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NEWSLETTER OF THE LAND FOR WILDLIFE SCHEME

October 2014 | Vol. 18, Number 4

WHAT LIES BENEATH ...?

Martin Caswell

Imagine if you will a world beneath your feet. A subterranean world of rock, earth and water. A world inhabited by creatures that shun the light of day. Enter the realm of stygofauna.

So just what are stygofauna? Globally, stygofauna represent an extremely diverse assemblage of aquatic creatures exhibiting an incredible array of forms, within what is arguably the most extensive terrestrial habitat on earth. And you're standing on it. Groundwater.

The vast majority of stygofauna are invertebrates including countless species of worms, snails, insects, mites and crustaceans. The relatively minor vertebrate component of the fauna is not surprisingly dominated by fish, with some amphibians present in Eurasia and the Americas. They inhabit a wide array of groundwater habitats from caves large enough for humans to enter, down to tiny cracks and fractures within bedrock, and in the spaces between grains of sand. Many sedimentary and volcanic rocks provide ideal habitats for stygofauna. Karstic limestone formations and volcanic lava tubes are just two such habitats. Stygofauna are even known from meltwater in ice caves.

What lies beneath this "land of drought and flooding rains"? You may be surprised! Photo: Penny Hussey

The subterranean environment

The defining characteristic of subterranean environments is the absence of sunlight, which has two major implications. Obviously it influences how animals sense their world; eyes are no longer effective and creatures rely more upon touch and the ability to detect vibration. More important though is the effect on energy and nutrient availability. Without light, there is no photosynthesis, so this fundamental source of energy is absent from the system.

Subterranean ecosystems are typically dependent on energy and nutrients generated above ground, which then finds its way below ground. Transport mechanisms include surface organisms washed into caves, guano from cave visitors such as bats, birds and lizards, and percolation of nutrients down through the permeable soil profile. This material is harvested by scavengers and detritivores, which are in turn preyed upon by carnivorous fauna. Food tends to be widely dispersed and sporadically available.

Adaptations

Life within such extreme environments demands extreme adaptations. Whilst some stygofauna may commute between ground and surface waters, many are permanently confined to life within perpetual darkness. It is the latter that display the suite of adaptations that are characteristic of subterranean creatures. In a wonderful example of convergent evolution, animals as distinct as crustaceans and fish have responded to the environmental constraints of subterranean life with similar behavioural, morphological and functional adaptations.

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Editorial

Greetings all!

Responsible management of the country's natural resources includes all levels of human activity, including legislation and regulation. An article in this issue introduces readers to the *Biosecurity and Agriculture Management Act 2007*, which first started being used in 2013. This is a very important piece of legislation that seeks to minimise threats arising from potentially damaging pests and diseases. It is very complex, and a magazine such as *Western Wildlife* can only scratch the surface of all its implications. However, it does give you a comprehensive list of contacts – both electronic and human! – which interested readers could access to obtain further information.

Our lead story goes below the land surface, to consider the extraordinary subterranean life forms that exist in groundwater. It got me thinking about just how adaptable and resilient life is, but also how easily we unthinking humans can cause irreparable harm. But there are also plenty of delightful stories from people who do care; check out the eagle eyes, frogs eggs or the bustard egg!

If a species is listed as Threatened under the Commonwealth legislation, it is afforded additional protection and this may allow increased opportunities for research funding. Carnaby's Cockatoos have been so listed for a few years now, and that accounts for some of the community concern and excellent research that has been undertaken on the biology and natural history of the bird. Over the years, *Western Wildlife* has published 26 articles with Red- or White-tailed Black Cockatoos as a focus! This issue continues the trend, with two papers focusing on nesting requirements, one from the scientific and one from the community perspective.

Please note that, due to financial restrictions, Mal Harper and Phil Worts are no longer working with *Land for Wildlife*. This leaves Avril Baxter as the only *LFW* Officer in the Wheatbelt, so please be understanding if she is slow responding to your enquiries. However, both Mal and Phil have said that they will be able to answer queries related to their local area, therefore we have left their contacts on the list below.

