The Derdibin Gnamma Storybook

'It's what kept our ancestors alive out here'
- Kevan Davis, Noongar Elder

Gnamma

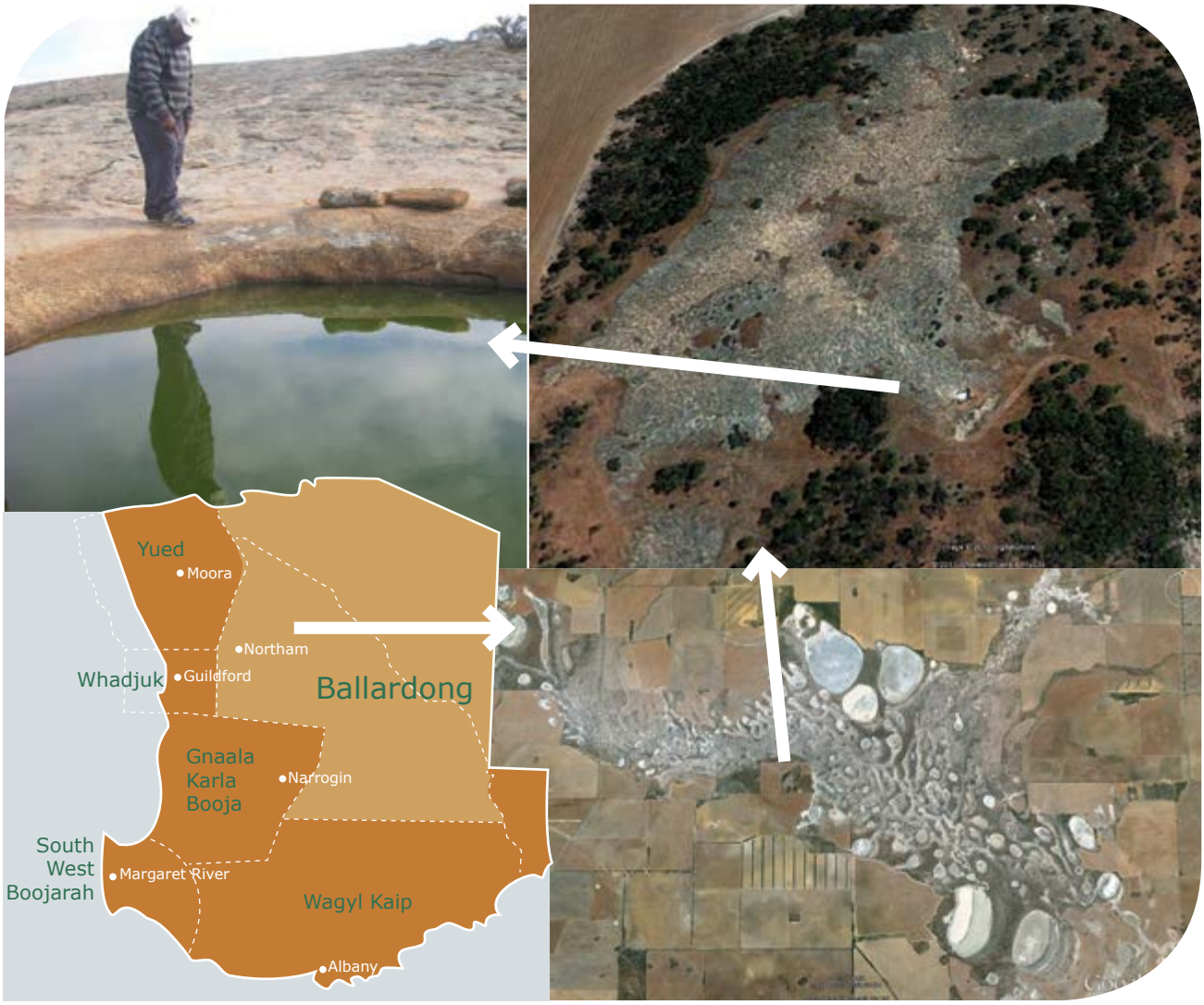
Gnammas are rock holes that fill with rain water.

'Derdibin gnamma would have been guarded in the old days as water was very scarce. It's one of the three biggest gnammas in the region, so it was a very important source of water. It's also a sacred site because it gives life.'
- Kevan Davis

Rock

The Derdibin gnamma is at the base of Derdibin Rock, an ancient granite outcrop on private farm land in Western Australia's Central Wheatbelt.

The Derdibin gnamma is a *pit gnamma* which means it's deep. There are also shallow *pan gnammas* higher up on the rock.



Derdibin is in the *boodja* (country) of Western Australia's Ballardong Noongar people. The word gnamma (also spelled *ngama*) is from the Noongar language.

The Noongar pronunciation is ng-ama: *ng* sounds like the end of sing, and *-ama* rhymes with llama.

Noongar boodja

Derdibin Rock is set within a string of *playas* (salt lakes following ancient river valleys).

Land 500m to the east of the rock wasn't cleared until the 1960s. The lessee farmer saw that clearing it led to a rise in salt levels. He said the area had *'lovely wildflowers at times. The nesting birds in spring are numerous and gorgeous... I would like to see it a proper flora and fauna reserve'*.

Later, in 1977, the 133.1ha Derdibin Nature Reserve was created to conserve its unique flora, fauna and habitats.

Land

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Gnammas you can visit are listed on page 14.

Like Derdibin, many gnammas are on private property.

Gnammas and Noongars

My name is Kevan Davis. Gnammas were life-giving sources of water for my Noongar ancestors for many thousands of years.
I want to tell you the story of the Derdibin gnamma, but first let me tell you a little bit about gnammas and Noongar life in general.

Noongar people didn't live in one place. They travelled in family groups of about 15 people to the best place in their *boodja* (country/land) to find food and water during each season.

"When the people walked the track following the Avon River they made camp along the way. You don't camp too close to the waterhole because it frightens the* waitch *and* yonger *(emu and kangaroo) away.

Mind you, the old people wasn't going anywhere in a hurry.

They had plenty of time to hunt and be patient."

- Ralph Winmar (Munyari) (RIP), from his book *Walwalinj: the hill that cries*

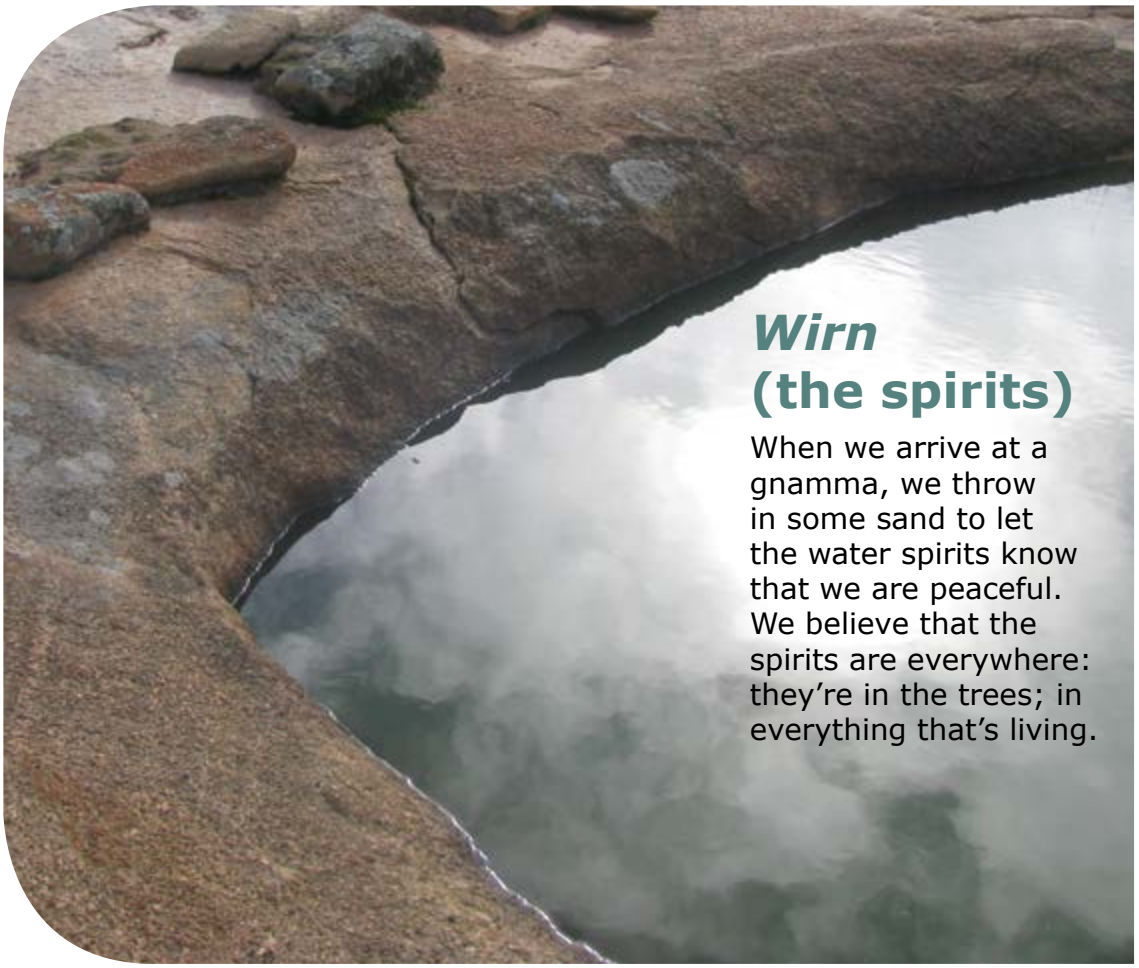
Birak – Bunuru – Djeran – Makaru – Djilba – Kambarang (seasons)

The six Noongar seasons are based on the changing weather and how it affects plants and animals. Different types of food were available in each season in various parts of our boodja, so my ancestors' diet would have varied throughout the year.

