NSW SCIENTIFIC COMMITTEE

Northern Corroboree Frog *Pseudophryne pengilleyi*

Review of Current Information in NSW

May 2010

Current status:

The Northern Corroboree Frog *Pseudophryne pengilleyi* (Wells & Wellington 1985) is currently listed as Vulnerable under the Commonwealth *Environment Protection and Biodiversity Conservation Act* 1999 (EPBC Act) and as Endangered in the Australian Capital Territory (ACT) under the *Nature Conservation Act* 1980 (NC Act). The NSW Scientific Committee recently determined that the Northern Corroboree Frog meets criteria for listing as Critically Endangered under the NSW *Threatened Species Conservation Act* 1995 (TSC Act), based on information contained in this report and other information available for the species.

Species description:

The Northern Corroboree Frog is a small frog, adults reaching a length of between 2.5 to 3 cm. The species has a distinctive dorsal colouring of greenish-yellow with shiny black stripes that are frequently broken and interconnected (Pengilley 1966; Cogger 1992). This pattern extends over the limbs and flanks. The underside is marbled with black and white, or black and yellow. A large flat femoral gland is present on each hind limb and the inner metatarsal tubercle is low, round and not shovel-shaped. The inner toe has a single phalanx. The lime-yellow, narrow broken pattern of stripes of the Northern Corroboree Frog distinguishes it from the Southern Corroboree Frog *P. corroboree* which is brighter yellow and has a broader unbroken striped dorsal pattern (Osborne 1991). In addition, *P. pengilleyi* has a smaller body and tibia length than *P. corroboree* (Osborne *et al*. 1996).

Taxonomy:

Until recently, only one species of Corroboree Frog was recognised (Cogger 1992). Wells & Wellington (1985) provided the first case for recognising the Northern Form as a separate species, which they named *Pseudophryne pengilleyi*. Genetic divergence (Roberts & Maxson 1989; Osborne & Norman 1991; Morgan *et al*. 2008), differences in colour-pattern, skin biochemistry (Daly *et al.* 1990), morphology and call (Pengilley 1966; Osborne *et al.* 1996) further support the case for there being two species. In addition, the two forms are allopatric in their range (Figure 1), being separated by the Kiandra and Coolamine Plains, and the steep topography associated with the upper Tumut River catchment. The existence of two species is now generally accepted by authorities (eg. Tyler 1997; Cogger 2000) and the two forms are recognised as distinct species in NSW under the TSC Act.

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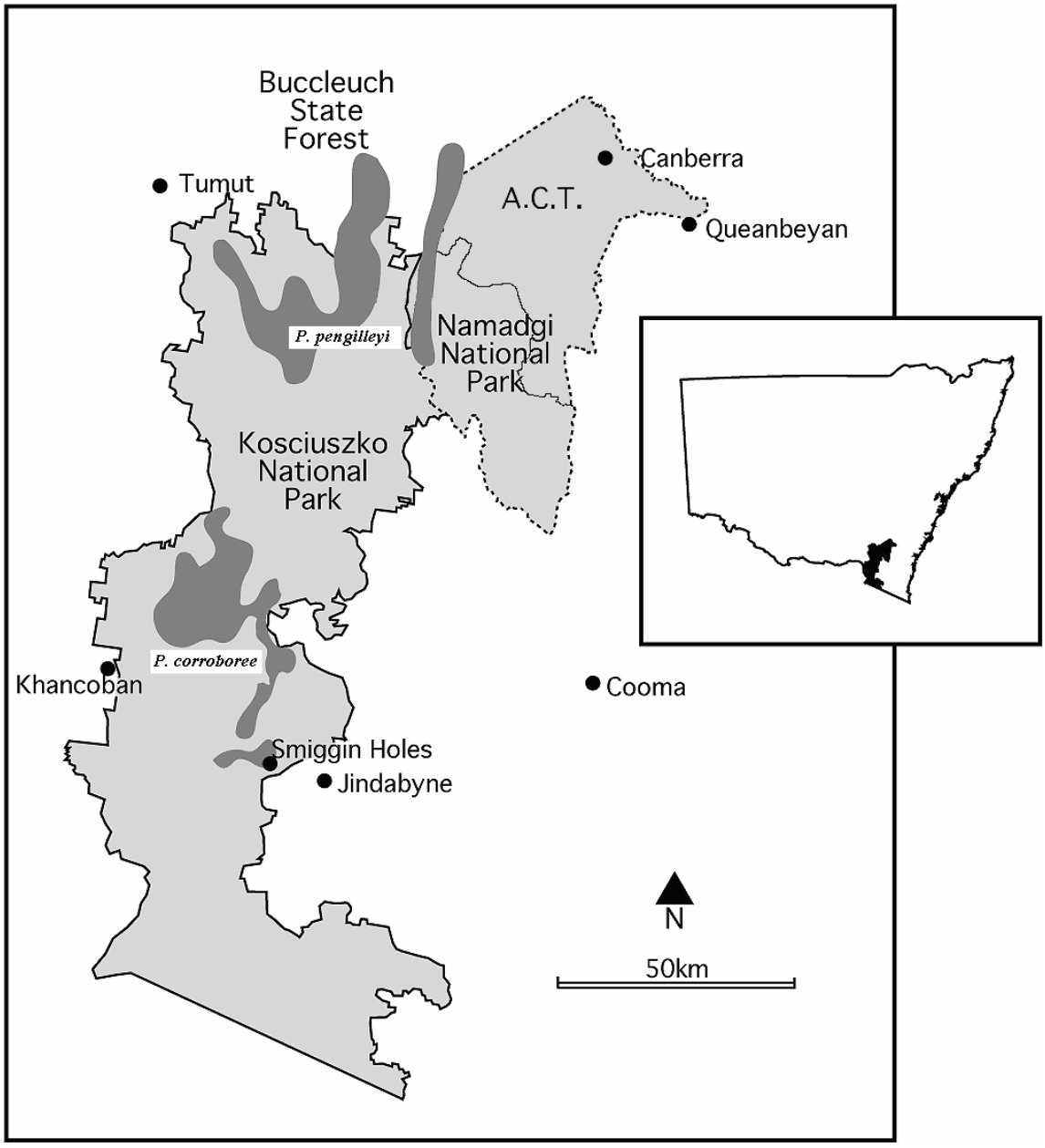

