The international Association of Zoos and Aquariums has declared this year the **'Year of the Frog'** to highlight the plight of frog species. Many frog populations across the globe are threatened with extinction. But what is causing their decline and how are we helping them to retain their tentative grip on life?

Fascinating frogs

by Samille Mitchell

Some people believe our planet could be facing the single biggest mass extinction since the disappearance of the dinosaurs. But this extinction doesn't affect frightening, reptilian giants. It targets amphibians—charismatic frogs that delight with their weird and wonderful traits and often wild designs.

After thriving for more than 360 million years, these animals are under threat. One third to one half of the 6,000 amphibian species across the world are considered by some to be at risk of becoming extinct in our lifetime. Australia is no exception. With 219 species across the country, we have one of the most diverse frog populations in the world. Of these species, 93 per cent are endemic to Australia and 27 per cent are threatened with extinction. Four are already believed extinct and at least 16 species are now ranked as endangered or critically endangered. In Western Australia we have 77 frog species, of which three are on State and national threatened species lists.

This extinction rate is the worst for any vertebrate species in the world—worse than birds listed as 12 per cent and mammals at 23 per cent. Their loss is not only devastating for humans who marvel at their colours and form. In the words of Amphibian Ark chairman Jeffrey Bonner:

> "Widespread extinction of amphibians would be catastrophic. In addition to their intrinsic value, they offer many benefits and are a critical part of a healthy world. They play an important role in the food web as both prey and predator, eating insects which benefits agriculture and minimises disease spread. Their skin also has substances that protect them from some microbes and viruses, offering promising medical cures for a variety of human diseases."

What's to blame?

Many people regard frogs as an 'indicator' species. Their permeable skin means they may be among the first species to suffer from environmental threats like air pollution. Like most other species, frogs are also vulnerable to habitat loss, introduced animal invasion, pesticides and climate change. In WA, the drought which has gripped many areas of the State is drying up many frog habitats. But some fear the biggest single threat facing frog species across the world is an infectious disease called chytridiomycosis, which is caused by chytrid fungus (*Batrachochytrium dendrobatidis*).

Chytrid fungus was discovered in frogs in the mid 1980s (see 'In pursuit of the frog fungus', *LANDSCOPE*, Autumn 2001). While intensive research into the fungus followed, researchers don't yet fully understand how chytrid fungus kills frogs, other than to know it damages their skin by attacking the keratin layer.

Previous page
Main Motorbike frog (*Litoria moorei*).
Photo – Jiri Lochman
Inset Cave dwelling frog (*Litoria cavernicola*).
Photo – Barry Baker

Above The sharp-snouted day frog (*Taudactylus acutirostris*) is believed extinct.
Photo – Stanley Breeden/Lochman Transparencies

Below The magnificient tree frog (*Litoria splendida*) occurs in the Kimberley.
Photo – Jiri Lochman

So how did this fungus start to affect frog populations? It is believed to have spread from Africa in the 1930s when African clawed frogs (*Xenopus laevis*), which are resistant carriers of the fungus, were shipped across the world for use in human pregnancy tests and laboratory studies. A pregnant women's urine would induce ovulation in the frogs and therefore indicate pregnancy. This species is thought to have inadvertently spread the fungus across the globe. The introduction of frog species to new environments and the aquarium and commercial trade may also have contributed to the spread of the disease. It moves at rates of one to 280 kilometres a year. Now the fungus has invaded frog populations across the globe.

The disease is largely unstoppable and untreatable in the wild. The International Union for the Conservation of Nature (IUCN) rates it as the worst infectious disease ever recorded among vertebrates in terms of the number of species impacted and its potential to drive them to extinction. It can wipe out 80 per cent of native amphibians within months. In some populations only a few frogs die, in others 100 per cent of the population is destroyed. What's worse, climate change may exacerbate the problem. As warmer temperatures dry moist areas where most frogs thrive, increased stress can leave frogs more susceptible to the disease.

While some species are highly susceptible and die quickly, others seem to be able to handle an invasion. Several species in Queensland affected by chytrid fungus were killed at high altitudes but those sites are now being reinvaded by frogs from resistant lowland populations.

Even so, dozens of frog species are thought to have already succumbed to the disease—never again to delight onlookers with their form or play their vital role in nature's intricate web of life.