Precious water

Water kept our people alive, so gnammas were sacred. They were guarded and regularly cleaned. Slabs of rocks were placed over some smaller pit gnammas to reduce evaporation and prevent wildlife from falling in and drowning. Large gnammas like the Derdibin gnamma were rare and highly valued.

When a group of people first arrived at a gnamma only the eldest – the decision maker – would drink the water at first. This elder would ensure that the water was safe. The others would wait, and then take turns to drink one by one.



Wirn (the spirits)

When we arrive at a gnamma, we throw in some sand to let the water spirits know that we are peaceful. We believe that the spirits are everywhere: they're in the trees; in everything that's living.

Food

Gnamma attracted animals and birds that we hunted and ate including *yonga* (kangaroo), *djurrang* (lizards), *djert* (birds) and *yerderap* (ducks).

There are *mangart* (jam trees) near the Derdibin gnamma. Aboriginal people would have dug carefully around the mangart roots to gather *bardi* (witchetty grubs). The mangart had 73 uses, including being burnt in smoking ceremonies for healing and protection. We never cut mangart or *kwel* (she-oaks) down; we just used what had fallen.

Flowering **kwel** - she-oak - *Casuarina obesa*

Kwel (she-oaks)

While women were washing at a gnamma they would lay their babies under nearby kwel. The sound of the breeze through the kwel is the spirits of the Ancestors speaking, which gently lulled the babies to sleep.

This *yoort* (white ochre) was found at Derdibin.

Yoort would have been traded for stone tools like these.

Corroborees and trade

Yoort (white ochre) was used for painting their bodies for ceremonial dances; corroborees. If a group had yoort in their *boodja* (land), they'd be rich because it was used for trade.

An old Aboriginal fella told me that every 75 years many groups of Aboriginal people would meet and camp somewhere in our boodja and have a corroboree.

The last one was held where the Wyalkatchem CBH is now, and he was at it.

Secret water signs

At Shackleton there is a circle of rocks on the ground with an added triangle of rocks on the end that points to where permanent water could be found. These signs were for other Noongars, not *wadjellas* (non-Aboriginal people). There is a beautiful one at Mukinbudin.

I was told that when wadjellas first came, our people would be in trouble with other Noongars if they told wadjellas where the water was, even though sharing is very important in our culture. But Noongars would be in trouble with the wadjellas if they didn't tell.

Boodja, moort and *kaartdijin*

Noongar people value connection to boodja, *moort* (family) and *kaartdijin* (knowledge). The *Wargal*, the dreamtime snake, gave us our knowledge of the seasons and how to manage our boodja, and this helped us survive.

This kaartdijin was passed down by our Elders and moort in stories about people, seasons, stars, when it's time to move camp, when bush foods will be in season, and what a change in animals' activities mean. The stories represent our belief systems and our knowledge of country.

We have a deep respect and obligation to our boodja. We took only what we needed from nature. We ate foods when they were plentiful and in season. We left some behind when we moved camp so that resources would be available the next year.

Karl-ngarra (firestick farming)

When our ancestors moved on from a gnamma, they sometimes burned the surrounding area so that it would be green and regenerated when they came back. The green vegetation would attract animals for hunting.

Nyingarn - Echidna - *Tachyglossus aculeatus*

How gnammas formed

The people used to heat the rock up and keep pounding it until it got deep enough so that they could have a water hole.

Some Noongar stories say gnammas were created in the dreamtime by the Wargal, the spirit snake that also made the rivers, lakes and wetlands.

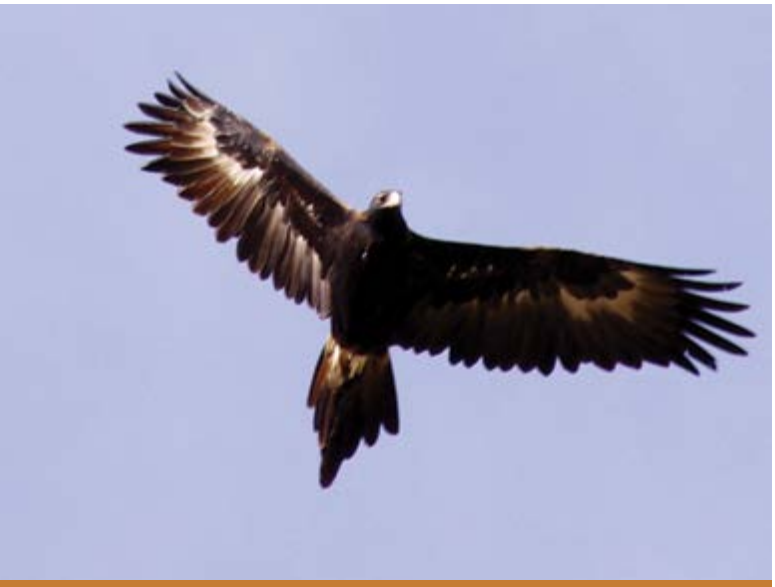
Another dreamtime story says that the row of five pit gnammas in Trayning were dug by a *nyingarn* (echidna) digging pits as he migrated south.

	Noongar words & phrases
Camping / dwelling place	*Kornt / kaylap / karla-mia*
Fire, firewood, camp	*Karla / karl-boorn*
Ground, earth, land, country of origin or belonging	*Budgar/budjara /boodja*
The ribs of the kangaroo are good	*Coong-moordich*
Eating witchetty grubs	*Bardi-ngarninj*
He's having a sleep	*Baal-ngoondinj*

The Derdibin gnamma

Now I'll tell you about the Derdibin gnamma. My family and I love the place. We arrange with the farmer to go there sometimes. We throw sand in the gnamma for the spirits when we arrive. We like just sitting around.

We have a *warlitj*, a wedge-tailed eagle, that flies over every now and then. But I haven't always known about the gnamma at Derdibin.



Warlitj - Wedge-tailed Eagle - *Aquila audax*

I was born in Beverley and lived in Shackleton where my family relied on a small gnamma for water. When I grew up I worked on the railways, married Rose on Anzac Day 1964, and we moved to Wyalkatchem in 1969.

I met a man named Paul de Pierres through footy and cricket and began seasonal work for his dad on his farm in the seventies. I used to drive his tractor right next to Derdibin Rock. You'd get a feeling. I knew there was something there. But I didn't stop to look because I was there to work.

One day I got to visit the rock and saw the gnamma – the kind that would have kept my ancestors alive.

My friend Paul couldn't tell me much about the Aboriginal history there. His grandfather, who bought land at Derdibin 100 years ago, remembers Aboriginal people camping there from time to time early on and that an Aboriginal kangaroo shooter camped there later in the 1940s. Paul says the gnamma is always full of tadpoles and has never been empty in his lifetime, except for when it was cleaned out.

Because of their knowledge of water sources, Noongars were employed as drovers, moving livestock through the region. Many early farmers and miners relied on gnammas until wells and bores were made.

No one else I've asked has been able to tell me what happened to the Noongars whose boodja included Derdibin.

Many Noongars who traditionally travelled from place to place throughout the year may have started working for white settlers. They may have been moved onto native reserves, and their children may have been taken to mission schools.

Noongar culture is still strong, even though our moort (family) was split up, the flow of our kaartdijin (knowledge) was disrupted, and our boodja (land) was taken over.

All that's known about the people in this picture is what's written on a scrap of paper with the photo...

"1908 Derdibin No 10849. This native camp on Derdebin Rock which was on part of the lease hold property of Dr. J. Morell of Northam… The natives were employed by Morells looking after sheep."

The photo was taken by Wyalkatchem farmer Jim Riches' grandfather and appears in the book *Wyalkatchem: a History of the District* by John C Rice, published by the Wyalkatchem Shire Council in 1993.

The de Pierres

French nobleman Vicomte (Count) Guillaume Charles Baptiste (Guy) de Pierres took up land at Derdibin in 1913. Guy's first camp with his wife, brother and sister-in-law was at Derdibin Rock near the gnamma and well.

Paul is Guy's grandson. In his family history 'Loyalty Sustained', Paul wrote: *"On the 5th of January [1934]… one of the workmen didn't find the cattle when he should have and nine big steers fell into the gnamma hole at Derdebin Rock while trying to get a drink. It was a gruesome sight in the summer heat, the maggots were huge and the stench incredible. Guy sent* [his son] *Stanley and Alec Noble with the tractor (and a bottle of whiskey) to clean the hole out, it took them all day and he arrived at 3.30pm to give a hand. Undeterred the family attended a party at Jeffrees that evening and had a wonderful time."*

A fence was built around the gnamma later to protect both it and animals, but the fence deteriorated over time.

The gnamma at Derdibin, like many others, stagnated without the regular care of Aboriginal people.

You'll read later in this booklet about how we cleaned it in 2011.

Since then scientific surveys show its diversity of tiny water animals has grown. This helps other animals that live near the gnamma too.