Figure 1. The distribution of *P. pengilleyi* and *P corroboree.* Darker shading indicates the historic range of the two species. Source: DECC 2007.

Distribution and number of populations:

The Northern Corroboree Frog lives the high montane and sub-alpine bog environments in the northern Australian Alps of NSW and high country around the ACT.

The species is known from sites within three disjunct geographic areas in NSW (Figure 2) which represent three subpopulations: Fiery Range, southern Brindabella and northern Brindabella (Morgan *et al.* 2008; expert advice, 2009).

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The Fiery Range subpopulation extends from Yarrangobilly in Kosciuszko National Park north to near the Buccleuch State Forest. The altitudinal range of this subpopulation is 850 - 1520 m (Osborne 1989; 1991).

The southern Brindabella subpopulation is found only in the subalpine zone (above about 1 400 m), occurring along the Bimberi Ranges from near the summit of Mt. Bimberi northward to Ginini Flats, ACT (ACT Govt 1997). This subpopulation occurs only within Namadgi National Park (ACT) and the adjacent Bimberi Nature Reserve in NSW, with the largest groups of frogs occurring at Ginini Flats and Snowy Flats in the ACT.

The northern Brindabella subpopulation occurs further north at lower altitudes (from 900 to 1 000m) along the Brindabella Ranges (ACT Govt 1997; Osborne *et al.* 1999). This subpopulation occurs in Namadgi National Park, Brindabella National Park and an area of land in NSW near the ACT border which is the responsibility of the Commonwealth.

Although, at their closest, frogs in the Fiery Range are only 10 km from the two Brindabella Range subpopulations, environments unsuitable for Corroboree Frogs separate these areas (the Goodradigbee River valley and the Coolamine plains) and no suitable breeding sites have been found that would facilitate dispersal (Osborne, 1989).

Because of the distances involved and the low vagility of the species, it is unlikely that there is interchange between the three subpopulations.

Number of Locations

The three sub-populations should be considered as one location (sensu IUCN 2008). The biggest threats to this species are chytrid fungus and climate change.

Chytrid fungus could easily be spread through all subpopulations of this species, as all known breeding sites are accessible to the public (through recreational activities such as skiing or bushwalking) and researchers also visit sites.

The Northern Corroboree Frog occurs in a narrow climatic range (the sub-alpine and alpine regions of eastern Australia), hence climate change is likely to have a serious impact on all three subpopulations of this species.

The entire population of the Northern Corroboree Frog is therefore restricted to a single ‘location’ (IUCN 2008).

Land tenure

All known and historical occurrences of the Northern Corroboree Frog in NSW occur within Kosciuszko National Park, Brindabella National Park, Bimberi Nature Reserve, Buccleuch State Forest, Wee Jasper State Forest or an area of land in NSW near the ACT border which is the responsibility of the Commonwealth (ACT Govt 1997). In the ACT, the species occurs in Namadgi National Park.