With best wishes for an excellent end to the season,

Penny Hussey

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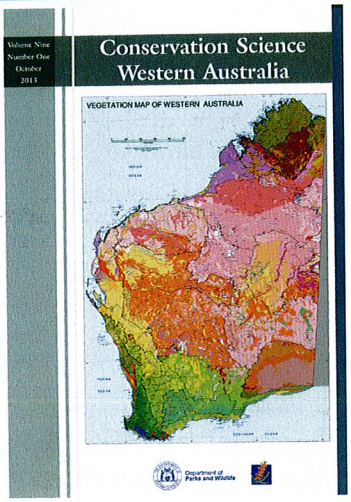

This is the new Beard Vegemap - see p. 17.

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www.dpaw.wa.gov.au/landforwildlife

EAGLE EYES

Amanda and Stuart Payne

We have been rehabilitating birds of prey for 21 years under WA Conservation of Raptors and also work full-time in unrelated jobs. One of the species we regularly care for is the Wedge-tailed Eagle, Australia's largest bird of prey with a wingspan of between 1.8m and 2.5m.

Over the 21 years we have probably handled more than 200 Wedge-tailed Eagles with about a 35% success rate of releasing them back into the wild. Unfortunately, when they are handed in to us they have often been hit by trucks, and when trucks hit eagles it is usually terminal, due to broken bones and internal injuries. We helped to reduce this many years ago by Stuart attending a couple of mine site talks and requesting that someone goes around in the morning and removes kangaroo carcases from the side of the road, pulling them well off into the ditch, to enable Wedge-tailed Eagles to eat without being hit. We believe this is now a part of the early morning routine at many mine sites.

Over the years we have had great opportuniies to observe Wedge-tailed Eagles in captivity and have had the unique experience of getting a close look at their eyes. It is still a privilege to do this even after 21 years.

Whilst administering medications or changing dressings, we are obviously looking into the eyes of the eagles and we have noticed that there is a distinct variation in colouring between juvenile and adult eagles. Juvenile eagles (as seen in Photo 1) have a uniform eye colour ranging from a pale tan to olive, whilst mature eagles (as seen in Photo 2) of a mature female, have mostly dark irises with many distinct golden coloured flecks. It appears that as the birds age they get more golden flecking in the eyes. The juvenile bird in Photo 1 is most likely under two years old, whilst the mature bird in Photo 2 is most likely ten or more years old.

The keen eyesight of Wedge-tailed Eagles extends into the infrared and ultraviolet bands. This helps them to spot prey and allows them to see rising thermals, which they can use to gain altitude while conserving energy. Wedge-tailed Eagles hunt by day and have sophisticated binocular vision which they use to accurately assess distances and pinpoint their prey, but their eyesight is not so good in low light conditions.

Juvenile eagles and mature eagles have a variety of colours. Juveniles range from an almost blonde head and golden shoulders through to dark chocolate brown. Mature adults are uniformly dark brown, almost black with a white 'V' down their back. These colour variations enable a juvenile eagle to fly through a mature eagle's territory relatively unharmed, as the mature eagle recognises the juvenile's colouring as being non-threatening, so there is no need for the mature eagle to waste energy in chasing it out of the territory. However, if a mature single eagle with its dark colouring dares to fly through the territory of a mature eagle pair it will most likely get killed by those eagles that have claimed the territory.

The beak of the Wedge-tailed Eagle also changes colour as the bird matures. The eagle's beak is black much further up the beak when the bird is young and as it matures the black colouring slowly reduces until it is just on the tip of the beak in very old birds.

Photo 1: juvenile.

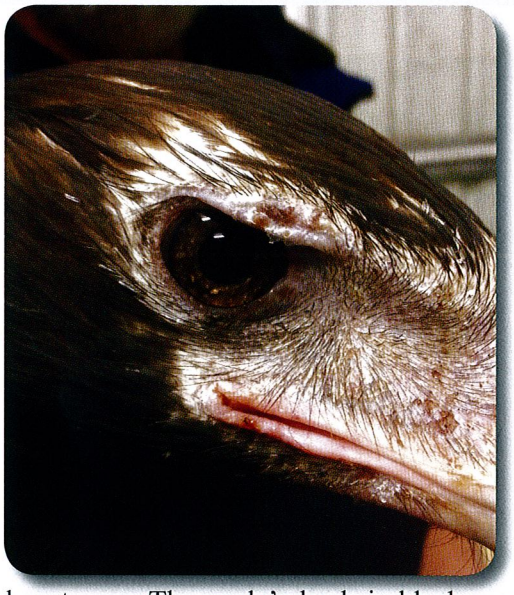

Photo 2: adult
Photos: Amanda Payne

We hope that we can enjoy looking into eagles' eyes for a lot longer and also raise our success rate for release as it would be good to get these guys back out where they belong.

