Gnangara Sustainability Strategy

An across-government initiative

Groundwater – Biodiversity – Land use

REPTILE FAUNA OF THE GNANGARA SUSTAINABILITY STRATEGY STUDY AREA: A LITERATURE REVIEW

Natalia Huang

Department of Environment and Conservation

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GOVERNMENT OF WESTERN AUSTRALIA

Department of Water
Department of Agriculture and Food WA
Department for Planning and Infrastructure
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Natalia Huang

Department of Environment and Conservation

Government of Western Australia
Department of Environment and Conservation

Gnangara Sustainability Strategy Taskforce
Department of Water
168 St Georges Terrace
Perth Western Australia 6000
Telephone +61 8 6364 7600
Facsimile +61 8 6364 7601
www.gnangara.water.wa.gov.au

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Executive Summary

The Gnangara Sustainability Strategy (GSS) study area is located on the northern Swan Coastal Plain (NSCP) which is well-known for its diversity of terrestrial reptile taxa. A comprehensive survey by the Western Australian Museum (Storr *et al.* 1978) found the NSCP to support 34 reptile genera and 57 species. Records of additional species and new taxonomic rankings have now indicated that the NSCP support the relatively rich reptile fauna of 39 genera and 63 species, consisting of 2 turtles, 8 geckos, 8 pygopods, 2 dragons, 3 goannas, 20 skinks, 4 blind snakes, 2 pythons and 14 elapid snakes. The fauna include species restricted to the Swan Coastal Plain and toward the limits of their distribution, and many are widespread southwest endemics.

The NSCP is composed of a variety of habitats made up of different landform units and vegetation types. Representatives from each reptile family are known to occur in every habitat on the NSCP, included urbanised areas, with frequent overlapping of species between habitats. The persistence of their high diversity within this wide variety of habitats may demonstrate their resilience to disturbance. Across the landform units (Quindalup, Spearwood and Bassendean dunes), there are only marginal differences in reptile communities as a whole (Storr *et al.* 1978). Any variation in abundance, richness and diversity across the NSCP is likely to be driven by individual species' life history attributes.

There have been few changes to the reptile communities on the NSCP since European settlement. Only one species, Stimson's Python *Antaresia stimsoni stimsoni*, is believed to have become locally extinct from the NSCP (How and Dell 1994). Eleven species have not been recorded since the WA Museum study in 1978, while 5 additional species have since been added to the species list of the NSCP. Most of these species are at the western limits of their distribution and are likely to occur in low numbers on the NSCP which may explain their absence in consequent surveys or in the WA Museum survey.

Six species (*Pseudemydura umbrina, Delma concinna concinna*, *Pletholax gracilis gracilis*, *Rankinia adelaidensis adelaidensis, Hemiergis quadrilineata* and *Neelaps calonotos*) are endemic or largely restricted to the Swan Coastal Plain of WA. The Western Swamp Tortoise, *Pseudemydura umbrina*, is the only species endemic to the NSCP and is known as Australia's most threatened reptile. It is classified as *Critically Endangered* under the IUCN Red List (2008) and WA *Wildlife Conservation Act 1950* and is restricted to the swamps of Ellenbrook Nature Reserve and Twin Swamps Nature Reserve on the eastern side of the GSS study area. The Carpet Python, *Morelia spilota imbricata*, is listed as Schedule 4 under the WA Wildlife Conservation Act and as Priority 4 fauna on the DEC Priority List. The Black-striped Snake, *Neelaps calonotos*, and the Jewelled Ctenotus, *Ctenotus gemmula*, are listed as Priority 3 fauna on the DEC Priority List.

Threatening processes impacting on the reptile communities of the GSS study area may include fragmentation and/or habitat loss from urban development, declining groundwater levels, inappropriate fire regimes or wildfires and *Phytophthora* infection. In general, reptile response to any of these threatening processes is likely to be based on individual life history attributes. Several studies have shown that reptiles are relatively resilient to urbanisation and appear not to react negatively to development, or are at least slow to respond to landscape-level changes (Gardner *et al.* 2007; Jellinek *et al.* 2004; Tait *et al.* 2005). On the NSCP, most reptile species retain healthy viable populations on urban remnants and are not believed to be drastically affected by European settlement (How and Dell 2000).

Declining groundwater levels is likely to impact most severely on wetland-dependent species, such as *Chelodina oblonga*, *P. umbrina*, *Acritoscincus trilineatum*, *Egernia kingii*, *Egernia luctuosa* and *Notechis scutatus*. These species may already be experiencing contracted distribution on the NSCP following the historical draining of wetlands at the time of European settlement (Seddon 1972), and may be in danger of local extinction on the plain if there is further contraction of their wetland-associated habitat.

Short and long-term responses of reptiles to fire can largely be predicted by features of the life history attributes of each individual species (Christensen and Abbott 1989; Friend 1993). Some species may favour the habitat of a recently burnt area, while other species may respond negatively to post-fire habitat. Reptile communities also appear to vary in richness, composition and abundance through various post-fire successional stages as time passes following fire. Several studies have documented or suggested this post-fire successional process, whereby changes in species composition reflect the responses of species to temporal changes within post-fire habitat structure (Bamford 1986; 1995; Braithwaite 1987; Caughley 1985; Letnic *et al.* 2004; Lunney *et al.* 1991; Masters 1996; Means and Campbell 1981; Pianka 1996; Simovich 1979; Trainor and Woinarski 1994).

Finally, the effects of *Phytophthora* infection on reptiles are similarly likely to be related to species habitat preferences. Consequences of infection may include species loss of susceptible flora, reduction in primary productivity and biomass, and degradation to remaining habitat for flora and fauna (Cahill *et al.* 2008; Environment Australia 2001; Hill *et al.* 1994; Shearer *et al.* 2007; Wilson *et al.* 1994). While certain species may exploit the change in vegetation structure, these habitat changes will inevitably impact on the diversity of reptiles in the area. Further study into fauna responses to *Phytophthora* infection on the NSCP is imperative given the high susceptibility of the remnant bushland in the study area and the rapid spread of the pathogen.

Introduction

The Gnangara Sustainability Strategy (GSS) study area covers an area of approximately 2,200 square kilometers on the northern Swan Coastal Plain (NSCP), bounded by Gingin Brook to the north and Ellen Brook to the east. The NSCP experiences a Mediterranean-type climate (Beard 1984), characterised with hot dry summers and cool wet winters. It is broadly composed of longitudinal strips of sands from east to west: the Quindalup, Spearwood and Bassendean landform units. Vegetation complexes on the GSS study area include *Banksia* woodlands (dominated by *Banksia menziesii* and *B. attenuata*), *Melaleuca / Eucalyptus rudis* wetlands and damplands, forests of Jarrah (*Eucalyptus marginata*) and Tuart (*E. gomphocephala*), Proteaceous heathlands and Coastal Scrub.

