

6. Threatened reptile and frog species of Kakadu National Park: current status; known and potential threats; and what needs to be done for them?

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6.1 Introduction

Kakadu National Park supports at least 131 non-marine reptile and 27 frog species, an unusually high species richness compared to most other protected areas in Australia. Many of these species have a large proportion of their natural range contained within the Park. Consequently Kakadu National Park plays a key role in the conservation of a large proportion of Top End and Northern Australian reptile and amphibian diversity. Nevertheless, several of these species are considered threatened or have declined in recent years, whilst the status of many other species within the Park is poorly known. Here, we provide an inventory of the currently listed threatened non-marine reptile species occurring in Kakadu National Park, a summary of the current status of these species in the Park, an assessment of their threats and management requirements, and a prioritisation for conservation management.

For Kakadu, the most relevant threatened species listings are those for Australia (under the *Environment Protection and Biodiversity Conservation Act 1999*: 'EPBC Act') and the Northern Territory (under the *Territory Parks and Wildlife Conservation Act 2000*). There is overlap between these lists, and the criteria for eligibility are broadly similar. However there are differences in composition of the lists that reflect, in part, geographical scope – species may be declining rapidly in the Northern Territory but not elsewhere in Australia, or vice-versa. However, other differences between lists relate to relative currency: the Northern Territory list is comprehensively reviewed at c. 5 year intervals (most recently in 2012), whereas the Australian list is modified much more haphazardly. Consequently we include here details of the conservation status identified by both lists.

Seven reptile species occurring in Kakadu National Park are currently considered threatened either in Australia or the Northern Territory (Table 6.1). Three species are considered threatened by both jurisdictions. No frog species are currently considered threatened. None of the threatened species is restricted to Kakadu; however, the Park comprises much of the range (and/or population size) of the Yellow-snouted Gecko, Arnhem Land Skink and Oenpelli Python.

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Table 6.1 List of threatened reptile species recorded from Kakadu National Park. Conservation status codes: EN=endangered; VU=vulnerable.

Common name	Scientific name	EPBCA Listed	NT Listed
Yellow-snouted Gecko	<i>Lucasium occultum</i>	EN	VU
Arnhem Land Skink	<i>Bellatorias obiri</i>	EN	VU
Merten's Water Monitor	<i>Varanus mertensi</i>		VU
Mitchell's Water Monitor	<i>Varanus mitchelli</i>		VU
Yellow-spotted Monitor	<i>Varanus panoptes</i>		VU
Plains Death Adder	<i>Acanthophis hawkei</i>	EN	VU
Oenpelli Python	<i>Morelia oenpelliensis</i>	-	VU

6.2 Status and accounts of threatened reptile species

The following accounts provide current information on population status and trends of formally listed threatened species in Kakadu National Park:

- The Yellow-snouted Gecko has a highly restricted distribution that includes the Kapalga area of Kakadu (Woinarski et al. 2007). There have been only five records of this species from within Kakadu since 1988 despite intensive searches. This ground-dwelling species is associated with open woodland with red loamy soils (Woinarski et al. 2007). Most individuals located to date have been associated with well developed leaf litter and grass (King et al. 1982, Johansen 2006). Although data are limited, patterns of occurrence suggest that inappropriate fire regimes and spread of introduced pasture species are likely to be key threats to the Yellow-snouted Gecko (Woinarski et al. 2007).
- The Arnhem Land Skink is restricted to the western Arnhem Land sandstone massif with approximately one third of its range contained within Kakadu. The species inhabits rock ledges and crevices and has been recorded at only nine locations in Kakadu. Many individuals were caught as by-catch in mammal surveys at Nawurlandja in the late 1970s, suggesting that it was locally common at that time (Begg et al. 1981). However, subsequent surveys have failed to detect the species in that area (Watson & Woinarski 2003, Armstrong & Dudley 2004, Gillespie et al unpublished data). There have been only four records of this species found in Kakadu since 2002 (Armstrong & Dudley 2004, DLRM unpublished data). The cause(s) of decline of this species are not known but may include predation by feral cats, poisoning from ingestion of Cane Toads and changes in food resources resulting from altered fire regimes (Woinarski et al. 2007).
- Merten's Water Monitor, Mitchell's Water Monitor and the Yellow-spotted Monitor are widely distributed across the Top End and other parts of northern Australia. Merten's Water Monitor and Mitchell's Water Monitor are both aquatic species usually associated with rivers and lagoons. The Yellow-spotted Monitor occurs in a wide range of habitats, including floodplains, woodlands, grasslands and coastal

beaches. Formerly common throughout the region, all of these species have undergone substantial population declines with the arrival of Cane Toads due to poison ingestion (Doody et al. 2009, 2013, Ujvari & Madsen 2009). These declines also occurred in Kakadu National Park (Griffiths & Holland 2004, Griffiths & McKay 2007). Reports suggest that all three species still persist in Kakadu National Park but at densities much lower than historical levels, and local extinctions may have occurred in some areas.

