

A black snake with a red eye is perched on a piece of weathered driftwood. The snake's head is raised, and its body is coiled around the wood. The background is a clear blue sky. The driftwood is light-colored and shows signs of weathering and decay.

Are the animals of the
Gnangara Mound north of
Perth declining along with
the groundwater levels?
A new study investigates.

Dry times ahead:

the future for fauna of the Gnangara Mound



by Brent Johnson and Alice Reaveley

Early European settlers arriving at the Swan River Colony were greeted by many new sights, including curious-looking animals unlike anything found in the northern hemisphere. Biologists and collectors of the time recorded many of these animals in an area now known as the Gngangara Mound, north of Perth. Concerningly, many of the animals which once fascinated these newcomers have now disappeared from the mound.

In the 1970s, the Western Australian Museum documented the ecology of the Gngangara Mound to assess the effect of a new groundwater extraction scheme. This resulted in a comprehensive fauna survey and review of the old records. Since then, researchers have conducted many other smaller investigations in the area, usually focused on small reserves, bush fragments, developments and other specific issues. Their common finding? A significant decline in native animals since first settlement.

While there may be many factors contributing to this decline, museum staff and other researchers suspect changes to vegetation and wetland habitats due to a shrinking aquifer to be the major cause.

The Gngangara Sustainability Strategy

The Gngangara Mound groundwater system consists of several different aquifers on the Swan Coastal Plain.



The groundwater system is recharged directly by rainfall and covers approximately 2,200 square kilometres. It underlies suburbs as well as seasonal and permanent wetlands, farmland, pine plantations and extensive areas of native banksia woodlands. It also encompasses the largest areas of contiguous bush on the Swan Coastal Plain, significant threatened species and ecological communities and highly diverse groundwater-dependent ecosystems including wetlands, caves and tumulus mound springs. Importantly, these combined aquifers supply more than 60 per cent of Perth's public water. However, the sustainability of the Gngangara system is under threat because of declining groundwater levels. The decline has been attributed to decreasing rainfall over the past 30 years, increased groundwater extraction for commercial and private use, and water drawn by pine plantations.

In 2007, the state government established a taskforce to develop the *Gngangara Sustainability Strategy* (GSS),

which aimed to ensure sustainable use of water and protection of the environment, and to develop land, environment and water management options to achieve these aims. It was led by the Department of Water, and included representatives from the Department of Agriculture and Food, Department of Environment and Conservation (DEC), the then Department for Planning and Infrastructure, Forest Products Commission, Water Corporation and CSIRO. A team of some 20 technical staff, academics and consultants undertook a range of field studies and reviews between 2007 and 2010. As part of the GSS projects, DEC conducted a number of biodiversity surveys across the Gngangara Mound to determine the current species richness and abundance of ground-dwelling vertebrate fauna and to investigate patterns of their biodiversity.

Mammals discovered

The survey team captured six mammal species across the Gngangara Mound and recorded an additional 10 species by observation. Of the 16 species recorded in total, nine were native to the area and seven were introduced species. Sadly, older historical data suggests up to 33 native mammal species once inhabited the area. The nine native species recorded during the recent surveys included the echidna (*Tachyglossus aculeatus*), honey possum (*Tarsipes rostratus*), bush rat (*Rattus fuscipes*), quenda (*Isodon obesulus fusciventer*), brushtail possum (*Trichosurus vulpecula*), western grey kangaroo (*Macropus fuliginosus*), western brush wallaby (*Macropus irma*), rakali (*Hydromys chrysogaster*) and dunnart (*Sminthopsis* sp.). While the chuditch (*Dasyurus geoffroi*) was not recorded in



Previous page

Main The long-necked turtle is one of the reptile species on the Gngangara Mound that has lost large areas of suitable habitat. Photo - Jiri Lochman

Left Echidnas were one of nine native species recorded on the Gngangara Mound during recent surveys. Photo - Wayne Eddy



this survey, there is substantial evidence that this highly mobile species has an increasing presence on the coastal plain (see 'Spotted surprise: the chuditch comeback', *LANDSCOPE*, Summer 2009–10).

Overall mammal capture rates were low, with honey possums the most consistently captured native mammal species. These were found to be distributed widely across the study area. Quenda were recorded at five of the nine sites that were selectively targeted for this species and rakali were trapped at three lakes. Rakali are semi-aquatic mammals and their survival is critically linked to the persistence of healthy wetland ecosystems (see 'Rakali: the Aussie otter', *LANDSCOPE*, Autumn 2011). Several of the remaining mammal species on the Gngangara Mound are most probably restricted to isolated remnants. In comparison with reptiles, mammals are considered to have less resilience to threats, particularly introduced predators, habitat loss and fragmentation, disease and altered fire regimes.