	Noongar words
Dust	*Dooka*
Dusty (becoming)	*Budjar-dooga*
Wind blowing dust	*Keniny*
Willy willy	*Wanbaar*
Dirt, sand, clay	*Yalya / yaly*

The neglected gnamma at Derdibin before the 2011 clean-up.

Science and Aboriginal beliefs agree it's important to protect nature, because the lives of living things are connected.

We all need each other to survive.

Derdibin well

Paul de Pierres believes the government built this public well, near the gnamma, in the early 1900s on a separate 2 acre title.

It was one of a series of public wells for people to use on their way to the Goldfields: there is another beautifully made well on De Pierres Rd.

Paul last remembers water being in the Derdibin well in the 1950s. He says it has filled with leaf litter and other natural debris now so is about two metres shallower than it used to be.

After a very dry June in 2013 the well was dry as usual, a newer dam nearby had a puddle in the bottom but the gnamma was almost full.

The Derdibin well was fenced in 2011 by the Wyalkatchem Men's Shed.

Greatest gnammas on Earth

Although other countries have rock holes, Western Australia's ancient landscapes have the biggest and best pit gnammas in the world.

This is the rough hemispherical pit gnamma at the base of Derdibin Rock in July 2013. At 5.5m long, 3.5m wide and 3m deep, it is larger than many pit gnammas.

Dingo Rock, Wongan Hills

Pit gnammas

Pit gnammas are usually deeper than 50cm and typically form in granite, often at the base of an outcrop. Round pit gnammas in WA measure up to 12m in diameter, with canoe-shaped ones as long as 15m. They can hold water for a long time

Pit gnammas are mostly found in the WA Wheatbelt, with some out in the Goldfields. There are a few in South Australia on the Eyre Peninsula. There are none in eastern Australia.

Oak Flat West, Goomalling

Far Northeast and Northeast, Trayning

Pan gnammas

Pan gnammas are typically 5-20cm deep, 1-3m in diameter and usually form in granite but can occur in other rock types. They hold seasonal rain water for a short time. Pan gnammas are the most common kind.

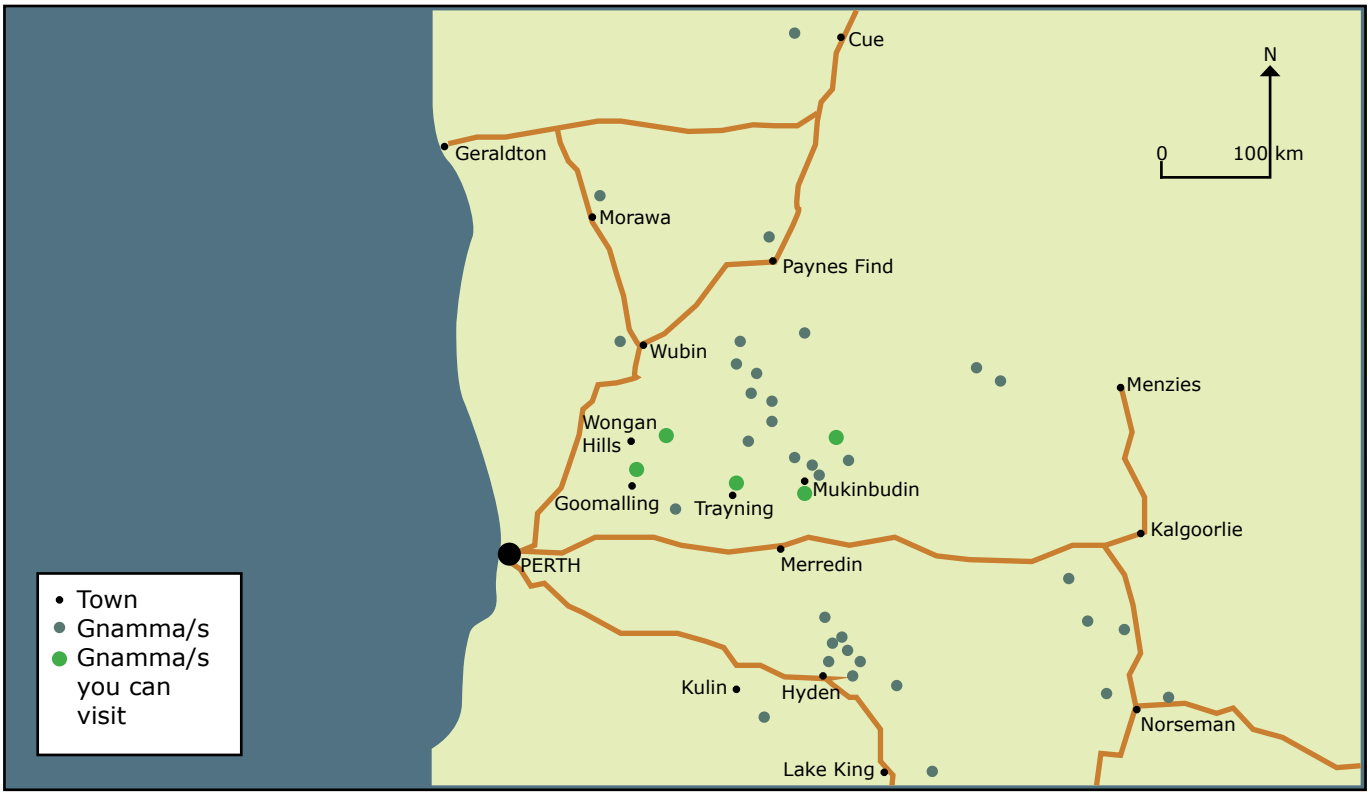
Other kinds

Rare **pipe gnammas** have narrow shafts 30-60cm diameter up to 2m deep. They typically form in lateritic rock further east in the Gibson and Victoria Deserts.

Armchair gnammas are uncommon too. They are like seats built into sloping rock, with steep back and side walls with either a flat or deep bottom.

	Noongar words
Rain cloud	*Mari warabiny*
Rain	*Burong / djart*
Rock, stone	*Boya*

A pan gnamma on Derdibin Rock, July 2011



Pit gnammas to visit

Gnammas are a kind of freshwater wetland.

Professor Brian Timms (of the Australian Wetlands, Rivers and Landscape Centre at the University of NSW) has studied aquatic invertebrates (tiny water animals) in 80 Western Australian pit gnammas at locations on the map above.

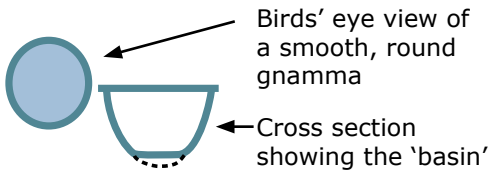
As he went, he also studied and measured the gnammas. Most gnammas he saw can't be accessed by the general public, but you can visit the ones listed below.

Wiera, Mukinbudin

		Width (m)	Depth (cm)	Volume (m^3)
Oak Park gnammas, Goomalling	Oak Flat East	2.5 x 2.1	80	1.66
	Oak Flat West	2.6 x 2.1	90	1.95
Five gnammas 14km north of Trayning	Trayning Far Southwest	2.8 x 2.8	105	3.23
	Trayning Southwest	1.6 x 1.1	85	0.61
	Trayning Mid	1.3 x 1.0	~100	0.52
	Trayning Northeast	2.7 x 1.3	95	2.56
	Trayning Far Northeast	2.3 x 0.8	60	0.82
Wiera, Mukinbudin		8.5 x 5.0	150	26.84
Berringbooding North, Mukinbudin		12.0 x 12.0	>200	>110.00
Dingo Rock gnamma, Wongan Hills		2.7 x 2.0	67	1.39

How gnammas form

The three-stage process below forms a smooth, roundish, hemispherical basin.



1

A depression in the rock starts.

Possible ways it starts include:

- sun exposure causing flaking,
- breakdown of crystalline irregularities,
- lichen attachment,
- attack of acid groundwater on bedrock.

2

The rock breaks up.

Alternate wetting and drying weathering bedrock granite is the most accepted explanation of how rock breaks up. Other possibilities include:

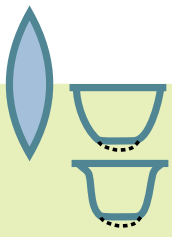
- continued sun exposure,
- xenolith (bits of foreign rock) attack, and
- the direct action of wind and running water.

3

The debris is evacuated.

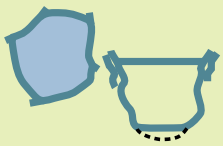
The broken rocks:

- get taken away by wind,
- get dissolved in solution, or
- are removed by people.



Canoe

If there are weaknesses in certain places in the rock, more weathering happens there, changing the neat round shape into other shapes. For example, weakening in rock joints helps form canoe-shaped gnammas.



The Derdibin gnamma has a rough hemispherical shape that Professor Brian Timms says formed *'along three joints in the rock which acted as weaknesses. The rock rotted in those particular areas, perhaps helped by some Aboriginals digging and burning.'*

Kevan Davis pointing out one of the weak joints in the granite that professor Brian Timms says helped the Derdibin gnamma form into its rough hemispherical shape, rather than a plain circle shape.