The NSCP is well known for its diversity of terrestrial reptile taxa (How and Dell 2000; Storr *et al.* 1978). A comprehensive report by the Western Australian Museum (Storr *et al.* 1978) found the northern SCP to support 34 genera and 57 reptile species. Since then, additional species have been found and new taxonomic rankings have now indicated that the NSCP supports a total of 39 genera and 64 species (see Appendix). The fauna include species restricted solely to the Swan Coastal Plain, with several at the northern, southern and western limits of their distribution, and many widespread south west endemics.

The GSS study area includes metropolitan Perth from the Swan River to the north and as such has been exposed to urbanisation pressures and associated disturbance since European settlement. Where other groups, such as the mammalian fauna, have declined widely in the face of such disturbances, including fire, *Phytophthora* infection and weed invasion (see Reaveley 2009), reptiles have been recorded as being generally resilient, appearing to persist in disturbed areas, albeit with altered community composition (How and Dell 2000). Although the reptile communities of the NSCP do not appear to have changed drastically in the past 200 years since European settlement, there has been a marked declined within metropolitan Perth (Storr *et al.* 1978).

Since the comprehensive reptile survey by the WA Museum in 1978, there have been no similar surveys examining reptiles on a landscape scale on the NSCP. Furthermore, there have been few studies examining the impacts of threatening processes on the reptiles of the

GSS study area. The following review examines literature on reptile communities within and adjacent to the GSS study area, referred to as the NSCP. Threatening processes facing these reptile communities, such as fragmentation and habitat loss due to urban development, declining groundwater levels, fire and *Phytophthora* infection are explored.

Historical Studies

A large number of the presently known reptile species were first identified in the 1800s, with a catalogue of lizards and snakes being produced in the 1880s (Boulenger 1885-1887; 1893-1896) .

Key Recent Studies

There have been few historical studies examining the reptile communities across the Swan Coastal Plain. The first large-scale herpetofaunal study was on the northern Swan Coastal Plain in 1977-1978 by the Western Australian (WA) Museum. This reptile inventory carried out by Storr *et al.* (1978) found some 34 reptile genera and 57 species.

The WA Museum study was, and appears to still be, the most comprehensive survey carried out on the northern SCP and has been used widely as a foundation on which future NSCP faunal studies have been based. Consequent surveys have largely examined isolated areas, have targeted particular reptile groups or were carried out over shorter time-frames. Table 1 outlines the key reptile studies carried out on and around the GSS study area from 1975 to present and the reptile species richness recorded by each study. Given the variation in survey technique, it is difficult to glean any real richness changes over time from this table. Any differences in species counts could be due to landscape parameter differences such as landform or vegetation, or indeed to survey area or survey season.

Table 1 Major reptile studies carried out on or adjacent to the northern Swan Coastal Plain from 1975 to present

Author	**Year**	**Study Area**	**Number of Reptile Species**
Jackson *et al.* (for WAM)	(1975)	Mussel Pool, Whiteman Park	22
Storr *et al.* (for WAM)	(1978)	Northern Swan Coastal Plain	57
Friend (DEC data)	1985	Woodvale Nature Reserve	17
Bamford	(1986)	Mooliabeenee Nature Reserve	31
Friend *et al.* (DEC data)	1987	Melaleuca Park	25
Bamford & Bamford	(1990)	Yellagonga Nature Reserve	23
Arnold *et al.*	(1991)	Whiteman Park	22
Watkins *et al.*	(1993)	Ellenbrook Nature Reserve	29
Dept. of CALM	(1993)	Neerabup National Park	15
Success Hill Action Group Inc.	(1999)	Bennett Brook	12
Burbidge *et al.*	(1996)	Boonanarring Nature Reserve	18
Maryan (DEC data)	1996	Melaleuca Park	25
How *et al.*	(1986)	Northern Remnants of the SCP	27
Harvey *et al.*	(1997a)	Trigg Dunes	24
Harvey *et al.*	(1997b)	Shenton Park	17
Ecologia Environmental Consultants	(1997)	Mitchell Freeway	17
Kinhill Pty Ltd.	(1997)	Reid Highway to Maralla Road	31
Drew	(1998)	Whiteman Park	18
How	(1998)	Bold Park	26
Maryan *et al.*	(2002)	Maralla Road	35
Davis (pers comm)	2006	Ioppolo Road	28
Wheeler (DEC data)	2006	Yanchep National Park	15
Davis (pers comm)	2007	Old West Road	17

Reptile Distribution

Many species occurring on the NSCP appear to be contained within their wider distribution (see Appendix). Only 6 species are restricted to the coastal plain: *Pseudemydura umbrina*, *Delma concinna concinna*, *Rankinia adelaidensis adelaidensis*, *Hemiergis quadrilineata*, *Pletholax gracilis gracilis* and *Neelaps calonotos* (Bush *et al.* 2007; Cogger *et al.* 1993; 2003; Storr *et al.* 1978). The only true endemic vertebrate species on the GSS study area and the NSCP is the critically endangered Western Swamp Tortoise, *P. umbrina.* Twenty-three species are limited to the southwest of WA and a further 9 species are widespread WA natives.

The NSCP is considered biologically significant because of its zoogeographic importance to the reptiles of the southwest, the western coastline and Western Australia. Several species are at the northern, southern or western limits of their distribution, occurring on the plain in low numbers; this may explain why certain species were considered scarce or rare on the NSCP by the WA Museum study (Storr *et al.* 1978) or why some have remained elusive in consequent studies. Such species include *Delma concinna concinna* and *Elapognathus coronatus*, which are at the southern and northern limits of their distribution respectively and may not occur in high abundance on the NSCP.

The NSCP is composed of a variety of habitats made up of different landform units and vegetation types, eg. *Banksia* woodland on Bassendean soils, *Melaleuca* wetlands on Spearwood soils, limestone outcrops on Quindalup Dunes. Reptiles are known to occur in every habitat on the NSCP, including the urbanised areas, with frequent overlapping of species between habitats. Most of these reptile species are generalists and are not seen to be restricted to particular landform units or vegetation types, with representatives from each family known to occur across the variety of habitats on the NSCP. Across landform units, from Quindalup dunes in the west to Spearwood dunes then Bassendean dunes in the east, there are only marginal differences in reptile communities as a whole (Storr *et al.* 1978).

Reptile species distribution across habitats is likely to be driven by species' life history attributes. Species that are adapted to running through open spaces, such as dragons, are likely to occur more frequently in open *Banksia* woodlands than in more closed Jarrah forest. Fossorial species and sand-swimming species, such as *Hemiergis quadrilineata*, are likely to prefer the loose sands of the coastal Quindalup dunes. The high number of such skinks on the NSCP may offer an explanation into the general pattern observed during the WA Museum study: that skink diversity was considerably lower in the eastern Bassendean soils compared to Quindalup and Spearwood sands (Storr *et al.* 1978). Conversely, gecko diversity was found to be higher in the western Quindalup dunes than in the eastern areas due to the frequent limestone outcropping (Storr *et al.* 1978), which may reflect their preference for rocky and woodland areas. Other than these two groups, Storr *et al.* (1978) found reptile richness to be relatively even within groups from west to east on the plain.