Resilient reptiles

The GSS survey captured 38 of the 64 recorded reptile species of the Gngangara Mound with most of the remaining species being recorded by other biologists in recent times. Nearly half of the 64 reptile species recorded on the Gngangara Mound are only

found in south-west Western Australia and seven of these are unique to the Swan Coastal Plain. Australia's most threatened reptile, the western swamp tortoise (*Pseudemidura umbrina*), is the only reptile that occurs in the Gngangara Mound study area and nowhere else. It has lost much of its habitat to clearing for agriculture and housing and, as it requires water for part of the year, the reduction in rainfall and declining groundwater in the few suitable areas that remain make existence for this species very tenuous. The long-necked turtle (*Chelodina oblonga*), although not threatened, has also lost large areas of habitat.

Generally reptiles are a very resilient group and extinctions have been rare throughout Australia. The reptile assemblage on the Gngangara Mound is considered relatively intact, although some species have disappeared from some of the smaller fragmented reserves and uncleared areas that remain within the urbanised metropolitan area. The larger predatory reptiles such as the carpet python (*Morelia spilota imbricata*) and goannas (*Varanus* sp.), appear most affected by the changes occurring on the Gngangara Mound, probably by a combination of reduction in available prey and predation by foxes (*Vulpes vulpes*) and feral cats (*Felis catus*).

Different reptile species also have distinct relationships with the varying habitat types and vegetation structures

Above left The south western spiny-tailed gecko is a common inhabitant of the Gngangara Mound.

Photo – Leonie Valentine

Above Honey possums were commonly captured during surveys.

Photo – Alice Reaveley/DEC

that occur on the mound. In the surveys the banksia woodlands and coastal scrub were found to support the most diverse reptile fauna while the thick leaf litter found under tuart trees (*Eucalyptus gomphocephala*) had high numbers of several skink species. The presence of leaf litter and woody debris is largely dictated by the length of time since fire and these areas are important in conserving the biodiversity of bushland. Several species that prefer moist habitat, such as the western glossy swamp egermia (*Egernia luctuosa*), south-western cool skink (*Acritoscincus trilineatum*) and tiger snake (*Notechis scutatus*), have suffered a reduction in distribution throughout the study area.

Much of the Gngangara Mound is very sandy, and an interesting group of small burrowing snakes and legless lizards are present. Many have adapted to living in soft sand by being able to burrow or 'swim' swiftly through the loose soil. Several are insectivores, while some prey on smaller reptiles.



Above The moaning frog can remain underground for several months awaiting rain.

Photo – Leonie Valentine



Left Fire must be carefully managed in a drying environment.

Photo – Alice Reaveley/DEC

The small elapid (meaning ‘front-fanged’) black-striped snake (*Neelaps calonotus*) has the ability to hunt small skinks from under the soil, rising up to the surface to quickly snatch its prey.

Frogs

The previous WA Museum survey recorded 13 species of frog, none of which is considered rare or restricted to the Gngangara area. This study found nine of these species, with the remainder expected to still occur, although there has been a significant reduction in the available habitat for all frog species.

The diminishing number of permanent or near-permanent wetlands on the Gngangara Mound is likely to be having some effect on species such as the quacking frog (*Crinia*

georgiana), slender tree frog (*Litoria adelaidensis*), motorbike frog (*L. moorei*) and pobblebonk frog (*Limnodynastes dorsalis*). With declining rainfall and lower groundwater levels, frog species that rely on seasonal wetlands—such as Glauert’s froglet (*Crinia glauerti*), sandplain froglet (*C. insignifera*), moaning frog (*Heleioporus eyrei*) and Guenther’s toadlet (*Pseudophryne guentheri*)—are more likely to have reduced breeding opportunities. Some, such as the burrowing and long-lived moaning frog, may be present for many years before this lack of breeding becomes obvious when a predominantly adult frog population eventually dies off. With shorter-lived frogs this effect will be noticed much sooner.

Another burrower, the turtle frog (*Myobatrachus gouldii*), does not require water to breed but has already lost much of its sandy banksia woodland habitat from clearing for urban expansion, horticulture and plantations. The pobblebonk frog and moaning

frog spend the non-breeding season in upland woodland habitats and may also have locally declined as a result of this habitat loss.

Most of the species found on the Gngangara Mound are thought to be susceptible to the amphibian chytrid fungus, an infection that has caused the extinction of frog species elsewhere (see ‘Fascinating frogs’, *LANDSCOPE*, Spring 2008). This additional threat casts a darker shadow over frog populations on the Gngangara Mound.