The situation in WA

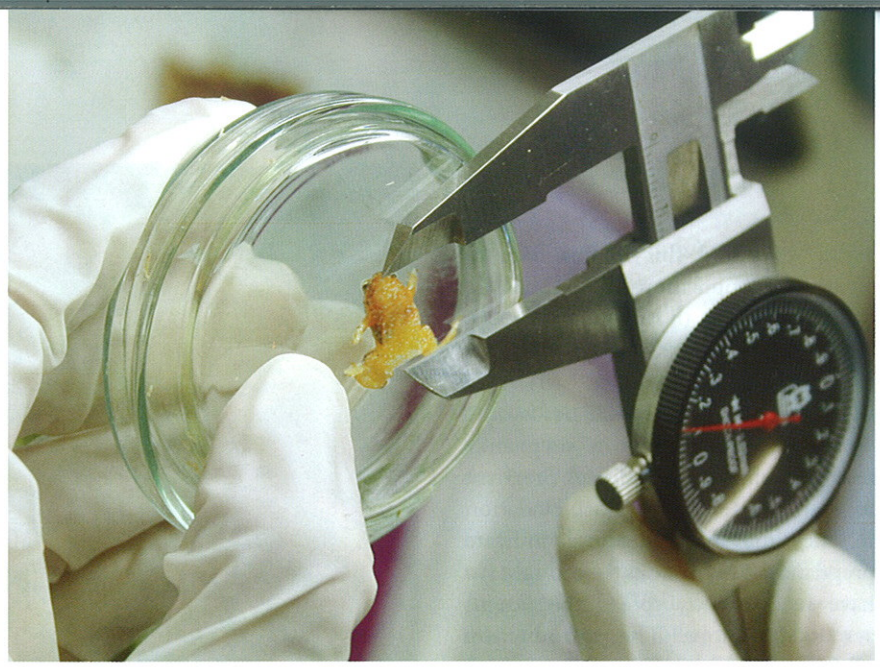
In WA, chytrid fungus has been active for at least 23 years. It is thought to occur over most, if not all, areas of the State where frogs occur. However, although it has killed many individuals, it is not clear whether it is the main cause of population decline. It has been prevalent in populations of the orange-bellied frog (*Geocrinia vitellina*) and the motorbike frog (*Litoria moorei*) with no obvious impact on these populations. Regrettably, the cane toad is also immune to its effects.

Above The western banjo frog (*Limnodynastes dorsalis*) occurs in south-western Australia.
Photo – Babs and Bert Wells/DEC

However, further afield, some people point the finger at chytrid fungus for the extinction of two species of gastric-brooding frogs (*Rheobatrachus* spp.) and the sharp-snouted day frog (*Taudactylus acutirostris*) in Queensland. It is also blamed for the decline of other eastern states' species such as the waterfall frog (*Litoria nannotis*), common mistfrog (*L. rheocola*), spotted tree frog (*L. spenceri*) and the lace-eyed tree frog (*Nyctimystes dayi*).

The Department of Environment and Conservation (DEC) regularly monitors populations of frog species on the threatened species list to determine their conservation status. Recent monitoring has revealed some alarming trends in calling behaviour. DEC monitoring of the sunset frog (*Spicospina flammocaerulea*), which is listed as vulnerable, is particularly troubling. The species is currently monitored by listening for its call during breeding season. However, during the last monitoring period, very low calling activity was recorded, which could be an indicator of reduced reproductive behaviour and population decline. More field research is required to determine whether this is a true decline. While chytrid may be responsible for at least part of the reduced reproductive behaviour, DEC scientists believe it is more likely attributed to several years of low winter rainfall and a subsequent reduction in groundwater recharge processes, which has caused groundwater levels to drop and water acidity levels in the peat-based ecosystems to rise. It is possible that tadpoles of the sunset frog are unable to survive these high acidity levels.

The story is similar with the critically endangered white-bellied frog (*Geocrinia alba*), which has also dramatically declined in number. If the decline doesn't halt, this species is expected to become extinct within the next few decades. Monitoring for this species, and the vulnerable orange-bellied frog, started in 1993 and now



Above Perth Zoo Native Species Breeding Program Coordinator Glen Gaikhorst with a cave dwelling frog (*Litoria cavernicola*).

Above right Measuring a roseate frog (*Geocrinia rosea*) at the Perth Zoo. *Photos – Barry Baker*

Right Monitoring for the sunset frog (*Spicospina flammocaerulea*) near Walpole. *Photo – Karlene Bain/DEC*

encompasses 126 sites, representing all known sub populations of both species. The study has shown that 25 per cent of all known white-bellied frog monitoring populations have disappeared. However, in the same period no orange-bellied frog populations have disappeared. While wildfire, pigs and chytrid fungus may have contributed to the decline of the white-bellied frog, habitat loss and disrupted hydrological patterns are thought to be the major culprits. The orange-bellied frog lives in protected, uncleared lands so has not suffered from the same pressures.

Saving frogs

As frog populations continue to nose-dive, an ambitious, worldwide project is seeking to save frogs from extinction by developing an 'Amphibian Ark'. Zoos across the world are taking part, conserving frogs from their section of the globe in a bid to save the species. The Perth Zoo is on board, focusing on developing breeding and husbandry techniques for Western Australian frogs. It has established a four-year frog breeding research program through a grant from the Department of Industry and Resources' Office of Science, Technology and Innovation to develop successful captive breeding and management techniques for frogs. By developing this expertise, the zoo hopes to be able to provide a safety net for threatened frog species if their populations collapse in the wild as a result of disease or the impact of cane toads.