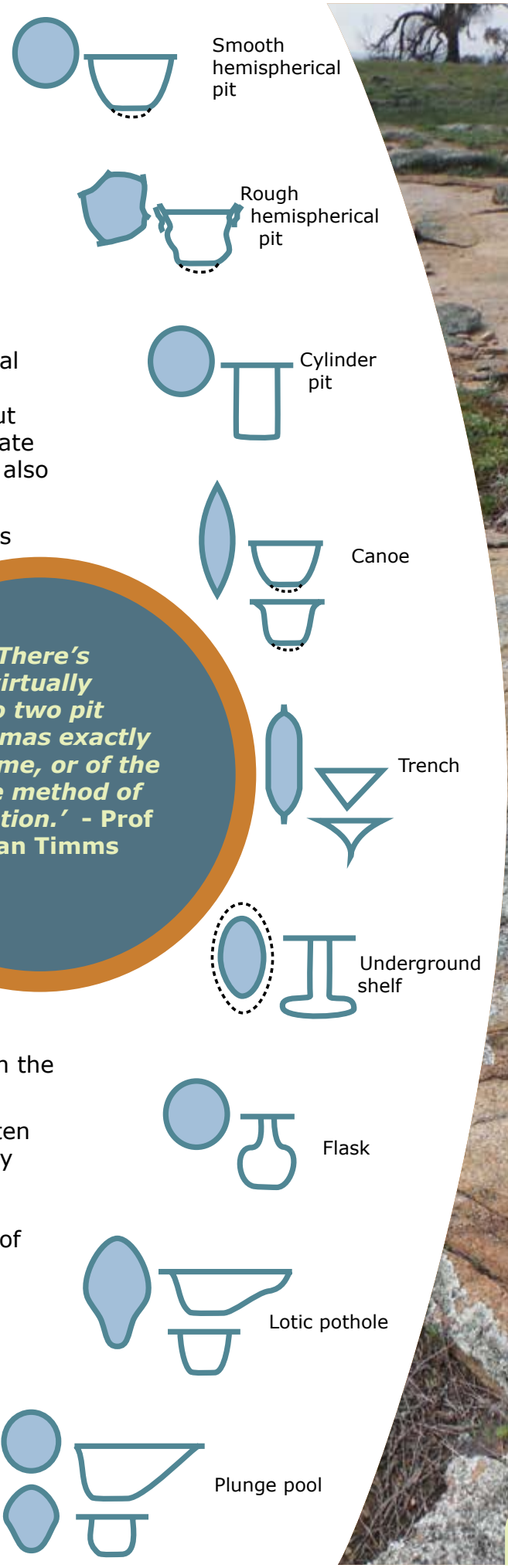
Unique formations

The WA pit gnammas Brian studied had more shape variations than were taken into account when the 'three-stage process' of gnamma formation idea was suggested.

His paper *Geomorphology of pit gnammas in southwestern Australia* published in the Journal of the Royal Society of Western Australia outlines his ideas about what additional factors help create the extra shapes. Brian's paper also says…

- Early miners in the Goldfields realised the value of gnammas. There's a diagram of a pit gnamma in the first annual report of the Western Australian Department of Mines.
- There were many skirmishes between local Aborigines and the new explorers, miners and pastoralists over the water in the gnammas.
- The location of gnammas often determined the route of early European tracks (e.g. the Holland track to Coolgardie) and sometimes the location of early homesteads (e.g. the Wattoning Homestead north of Mukinbudin).
- Just say 'gnamma'. The term 'gnamma hole' is a tautology and though widely used, is incorrect. Noongar people used 'gnamma' to describe the rock hole and its retained water.

***'There's virtually no two pit gnammas exactly the same, or of the same method of formation.'* - Prof Brian Timms**

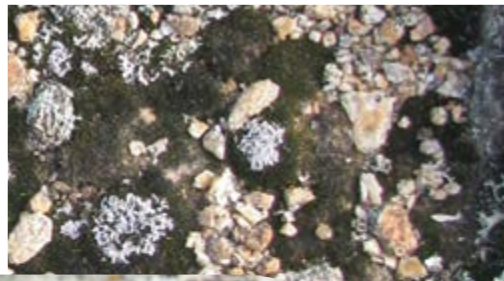


A granite outcrop in Goomalling

Special, isolated habitats

The isolation of ancient granite outcrops and gnammas within the landscape has contributed to the evolution of endemic species. Endemic means native to or confined to a certain region. There are at least 50 aquatic invertebrates endemic to gnammas. WA granite outcrop endemic plants include Caesia Gum (*Eucalyptus caesia*), Silver Mallee (*E. crucis*) and Granite Kunzea (*Kunzea pulchella*). Special habitats like gnammas and ancient granite outcrops are just one of the reasons Australia has such a rich variety of unique plants and animals.

Anisops, a kind of backswimmer found in the Derdibin gnamma.



These lizards are heavily dependent on sheets of rock for cover. They have disappeared from most granite hills near settlements because people invariably remove rock slabs for building water catchments (historically) and for garden landscaping.

The Ornate Crevice-dragon is a WA granite outcrop endemic. This one was at Brookton on 9 March 2013. There are none at Derdibin.

'Although many aquatic plants and animals have probably been lost from the region, the Avon and wider Wheatbelt retain a large number of functioning aquatic ecosystems. These continue to support a very high diversity of wetland plants and animals, many of which are not known from anywhere else in the world. The degree to which the region's wetlands continue to decline is dependent on what actions can be taken to manage and protect what is left.'

- Aquatic invertebrates and waterbirds of wetlands in the Avon region

How to protect granite outcrops and gnammas and their biodiversity

1. Fence them off to exclude livestock. This will let seedlings establish in the surrounding earth, prevent soil compaction and erosion, and limit nutrient enrichment from droppings.
2. Get rid of weeds to give native plants an improved chance of establishing and surviving.
3. Revegetate surrounding areas with hardy, native plants.
4. Eliminate feral animals such as rabbits which damage vegetation and cause erosion.
5. Provide habitat such as boxes, hollow logs and perches.

Local environment groups and organisations such as Land for Wildlife and Wheatbelt NRM may be able to provide financial or practical assistance.

The Derdibin gnamma clean-up

Without the care of the Ballardong people, the gnamma at Derdibin became like most ancient watering holes that had been left to stagnate – silted up from wind-blown topsoil and putrid from thirsty animals falling in and drowning.

In 2010 local Noongars and Nathan Heal of Wheatbelt NRM met at Derdibin to plan a gnamma clean-up for the following year.

The Derdibin gnamma before the clean up

In April 2011, on a blistering day under the Wheatbelt sun, Kevan Davis oversaw the restoration of the Derdibin gnamma.

1 *'We carried out a bit of a ceremony before we started. We smoked it, the smoke cleansed everything. The ceremony helped protect the volunteers.'* – Kevan

2 *'We threw sand in the water that tells the spirits we are friendly and don't mean to harm anything. It was all carried out with respect to the spirits there.'* - Kevan

3 Slime-green sludge was pumped out using a pump and hoses borrowed from the Wyalkatchem Water Corp depot.

After the water was pumped out, Phil Lewis from WWF was left standing in the bottom mud where tiny water animals lay their eggs.

The mud was deliberately left there to protect the eggs and other small creatures, instead of stirring the mud up in the water and pumping it out that way.

Some life-containing mud and a frog were saved and put back in after the clean-up.

4 Volunteers jumped into waist-deep mud to shovel out possibly 100 years' worth of silt, fencing posts, animal bones and other assorted refuse.

5 Other volunteers worked on the bucket line, carrying buckets of mud to the wheelbarrow.

6 Everyone else took turns at wheelbarrowing away the sludge or piling up the sticks and rocks. All the mess was placed down the slope from the gnamma to prevent it from washing back in.

'[Filthy gnammas] are not prime habitats for invertebrates and for tadpoles, so it's great to see [it] cleaned out.'
– Prof Brian Timms

'They worked it so that before the rains came they'd get it all cleaned out and have it ready to fill.' – Kevan

Kiel Atwell and Phil Lewis

After the messy clean-up the 3m deep hole was ready to fill with fresh winter rain.

"That water will come alive again."
– Kevan

Noongar words	
Empty	*Wirt/woorl*
Cloud	*Maar*
Water	*Kep/kepa*
Rain coming	*Kep koorliny*
It's going to rain	*Kearp-burununginj*
Lightning	*Babanginy*
Thunder	*Malkar/mariga*
Frogs making noise for more rain	*Kweark-wanginj*

Since the clean-up

More tiny animals live in the fresher gnamma water.

When Kevan visited the gnamma on 10 July 2013, there were *kwiya* (frogs), *kubalang* (tadpoles), dragonflies and backswimmers.

Kevan works together with the land owner, WWF and Wheatbelt NRM to share the story of the Derdibin gnamma.