Several species on the species list outlined in the Appendix have outlying populations on the NSCP, such as the geckos *Crenadactylus ocellatus* and *Underwoodisarus milii*, and the legless lizard *Aprasia pulchella*. These species are widely distributed to the east on the Darling Range and may occur on the eastern edge of the NSCP at the western limit of their distribution.

Changes Over Time

General Patterns

There have been few changes to the reptile composition on the NSCP since European settlement. Reptiles are a hardy, resilient and adaptable group which appear to take environmental alterations in their stride. Any changes to the reptile communities on the NSCP are likely to be in abundance and distribution, both within and between the NSCP and surrounding areas.

It is likely that many reptile species may have declined in abundance and distribution over time as a result of perturbations such as urban development, declining groundwater levels, fire and *Phytophthora* infection. These changes will be discussed in the relevant sections below. Those reptiles remaining in metropolitan Perth are restricted predominantly to the few bushland remnants (How and Dell 1993) or have adapted to living in urban areas. There has been no known establishment of introduced reptiles in the Perth region; all reptiles currently occurring in the GSS study area are within their known distribution.

Stimson's Python, *Antaresia stimsoni stimsoni*, is the only reptile believed to have become locally extinct from the NSCP (How and Dell 1994). .

In the sections that follow, we will examine species which have not been recorded and those that have since been recorded on the NSCP since the WA Museum study in 1978.

Missing Species

Since the WA Museum survey, some 11 species (1 gecko, 2 pygopods, 1 skink, 1 varanid and 6 snakes) have not been recorded in formal surveys on the NSCP (see literature cited above). These include the following: *Underwoodisaurus milii*, *Aprasia pulchella*, *Delma concinna concinna*, *Egernia luctuosa*, *Varanus rosenbergi*, *Elapognathus coronatus*, *Pseudechis australis*, *Pseudonaja nuchalis*, *Demansia psammophis reticulata*, *Antaresia stimsoni stimsoni* and *Ramphotyphlops bituberculatus*. Most of these species predominantly occur on the adjacent Darling Scarp and are likely to occur in low numbers on the NSCP. Indeed urban development may have now forced such species to contract their range so they may now be extinct from the plain. Habitat preferences and distribution are taken from Cogger (2000) and Bush *et al.* (2007).

Underwoodisaurus milii

This species prefers rocky habitat and is abundant on the adjacent Darling Scarp. It was found to be scarce in the WA Museum study. As no recent studies have studied this habitat type, it is likely that this species is still occurring in small patches of rocky limestone caves and outcrops in the western area of the NSCP.

Aprasia pulchella

This species is associated with rocky areas and woodlands and is abundant on the Darling Range. It was found to be scarce in the WA Museum study. There may be small outlying populations close to the scarp on the eastern edge of the NSCP.

Delma concinna concinna

This species is found in coastal sandplains north of Perth. It was found to be scarce in the WA Museum study. Its absence in recent studies may be because the NSCP is at the southern limit of their distribution and thus it may not occur commonly here. As there is still suitable habitat for this species on the NSCP, it is likely that this species is still present in small numbers throughout the plain at present.

Egernia luctuosa

The Glossy Swamp Skink is associated with dense riparian vegetation adjacent to waterbodies. It was found to be scarce in the WA Museum study. Perth may be at the northern limit of its distribution. Rather than indicate local extinction, the lack of *E. luctuosa* from recent survey records is likely to indicate a paucity of wetland surveys. This species is still known to occur on the swampy fringes of Herdsman Lake (M. Bamford, per. obs). However, the contracting number and quality of wetlands is likely to have reduced the abundance and distribution of this wetland-dependent reptile on the NSCP.

Varanus rosenbergi

This species is known from a variety of habitats including woodlands, sandplains and rocky areas. Only one individual has been formally recorded on the NSCP: at Whiteman Park in the east. The NSCP is at the northern limit of its distribution. The large varanid may have declined in abundance on the plain due to urbanisation pressures that have reduced larger prey items (How and Dell 1993). It is likely that its northern equivalent, *Varanus gouldii*, has filled its niche on the NSCP and if it does occur here, it may only be in very low numbers.

Elapognathus coronatus

This species is associated with wetlands, rocky outcrops and woodlands. It was found to be scarce on the NSCP in the WA Museum study. The northern limit of this species' distribution is at Muchea, north of Perth, and as such it would be expected to be persisting on the NSCP. The contraction of wetland habitat in the GSS study area may have reduced its abundance here, while the paucity of studies on rocky and wetland areas may have reduced the opportunities for recording this species.

Pseudechis australis

The Mulga Snake is found in a wide variety of habitats, including urbanised areas, and would be expected to occur on the NSCP with its wide range of habitats. The NSCP may be just outside its distribution, on the southern and western limit, and may not occur commonly on the plain. The WA Museum study suggested the few individuals found on the NSCP were introduced from further north or east. A few individuals have been reported around Bullsbrook to the east (M. Bamford, pers. obs).

Pseudonaja nuchalis

The Gwardar's habitat preferences and distribution are similar to that of the Mulga Snake, except that this species is believed to extend into the Swan Valley on the NSCP. The WA Museum study suggested it is moderately common in the agriculture areas of the plain. It is likely that this species is being out-competed on the NSCP by its southern counterpart, *Pseudonaja affinis affinis*, which is encountered very frequently here.

Demansia psammophis reticulata

This species is found on coastal dunes, sandplains, woodlands and occasionally around rocky outcrops. It was found to be moderately common in western areas but declining in urban areas in the WA Museum study. This species was found in the Mooliabeenee Nature Reserve, adjacent to the NSCP (Bamford 1986). It appears that this species is still prevalent across the NSCP and failure by recent studies to capture this species cannot be explained.

Antaresia stimsoni stimsoni

Stimson's Python is known to occur in rocky areas, creeks and urban areas. It was found to be scarce in the WA Museum study and restricted to areas in the east and Tuart habitat in the west. The NSCP is at the southern and western limit of its distribution and it may occur infrequently here. How and Dell (1994) believe that this species has become locally extinct and no longer occurs on the NSCP.

Ramphotyphlops bituberculatus

This blind snake has similar habitat preferences to other blind snakes, preferring coastal dunes, rocky areas, sandplains and woodlands, and is mostly fossorial. The lack of captures in consequent studies of this species may reflect its tendency to emerge under particular weather conditions such as post-rain in summer. It is more likely that this species is uncommon on the NSCP as this is the western limit of its distribution.