Animal responses to fire

The results of the survey demonstrated that the composition of reptile communities varied among different combinations of vegetation type and the time since fire. Overall reptile abundance, as well as the abundance of some specific species, was higher in long-unburnt sites.

However, in the banksia woodland, reptiles tended to respond in different patterns to time since fire. This indicates that a diverse range of post-fire habitat is necessary to cater for the species-rich reptile fauna. For the mammals, honey possums demonstrated peaks in relative abundance at sites that were 20 to 26 years since the last fire.

Why have the animals gone?

Several threats have been implicated in the extinctions and declines of fauna on the Gngangara Mound. These include habitat clearance and fragmentation as a result of agriculture and urbanisation, changed fire regimes and predation by foxes and feral cats. The impacts of wildlife disease and the plant pathogen *Phytophthora cinnamomi* have also been implicated in the decline of mammal species in WA. Habitat destruction and fragmentation, which began with land clearing during the founding of the Swan River Colony, reduced the extent of native vegetation and systematically broke up the remaining tracts of bush into compartments that were often isolated.

Secondary threats such as fire have become a significant problem due to this fragmentation, with intense or too-frequent fire potentially causing local extinction from an isolated remnant

with no capacity for recolonisation. Habitat loss causes greater competition for the remaining refuge and food resources, and fragmentation provides boundary access for predators and exposure to animals moving between unconnected habitats. Habitat loss has included the draining of many of the lakes, sumplands and damplands on the Swan Coastal Plain.

The water issue

One of the main processes threatening biodiversity on the mound is declining groundwater levels due to climate change, reduced rainfall and increasing groundwater use. The dependence of mammals on groundwater is largely indirect, with the exception of the priority-listed rakali, which is restricted to more permanent wetlands and rivers. Other mammal species rely on the dense vegetation associated with wetlands for shelter. For nectar-feeding species such as honey possums, declining rainfall and a lowering groundwater table may affect the flowering period of banksia species, on which these marsupials primarily feed. Drought stress and the lack of soil moisture may have a significant influence on the duration and abundance of flowering, leading to banksia decline and corresponding declines in honey possum populations.

Overall, declining groundwater levels and reduced rainfall rates are predicted to alter vegetation communities, and subsequent changes may be expected in vegetation cover, floristic composition and productivity. These changes may result in altered microhabitats (for example, thermal properties) and resource availability for fauna (for example, food resources and protection from predators) as well as potentially modified fire regimes. Consequently, declining groundwater levels may indirectly affect all fauna on the Gngangara Mound.

Less rain, more pain?

The purpose of the recent survey was to identify biodiversity values on the Gngangara Mound and to provide a baseline for future work in the area. It appears that long-term reductions in groundwater levels and rainfall have already altered, and will continue to affect, the diversity of habitat above the

Gngangara Mound and most members of the fauna community.

Reducing the pressures of other threatening processes occurring above the mound is also very important. Appropriate burning regimes that consider factors such as years since the last fire, season of burn and proximity to older unburnt vegetation will be crucial for the survival of species and successful recolonisation of recently burnt areas. The coordinated and integrated control and reduction of introduced species, particularly foxes and cats, on both conservation estate and remnant vegetation is also vital.

Major recommendations of the strategy released in 2009 included reducing abstraction of water by 20 per cent, developing additional

desalination plants and injecting treated wastewater and stormwater back into the aquifers. Recommendations for improving the resilience of biodiversity included directing water to high-value wetlands and dependent ecosystems and establishing strategic ecological linkages.

The balance between maintenance of groundwater levels, the health of the environment and a variety of land uses will forever be a difficult and compromising matter for land and water managers on the Gngangara Mound.

Below Yeal Lake following a fuel reduction burn.

Photo - Owen Donovan



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The reports of the Gngangara Mound studies are available at the GSS website accessed via www.water.wa.gov.au.

- 46 Piggyback on a fish: the marsupial freshwater mussel tells its tale
Studies into these little-known creatures reveal, among other things, a tendency for hitchhiking on fish.
- 48 Lessons learned since the Dwellingup fires
Fire management has made huge advances since the early days.
- 56 Dry times ahead: the future for fauna of the Gngangara Mound
New work investigates whether the animals of this area near Perth are declining along with the groundwater.

Regulars

- 3 Contributors and Editor's letter
- 9 Bookmarks
Beyond the Edge
Tempered by Fire
Exploring Western Australia's natural wonders: national, marine and regional parks
- 30 Feature park
Geikie Gorge National Park
- 45 Endangered
Shrublands on dry clay flats
- 62 Urban Antics
Eucalypts ...

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23



35



48



10