*Maccullochella macquariensis*)—an endangered species.

No. 13 Macquarie Perch (*Macquaria australasica*)—an endangered species.

No. 14: Murray River Crayfish (*Euastacus armatus*)—a vulnerable species.

No. 15: Hooded Robin (*Melanodryas cucullata*) — a vulnerable species.

No. 16: Swift Parrot (*Lathamus discolor*) — a vulnerable species.

No. 17: Superb Parrot (*Polytelis swainsonii*) — a vulnerable species.

No. 18: Brown Treecreeper (*Climacteris picumnus*)—a vulnerable species.

No. 19: Painted Honeyeater (*Grantiella picta*) — a vulnerable species.

No. 20: Regent Honeyeater (*Xanthomyza phrygia*)—an endangered species.

No. 21: Perunga Grasshopper (*Perunga ochracea*)—a vulnerable species.

No. 22: Brush-tailed Rock-wallaby (*Petrogale penicillata*)—an endangered species.

No. 23: Smoky Mouse (*Pseudomys fumeus*)—an endangered species.

No. 24: Tuggeranong Lignum (*Muehlenbeckia tuggeranong*)—an endangered species.

No. 25: Ginninderra Peppercress (*Lepidium ginninderrense*—an endangered species.

No. 26: Silver Perch (*Bidyanus bidyanus*)—an endangered species.

No. 27: Woodlands for Wildlife. ACT Woodland Conservation Strategy.

Incorporating Action Plans for the following threatened species and communities:

- Yellow Box – Red Gum Grassy Woodland
- A Leek Orchid (*Prasophyllum petilum*)
- Small Purple Pea (*Swainsona recta*)
- Hooded Robin (*Melanodryas cucullata*)
- Swift Parrot (*Lathamus discolo*r)
- Superb Parrot (*Polytelis swainsonii*)
- Brown Tree creeper (*Climacteris picumnus*)
- Painted Honeyeater (*Grantiella picta*)
- Regent Honeyeater (*Xanthomyza phrygia*)
- Varied Sitella (*Daphoenositta chrysoptera*)
- White-winged Triller (*Lalage sueurii)*

No. 28: A Vision of the Grassy Plains Extended. ACT Lowland Native Grassland Conservation Strategy.

Incorporating Action Plans for the following threatened species and communities:

- Natural Temperate Grassland
- Striped Legless Lizard (Delma impar)
- Grassland Earless Dragon (Tympanocryptis pinguicolla)
- Golden Sun Moth (Synemon plana)
- Perunga Grasshopper (Perunga ochracea)
- Button Wrinklewort (Rutidosis leptorrhynchoides)
- Ginninderra Peppercress (Lepidium ginninderrense)

No. 29: Ribbons of Life. ACT Aquatic Species and Riparian Zone Conservation Strategy.

Incorporating Action Plans for the following threatened species and communities:

- Two-spined Blackfish (*Gadopsis bispinosus*)
- Trout Cod (*Maccullochella macquariensis*)
- Macquarie Perch (*Macquaria australasica*)
- Murray River Crayfish (*Euastacus armatus*)
- Silver Perch (*Bidyanus bidyanus*)

- Tuggeranong Lignum (*Muehlenbeckia tuggeranong*)
- Pink-tailed Worm Lizard (*Aprasia parapulchella*)

No. 30: Spotted-tailed Quoll (*Dasyurus maculatus*)—a vulnerable species.

Further information

Further information on this Action Plan or other threatened species and ecological communities can be obtained from:

Environment and Sustainable Development
ACT Government

Phone: 02 132281

Website: www.environment.act.gov.au