The zoo's amphibian research facility includes three rooms of different temperatures to deal with frogs from different climates within WA. At first the zoo started with common frogs to hone their breeding techniques. They started with the motorbike frog and began successfully breeding them immediately. Next they focused on the roseate frog (*Geocrinia rosea*) and the cave-dwelling frog (*Litoria cavernicola*), which are now also successfully being bred. It is hoped that common species like the motorbike frog and the roseate frog can provide valuable information about husbandry, reproductive biology, growth, development and captive management for threatened species, in particular the threatened orange-bellied frog and white-bellied frog species found in south-west WA.

As well as developing breeding techniques, Perth Zoo staff are also researching growth rates, bone density, feeding techniques and quarantine requirements. In addition, the zoo is trialling chytrid treatment procedures using a fungicide called Itraconizole. Zoo staff have discovered the fungicide doesn't necessarily kill the fungus, but does keep it under control. However, treating frogs in a controlled laboratory environment is one thing, attempting to treat them in the wild is quite another.

Critics argue there is no point saving frogs if they can't survive in the wild. But efforts to conserve the frogs in the Amphibian Ark will buy time until a better solution arises. The IUCN believes the only hope for populations and species at immediate risk of extinction is immediate establishment and management of captive colonies.

DEC is also playing a role. It has experimented with translocation of the threatened orange-bellied frog since 2000. The relocation works by moving burrows containing eggs to a new location of frog eggs—a long, frustrating and painstaking task. DEC staff usually need to find at least five or

Sunset frog

(Spicospina flammocaerulea)

While the sunset frog evolved some 30 to 40 million years ago, this species was not discovered until 1994. It occurs only in south-west Australia, in the Walpole–Nornalup area. It is an easily recognisable frog, with knobbly skin, bright orange hands and feet and a belly that is half orange and half covered with striking, light blue spots. It grows to just 35 millimetres long. Of the 17 sites where it was known to exist, only seven are now believed to be inhabited by this frog. A drying environment, chytrid fungus, clearing for agriculture, water extraction pressures for domestic water use and the introduction of exotic plant and animal species are thought to be to blame for its decline.

Sandhill frog

(*Arenophrynexyphorhynca* – Kalbarri region species)
(*A.rotunda* – Shark Bay region species)

Think of frog habitats and most people imagine a wet environment. But the sandhill frog inhabits arid homes in sandhills. It is also unusual in that it does not develop a tadpole stage and never inhabits water. Young frogs develop in eggs deep underground and hatch after about two months. There are two slightly different species of sandhill frog—one is endemic to sandhills in the Kalbarri area while the other lives around Shark Bay. The sandhill frog emerges from the sand after rains or on dewy nights to feed on ants and other insects. Its nocturnal behaviour means you are unlikely to see one. But you may spot their distinct tracks which are marked at the beginning and end with a small depression. The frog features unusually short legs, a squat body and makes a strange squelching noise.

Orange-bellied frog

(Geocrinia vitellina)

This threatened species is probably the most restricted vertebrate on mainland Australia. It occurs only in an area of six square kilometres within State forest to the north of the Blackwood River, north-east of Augusta. The orange-bellied frog does not have a free-swimming tadpole stage. Eggs are laid in burrows, moist depressions between litter or under dense vegetation. After hatching, the tadpoles remain in the burrow feeding on the jelly surrounding the eggs until they metamorphose into tiny froglets, with a body about the size of a thumbnail.

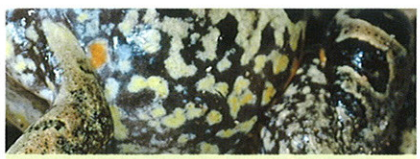
Left to right Sunset frog, sandhill frog, orange-bellied frog.
Photos – Gunther Schmida/Lochman Transparencies, Jiri Lochman, Grant Wardell-Johnson/DEC

six active burrows to locate a burrow suitable for translocation. To find a burrow, they must work deep within the bush at night, listen for the call of the frogs, follow the sound to a burrow sized about two centimetres across and then excavate the burrow and move it to a new location. While the mechanics of this technique have now been proven successful and at least some of the translocated frogs have survived, the fact that frogs take four years to reach sexual maturity (and can only be located by their call during breeding season) means it's too early to tell if these translocated frogs are surviving to breed successfully.

Frog future

The effects of climate change, habitat and probably chytrid fungus, mean many of WA's amphibian species are facing a bleak future. The difficulty in monitoring populations adds to the problem. And yet there is hope. Not everyone prescribes to the doomsday predictions. Some argue that frog populations have survived the threat of chytrid fungus so far, so there's no reason they shouldn't continue to do so. And, while the fungus is prevalent among WA's threatened frog species, it can't be conclusively proven to be responsible for their decline.

So, with the continued success of DEC translocation projects and the research and successful captive breeding at Perth Zoo, these charismatic creatures may retain their grip on life. They have, after all, seen the coming and going of the dinosaurs and already survived extreme changes in the environment. Let's hope, with help, they can battle on in the face of disease, drought, declining habitats and other pressures.



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contents

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