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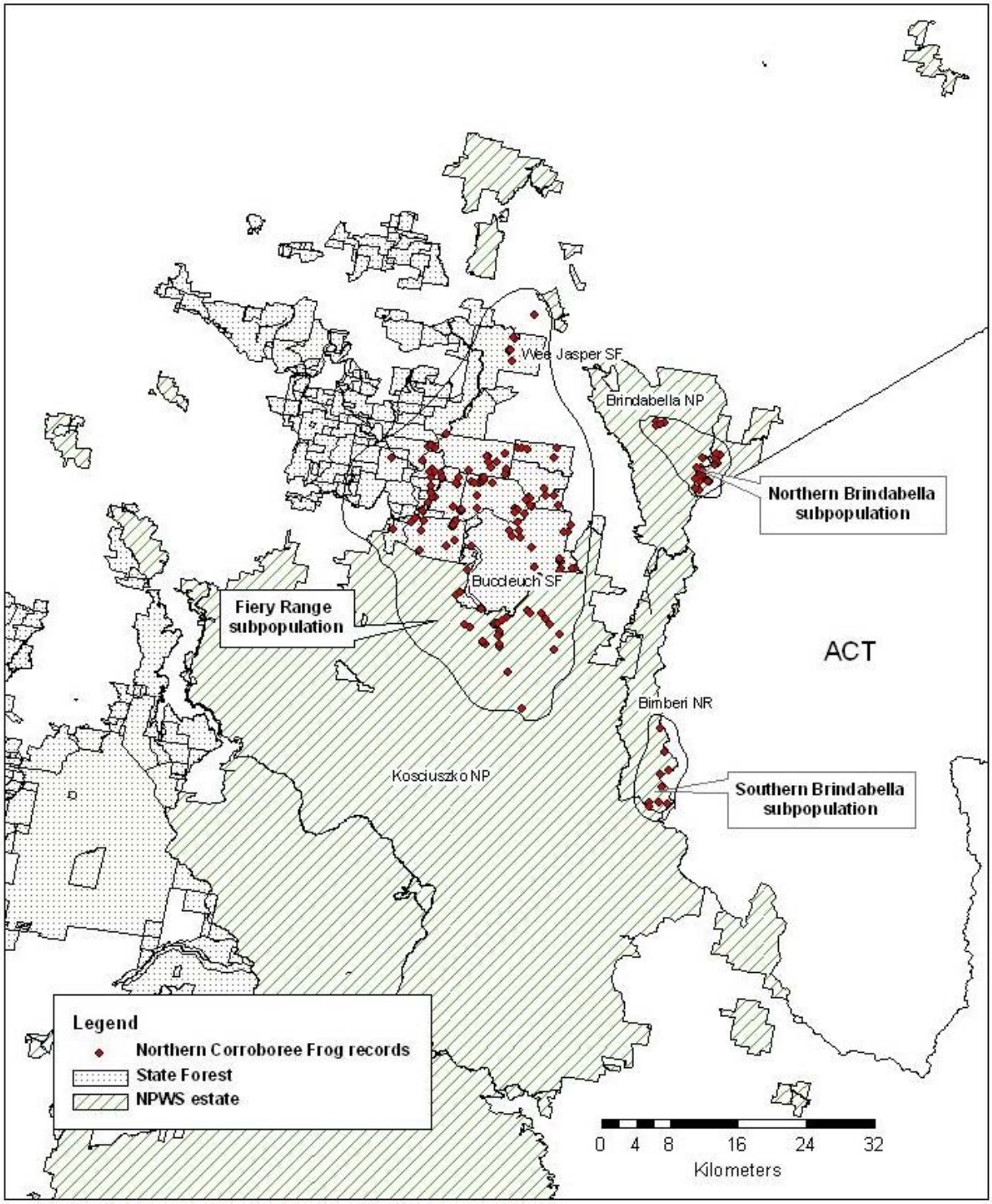

Figure 2. Northern Corroboree Frog records from the three recognised subpopulations for the species in NSW.

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Ecology:

Key habitat requirements

The Northern Corroboree Frog is a habitat specialist, restricted to montane and sub-alpine woodlands, heathland and grassland above around 1 000 m. This species utilises two distinct habitat types. The summer breeding habitat is associated with temporary pools and seepages in sphagnum bogs, wet tussock grasslands, and wet heath. The terrestrial non-breeding sites occur in the litter, logs and dense ground cover in the understorey of snow gum woodland and heath forest adjacent to the breeding area. This habitat is the same as used by *Pseudophryne corroboree*, except that *P. pengilleyi* is more often found in the leaf litter of wooded areas (Cogger 2000). Breeding and non-breeding sites for the Northern Corroboree Frog are usually separated by distanced of 10-30 m (expert advice, 2010).

Reproductive biology

Like most frogs, the Northern Corroboree Frog has a typical two-stage life-cycle with an aquatic tadpole stage and terrestrial post-metamorphic juvenile and adult stage.

In early summer the adult males move into the breeding habitat. During favorable weather conditions from late December through to mid February, the males call from small chambers in moss or other soft vegetation at the edges of the breeding pools (Osborne 1991).

Breeding occurs from January to March (Pengilley 1966; 1971a; 1973). Females deposit 16 to 38 eggs (average of 24) in terrestrial nests occupied by the breeding males. Tadpoles develop within the egg capsule and hatching occurs at four to six months during autumn and winter, in periods of high rainfall or snowmelt. Tadpoles then move out of the nest site and into an adjacent pool before undergoing metamorphosis over a period of six to eight months during early summer (Pengilley 1966; 1973; Hunter *et al*. 1999). As they grow larger, the juveniles leave the breeding area and move into the adjacent non-breeding habitat where it is thought they remain until they are adults.

The average survivorship from egg to metamorphosis for this species was found to be 20% in the absence of early pool drying (i.e. drying of the pools before tadpoles reach metamorphosis) (Hunter 2000). Early pool drying during drought years typically causes 100% failure of recruitment to metamorphosis for that year (Hunter 2000). There is no information available on survivorship from metamorphosis to sexual maturity.