Additional Species

Since the WA Museum Survey, 5 species have been added to the list of species known to occur on the NSCP. Note that the then *Strophurus spinigerus* has now been split into the two subspecies *Strophurus spinigerus inornatus* and *Strophurus spinigerus spinigerus*, so is not included in this count. These include *Diplodactylus granariensis granariensis, Lerista christinae, Parasuta nigriceps*, *Ramphotyphlops pinguis* and *R. waitii*. Most of these species are on the limits of their distribution on the NSCP and may not have been recorded during the WA Museum study due to their low numbers and/or the restricted survey areas. Rather than since colonising the NSCP, it is likely that these species were always on or close to the NSCP to some extent. Habitat preferences and distribution are taken from Cogger (2000) and Bush *et al.* (2007).

Diplodactylus granariensis granariensis

This species prefers rocky areas and woodlands. Two specimens from Subiaco and Wanneroo are recorded on the WA Museum database. It is not believed to occur on the Swan Coastal Plain and these specimens may be introduced rather than reflecting a real local population.

Lerista christinae

This species is known from sandplains with and without *Banksia*. It was been recorded to the east at Ellenbrook (Watkins *et al.* 1993; WA Museum Specimen Database), WA Museum Specimen Database) and Ioppolo Road (Davis, pers. comm.), to the southeast at Maralla Road (Maryan *et al.* 2002) and at Mooliabeenee Nature Reserve (Bamford 1986), which is adjacent to the NSCP. It is likely that this species occurs on the NSCP but in low numbers.

Parasuta nigriceps

This species prefers rocky areas, sandplains and woodlands. It has been recorded from Wanneroo, Whiteman Park and at Muchea (WA Museum Specimen Database). Its distribution extends north and south of the Swan Coastal Plain and thus is expected to occur on the NSCP.

Ramphotyphlops pinguis

This species is fossorial and prefers sandy or rocky areas and woodlands. The NSCP is at the western limit of its distribution. One individual has been recorded from Yanchep. It may occur on the plain in low abundances.

Ramphotyphlops waitii

This species has the same habitat preferences as *R. pinguis*. The NSCP is on the western and southern limits of its distribution. One specimen was recorded from Ellenbrook, with more found to the east of the NSCP. It may occur on the plain in low abundances.

Threatened Taxa

Threatened reptile taxa can be classified as such under several acts or lists. The International Union for Conservation of Nature (IUCN) maintains the IUCN Red List (2008), a threatened fauna list for the world. At the Australian Federal government level, the Department of the Environment, Water, Heritage and the Arts maintains the Environment Protection and Biodiversity Conservation (EPBC) Act *2008* which details a list of threatened fauna for Australia. The WA government maintains the WA *Wildlife Conservation Act 195*0, which lists fauna species under Schedules based on their threatened status, while the DEC maintains a Priority list which applies priority management to certain species that are poorly known and/or conservation dependent. The Australian Action Plan by Cogger *et al.* (1993) offers some threatened levels to reptiles of Australia based on these lists at that time. Table 2 outlines species on the NSCP that are listed under any of these acts or lists.

There is only one terrestrial reptile species occurring on the NSCP that is listed under all of the above acts and lists. The Western Swamp Tortoise, *Pseudemydura umbrina*, is listed as *Critically Endangered* by the IUCN (2008), the EPBC *Act 1999*, the DEC Priority List and in Cogger *et al.* (1993). The *Wildlife Conservation Act 1950* lists this species under Schedule 1: rare or with likelihood of becoming extinct and in need of special protection. It is restricted to the swamps of Ellenbrook and Twin Swamps, an area of just 228 Ha (Burbidge and Kuchling 2004), making it the world's most area-restricted species. It is

Australia's most endangered reptile (Cogger 2000) and is now subject to an intensive conservation program.

Under Schedule 4 of the Wildlife Conservation Act, the Carpet Python, *Morelia spilota imbricata*, is listed as a Specially Protected Fauna, and is known to occur on the Swan Coastal Plain. It is listed as a Priority 4 species by the DEC (Priority 4 species include taxa in need of monitoring) and is also considered *Vulnerable* by Cogger *et al.* (1993).

The elapid *Neelaps calonotos* is listed by the DEC as a Priority 3 species, which means it is a taxa with several, poorly known populations, some on conservation lands, and is considered to be *Endangered* by Cogger *et al.* (1993). The Swan Coastal Plain population of *Ctenotus gemmula* is also listed by the DEC as a Priority 3 species.

Table 2. Threatened reptile species on the northern SCP and their conservation status assigned by the IUCN Red List (2008), the EPBC Act 1999, the WA *Wildlife Conservation Act 1950* and the Threatened and Priority List as maintained by the DEC. CE – Critically Endangered; S1 – Schedule One: Rare or with a likelihood of becoming extinct; S4 – Schedule Four: Specially Protected Fauna; P# – Priority Number on the DEC Priority List.

Species	**Common Name**	**IUCN Red List (2008)**	**EPBC Act 1999**	**WA Wildlife Conservation Act 2008**	**DEC Priority List**
Pseudemydura umbrina	Western Swamp Tortoise	CE	CE	S1	CE
Morelia spilota imbricata	Carpet Python			S4	P4
Ctenotus gemmula	Jewelled Ctenotus				P3
Neelaps calonotos	Black-Striped Snake				P3

Threatening Processes

There has been no known reptile extinction in Australia since 1788 (Cogger *et al.* 1993). The resilience and physiology of reptiles appears to aid their survival and persistence in ever-changing landscapes in the face of habitat modification around Australia.

The most threatened species on the NSCP is the Western Swamp Tortoise, as discussed above. Suitable habitat has been significantly reduced by agriculture, alteration to drainage patterns, urbanisation processes such as housing development, and reduced rainfall recharge to its required wetland habitat. Both introduced and native predators have undoubtedly impacted on the abundance of this reptile.

The threatened Carpet Python is believed to be highly adaptive to a diversity of habitats (Pearson *et al.* 2005). The decreased abundance of this species on the NSCP may be attributed to the progressive historical loss of mammal prey and protected refuge sites (Pearson *et al.* 2005). Carpet Pythons are generally thought to be flexible and use a wide range of habitat types and prey taxa (Shine 1994; Shine and Fitzgerald 1996). However, the southwestern species, *Morelia spilota imbricata*, has declined in abundance in much of its historic range in southwest WA and is now rarely recorded on the NSCP (Pearson 1993; Smith 1981). Pearson *et al.* (2005) suggest this decline may be due to the loss of suitable shelter from where they can ambush prey and brood their eggs. Similarly, (Webb and Shine 1998) found that among snakes, large ambush predators may be at most risk to habitat destruction and fragmentation. This is because such species utilise vegetation structure for concealment from potential prey and predators. (Reed and Shine 2002) found even minor changes in habitat to have serious effects on their population viability.