- The Plains Death Adder is distributed across the Top End and through the Gulf country into western Queensland; however the taxonomic status of some populations requires further resolution. The species inhabits floodplains, woodlands and grasslands. This species also appears to have undergone widespread population decline due to poisoning from ingestion of Cane Toads. Phillips et al. (2009) recorded nearly a 90% decline in Plains Death Adder survivorship associated with the arrival of toads. Adult female Plains Death Adders feed mostly on mammals (Webb et al. 2005); however, the decline of small native mammals throughout the range of this species may not only reduce an important component of its natural prey base, but also increase the likelihood of death adders preying on toads, thus further reducing survivorship. Inappropriate fire regimes that reduce grass and other ground vegetation cover have also been shown to be detrimental to other death adder species (McDonald et al. 2012).
- The Oenpelli Python is restricted to the western Arnhem Land sandstone massif and approximately one third of its range is contained within Kakadu. The species inhabits the rugged sandstone escarpment and associated gorges, although some individuals have been reported on nearby floodplains. The species has been recorded at only 10 localities in Kakadu (Gillespie et al. unpublished data). There is some anecdotal indication of local declines of this species in some accessible areas of the Park (I. Morris pers. obs.), possibly due to illegal collecting (Woinarski et al. 2007). Targeted surveys for this species at known localities where it has been recorded, as part of the Kakadu Hotspot Survey program between December 2012 and June 2013 failed to locate any individuals (Gillespie et al. unpublished data); however five individuals were found during this survey period to the east of the Park. Little is known about the ecology of the Oenpelli Python, but as with many other large predatory snakes, it probably occurs naturally at low densities, may have low activity levels, spend a large proportion of time sheltering and hidden from detection, thus making it difficult to survey and monitor. Although infrequently encountered, the overall pattern of reports shows no discernible overall decline of this species since the early 1970s when it was first described (G. Gillespie unpublished data); however increased public interest and search effort for this species in recent years may also be influencing this pattern. Several threats are potentially operating that could be contributing to the rarity of this species, or causing populations to decline, including: poaching, changes in mammalian prey resources and predation. The small mammal prey base for juvenile Oenpelli Pythons has undergone catastrophic decline in recent decades (Woinarski et al. 2011). Juvenile Oenpelli Pythons are also within the prey size range of feral cats, which occur throughout the range of the species, and are known to predate small pythons. Inappropriate fire regimes may also have adversely affected this species, either by loss of habitat components, such as tree hollows, which are important for other arboreal python species (see Bryant et al. 2012), or by contributing to reduction of its prey species.

- In addition to species formally listed as threatened, other species occur within Kakadu National Park whose conservation status is currently uncertain or indeterminate. Information on the distributions, population sizes or population trends of these species is insufficient to assess their current conservation status, either broadly throughout the Northern Territory or specifically within the Park (Table 2). In all cases the number of recent records, as collated by NT DLRM and Kakadu National Park, of these species in Kakadu National Park (during the past 10 years) is very low or zero. However, it is likely that many observations of some of these species, either by members of the public or land managers, go unreported; therefore these figures may not be a true indication of the distribution and status of the species.
- In some cases, such as the Blue-tongued Lizard and Stone Country Death Adder, population declines have been reported elsewhere in the Top End, associated with arrival of Cane Toads, and this threat is known to be operating upon populations within the Park. In other cases, such as the Northern Carpet Python and King Brown Snake, declines have been reported elsewhere but the cause(s) is unclear and may also be occurring in the Park. These species feed predominantly on small mammals, which have undergone substantial declines in abundance in recent decades (Woinarski et al. 2013), possibly resulting in a reduction in prey availability. Carpet pythons utilize tree hollows for shelter and leaf litter and ground cover vegetation for shelter and nesting (Shine 1991, Heard et al. 2004, Pearson et al. 2005, Bryant et al. 2012). Inappropriate fire regimes may be reducing the availability of microhabitats critical for persistence of this species.
- For other species, such as the Alligator River Ctenotus, Kakadu Ctenotus, Chameleon Dragon, Taipan, Western Brown Snake, Pig-nosed Turtle and Sandstone Long-necked Turtle, data are simply insufficient to make any informed assessment about their population status or trends.
- To date there is no evidence of declines of any frog species in Kakadu National Park; however three frog species (Giant Frog *Litoria australis*, Northern Dwarf Tree-frog *L. bicolor* and Ornate Burrowing Frog *Platyplectrum ornatus*) are listed in the Northern Territory as Data Deficient on the basis of some preliminary indications of decline following the arrival of cane toads. The arrival of Cane Toads may have influenced the dynamics of populations of some species and assemblages (Shine 2010); however there is no evidence to date that any Top End species have declined as a result of toads through predation or competition. Nevertheless, systematic monitoring data on frogs in Kakadu and elsewhere in the Top End is limited, and there is generally high uncertainty in the formal conservation assessments of many species in the region (Gillespie et al. 2011). This is exacerbated by poorly-resolved taxonomy of some genera, such as *Uperoleia* species.