Movement

The Northern Corroboree Frog typically undertakes short, annual movements at the end of the breeding season from the bogs, ponds and other grassland breeding sites to the surrounding non-breeding habitats of low-lying heath and woodland (Duellman & Trueb 1986; Pengilley 1992). Osborne (1988) measured dispersal distances of up to 300 metres.

Diet

The Northern Corroboree Frog feeds mostly on small ants and, to a lesser extent, other invertebrates (Pengilley 1971b; Osborne 1990).

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Generation length

Age to first reproduction for the majority of males has been found to be four years from metamorphosis (Hunter 2000). In the lower altitude sites (northern Brindabellas and Fiery Range) females also reproduced four years after metamorphosis, however in the high altitude sites (southern Brindabellas) females take an additional year to mature (expert advice, 2009). Annual survivorship estimates for the adult life stage is restricted to information attained on a male breeding population as limited information is available for females (Hunter 2000). Maximum age is likely to be 10 years (expert advice, 2009), however, the average longevity is around six years (expert advice, 2009). Annual survivorship for adult males has been determined to be between 50% and 60% (Hunter 2000). 'Generation length' (IUCN 2008) is estimated to be five to seven years.

Number of mature individuals:

The number of mature individuals can be estimated from information on numbers of calling males in survey areas. Repeated sampling is undertaken at monitored male calling sites and although it is difficult to determine with complete certainty, it is believed that the majority of adult males do call (expert advice, 2010). Based on the number of males calling during surveys in January 2008 and the number of eggs in nests, the number of mature individuals in the wild is estimated to be between 2 000 and 3 000 (expert advice, 2009), assuming a ratio of males to females of 1:1 (expert advice, 2009).

The number of mature individuals in each of the subpopulation is estimated to be; 2 000-2 800 at Fiery Range, 20-30 at southern Brindabella and 30-120 at northern Brindabella (expert advice, 2009).

Threats:

Chytrid fungus

A major cause of decline in the Northern Corroboree Frog is now recognised to be the introduced Amphibian Chytrid Fungus (*Batridiochytrum dendrobatoides*) (Berger *et al.* 1999; Hunter *et al.* 2006). The initial decline of the Northern Corroboree Frog coincided with the first appearance of the disease in the population in the early 1990s (Hunter *et al.* in prep), and also with the decline of other frog species along the eastern ranges of Australia in which chytrid has been implicated (Berger *et al.* 1998; Osborne *et al.* 1999). Hunter *et al.* (in prep) did not detect the presence of chytrid fungus in pre 1990 museum samples of both Northern and Southern Corroboree Frog (Osborne 1989), however 61% of specimens collected from 1991-1993 tested positive to the infection.

Although present in all three subpopulations, much lower levels of infection have been observed in lower altitude Northern Corroboree Frog populations (14%) compared to higher altitude populations (Hunter *et al.* in prep). This pattern is consistent with that observed in other frog species where chytrid fungus has been implicated in their decline (Berger *et al.* 1998, McDonald *et al.* 2005). Hunter *et al.* (in prep), suggests the differing levels of infection may be due to the warmer and drier environments at lower altitudes which are less conducive to the spread and pathogenicity of chytrid (Woodham *et al.* 2003; Johnson & Speare 2003; Berger *et al.* 2004).

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'Infection of frogs by amphibian chytrid causing the disease chytridiomycosis' is listed as a Key Threatening Process in NSW under the TSC Act.

Climate change

Because the Northern Corroboree Frog occurs in a narrow climatic range (the sub-alpine and alpine regions of eastern Australia), any human induced or natural climate change is likely to have a serious impact on this species (Bennett *et al.* 1991).

Potential climate-related impacts include; altering the timing of breeding so that egg and tadpole development occurs earlier or later than is optimal, influencing the hydrology of breeding pools, and affecting the growth and dynamics of vegetation in the breeding habitat.

In addition, as the Northern Corroboree Frog typically breeds in highly ephemeral waterbodies, and has a lengthy period of tadpole development (approximately six months), this species is vulnerable to drought conditions, which may also be influenced by climate change.

'Anthropogenic Climate Change' is listed as a Key Threatening Process in NSW under the TSC Act.

Fire

Fire has the potential to have a significant impact on this species by causing direct mortality. The extensive fires that occurred during January 2003 in Kosciuszko National Park burnt through much of the range of the species. These fires occurred during the peak breeding period and direct observations were made of male frogs perishing in nest sites due to heat exposure (DECC 2007). Based on the number of eggs present in nest sites, it is also possible that these fires inhibited breeding activity or caused increase mortality in females (DECC 2007).

Fire may also affect the Northern Corroboree Frog through longer-term impacts associated with habitat alteration. For example, wildfire can severely damage bog habitats, through erosion and drying out of peat beds (Good 1973; Clark 1986). In addition, it is thought that regular hazard reduction burning of understorey litter and grass cover in over-wintering woodland and heath habitats may reduce available shelter, making the species more susceptible to predation, dehydration or freezing (Osborne 1991).

'High frequency fire resulting in the disruption of life cycle processes in plants and animals and loss of vegetation structure and composition' is listed as a Key Threatening Process in NSW under the TSC Act.