Please have a look at our Facebook page under WA Conservation of Raptors, or contact us on 0418 945 848 for birds of prey enquiries only.

Did you know ...?

... that humans have 200,000 light-sensitive cells in a mm^2 of retina; eagles have 1,000,000 light-sensitive cells in a mm^2 of retina.

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What lies beneath ... ?

Stygofauna typically exhibit adaptations that efficiently utilise the limited resources - such as longer lifespans, slower growth rates, reduced fecundity - and are less aggressive with individuals of the same species. Underutilised or redundant muscles, organs, pigments and fish scales atrophy or disappear altogether as it is 'expensive' using energy to maintain features with no survival benefit. In contrast, organs and appendages that provide information from tactile, vibrational and auditory cues become pronounced. Many invertebrates display elongated and sensitive hairs, legs and antennae. (Fish just bump into things and hope!)

Threats

Threats to stygofaunal communities are not unique to subterranean environments and comprise the usual suspects of over-utilisation of resources, environmental contamination, and changing environmental conditions, whether anthropogenic or (just as importantly) natural.

Many stygofauna are at high risk of extinction from even localised threatening processes, as many are endemic to a very restricted area. Even adjacent caves can have distinct faunal assemblages.

A major threat is posed by excessive aquifer drawdown. This results when the rate of abstraction of water exceeds the rate at which natural recharge tops up an aquifer, lowering the water table and leaving the fauna quite literally high and dry. This appears to have been a significant long-term issue for the Yanchep cave system north of Perth, Western Australia, where drawdown on the Gnangara water mound, which provides a significant portion of Perth's water supply, may be linked to the drying out of the cave system.

Excessive drawdown of freshwater aquifers may also result in contamination with brackish water from adjacent estuarine systems.

Groundwater may also be contaminated with chemicals and nutrients derived from industry and agriculture, and with the biodegradable fluids introduced during drilling and fracking of boreholes seeking water, hydrocarbons, minerals, and geothermal energy. The addition of nutrients to a naturally nutrient-poor ecosystem can have significant adverse consequences. Whilst some fauna may thrive in the 'enriched' environment, in an ecosystem adapted to limited resources the excess influx will likely prove detrimental to the majority.

Anthropogenic climate change has a significant potential to influence stygofauna via modified precipitation and drainage patterns, groundwater recharge, and brackish and saltwater incursion into aquifers as a consequence of altered sea levels.

Natural threats may result from localised and regional environmental change, both long- and short-term. These may include short-term fluctuations and long-term changes in climatic patterns as well as marine transgressions and regressions. It is worth noting that whilst natural 'threats' adversely impact stygofauna when viewed in the short-term, they may be the evolutionary drivers that have produced the fauna we see today.

WA stygofauna

Western Australia is considered a global biodiversity hotspot for stygofauna. Many Western Australian stygofauna have close relatives throughout the remainder of Australia and other continents, suggesting the ancestors of our present fauna were widely distributed across the Pangaean supercontinent prior to its split into Gondwana and Laurasia, and their subsequent fracturing into the continents we know today.

The diversity of our stygofauna is hardly surprising considering the wide array of groundwater ecosystems across our vast State, which straddles multiple climatic zones, from tropical in the north to temperate in the south, and encompassing both wet and arid precipitation patterns. However, the current picture is only part of the reason for such diversity. We also need to consider the physical evolution of the Western Australian environment through deep geological time. Most of Western Australia has been geologically stable for hundreds of millions of years. Over this time climatic patterns have repeatedly cycled between wet and arid. During arid periods, fauna retreat to isolated refuges, facilitating speciation.

Amongst the best known Western Australian stygofauna are those inhabiting the karstic limestone cave systems in the south west such as Yanchep and Margaret River, and in the Cape Range near Exmouth on the north-west coast. The cave systems within the Pilbara are becoming better understood as a consequence of environmental studies associated with iron ore mining. Additional stygofaunal communities are also widely distributed throughout the fractured rock aquifers of the goldfields and wheatbelt, are associated with mound springs and occur within the Gnangara and Jandakot water mounds. This list is by no means comprehensive.