Table 6.2 Reptile species currently considered data deficient or near threatened in Kakadu National Park. DD – Species formally identified as data-deficient in the Northern Territory; NT – Near threatened in the Northern Territory; LC – Least Concern in the Northern Territory.

Species	Comment	Northern Territory Status	Records in Kakadu since 2003
Alligator River Ctenotus <i>Ctenotus kurnbudj</i>	No current data on distribution in Kakadu; no data on population trends	DD	0
Arnhemland Ctenotus <i>Ctenotus arnhemensis</i>		DD	
Point Stuart Ctenotus <i>Ctenotus stuarti</i>		DD	
Kakadu Ctenotus <i>Ctenotus gagudju</i>	No current data on distribution in Kakadu; no data on population trends	DD	0
Blue-tongued Lizard <i>Tiliqua scincoides</i>	Declined throughout Top End associated with Cane Toad arrival (Price-Rees <i>et al.</i> 2010; Brown <i>et al.</i> 2013)	DD	3
Chameleon Dragon <i>Chelosania brunnea</i>	Limited current data on distribution in Kakadu; no data on population trends	NT	1
Black Spotted Ridge-tailed Monitor <i>Varanus baritji</i>	Limited historic or current data on distribution in Kakadu; no data on population trends	DD	13
Kimberley Rock Monitor <i>Varanus glauerti</i>	Limited historic or current data on distribution in Kakadu; no data on population trends	DD	2
Long-tailed Rock Monitor <i>Varanus glebopalma</i>	Limited historic or current data on distribution in Kakadu; no data on population trends	DD	20
Northern Ridge-tailed Monitor <i>Varanus primordius</i>		NT	
Spotted Tree Monitor <i>Varanus scalaris</i>	Limited historic or current data on distribution in Kakadu; no data on population trends	DD	10

Green Tree Snake <i>Dendrelaphis punctulata</i>	Limited historic or current data on distribution in Kakadu; no data on population trends	DD	11
Northern Carpet Python <i>Morelia spilota</i>	Limited historic or current data on distribution in Kakadu; no data on population trends. Population declines documented in part of range (Brown <i>et al.</i> 2013). Likely to be adversely affected by inappropriate fire regimes. Potentially affected by mammal decline	LC	4
Olive Whip Snake <i>Demansia olivacea</i>		DD	
Narrow-banded Northern Bandy-bandy <i>Vermicella multifasciata</i>		DD	
King Brown Snake <i>Pseudechis australis</i>	Declined throughout Top End; population declines documented in part of range preceding Cane Toad arrival (Brown <i>et al.</i> 2013). Potentially affected by mammal decline.	NT	16
Western Brown Snake <i>Pseudonaja nuchalis</i>	Limited historic or current data, but other large Elapid snakes have declined	LC	4
Taipan <i>Oxyuranus scutellatus</i>	Limited historic or current data, but other large Elapid snakes have declined. Potentially affected by mammal decline	DD	2
Stone Country Death Adder <i>Acanthophis</i> sp. nov.	Limited historic or current data; declines reported in congeneric species. Likely to be adversely affected by inappropriate fire regimes. Potentially affected by mammal decline		2
Pig-nosed Turtle <i>Carettochelys insculpta</i>	Limited historic or current data on distribution in Kakadu; no data on population trends	NT	1
Sandstone Long-necked Turtle <i>Chelodina burrungandjii</i>	Limited historic or current data on distribution in Kakadu; no data on population trends	DD	0

6.3 Characteristics and Trends

Relatively few of the threatened or data-deficient reptile species are considered habitat specialists; five species are restricted to the sandstone escarpment; four are strongly associated with streams and permanent waterbodies; and one species, the Yellow-snouted Gecko, has an association with particular soils and fire regimes. The remaining species have relatively generalized habitat associations but are typically associated with floodplains and lowland woodlands.