The priority listed fossorial reptile *N. calonotos* is restricted to deep sands of coastal heaths and low shrubland on the Swan Coastal Plain, feeding on lizards, mostly of the burrowing skink genus *Lerista* (Cogger 2000). Threatening processes facing this species are likely to be dominated by habitat fragmentation and loss due to the ongoing development taking place across the plain. As the small fossorial skinks it feeds on are often more abundant in long unburnt areas due to increased suitable habitat such as leaf litter, it is likely that the Black-striped Snake may be detrimentally affected by inappropriate fire regimes or wildfire as prey abundance contracts or suitable habitat decreases. Habitat fragmentation is also likely to be the driving threatening process facing the priority listed skink, *Ctenotus gemmula* (Swan Coastal Plain population). This population is restricted to the coastal heaths of the sandplains which is under threat from urban development.

Weed invasion may impact on faunal groups as floristic composition and vegetation structure are adversely altered. However, there has been a lack of studies examining the impact of weeds on reptile taxa. In general, it is thought that reptiles may respond to vegetation structure more so than floristic composition, so any reptile responses to weeds may be attributed to structural changes. The additional structural elements that weeds often provide may impact some reptile species but may in fact benefit others, depending on individual life histories.

Threatening processes facing the reptile community of the NSCP are likely to be dominated by continued urban expansion resulting in further fragmentation and loss of habitat. Declining groundwater levels due to water extraction and declining rainfall recharge may result in changes to soil moisture levels and vegetation complexes/structure and resultant reptile communities. Wildfire or inappropriate prescribed burning regimes may result in reduced optimum habitat, or may in some cases result in increased suitable reptilian habitat. The introduction of *Phytophthora* infection into areas may impact on habitat structure and floristics and lead to loss of productivity and resources. Predation and competitive pressure from introduced fauna may also be a contributing factor but is not explored here. Reptile response to these threatening processes will be discussed in the following sections.

Fragmentation/Habitat Loss due to Urbanisation

Fragmentation and habitat loss due to urban development may elicit a range of responses from faunal communities, which are likely to be based on individual life history attributes. Certain species may be able to adapt to an urban environment and persist or flourish within the new or contracted habitat, while other species may be detrimentally affected by the loss of their original habitat. Around Australia, several studies have shown that reptiles are relatively resilient to urbanisation and appear not to react negatively to development, or are at least slow to respond to landscape-level changes (Gardner *et al.* 2007; Jellinek *et al.* 2004; Tait *et al.* 2005).

Reptiles that respond negatively to fragmentation from development are likely to have more specialized life histories. For example, large wide-ranging reptiles such as goannas and snakes which require large amounts of prey and large home ranges have been reported as being the most detrimentally impacted reptile species in Perth as a result of urbanisation (Cooper 1995; How and Dell 1994; 2000). Storr *et al.* (1978) suggested that most reptile species did not persist in urban developed and intensive agricultural areas. On the NSCP, species that are adapted for and restricted to sandy soils such as the pygopods and fossorial reptiles, may be most detrimentally-affected by the proposed coastal urban expansion and consequent habitat loss on the plain. For example, *Pletholax gracilis gracilis* is dependent on *Banksia*-Eucalyptus woodlands or heaths on sandy soils (Wilson and Knowles 1988) and the reduction of this habitat on the NSCP due to human development has lead to a decline in the range of this legless lizard in the Perth region (Shea and Peterson 1993). How and Shine (1999) found small fossorial snakes to be more at risk from urbanisation than other reptile species. These included the Black-naped Snake *Neelaps bimaculatus,* the Black-striped Snake *Neelaps calonotos* and Jan's Banded Snake *Simoselaps bertholdi*. Such species are particularly susceptible to predation and dessication, and are poorly suited to moving long distances above ground or on hard surfaces such as concrete or roads (How and Shine 1999).

Another group of reptiles likely to be impacted by urban encroachment on the NSCP is the wetland-associated species. After European settlement, most wetlands on the NSCP were drained or reclaimed for urban development and horticulture (Seddon 1972). This is likely to have contracted the abundance and occurrence of species that are reliant on wetlands, including *Chelodina oblonga*, *Pseudemydura umbrina*, *Acritoscincus trilineatum*, *Egernia kingii*, *Egernia luctuosa*, *Notechis scutatus* and several other species which extend their range into wetland-type habitats. Further discussion on wetland-dependant species response to habitat loss reduction will take place in the following section.

As urbanisation encroaches on bushland, some reptiles may survive or thrive within the newly urbanised areas or within urban bush remnants. In urbanised areas, such species may utilise new habitats such as backyard gardens or road verges, and expand their diets to include food scraps or feral pests such as mice. The Dugite (*Pseudonaja affinis affinis*) has, to some degree, been favoured by urbanisation and is now common in urban bushland remnants and fringes of metropolitan areas due to preying on house mice (How and Dell 1993). The Bobtail (*Tiliqua rugosa rugosa*) has also thrived in urbanised area due to its ability to consume introduced plants as part of its diet (How and Dell 1993). The Marbled Gecko (*Christinus marmoratus)* and the Fence Skink (*Cryptoblepharus buchananii*) also appear to adapt well to urban environs and are often sighted in suburban backyards.

Urban bush remnants can provide an important refuge to reptile communities on the NSCP. Of seventeen remnants surveyed by How and Dell (1994), 40% of lizard species recorded in their surveys were known from just three or less remnants. These were often remnants in outer metropolitan Perth, where there were fewer urbanisation pressures. In general, it is believed that reptiles will occur in greater numbers on larger remnants of vegetation than in small remnants (How and Dell 1994; 2000). In these large remnants, it has been found that skinks are the most numerous and diverse of the subgroups, with remnants as small as four hectares retaining important reptile communities (How and Dell 2000). Snake species diversity has also been found to correlate positively with bushland area. Most reptile species retain viable populations on urban remnants and are not believed to be drastically affected by European settlement (How and Dell 2000), which is likely to be a reflection of their diverse life histories. For example, insectivorous reptile species may still exist because they hibernate for much of the year and have sufficient resources for survival, whereas insectivorous mammals (which are locally extinct, see Reaveley 2009) which were active throughout the year may not cope with the diminished resources associated with urbanization. Reptile communities in several urban bushland remnants of the NSCP are briefly examined here.

Isolated Bushland Remnants

Fragmentation due to urbanisation has led to a range of isolated bushland remnants within the metropolitan region of Perth on the NSCP. These include remnants such as Kings Park in the central district, Bold Park in the west and Whiteman Park to the east. Such studies, including those by Turpin (1990) and Cooper (1995) in small isolated bush remnants in Perth, suggest that reptiles are somewhat resilient to urbanisation and are not particularly diminished with smaller remnant sizes.