Feral animals

Both Feral Pigs *Sus scrofa* and Horses *Equus equus* have the capacity to damage the Northern Corroboree Frog over-wintering habitats and adjacent bog environments. Trampling by wild horses has caused considerable disturbance in particular to breeding sites in the Fiery Range (DECC 2007). Feral Pigs can cause extensive damage to the vegetation and soil in frog breeding areas (Alexiou 1983), and when used as wallows can cause considerable damage to ponds that contain corroboree frog tadpoles (Helman *et al.* 1988).

'Predation, habitat degradation, competition and disease transmission by Feral Pigs, *Sus scrofa*' is listed as a Key Threatening Process in NSW under the TSC Act.

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Weeds

Invasive exotic plant species occur at a number of Northern Corroboree Frog breeding sites in the Fiery Range and Northern Brindabella Range subpopulations (Osborne 1990; NSW NPWS 2001). The two species considered most detrimental to the frogs are *Rubus fruticosus* (Blackberry) and *Mimulus moschatus* (Monkey Musk). Both weed species can potentially cover large areas of Northern Corroboree Frog breeding habitat. Blackberry can completely smother and shade breeding habitat making it unsuitable for the frogs. Monkey Musk, a short, broad-leafed herb, forms dense patches in seepages where it often occurs with a similar-sized native species *Gratiola latifolia.* Breeding sites in the Fiery Range often occur along lengthy seepage depressions and are probably susceptible to weed infestation as a result of sediment run-off from roads (Osborne 1991).

Extreme fluctuations:

Populations of the Northern Corroboree Frog apparently fluctuate as a result of variable breeding success in response to varying climatic conditions between seasons (Pengilley 1992). However, it is uncertain whether this species undergoes 'extreme fluctuations' (IUCN 2008).

Population reduction and continuing declines:

Observations made until the 1970s indicate that the Northern Corroboree Frog was abundant within its limited geographic range. Large numbers, often many hundreds of individuals, were frequently recorded at suitable breeding sites (Colefax 1956; Jacobson 1963; Pengilley 1966). The frogs present at some of these breeding sites have been monitored regularly over the last few decades, and the results indicate a substantial decline has occurred, particularly across the Brindabella Ranges (Osborne 1988; 1989; expert advice, 2010).

In the summers of 1985 and 1986, Osborne (1988; 1989) undertook the first extensive surveys of the distribution and relative abundance of the Northern Corroboree Frog, locating breeding sites across the known historic range of the species in the Fiery Range (88 sites) and the Brindabella Range (68 sites). The species was found in 35% of sites surveyed in the Fiery Range and 69% of sites in the Brindabella Range. It was concluded that, although the species appeared common and widespread, most breeding sites supported very low numbers of individuals. For example, at 66% of the Fiery Range sites and 64% of the Brindabella sites, there were fewer than 10 males calling with very few sites (between 12 and 20%) containing more than 25 calling males. Some sites in Brindabella were found to contain considerably less numbers of calling males than was recorded 20 years previously (Pengilley 1966), indicating that a reduction in abundance may have occurred there. In addition, the species was no longer found in the vicinity of Hume Sawmill (Brindabella Ranges) at the northern extent of its range.

Further surveys were conducted between 1994 and 1998, throughout the known range of the species in the Fiery Range and Mount Bogong (mainly along vehicle tracks) and more extensively in the Brindabella Range and Bimberi Range (Osborne *et al.* 1999). At this time, the species was still found to be relatively abundant and widespread in the Fiery Range, however, it was not located in the Yarrangobilly-Peppercorn Hill area where it was previously recorded by Pengilley (1966) and Osborne (1989). Surveys located animals at breeding sites (often remote from each other) throughout suitable

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parts of the Brindabella and Bimberi Range, both in the ACT and contiguous areas of New South Wales (Osborne *et al.* 1999), however the numbers present at breeding sites in the region were found to be considerably lower than those recorded previously (Osborne 1989).

Osborne *et al.* (1999) conducted long-term annual monitoring at Ginini Flats (ACT), a sub-alpine site (1 600 m asl), in the southern Brindabellas. During the first few years of monitoring, population size declined substantially, before apparently stabilising (Osborne *et al.* 1999). Continued monitoring has shown the population has now decreased substantially with only one male recorded in 2009 (expert advice, 2010; Figure 3). Osborne *et al.* (1999) undertook less-regular monitoring at another site in the northern Brindabellas (Coree Flats in NSW, 980 m asl), which also showed a decline between 1989 and 1998. More-regular monitoring at this site between 1999 and 2010 has reinforced suggestions of a decline, with only four males recorded from surveys in 2010 (expert advice, 2010; Figure 3). Earlier observations at this site by Pengilley (1966) indicated that the population was once very large (perhaps over 500 individuals).

Overall, Osborne *et al.* (1999) found there to be an ongoing decline in both range and abundance of the Northern Corroboree Frog, with declines in the higher elevation (above 1 400 m) or most eastern sites being more pronounced, even though the species was still relatively common at lower altitudes in the Fiery Range.