Whilst many of these communities are only documented in scientific or specialist publications, engaging *Landscope* articles* have been written on the Pilbara ecosystems and the Yanchep rootmat communities. Interested people are strongly encouraged to read these articles, as the nature of these complex ecosystems is well presented by specialists in the field.

The future

The subterranean world

remains underexplored and poorly understood relative to surface aquatic environments. Nevertheless, with increased opportunities for research our understanding of groundwater ecosystems has substantially advanced over the last few decades facilitated by improved access to bores, wells and pits generated during development of natural resources and groundwater supply. State Government agencies including the Museum and the Department of Parks and Wildlife are working with the support of the private sector to continue improving our understanding of this important environment.

Considering the ability of stygofauna to thrive in both fresh and saline water in subterranean environments as diverse as caves and fractures in rocks and ice, and within sand, soil and deeply weathered rock, you'd be hard pressed to find a body of groundwater that is not home to stygofauna.

Considering that much of our drinking water is derived from groundwater aquifers, next time you have a glass of fresh, filtered, bug-free water, just think about whose home you are drinking.

The author is a geologist with over 25 years experience in mineral and groundwater exploration, who was introduced to stygofauna over a can of beer in 2006. He currently volunteers with the Department of Parks and Wildlife, and previously assisted CALM and DEC.

[*For references, contact Editor.]

Did you know ... ?

... that in 1939, the London Zoo killed all its collections of venomous snakes, Black Widow Spiders, and other poisonous/toxic invertebrates, as a precaution against the possibility of them being 'liberated' during air raids?

WHOSE EGG?

Vikki Viela

We live on a 5 acre bush block in Yallingup and our herb and vegetable patch next to the house provided a constantly moist refuge for Bleating Froglets and the Slender Tree Frog over the long, hot summer. The froglets would occasionally be disturbed whilst I picked produce and the Slender Tree Frog would be seen at night on window ledges and occasionally the window pane itself – it took me a while to figure out how my windows got smeared! Motorbike Frogs would inevitably also pass through the area though they tend to prefer the other side of the house where the ponds are.

At the beginning of March, I went to pick a few lemon balm leaves for my tea and discovered about 10 of these frog egg-like spheres deposited individually on a few leaves as well as on fallen eucalyptus leaves on the ground. I left them undisturbed and continued watering the veggie patch as per normal. Over the course of a few days, the jelly on the eggs appeared to dry out which was not surprising due to the warm days. Whatever produced these eggs, subsequently tried again on four or so more occasions on a weekly basis until I cleared the area in order to plant the winter vegetables. As I left a few moist clumps of herbs, I have spotted both the froglet and the tree frog however, no more eggs appeared for three or so weeks until the other day (end of April). Only two eggs had been produced and I carefully moved them to the shallow pond at the front of the house so as to not see them dry out yet again.

The Bleating Froglet can lay single eggs though usually in shallow water and I have not heard any frogs calling yet. Last autumn I also had Quacking Frogs that started to call at Easter but I have heard nothing yet. I fear the three large Motorbike Frogs that are in the same area have eaten them but keep my fingers crossed that they will start calling soon.

Has anyone come across these egg like spheres to shed some light on the mystery of who they belong to?

Left: the mystery eggs

Above: Bleating Froglet, Crinia pseudinsignifera

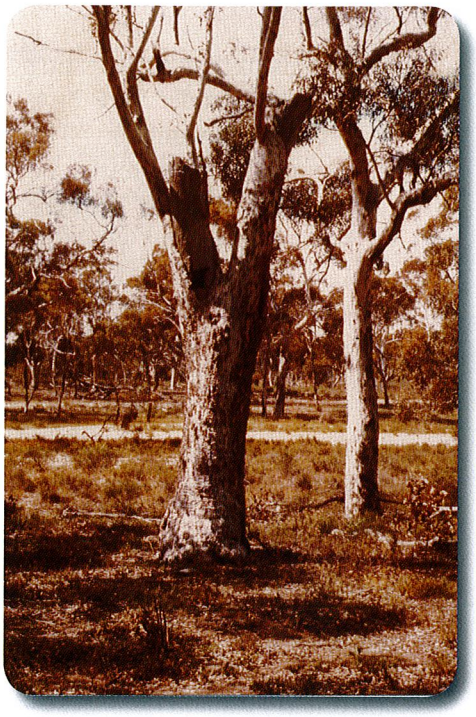
Below: Slender Tree Frog, Litoria adelaidensis