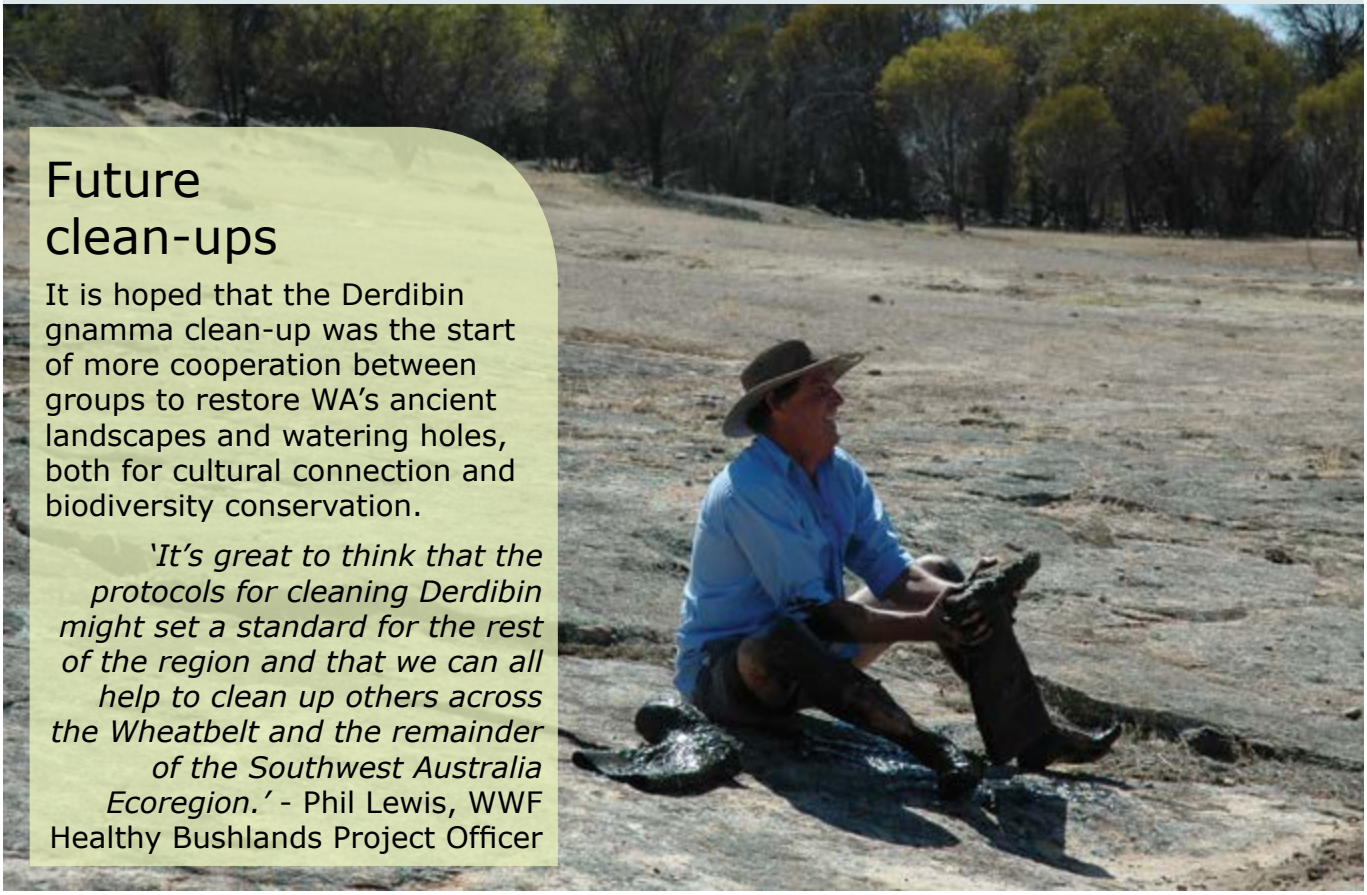
The clean-up was a *Caring For Our Country* initiative backed by the Aboriginal community, the landholder, Wheatbelt Natural Resource Management, conservation group WWF-Australia, the Shire of Wyalkatchem, and Northam TAFE Conservation and Land Management students Alisha Ashworth, Kiel Atwell, Shantelle Bennell and Margaret Bennell.

Phil Lewis and Mike Griffiths from WWF

Conservation and Land Management students Margaret Bennell, Shantelle Bennell and Kiel Atwell

Kiel Atwell said he was happy to reconnect with the land. 'I wanted to do this because not every young Noongar is. We have to start looking after the land – not just to save the environment but because it's part of our culture.'

Kevan Davis said 'It's great to see these youngsters helping out and reconnecting with the land. It's also a chance to experience how their ancestors would have lived.'



Future clean-ups

It is hoped that the Derdibin gnamma clean-up was the start of more cooperation between groups to restore WA's ancient landscapes and watering holes, both for cultural connection and biodiversity conservation.

'It's great to think that the protocols for cleaning Derdibin might set a standard for the rest of the region and that we can all help to clean up others across the Wheatbelt and the remainder of the Southwest Australia Ecoregion.' - Phil Lewis, WWF Healthy Bushlands Project Officer

See 'Gnamma cleaning tips' for how to organise a pit gnamma clean-up.

Derdibin gnamma fauna

Derdibin's special habitats – the granite outcrop and gnammas – and the wider landscape provide homes to a range of mammals, birds, reptiles and invertebrates.

Invertebrates are spineless animals that are usually tiny. Plankton, insects, crustaceans and spiders are examples – in fact, most of the world's known animal species are invertebrates.

Invertebrates are food for other animals, which are food for other animals, and so on.

Some invertebrates break down wastes and purify their environment.

All life needs invertebrates.

Tau Emerald Dragonfly *Hemicordulia tau*

Aquatic invertebrates survey

Professor Brian Timms found 18 aquatic invertebrate species at the Derdibin gnamma over three visits: five species on 16 August 2011, not long after the clean-up; nine on 18 October 2011 and twelve on 28 July 2012. The species are common and widespread in Wheatbelt gnammas. His list below shows on how many visits each one was seen.

Although called 'aquatic invertebrates' these tiny animals can also live in damp ground

Cumulative invertebrate species list

Group	Common name	Species	No. of Occurrences
Copepoda	Copepods	*Boeckella triarticulata*	1
Rotifera	Rotifers	*Asplanchna sp*	2
		Brachionus plicatilis	1
Odonata	Dragonflies	*Hemicordulia tau*	1
Hemiptera	True bugs	*Micronecta gracilis*	1
		Agraptocorixa parvipunctata	3
		Anisops thienemanni	2
Trichoptera	Caddises	*Triplectides australis*	1
Coleoptera	Beetles	*Antiporus gilberti*	1
		Hyphydrus elegans	2
		Lancetes (larvae only)	1
		Limnoxenus (larvae only)	1
		Rhantus suturalis	1
		Sternopriscus multimaculatus	1
Chironomidae	Blood midges	*Chironomus alternans*	2
		Chironomus tepperi	1
Culicidae	Mosquitoes	*Aedes occidentalis*	2
Stratiomyidae	Maggots	*Unidentified species*	1

The larvae of some non-biting midges are called bloodworms: they are red because they contain the red blood pigment haemoglobin which lets them absorb oxygen from water. Larvae can develop in gnammas. The swarms of midges we see are adult males.

***Aedes occidentalis* only exists in gnammas and is endemic to the southwest and Goldfields.**

Invertebrate species come and go from gnammas. Insects can easily fly in and out. Rotifers and crustaceans can be carried in by birds.

Brian expects as many as 20-30 invertebrate species to come and go from the Derdibin gnamma over time, with fewer than that present at any one time.

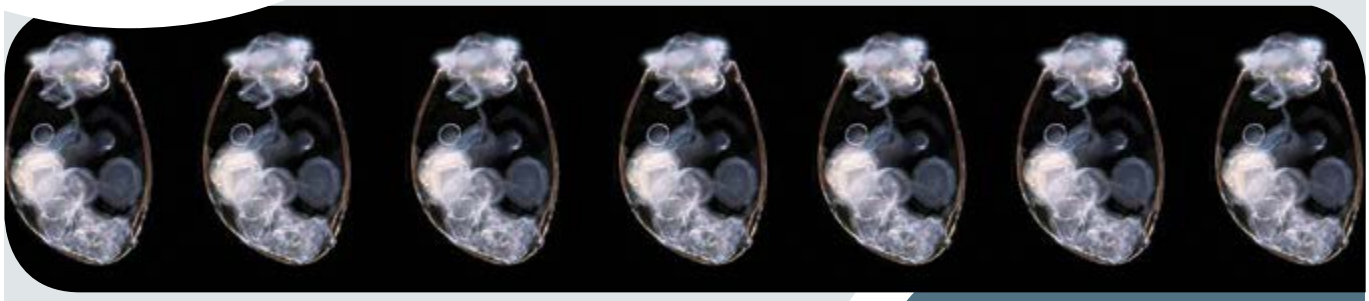
The next pages will introduce you to some of the tiny critters Brian found at the Derdibin gnamma. As you'll see, the more species the merrier: they all have a role to play eating, being eaten, cleaning or a combination of these.

Rotifers: miniature wonders

Most people have never heard of rotifers, but we couldn't live without these tiny (generally less than 0.5mm), see-through organisms.

Rotifers are food for other invertebrates and fish larvae. They indirectly nourish larger animals in the food web, including people.

Rotifers clean water by eating organic particles and algae, using a crown of hair-like cilia to wave food into their mouth. A typical rotifer stomach is made of only 15 or so cells.



Rotifers use their cilia to propel themselves along. Some rotifers have a foot that secretes a sticky substance that lets them attach to a surface.