Population monitoring across the three subpopulations has occurred as part of a recovery program since 1997 (Figures 4 to 6). Results suggest some fluctuation in the size of subpopulations, which may reflect differences in climatic conditions between survey years, notably the probable influence of drought (Hunter *et al.* 2006; Hunter *et al.* 2007). It is therefore difficult to confidently determine what the population trends for this species are in the last decade. However, subpopulations in the Brindabella Ranges appear to be in a serious state of decline, as many sites no longer contain the species, or if present, it is found in extremely low numbers (Hunter *et al.* 2007). In 2009, of the 22 known NSW sites in the northern Brindabella subpopulation, nine were occupied and 41 males were recorded. In the same year, at the six known NSW sites within the southern Brindabella Ranges, only three sites contained frogs and only eight males were recorded (expert advice, 2010). The vulnerability of the Brindabella subpopulations is exacerbated by the linear nature of the area occupied by the frogs, which restricts migration between breeding sites within the subpopulation. The status of the Fiery Range subpopulation is less certain as there may not have been significant declines here over the last decade (expert advice, 2009) (Figure 4a & 4b).

Over the past 15-20 years (a time frame appropriate to the life cycle of the species), it is clear however, that there has been a large decline in the number of males calling at breeding sites. In 1988, the adult male Northern Corroboree Frog population in the Brindabella Range (combining northern and southern subpopulations) was estimated to be 2 000-3 000 and the Fiery Range population was estimated at tens of thousands (Osborne 1989), although a conservative estimate of 10 000 – 20 000 mature individuals is considered likely (expert advice, 2009). Comparison of these subpopulation sizes with those of 2009 show that the Brindabella subpopulations (combined) have declined by more than 95%. Although available historic population estimates for Fiery Range are very broad, assuming a minimum

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population of 10 000 male Northern Corroboree Frogs in 1988 and a conservative estimate of 2 800 individuals, or 1 400 males, in 2009, gives a decline in abundance over the past 21 years of 86%.

Given the increased fragmentation and loss of habitat (through drought, weeds and feral animal damage), and the threats of climate change, chytrid fungus, and fire to the populations, it is reasonable to conclude that the species will continue to decline in the future.

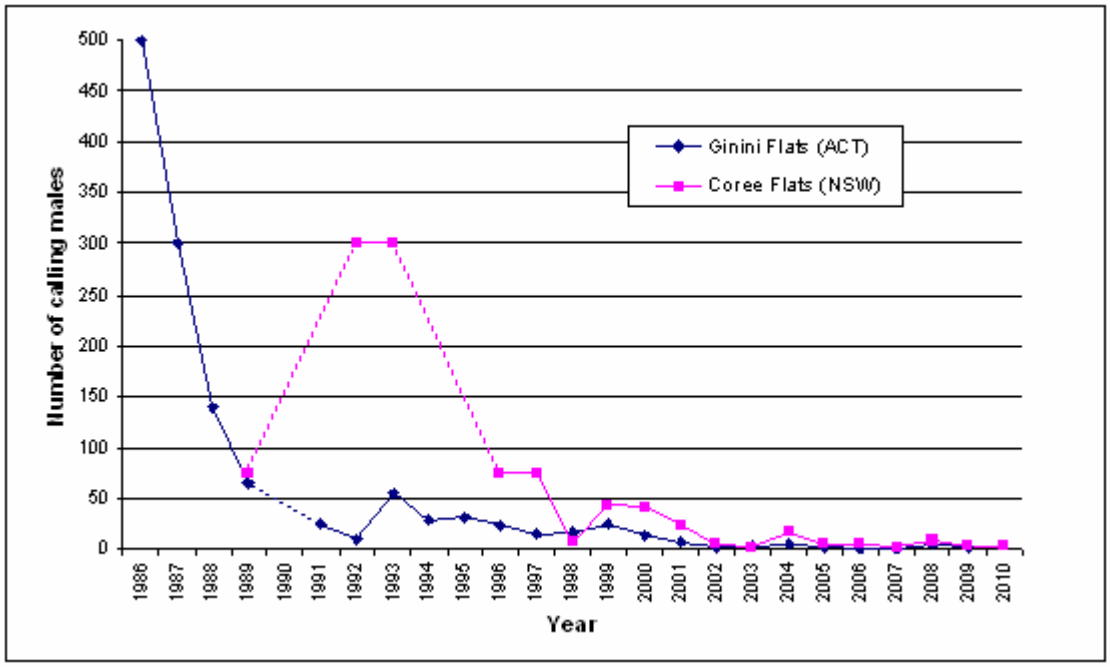
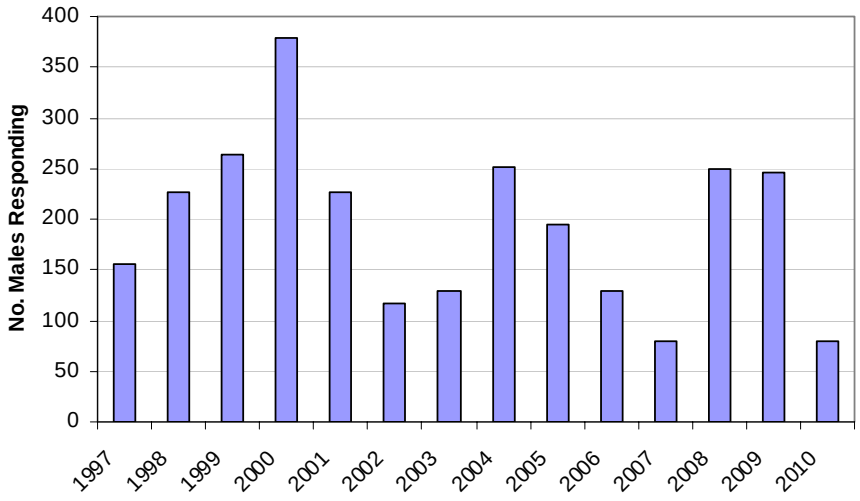