The reptile fauna of Bold Park is the richest remnant community recorded in the Perth Metropolitan region, with 29 species sampled in the 300 ha reserve (How 1998; How and Dell 1989). Observations of the large goanna species such as *Varanus rosenbergi* and *V. gouldii* were recorded as well as more uncommon species such as the Carpet Python, the gecko *Diplodactylus alboguttatus* and the skink *Morethia lineocellata.* All 5 species of burrowing snake known on the NSCP are found in Bold Park, including the priority-listed *Neelaps calonotos* (How and Dell 2000). In the similar-sized reserve of Kings Park, 20 reptile species have been recorded; further study is likely to reveal additional species in this native intact bushland.

A total of 32 species of reptiles were recorded in the considerably larger area of native vegetation within Whiteman Park. The south eastern portion of the GSS area around Ellenbrook and Maralla is also relatively species rich (Maryan *et al.* 2002; Watkins *et al.* 1993). Two nature reserves outside the north eastern GSS zone boundary, Mooliabeenee and Boonanarring Nature Reserves, also have a high species richness with the composition being similar to the community on the NSCP. A small urban remnant of bushland at the Karrakatta Cemetery near Perth was found to be home to a population of *Varanus gouldii* (Thompson 1992). The study suggested that small areas of suitable habitat in urban areas had the capacity to support this species, although some individuals may range farther.

Decline in Groundwater levels

For the greater community of reptiles, it is likely that the main response to the declining groundwater levels will be indirect, with responses likely to be related to individual life histories and reflecting changes in vegetation structure as vegetation communities become more xeric. A drop in groundwater levels is believed to be able to cause changes in the vegetation continuum along the soil-moisture gradient, changes in floristic composition, weed invasion and loss of wetland-associated floral species (Havel 1975). Micro habitat characteristics, whereby moisture levels are altered, may impact on the availability of suitable hibernation, refuge and breeding sites. Changes in reptile communities, if any, are likely to be in species composition, as changing habitats complement a different suite of life histories. In some cases, declining groundwater levels may benefit certain reptile communities. For example, there are several areas in the study area which have experienced gradual terrestrialisation as bore abstraction takes places, such that the once swampy *Melaleuca* wetland is now characterised by *Banksia* woodlands and grass trees. Reptile communities in such area are likely to be changing to complement a suite of species favouring woodlands rather than wetlands. It is expected that further terrestrialisation may attract additional *Banksia*-associated species into the area, increasing local reptile diversity to a range higher than is typical of an inundated wetland.

For the other more wetland-associated or dependent reptiles, declining groundwater levels is likely to have a detrimental impact on their occurrence, distribution and abundance on the NSCP. As mentioned in the previous section, most wetlands on the NSCP were drained or reclaimed for urban development and horticulture at the time of European settlement (Seddon 1972). Since then, groundwater abstraction has taken place at an unprecedented rate to meet urban demands. Recently, declining rainfall and further aquifer abstraction has led to declining groundwater levels (Yesertener 2007). There is also evidence that lake systems are being converted to swampy flats, and seasonal wetlands are drying with some becoming acidic (Froend *et al.* 2004a; Froend *et al.* 2004b; Froend *et al.* 2004c; Pettit *et al.* 2007). With the quantity and quality of wetlands diminishing rapidly, species that are reliant on such ecosystems are likely to respond negatively to declining groundwater levels.

Upon examination of individual life histories of reptiles of the NSCP, approximately 15% of the 63 known species require wetlands or wetland-associated vegetation as habitat. Species mostly likely to be under threat from declining groundwater levels include the turtles *Chelodina oblonga* and *Pseudemydura umbrina*, the skinks *Egernia luctuosa* and *Acritoscincus trilineatum*, and the Tiger Snake, *Notechus scutatus*. As the NSCP has been experiencing declining groundwater levels and wetland contraction for nearly 200 years, it is likely that these species have already contracted in abundance and occurrence on the plain. The continued drop in groundwater levels will probably impact on already diminished habitat opportunities for these species.

The Oblong Turtle, *C. oblonga*, is widespread in permanent freshwater lakes, rivers and seasonal swamps. Its reliance on permanent and seasonal waterbodies may mean it will respond negatively to declining groundwater levels as areas with surface water contract. Similarly, the impact of declining surface water levels on the Western Swamp Tortoise, *P. umbrina*, may be devastating to the two small isolated populations that are already facing a precarious future due to habitat loss. It is likely that the Glossy Swamp Skink, *E. luctuosa*, has already declined in abundance and distribution on the NSCP as a result of contracting wetland and dampland habitat. The lack of this skink from recent survey records suggests both a paucity in wetland surveys and a reduced sample population size on the NSCP. It is still known from the swampy riparian vegetation on Herdsman Lake (M. Bamford, pers. comm.). The WA Musuem study of the 1970s found this species to be scarce. Similarly, the dampland inhabitant *Acritoscincus trilineatum* was ranked as "moderately common" in the WA Museum study and may be undergoing a range contraction to a more southern distribution due to wetland loss. The large elapid *N. scutatus* may be detrimentally affected by declining wetland and dampland habitat as it often occurs more frequently in lower-lying areas where dampness and high frog abundance are likely to benefit this species (Maryan *et al.* 2002). Further targeted study into wetland-dependent species is required to better comprehend the impacts of declining groundwater levels on reptiles on the NSCP.

Fire

Fire has been a part of the Australian biota for over 15 million years (Kemp 1981; Singh *et al.* 1981), with Australian flora and fauna co-evolving a suite of attributes particularly suited to this fire-prone environment. Many reptile species currently existing today are believed to have originated and persisted since the late Tertiary (Heatwole 1976). Given this long association with fire, it may be suggested that reptiles are able to survive, or in some cases flourish in frequently burnt environments.

While there have been many studies carried out on the effects of fire on Australian plants (e.g. Christensen and Kimber 1975; Gill 1975) and several studies on the fire responses of birds and small mammals (e.g. Kitchener *et al.* 1978), there are relatively few studies examining the effect of fire on Australian reptile communities, and even fewer in the southwest of WA. In general, the literature that is available suggests that reptile communities are generally resilient to the short-term impacts of fire, but their abundances may change in the long term (Friend 1993).

Short and long-term responses of reptiles to fire are likely to be largely affected by, and can be predicted, by features of the life history attributes of each individual species

(Christensen and Abbott 1989; Friend 1993). These attributes will respond to changes in vegetation structure and composition following each fire.

In general, however, reptile communities, in terms of species richness, have been shown to have high survival rates through fire (Arnold *et al.* 1993; Bamford 1995; Braithwaite 1987; Erwin and Stasiak 1979; Means and Campbell 1981; Patterson 1984) and may exhibit a positive response to fire. Such response may be attributed to favourable changes in vegetation structure and its associations, such as invertebrate availability, which may encourage persistence within and migration into the burnt area. Within Australia, many lizard communities have been observed as having higher richness and abundance in burnt areas than in long unburnt sites (Bamford 1995; Cogger 1969; 1972; Griffin *et al.* 1988; Pianka 1996). Reptiles may in fact prefer recently burnt areas if sheltering, thermoregulatory and foraging opportunities favour their individual attributes. In *Banksia* woodland on the Swan Coastal Plain, Bamford (1986) found the dragon *Rankinia adelaidensis* to be more abundant in recently burnt area than unburnt areas, attributing this response to the absence of leaf litter which increased prey availability. The same study also found burrowing lizards, such as species of *Lerista*, to favour recently burnt areas. Species that occur in low numbers in unburnt areas but prefer open habitats may also preferentially migrate into burnt habitat and reach high numbers in these areas (Pianka 1996).