The threatened or data-deficient species comprise most of the large reptiles in the Park, including all the large elapid snakes and monitors, and the largest python. These species make up a large component of the terrestrial predator community and their decline may have significant adverse ecological consequences. Evidence already exists that reduction of some of these predators has resulted in meso-predator release of other species, including several colubrid snake species (Doody et al. 2013, Brown et al. 2013), with as yet unknown knock-on effects on smaller vertebrates down the food chain.

In some cases declines are very clearly linked to specific threats, such as poisoning from ingestion of Cane Toads in the case of monitor lizards, elapid snakes and Blue-tongue Lizards. These species comprise most of the habitat generalists that have declined. Many of these declines were predicted before the arrival of toads (Smith & Phillips 2006), and populations of most of these species may recover in time through natural selection of toad avoidance (Woinarski et al. 2007). However, the rate, magnitude and geographical pattern of recoveries is unknown, and is conditional on the persistence of viable populations, and the particular life history, ecological and behavioural characteristics of species. Other factors may also be contributing to the decline of some of these species; for instance there is some evidence that declines of the King Brown Snake commenced prior to arrival of Toads (Brown et al. 2013), possibly in response to mammal declines.

In many cases, such as with the Oenpelli Python, Arnhem Land Rock Skink and some data-deficient species, the nature of declines (magnitude and/or cause) is unclear. This reflects firstly, major knowledge gaps in our understanding of the past and present distribution of these species, and how these relate to extraneous environmental factors; and secondly, the presence of several contrasting potential threatening processes operating in the Park, including: inappropriate fire regimes; introduced predators and resultant changes in prey base; and potentially complex interactions and cascading ecological effects of these processes.

Compared with mammal and bird species, information on population trends for many of the reptile and frog species in Kakadu is poor. The existing general fauna fire plot monitoring program has provided reasonable data for many small reptile species in Kakadu; however, this monitoring has been inadequate for large predatory species that occur at low densities (e.g. large snake and monitor species), rare or patchily distributed species, and frogs and other species with highly variable activity patterns. Consequently, apart from specific targeted studies on selected species, such as monitors (Griffiths & Holland 2004), information on population trends for most large reptile and frog species is very poor. A consequence of this is that declines of some species will be detected much later than when they become in trouble.

6.4 Current Management and Management Requirements

The paucity of knowledge of distribution and current population status and trends of most threatened and data-deficient reptile species means that there is less certainty about their conservation status compared with mammals. Consequently more species may be threatened than current information suggests.

Compared with the information available for mammals, there is relatively limited existing knowledge of the ecology of many threatened and data-deficient reptile species in Kakadu. Whilst some inferences can be made from studies of congeneric species from other regions, this is limited for some endemic species that lack ecological analogues, such as Oenpelli Pythons. Furthermore, for the most part our knowledge of relationships between threats and species is poor, limiting the development of targeted management actions. None of the EPBCA listed threatened species have recovery plans.

For species whose status in Kakadu is poorly resolved, there is a priority to clarify that status (particularly in relation to threats), through targeted surveys. Furthermore, systems are required for better capture and management of information informally gathered on rare or cryptic species by Park Staff, visiting researchers and members of the public, as this is a valuable source of baseline distributional data for some threatened and data-deficient species.

Carefully designed monitoring programs, complementing existing biodiversity monitoring programs, are required to evaluate population trends of potentially declining species, as well as those that may recover after Cane Toads. Targeted research is required to improve knowledge of impacts of other key threatening processes on threatened species, in particular fire and feral cats, and how to manage them.

Currently no management initiatives are available to mitigate the impacts of Cane Toads, because the technology does not exist to eradicate or suppress toad populations in any part of the Park. Apart from allowing natural evolutionary processes to operate on extant populations of effected species, management should be focussed on other, more pervasive threats, where intervention may be effective and beneficial.

As for mammals, there is a high priority across species to manage fire in a manner that more effectively targets increased retention of longer-unburnt woodlands. For some species, there is a high priority to control feral cats. The nature of these threats, the types of species adversely affected and the nature of the environment under management means that an adaptive experimental approach needs to be adopted. This approach will enable structured management intervention to be undertaken, coupled with tightly-focused monitoring to assess its effectiveness.

The challenges posed by the targeted management of fire and feral cats means that intervention is likely to be most effective in localised areas. The most beneficial outcomes will be achieved at sites that hold significant populations of particular threatened species. Such sites need to be identified across taxonomic groups.

As with mammals, we note that integration of actions across species, and ongoing review and refinement of conservation efforts, would be substantially facilitated by the establishment of a Recovery Team or analogous advisory group.

Furthermore, we recommend that annual reporting for Kakadu NP should include consistent indices that measure trends for threatened reptile species and the mitigation of their threats.

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