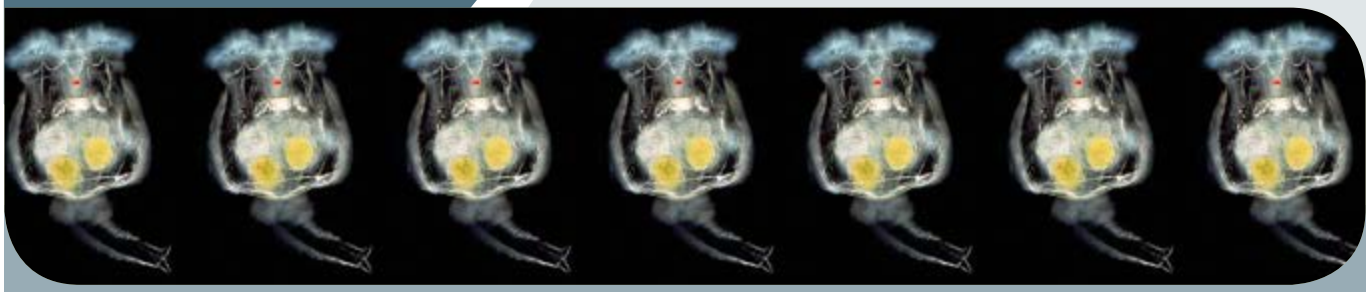
Asplanchna (above), the killer whale of rotifers, are strong swimmers that grow to around a millimetre in length.

Some larger *Asplanchna* are predatory, most often preying on smaller rotifers. They thrust their jaws forward, seize the prey and haul it inside their see-through bodies in one rapid action.

Rotifers live in water or damp earth and can survive long periods (perhaps hundreds of years) in a dried or frozen state. They spread easily on the wind or on the feet of birds.

The salinity tolerant rotifer *Brachionus plicatilis* was found at Derdibin. You can see the single red eye in the *Brachionus* below. The yellow bodies may be eggs developing. *Brachionus*, common in fresh water ponds and streams, have a lorica: a hard or semi-hard shell which forms the outer surface of the body of some rotifers. *Brachionus* is being mass cultured in the fish industry as food for fish larvae.

Although they have about 1000 cells, rotifers are much smaller than common single-celled organisms. A typical rotifer's brain is made of fifteen or so cells. They have one or two light sensitive red eye spots. Rotifers don't grow in size by cell division. Instead, the cells they were born with get bigger.



Rotifer means wheel animal. Early microscopists named them this because their crown of beating cilia looks like rapidly rotating wheels. See them in action in "Rotifers are awesome!" at youtu.be/wDyKhhqP0Xc.








Copepods: tiny crustaceans

Cousins to crayfish and toy Sea-Monkeys (which are actually tiny crustaceans called brine shrimp), copepods are an extremely abundant group of micro-invertebrates, second only to the rotifers.

Copepods use their ten legs for swimming and their abdomen helps them steer. From <0.5-2mm in size, copepods live almost everywhere there is fresh water including in damp soil and ditches; swamps, wetlands and temporary waters like gnammas; drops of water that collect in plants; the bottoms or shores of lakes and rivers.

Copepods eat algae, particles of organic material, bacteria, rotifers, crustaceans, protozoans and tiny insect larvae.

Copepods are eaten by plankton eaters such as fish, amphibians, water fleas, rotifers and aquatic insects. Like rotifers, copepods indirectly nourish larger animals in the food web and help to clean water. Scientists can study copepods to see how clean water is.

Most copepods produce drought-resistant eggs that lie dormant in the sediment and hatch when the wetland refills. Development time from egg to adult is from 1-3 weeks, whilst the adult life span is from one to 3 months. Copepods are frequently transported by birds to new places.

The copepod *Boeckella opaqua* is only found in gnammas.

There are at least 43 species of copepods in Avon wetlands.

The fresh water copepod *Boeckella triarticulata* was found at Derdibin gnamma in 2012. *Boeckella triarticulata* is advantaged by having eggs in the bottom mud but can arrive anytime by birds. Brian expects more copepods will turn up at Derdibin.

'So far iconic crustaceans have not yet turned up and will not do so until the gnamma dries. I refer to the waterflea Moina australiensis *(and maybe other waterflea species like* Daphnia carinata*) and the pea shrimp* Lynceus*. Both hatch from eggs that need to dry in the bottom mud. Given that Derdibin is a deep gnamma, it probably will not dry naturally until in a bad drought.' — Prof Brian Timms, 2011*

Tau Emerald Dragonfly

The Tau Emerald *(Hemicordulia tau)* lives in all parts of Australia except northern Queensland and north-western Western Australia.

Australia has over 200 dragonfly species and some are endemic to south west WA.

Dragonfly larvae live in a wide range of aquatic habitats and eat mainly aquatic insects. To escape predators, they can propel themselves by expelling water out of their anus. They live for several months (even several years for some species) in the aquatic habitat before emerging as adults.

Adults eat smaller insects which they capture in flight. Adults don't live more than several months.

Fir0002/Flagstaffotos CC BY-NC 3.0

Longhorned Caddisfly: *Triplectides australis*

Caddisflies look like fragile, hairy moths with really long antennae. Although they are not moths, they are sometimes called 'case moths' because the larvae make cases to protect themselves against predators. *Triplectides* larvae use their silk to make a case from a hollowed stem or twig.

Caddisfly larvae mostly eat organic debris and are eaten by frogs, dragonfly nymphs and other aquatic predators. They are sensitive to pollution so scientists can use them to assess water quality. Adults live on land close to water, are short-lived and don't eat.

A caddisfly © Australian Museum

Water boatman

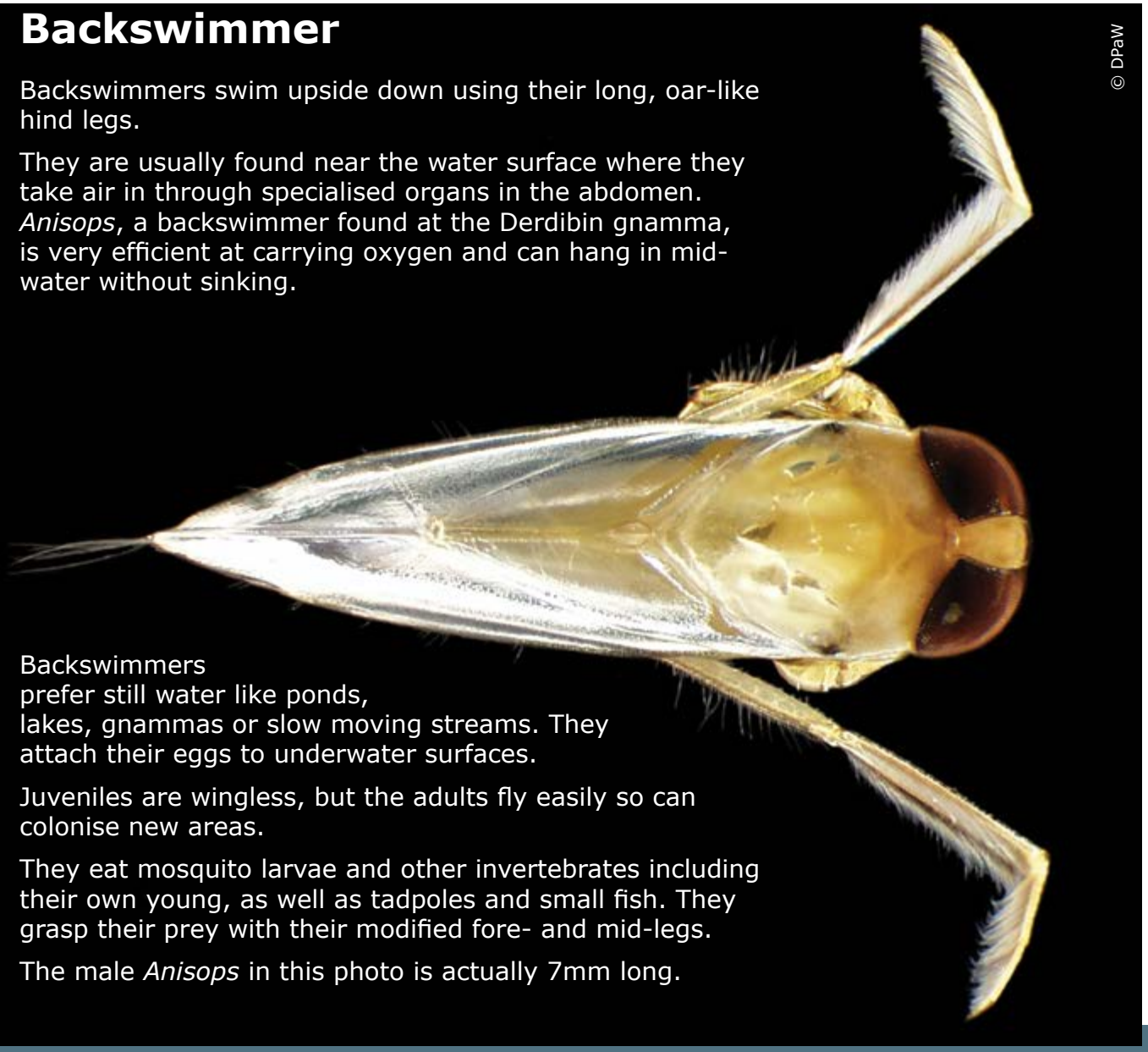
Brian found *Agraptocorixa parvipunctata* on each of his three visits and *Micronecta gracilis* on one visit. They have long hair-fringed hind legs shaped like oars which they use for swimming near the bottom of bodies of water, hence the name water boatman. They can grow up to 13mm long.

A few species are predatory, but the majority are herbivorous, eating algae and organic waste. They inject saliva into aquatic plants, the saliva digests the plant material, and then they suck out the liquefied food.

Backswimmer

Backswimmers swim upside down using their long, oar-like hind legs.