Photos: Vikki Viela

CARNABY'S COCKATOO, TREE HOLLOWS AND THE FATE OF LARGE HOLLOW-BEARING TREES

Denis Saunders, Peter Mawson and Rick Dawson

Carnaby's Cockatoo *Calyptorhynchus latirostris* is an obligate hollow nester, that is, it only nests in hollows in trees or in artificial hollows placed in trees or on poles. This black cockatoo is large; adult females are about 540mm long and 104mm across their shoulders with their wings closed and weigh around 650g. They also have a long tail of about 260mm; about half the length of their body. Unlike the Galah *Cacatua roseicapilla* and Western Corella *C. pastinator*, Carnaby's Cockatoo back into their nest hollows so the hollows they use must be large enough to allow them to manoeuvre their tail down the hollow. Hollows of this size are only found in large old eucalypts.



Tree 22 in 1970. This tree has two large hollows, both of which were regularly used in the same season by Carnaby's Cockatoos. The hollow in the left branch has an access hatch cut into the side and the hatch was in place when the hollow was not being inspected.
Photo: Denis Saunders

Tree 22 in September 2009, 39 years after the first photograph. Note that neither the tree nor the surrounding vegetation is much changed, however both hollows required renovations to make them suitable for use by Carnaby's Cockatoo.
Photo: Denis Saunders

One breeding population of Carnaby's Cockatoo at Coomallo Creek has been studied in detail since 1969 with at least two visits made to the area each breeding season for 22 of the years from 1969 to 1996 and then at least twice each year since 2009. During each visit, hollows known to be used by Carnaby's Cockatoo were inspected, the contents noted and if the nestling was at least three weeks old, the length of its folded left wing was measured (mm), it was weighed (g), sexed on the size and colour of its cheek patch, and banded with a uniquely numbered leg band. When a hollow was first found, its location was plotted on a map of the study area and it was assigned a unique number. The following characteristics and dimensions were taken; species of tree, entrance width and height (mm), depth (m) of the hollow from the lowest point of the entrance, aspect of the hollow (vertical, north, north-west, west, south-west, south, south-east, east or north-east), the height (m) of the hollow from the ground to the lowest point of the entrance, and if possible the diameter of the floor (mm). Each hollow was examined during every visit until the tree no longer stood or the hollow was no longer suitable for use by a Carnaby's Cockatoo. During each visit searches were made for any hollows in use that had not been previously located that were then added to the records. The breeding behaviour of the birds was also studied based on individually marked females; marked initially with leg bands and wing tags and then only with leg bands. In 2009 all hollow trees studied until 1996 which remained standing were re-measured.

Carnaby's Cockatoo at Coomallo Creek breeds in a 9km long uncleared strip of Wandoo *Eucalyptus wandoo* woodland, which is largely ungrazed by domestic livestock. This strip of woodland is an island of woodland habitat surrounded by cleared agricultural land and kwongan. At present native vegetation occupies about 35% of the study area. In addition, the birds breed in trees left in paddocks.

We established that breeding females demonstrate fidelity to nest hollows. They apparently prefer to nest in the same hollow they have used the previous season, provided they were successful in fledging young the previous year and the hollow was unoccupied when they next commenced breeding. For example, of 153 successive breeding attempts by individually marked females whose breeding outcome was

known; 44% successfully fledged at least one young and used the same hollow the next breeding season; 24% were successful, but moved hollows because the previous hollow was in use; 12% were successful, but moved hollows even though the previous hollow was apparently unoccupied; 19% were unsuccessful and moved to another hollow; and only 1% were unsuccessful, but used the same hollow as their previous breeding attempt. Breeding females also demonstrate location fidelity with 53% of breeding attempts made in the same hollow or one within 100m of their earlier hollow and 86% within 1km of their earlier hollow.

Fifteen females that fledged in the study area returned to breed. The average distance between the hollow from which they fledged and the one in which they were first recorded breeding was 2.2km with a range of 50m to 5.9km.