Conversely, Arnold *et al.* (1993) found some Australian reptiles to preferentially move into unburnt patches in a burnt landscape. As fires often remove the entire leaf litter layer, which provides important shelter and food opportunities for reptiles such as small skinks, such reptiles may be negatively impacted by fires (Dell and How 1995; Mushinsky 1985; 1992; Taylor and Fox 2001; Tolhurst 1996). Even the hardy and mobile goannas have been reported to decrease in abundance following a fire (Newsome *et al.* 1975; Recher *et al.* 1975). Apart from the obvious potential impact of direct mortality, persistence or migration into an area following a fire will similarly depend on individual life history attributes that favour the structure and habitat of a burnt area.

Frequently, however, reptiles exhibit little or no response to fires, particularly low intensity prescribed fires which may cause minimal alterations to the environment. Reptile species richness has been recorded as remaining the same following controlled fires in *Banksia* woodland on the Swan Coastal Plain as the fauna were able to shelter under rocks, in the soil or in trees during the fire (Bamford 1986). Similarly, Huang (2005) found reptiles were not dramatically affected by a severe wildfire and appeared to respond indirectly to fire by responding to changes in vegetation structure and canopy cover instead. If their primary habitat, such as fallen logs and branches, are not significantly altered, reptiles may not be significantly affected by fire (e.g. Tolhurst 1996). Ectothermy may be an adaptation to a fire-prone environment which may permit reptiles to become inactive and stay sheltered for a period following a fire until the vegetation and invertebrates recover (Pianka 1996).

Reptile communities also appear to vary in richness, composition and abundance through various post-fire successional stages as time passes following fire. These stages often result from changes in vegetation structure, as vegetation communities also experience post-fire successional stages. Several studies have documented or suggested this post-fire successional process, as reptile species composition changes, reflecting the responses of species to temporal changes within post-fire habitat structure (Bamford 1986; 1995; Braithwaite 1987; Caughley 1985; Letnic *et al.* 2004; Lunney *et al.* 1991; Masters 1996; Means and Campbell 1981; Pianka 1996; Simovich 1979; Trainor and Woinarski 1994). That is, species may be replaced by other species when the temporal characteristics of the environment no longer favour their particular life history parameters. Often the greatest amount of variation in reptile assemblage occurs in the first few years following fire, with migration playing a key role in repopulating reptile communities in burnt areas (Bamford 1995; Dell and How 1995). Other studies have proposed that reptile response to a fire can be predicted when post-fire vegetation changes are known and when the use of vegetation by each species is understood (Mushinsky and Gibson 1991; Russell *et al.* 1999), that is, when their habitat requirements are known.

Reptile response may also vary depending on the frequency and intensity of the fire, its patchiness, the type of vegetation burnt and the season the fire occurs (Christensen and Abbott 1989; Kikkawa *et al.* 1979).

Fire presents a threat to the critically endangered Western Swamp Tortoise, as wetlands do not recover quickly following an intense wildfire. The DEC has priority intensive management policies in place for the two reserves it inhabits to ensure its survival in the wild. The fossorial snake *N. calonotos*, and the fossorial skink *C. gemmula*, may be impacted negatively by fires if their habitat of leaf litter is removed. They can be expected to have a high survival rate through low intensity fire if they are able to shelter in the soil. The fossorial skink *Hemiergis quadrilineata* has similar habitat requirements and has been found to persist throughout high intensity fires by sheltering in the soil (see Fauna Survey Report by GSS 2009). Fires may be significant to Carpet Pythons as it may remove important shelter and foraging sites, and it may decrease the number of prey available.

Phytophthora infection

Phytophthora cinnamomi is a pathogen that destroys root systems of plants, starving them of food and water. It threatens almost 40 per cent of the South West Botanical Province's flora, representing nearly 2300 species (DEC 1996). Infested areas exhibit significant declines in plant diversity and structure leading to the loss of habitat and food sources for insects and vertebrates. The pathogen is widely distributed in the *Banksia* woodlands of the Swan Coastal Plain (Podger 1968; Shearer 1994), with 44% of the floral species in these areas being susceptible to infection (DEC 1996). Prominent Australian taxa that are susceptible include most of the Proteaceae family (e.g. *Banksia*), some of the Papilionaceae family, and a few of the Myrtaceae (e.g. jarrah *Eucalyptus marginata*) (Shearer *et al.* 2007). As this vegetation complex makes up a large portion of the GSS study area, the potential impacts of this pathogen on plant and faunal communities on the study area can be devastating.

The impacts of *P. cinnamomi* on native vegetation can be severe, leading to major changes of plant community composition, structure and function (Cahill *et al.* 2008; Shearer *et al.* 2007). Consequences of infection may include species loss of susceptible flora, reduction in primary productivity and biomass, and degradation to remaining habitat for flora and fauna (Cahill *et al.* 2008; Environment Australia 2001; Hill *et al.* 1994; Shearer *et al.* 2007; Wilson *et al.* 1994).

This severe vegetation degradation and significant alterations in plant communities associated with *P. cinnamomi* infection are expected to substantially affect fauna through changes to major resources such as food and availability of nesting sites, together with habitat and protective cover (Garkaklis *et al.* 2004; Wilson *et al.* 1994). While there have been some studies investigating the impacts on mammalian taxa and communities, there has been limited research on the impacts of *P. cinnamomi* on birds, reptiles, frogs and invertebrates (Garkaklis *et al.* 2004; Newell 1997; Nichols and Bamford 1985; Nichols and Watkins 1984; Wilson *et al.* 1994).

As with other threatening processes, reptile response to the pathogen is likely to be driven by the life history parameters of each species and their preference for resultant modifications to vegetation structure and composition. A study in *P. cinnamomi*-infested Jarrah forests appeared to support lower abundances of reptiles than healthy forests, whereas some species were more abundant in infected forests (Nichols and Bamford 1985). The increased abundance of some species in diseased areas was attributed to the increased sunlight available for these species which require elevated surfaces, such as logs, for basking and foraging (Nichols and Bamford 1985). If *P. cinnamomi* alters vegetation by creating a more open environment, it can be expected that species which prefer more open habitat may favour such areas.