They are usually found near the water surface where they take air in through specialised organs in the abdomen. *Anisops*, a backswimmer found at the Derdibin gnamma, is very efficient at carrying oxygen and can hang in mid-water without sinking.



Backswimmers prefer still water like ponds, lakes, gnammas or slow moving streams. They attach their eggs to underwater surfaces.

Juveniles are wingless, but the adults fly easily so can colonise new areas.

They eat mosquito larvae and other invertebrates including their own young, as well as tadpoles and small fish. They grasp their prey with their modified fore- and mid-legs.

The male *Anisops* in this photo is actually 7mm long.

Soldier flies: *Stratiomyidae*

This *Stratiomyidae* larva is actually about 1cm long. Soldier fly larvae eat decaying vegetation and algae, and some are predatory. Some are aquatic, but many are found in damp soil or rotting vegetation.

Mosquitoes: *Aedes*

Aedes are small and usually have black and white stripes on their bodies and legs. Females feed on animal blood. A few days later they lay about 200 eggs on any water surface. These hatch after two to three days. Mosquito larvae live in water but breathe air. Females live for about a month. Males feed on nectar and live for about week.

Adult *Limnoxenus*

Water beetles: *Coleoptera*

Larvae of *Limnoxenus*, a scavenger water beetle, were found on one of Brian's visits. The adults eat waste, algae and bacteria.

Most of the water beetles found at the Derdibin gnamma are predatory. Both adults and larvae eat a wide variety of small aquatic organisms. Most larvae have long jaws to suck fluids out of their prey. Larvae can attack animals much larger than themselves including insects, crustaceans, worms, leeches, molluscs and tadpoles.

The larva forms a cell in damp soil near the water. After pupation – the stage between larva and adult – adults return to the water. Most species are small to medium sized, but some adults grow to 35mm long.

Adults have flattened hind legs with a fringe of hairs that act like oars. They swim to the water surface to gather air which they store underneath their wing covers. This increases the time they can stay underwater.

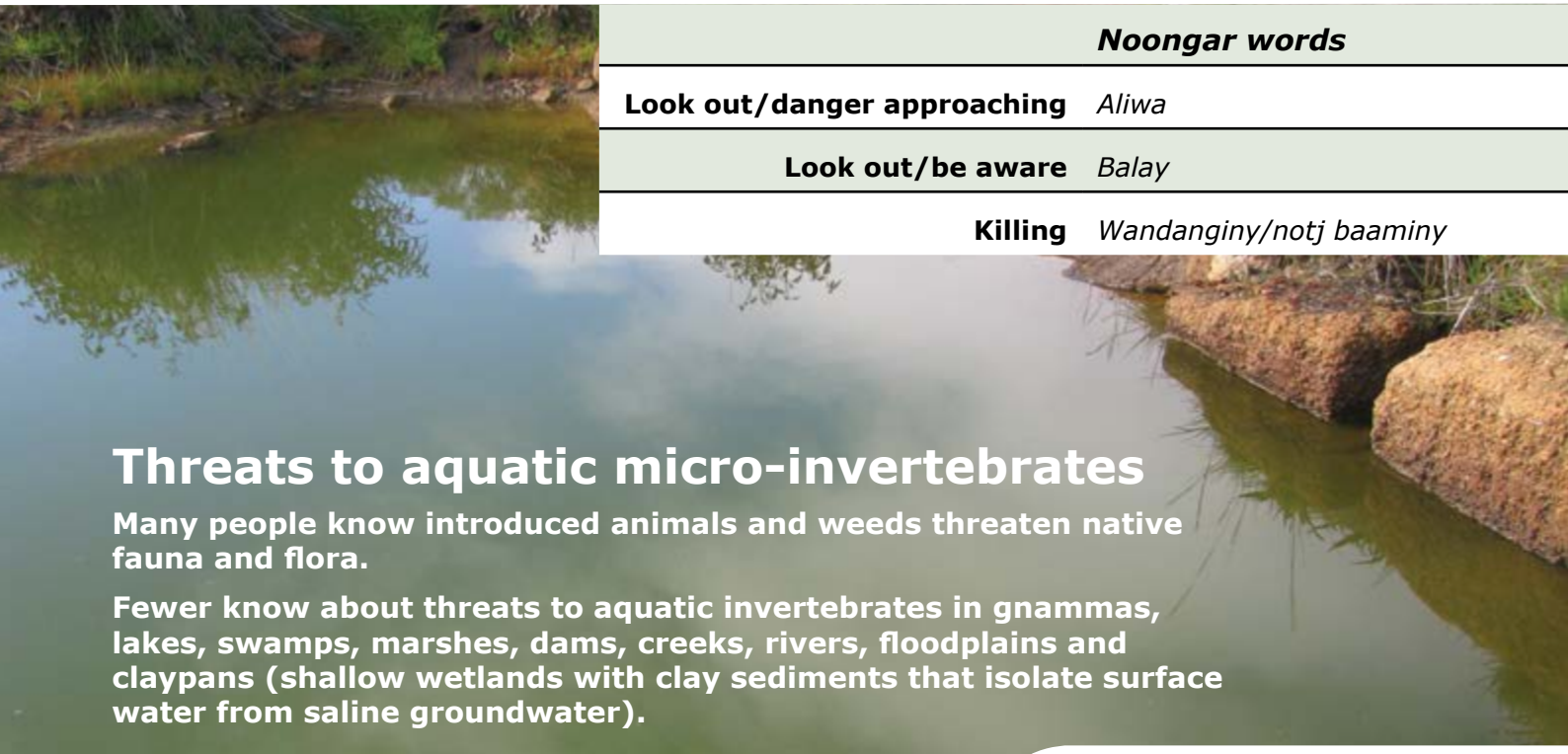
Adults can fly, generally when it's dark. They use reflected light from water surfaces to find new habitats. They prefer slow moving or stagnant water such as gnammas, ponds, lakes, billabongs and dams.

Antiporus Gilberti *Hyphydrus elegans* *Rhantus suturalis*

'The scientific world is still coming to terms with the huge diversity of more than 1,000 species of aquatic invertebrates in the Wheatbelt. Many of these species are not known from anywhere else in the world and this is especially true of the naturally saline playas and ephemeral freshwater wetlands (including pools on granite outcrops). This means the south-west of Western Australia is a biodiversity hot spot for many groups of aquatic animals, just as it is for flowering plants.

The invertebrate faunas of [gnammas] are unique as they have adapted to the unpredictable and temporary inundation periods with short life cycles.'

- Professor Brian Timms in ***Aquatic invertebrates and waterbirds of wetlands in the Avon Region***



	Noongar words
Look out/danger approaching	*Aliwa*
Look out/be aware	*Balay*
Killing	*Wandanginy/notj baaminy*

Threats to aquatic micro-invertebrates

Many people know introduced animals and weeds threaten native fauna and flora.

Fewer know about threats to aquatic invertebrates in gnammas, lakes, swamps, marshes, dams, creeks, rivers, floodplains and claypans (shallow wetlands with clay sediments that isolate surface water from saline groundwater).

Ecosystems would collapse quickly if microfauna were removed.

As well as salinisation, acidification, weed invasion, rubbish dumping and climate change, microscopic animals in wetlands (and hence the animals that rely on them) are threatened by:

Water turbidity (muddiness)	Dirty water interferes with the ability of micro-crustacea to swim, and reduces light availability for photosynthesis which inhibits algae growth. Water clarity deteriorates when bare soil blows or runs into the water.
Farm fertilisers	Phosphorous and nitrogen run off can generate excess algae, upsetting aquatic ecology.
Pesticide contamination	Many micro-invertebrates can accumulate pollutants in their bodies. Pesticides are known to kill aquatic organisms.
Habitat loss	Removing fallen trees from rivers has wiped out many micro-invertebrate habitats.
Increased run off	Land clearing, some farming practices and feral animals bare soil. When rain falls on bare soil, more of it runs into wetlands, affecting the aquatic micro-invertebrates.
Changed conditions	Many wetlands now are permanently dry or permanently contain water, changing the kinds of aquatic micro-invertebrate fauna able to live in them.

'…wetlands in the Avon region are continuing to decline due to salinisation, acidification and weed invasion, and a changing climate will have consequences for these wetlands that are as yet hard to predict.'

- Professor Brian Timms in *Aquatic invertebrates and waterbirds of wetlands in the Avon Region*

'Outcrops may … be important for the wider aquatic invertebrate fauna as a freshwater habitat, if salinity in the Western Australian wheatbelt continues to increase.'

- from *Granite outcrop pools in south-western Australia: foci of diversification and refugia for aquatic invertebrates*

Gnamma cleaning tips

If you want to organise a pit gnamma clean-up for cultural and/or biodiversity reasons, consider these suggestions.

Before the clean-up

People to involve	Understandings and agreements	Schedule	Equipment
Landholder Aboriginal Elders and community Regional and local NRM organisation/s Local government authority Scientists Other interested groups and community members	Gnammas as Aboriginal sacred sites Gnammas and granite outcrops as special biodiversity habitats Landholders' rights Permission to access the site: both for the clean-up and in the future	Make a time to meet, get to know each other and inspect the site. Schedule the clean-up just before winter rains so it gets refilled with rain water as soon as possible afterwards. Don't do it in summer heat. If you do flora and fauna surveys, schedule them for August – October when there are wildflowers and orchids blooming.	Electric pump and hoses Buckets Rope Wheelbarrows Ladders Food and drink Eager volunteers Something to wash and dry yourself with Cameras Change of clothes

	Noongar words
Welcome	*Wanju*
Thank you	*Kaya*
No	*Yuwart*
Exclamation (cry of joy, excitement or alertness)	*Yakai*
Wait	*Yelakitj*
Now	*Yey*

A frog protected during the Derdibin gnamma clean up in 2011.