Figure 3. Results of the long-term monitoring program for *P. pengilleyi* in the Brindabella Ranges until 1998; Ginini Flats is located in the southern Brindabellas and Coree Flats is in the northern Brindabellas (Results up until 1998 were adapted from data presented in Osborne *et al.* 1999. Data from 1999 onwards for Coree Flats is provided by R. Pietsch & D. Hunter unpubl. data and for Ginini Flats is M. Evans unpubl. data).



(a) Kosciuszko National Park (Fiery Range subpopulation, 30 sites monitored)

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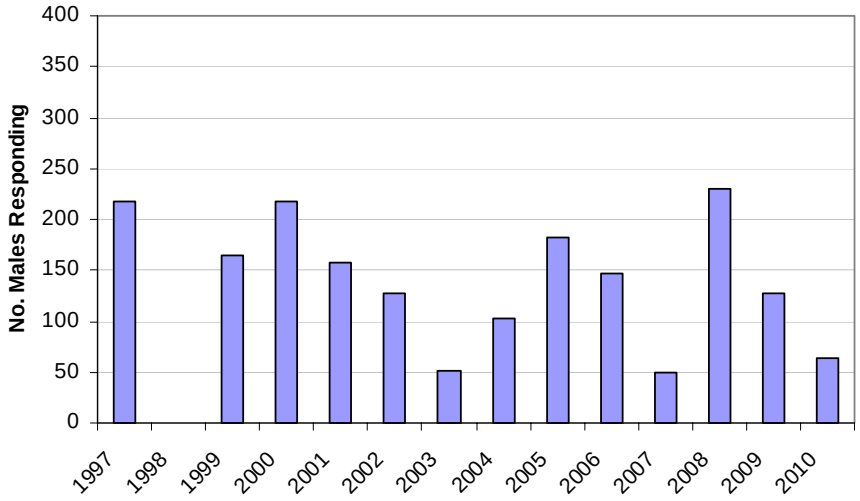
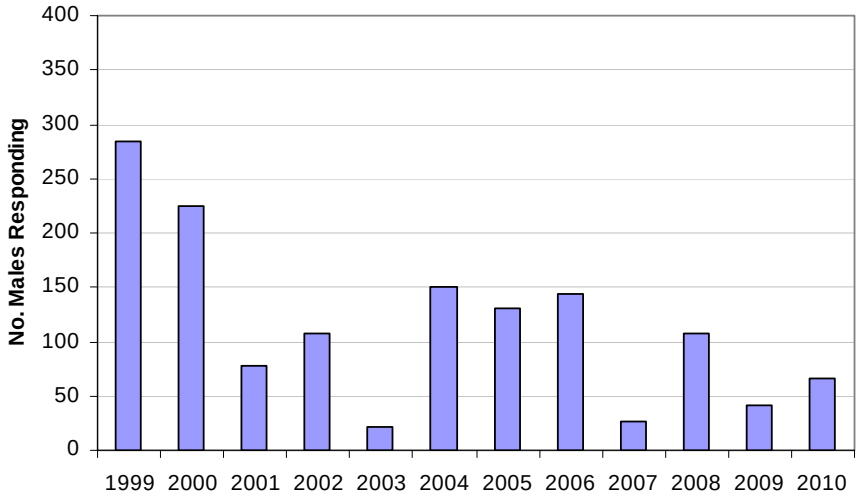


(b) Buccleuch State Forest (Fiery Range subpopulation, 14 sites monitored; data collected by Forests NSW).



(c) Brindabella National Park (Northern Brindabella subpopulation, 22 sites monitored). No monitoring occurred at these sites in 1997 and 1998.

Figure 4. Number of male Northern Corroboree Frogs responding at monitoring sites for three regions between 1997 and 2010.