However, while some species may persist within the altered habitat, it is likely that the slump in productivity and degraded habitat will elicit a negative overall response from reptile communities. Reptile diversity is likely to be lower within infested areas as structural layers are affected and floral diversity declines. As mentioned above, the pathogen is widespread across the NSCP and occurs throughout southwest WA. Given its current and potential widespread impacts, it is imperative that intensive study is carried out examining the short and long-term impacts of *Phytophthora cinnamomi* on reptile (and other faunal) communities on the NSCP (and southwest WA).

The DEC is currently mapping all known occurrences of *Phytophthora* and will continue to monitor and minimise its spread. A GSS Fauna Survey will be commencing in Autumn 2009 in *Phytophthora*-infected areas to examine the fauna communities in these areas versus non-infected areas. The report will be presented in the GSS Fauna Survey Report (Valentine *et al.* 2009).

Appendix

REPTILE SPECIES RECORDED ON THE NORTHERN SWAN COASTAL PLAIN AND THEIR DISTRIBUTION

The table shows reptile species that are known to occur on the northern Swan Coastal Plain, as suggested by literature (key recent studies as outlined above) and through consultation with local experts. Distribution of each species is listed as AUS (occurring within and outside WA), WA (restricted to WA), SW (restricted to southwest WA), SCP (restricted to the Swan Coastal Plain) or NSCP (restricted to the northern SCP).

Species marked with * indicate threatened species; threat status is in brackets (CE - Critically Endangered on IUCN Red List and EPBC Act; S1 – Schedule 1 of WA Wildlife Conservation Act; S2 – Schedule 2 of WA Wildlife Conservation Act; P3 – Priority 3 fauna on DEC Priority List; P4 – Priority 4 fauna on DEC Priority List). [a] indicates species that are endemic to the Swan Coastal Plain. [b] indicates species that are believed to be at direct risk from declining groundwater levels due to their association with wetland-type habitat.

Family	Species	Common Name	AUS	WA	SW	SCP	NSCP
Turtles and Tortoises: Class Reptilia, Order Testudines							
Chelidae	*Chelodina oblonga* [b]	Oblong Turtle			1		
	Pseudemydura umbrina [a, b,] * (CE, S1)	Western Swamp Tortoise					1
Lizards: Order Squamata, Suborder Sauria							
Gekkonidae	*Christinus marmoratus*	Marbled Gecko	1				
	Crenadactylus ocellatus ocellatus	Clawless Gecko			1		
	Diplodactylus alboguttatus	White-Spotted Ground Gecko			1		
	Diplodactylus polyophthalmus	Speckled Stone Gecko			1		
	Diplodactylus granariensis granariensis	Wheatbelt Stone Gecko	1				
	Strophurus spinigerus inornatus	Orange-eyed Southwestern Spiny-tailed Gecko^			1		

Family	Species	Common Name	AUS	WA	SW	SCP	NSCP
	Strophurus spinigerus spinigerus	South-western Spiny-tailed Gecko			1		
	Underwoodisaurus milii	Barking Gecko	1				
Pygopodidae	*Aclys concinna concinna*[a]	West Coast Javelin Lizard^				1	
	Aprasia pulchella	Granite Worm Lizard			1		
	Aprasia repens	Sandplain Worm Lizard			1		
	Delma fraseri fraseri	Fraser's Legless Lizard	1				
	Delma grayii	Gray's Legless Lizard		1			
	Lialis burtonis	Burton's Legless Lizard	1				
	Pletholax gracilis gracilis[a]	Keeled Legless Lizard				1	
	Pygopus lepidopodus	Common Scaly Foot	1				
Agamidae	*Pogona minor minor*	Western Bearded Dragon	1				
	Rankinia adelaidensis adelaidensis[a]	Western Heath Dragon				1	
Varanidae	*Varanus gouldii*	Gould's Monitor	1				
	Varanus rosenbergi	Southern Heath Monitor	1				
	Varanus tristis tristis	Black-tailed Monitor		1			
Scincidae	*Acritoscincus trilineatum* [b]	Southwestern Cool Skink			1		
	Cryptoblepharus plagiocephalus	Fence Skink	1				
	Ctenotus australis	West Coast Long-tailed Ctenotus			1		
	Ctenotus fallens	West Coast Ctenotus^		1			
	Ctenotus gemmula	Jewelled Ctenotus^			1		
	Ctenotus impar	Odd-striped Skink			1		
	Cyclodomorphus celatus	Coastal Slender Bluetongue		1			
	Egernia kingii [b]	King's Skink			1		
	Egernia luctuosa [b]	Glossy Swamp Skink			1		
	Egernia multiscutata	Bull-headed Skink		1			

Family	Species	Common Name	AUS	WA	SW	SCP	NSCP
	Egernia napoleonis	Southwestern Crevice Skink			1		
	Hemiergis quadrilieata[a, b]	Two-toed Earless Skink				1	
	Lerista christinae	Bold-striped Four-toed Lerista^			1		
	Lerista elegans	West Coast Four-toed Lerista		1			
	Lerista lineopunctulata	Line-spotted Robust Lerista^		1			
	Lerista praepedita	West Coast Worm Lerista^			1		
	Menetia greyii	Common Dwarf Skink	1				
	Morethia lineoocellata	West Coast Pale-flecked Morethia^		1			
	Morethia obscura	Southern Pale-flecked Morethia	1				
	Tiliqua occipitalis	Western Bluetongue	1				
	Tiliqua rugosa rugosa	Bobtail	1				
Snakes: Suborder Serpentes							
Typhlopidae	*Ramphotyphlops australis*	Southern Blind Snake	1				
	Ramphotyphlops bituberculatus	Prong-snouted Blind Snake	1				
	Ramphotyphlops pinguis	Fat Blind Snake	1				
	Ramphotyphlops waitii	Beaked Blind Snake		1			
Boidae	*Antaresia stimsoni stimsoni* [b]	Stimson's Python	1				
	Morelia spilota imbricata [b, *] (S4, P4)	Carpet Python			1		
Elapidae	*Brachyurophis fasciolata fasciolata*	Narrow-banded Shovel-nosed Snake		1			
	Brachyurophis semifasciata	Southern Shovel-nosed Snake	1				
	Demanisa psammophis reticulata	Yellow-faced Whip Snake			1		
	Echiopsis curta	Bardick	1				
	Elapognathus coronatus [b]	Crowned Snake			1		
	Neelaps bimaculatus	Black-naped Snake			1		
	Neelaps calonotos[a,*] (P3)	Black-striped Snake				1	

	Notechis scutatus [b]	Tiger Snake			1		
Family	**Species**	**Common Name**	**AUS**	**WA**	**SW**	**SCP**	**NSCP**
	Parasuta gouldii	Gould's Snake			1		
	Parasuta nigriceps	Black-backed Snake	1				
	Pseudechis australis	Mulga Snake	1				
	Pseudonaja nuchalis	Gwardar	1				
	Pseudonaja affinis affinis	Dugite	1				
	Simoselaps bertholdi	Jan's Banded Snake	1				
Total		**64**	**25**	**10**	**23**	**5**	**1**

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