The clean-up

Follow the basic steps outlined in 'The Derdibin gnamma clean up' on page 20.

After you've pumped out the water Professor Professor Brian Timms says:

'Resting eggs of the crustacean inhabitants will be in the bottom mud and it is important to retain these. There may also be resting snails and perhaps little frogs hiding among the rocks. Forget about any insects, as they come and go and survive dry times elsewhere. So:

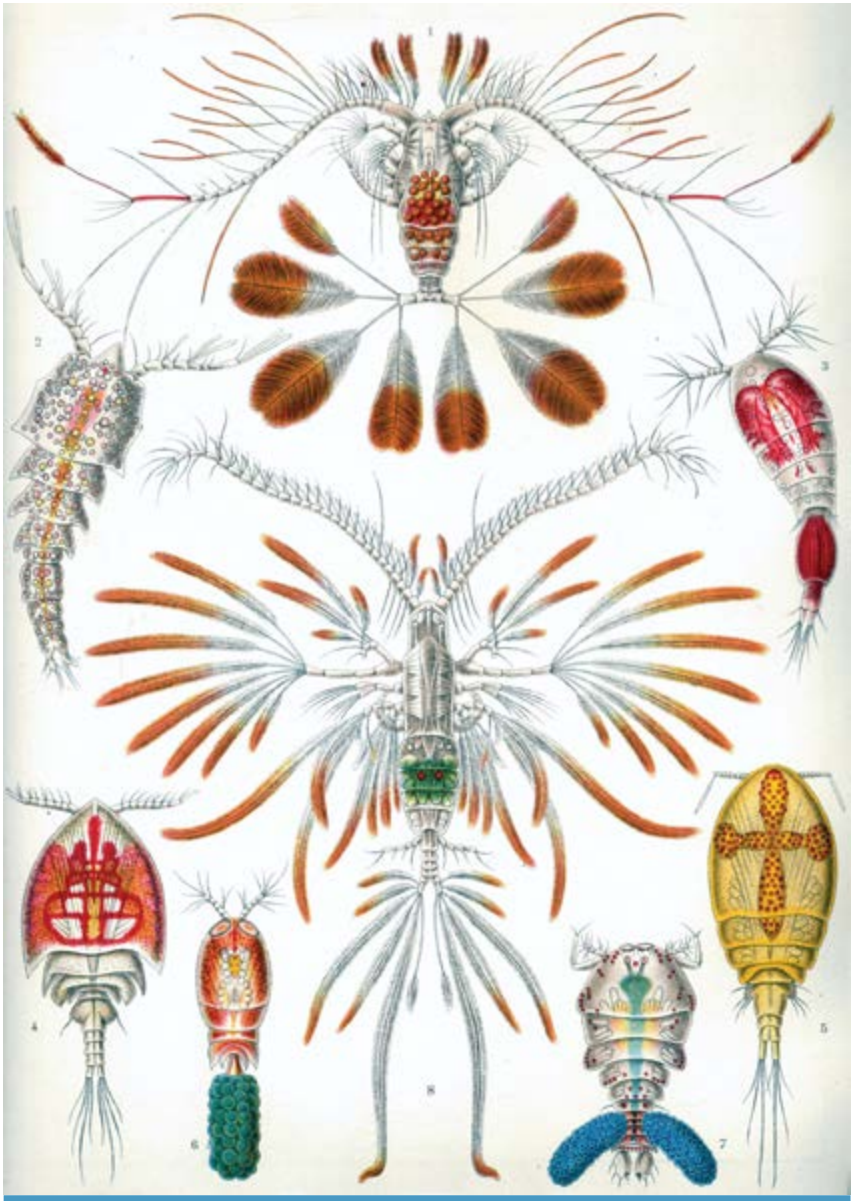
1. Take about a 10cm x 10cm slab of the bottom silt to a depth of about 2-3cm and store it for later return. Should a gnamma be large (>1m in diameter near the bottom) then take extra slabs, two for each extra metre in diameter. The extra slabs should be taken from different areas of the bottom. These slabs of material (which will no doubt have fallen apart) can be stored together.

2. *Remove as much of the other silt and rocks as reasonably possible, making sure the removed material is dumped beyond the catchment of the gnamma. This is because if it is left on the side of the gnamma, much of the silt will soon wash back into the gnamma.*

3. *Be careful about any resting snails and little frogs hiding in the debris. Try to catch these and keep them safe in a container. If lizards and other truly terrestrial animals (e.g. crickets) are found, then these can be placed on/in the pile of material removed. They will either stay with this material or move away and their chance of survival will be good.*

4. *Once the silt and rocks have been removed, return the 'slabs' taken out at the beginning to the bottom of the gnamma. If perchance there is some remnant water in the bottom then do not place the returned material in this, but in a dry place. This is recommended as it is possible any remaining water will be of poor quality and hence not be conducive to the survival of crustacean resting eggs. If necessary remove as much as possible of this poor quality water, so that the returned silt remains dry till the gnamma fills naturally. This may be an unnecessary precaution as resting eggs are very tough! Also if frogs are present, retain some water.*

5. *Return any snails and frogs, providing some small flat stones for them to hide under. If there are frogs and some water is present, then retain this in the gnamma to help in their survival. If snails are present then this precaution is not necessary.*



Copepods are tiny crustaceans that can be found in gnammas. These illustrations of copepods are from the 56th plate from Ernst Haeckel's *Kunstformen der Natur (1904)*.

During dry periods gnammas can be death traps for wildlife (kangaroos, emus, bobtails, snakes). I would imagine that before white settlement these would have been removed immediately, so if possible, patrol the gnamma in drying times as often as feasible, in order to save wildlife and to maintain water quality (though it is amazing what invertebrates can live in a gnamma with stinking carcasses!).'

- Professor Brian Timms, Australian Wetlands, Rivers and Landscape Centre, University of NSW

After the clean-up

Celebrate your success. Like Brian suggests, keep an eye on the gnamma, particularly in dry times, and remove any dead animals. Leave a large log poking out of the gnamma so if an animal falls in it has a chance of climbing out. Birds can perch on the log to have a drink and it can also provide a home for aquatic invertebrates.

Clean-up volunteer Kiel Atwell

Limnoxenus - a scavenger water beetle whose larvae were found at the Derdibin gnamma

More information...

Derdibin Gnamma

Clean up and fauna survey movie produced by Wheatbelt NRM in 2013 at youtu.be/YunoUEZTbCk

Movie shot from the air showing Derdibin rock, nearby salt lakes and the Derdibin gnamma produced by Wheatbelt NRM in 2012 at youtu.be/dQGj4Ww_CoM

Noongar culture

Noongar seasons and food: tinyurl.com/q4p5khf

Noongar language: *Nyungar Budjara Wangany Nyungar NRM Wordlist & Language Collection Booklet of the Avon Catchment Region*, published by Wheatbelt NRM in 2010 available at www.wheatbeltnrm.org.au/resources/nyungar-dictionary.pdf

The book *Walwalinj: the hill that cries / Munyari Ralph Winmar* by Ralph Winmar, published by Dorothy Winmar in 1996.

The website www.noongarculture.org.au

Invertebrates and/or gnammas

The book *Aquatic invertebrates and waterbirds of wetlands in the Avon region* by Susan Jones, Cara Francis, Anna Leung and Adrian Pinder at bit.ly/17NTNK1

The Journal of the Royal Society of Western Australia article *Granite outcrop pools in south-western Australia: foci of diversification and refugia for aquatic invertebrates* by A M Pinder, S A Halse, R J Shiel & J M McRae at bit.ly/1cWi3Qz

The Journal of the Royal Society of Western Australia has several other articles about gnammas and invertebrates by a range of authors. Search for gnammas, aquatic invertebrates, rock pools or Professor Brian Timms in the journal section of www.rswa.org.au.

www.australianwaterlife.com.au/microfauna.html

Biodiversity of the Southwest Australia Ecoregion

The website swaecoregion.org

Acknowledgements

Kevan and Rose Davis,
the Noongar community and volunteers

Professor Brian Timms, Australian Wetlands, Rivers and Landscape Centre, University of NSW

WWF-Australia: Phil Lewis, Mike Griffiths, Chris Curnow and Jenny Borger

Former Northam TAFE students: Kiel Attwell, Alisha Ashworth, Shantelle Bennell and Margaret Bennell

Wheatbelt NRM: Nathan Heal, Mick Davis, Sue Carter, Anika Dent, Dr Elizabeth Kington, Dianne Lovell and Kerry Horan

Adrian Pinder, Department of Parks and Wildlife

Jane McRae, Bennelongia Consultants

Shire of Wyalkatchem, Paul de Pierres, Jim Riches, Matt Hocking, Christie Kingston

This publication was produced by Wheatbelt NRM, through funding from the Australian Government's Caring for our Country.

Copies can be obtained from www.wheatbeltnrm.org.au or by phoning (08) 9670 3100.

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Watch a movie about the Derdibin gnamma clean-up and fauna survey at youtu.be/YunoUEZTbCk