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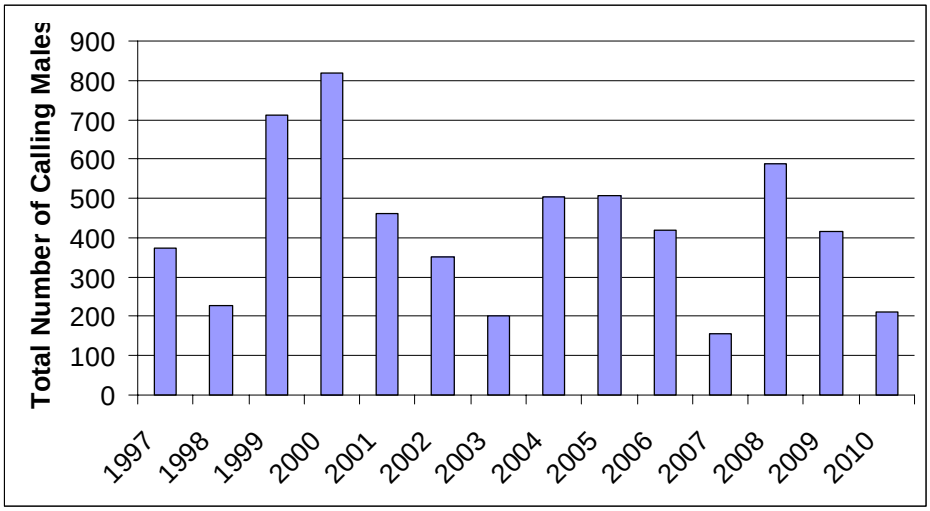

Figure 5. Total number of male Northern Corroboree Frogs responding at all monitored sites (66 sites).

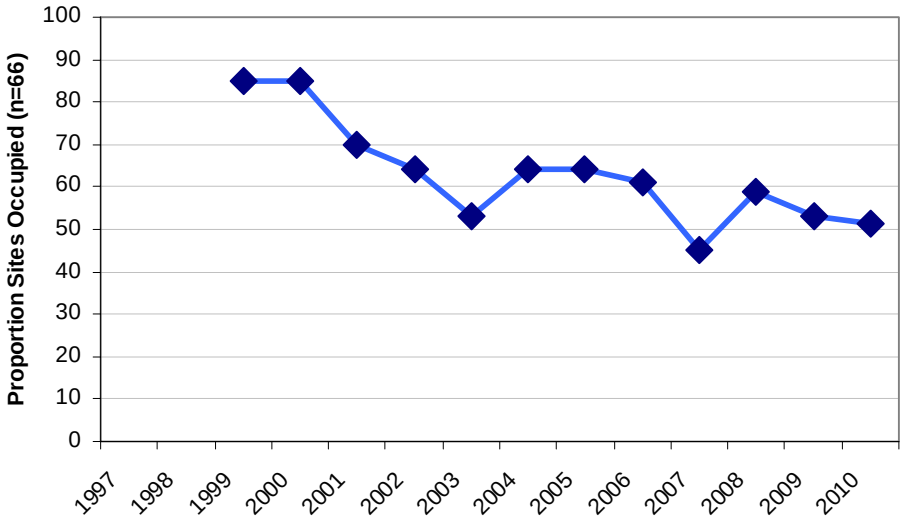

Figure 6. Proportion of occupied sites within NSW monitoring area.

Extent of Occurrence (EOO) & Area of Occupancy (AOO):

The Fiery Range subpopulation is widespread, occupying about 550 km². The Brindabella Range subpopulations are more restricted in distribution, occupying an area of about 60 km² in a narrow strip along the mountain range (Osborne 1989).

The EOO for the species is estimated to be less than 2 000 km^2 (based on the distance between the most widely separated occurrences and the linear alignment of locations; the method recommended by IUCN 2008 for assessment of EOO). The AOO is estimated to be no more than 340 km^2 (based on a 2 x 2 km grid cell, the scale recommended by IUCN 2008 for assessing areas of occupancy).

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Severe fragmentation:

Genetic studies have shown that there is highly restricted gene flow between the known subpopulations of the Northern Corroboree Frog (Morgan *et al.* 2008), probably as a result of physical barriers restricting movement and the reduction of suitable habitat between subpopulations. Several breeding sites of the species have been destroyed or damaged (Osborne 1988; 1991), with annual monitoring suggesting an estimated 50% of sites are now 'lost' across the species' range (expert advice, 2009).

Fragmentation and isolation of populations is such that frogs are unlikely to be able to disperse between extant sites. In addition, the species is considered to be slow-moving and has high breeding site fidelity (expert advice, 2010), making dispersal even more unlikely.

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Explanatory note

Between 2007 and 2009 the NSW Scientific Committee undertook a systematic review of the conservation status of a selection of plant and animal species listed under the Threatened Species Conservation Act. This species summary report provides a review of the information gathered on this species at the time the Review was undertaken.

The Scientific Committee's report on the Review of Schedules project and final determinations relating to species that were either delisted or had a change in conservation status can be found on the following website: www.environment.nsw.gov.au .

The Committee gratefully acknowledges the past and present Committee members and project officers who ably assisted the Committee in undertaking the Review of Schedules Project. Information on the people involved in the project can be found in the Acknowledgement section of the project report entitled "Review of the Schedules of the Threatened Species Conservation Act 1995. A summary report on the review of selected species" which is available on the abovementioned website.

This species summary report may be cited as:

NSW Scientific Committee (2010) Northern Corroboree Frog *Pseudophryne pengilleyi*. Review of current information in NSW. May 2010. Unpublished report arising from the Review of the Schedules of the Threatened Species Conservation Act 1995. NSW Scientific Committee, Hurstville.

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