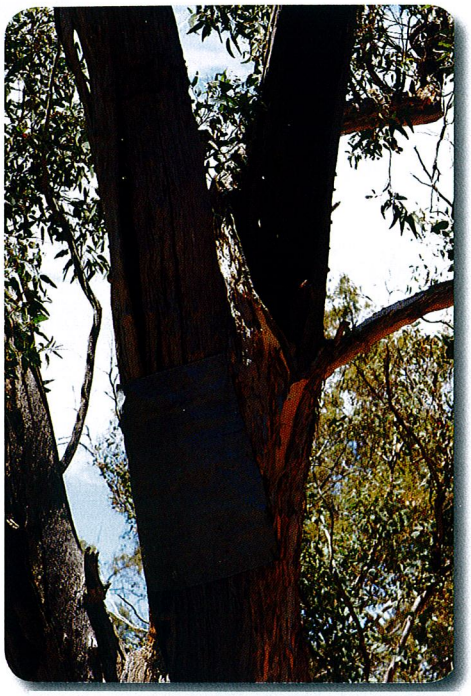
Two species of eucalypt provided the hollows used by the black cockatoos at Coomallo Creek; 228 were in Wandoo and three in Powderbark Wandoo (*E. accedens*). Over the period of the study, 1281 breeding attempts were made in Wandoo and 12 in Powderbark Wandoo. Hollow entrances were usually round, with an average entrance height of 271mm and width of 268mm. The average depth was 1.24m, average floor diameter of 407mm and average height above ground of 4.71m. 58% of the 221 hollows for which data on aspect were available opened vertically and the other 42% were randomly distributed around the eight compass classes (N, NE, E, SE, S, SW, W and NW). Basically our data indicate that females select hollows regardless of aspect and in proportion to their availability. Choice of aspect did not seem to confer any advantage for successful breeding.

Carnaby's Cockatoo need a hollow deep enough to prevent their nestlings from falling out and birds nesting in hollows less than 0.4m deep were less successful than those using hollows at least 1.00m deep. We saw a number of cases where birds in shallow hollows were poorly protected from rain and cold winds and this may have contributed to the higher failure rates.

Galah, Western Corella, Regent Parrot *Polytelis anthopeplus*, Barn Owl *Tyto alba*, Nankeen Kestrel *Falco cenchroides*, Southern Boobook *Ninox novaeseelandiae*, Australian Ringneck *Barnardius zonarius*, Laughing Kookaburra *Dacelo novaeguinea* and European Honey Bee *Apis mellifera* all used hollows that had been used by Carnaby's Cockatoo. On average these competitors used 10% of the available hollows while Carnaby's Cockatoo used 32%. In other areas Galah, Western Corella and European Honey Bees do pose threats to Carnaby's Cockatoo by competing for nest hollows, but at present none of these species pose a serious threat to Carnaby's Cockatoo at Coomallo Creek.

Data were available on the change in depth of 95 hollows over periods up to 41 years. On average, hollow floors fell by 29mm/year. The extreme changes in depth were one hollow floor which fell 4.4m over 38 years and one which rose by 1.8m over 37 years. Hollow floors fell because the decayed heartwood compressed over time or because a crack lower down allowed the filling to fall out. Hollow floors rose because decayed heartwood in the trunk above the entrance to the hollow fell into the hollow.

We recorded 252 hollow-bearing trees used by Carnaby's Cockatoo between 1969 and 2013. At the end of the 2013 breeding season 40% of these trees had been destroyed or damaged such that the hollows were no longer suitable for use by the black cockatoos, and only 22% had hollows suitable for use by the birds. Damage



Tree 15 showing repairs to the side of the hollow, the floor of which had been exposed and the hollow was no longer being used. After the repairs the hollow was used by Carnaby's Cockatoo. Photo: Denis Saunders

or loss was caused by wind throw/tree fall, deliberate fire or wildfire, agricultural clearing, parts of the tree breaking off or change in diameter of the floor.

In late December 2009, when a wildfire started by agricultural machinery swept through the southern end of the study area, there were 28 nest trees in the path of the fire. Twelve of these were in the bush and 16 in paddocks. Sixteen of these trees were destroyed by the fire. At the time, three contained Carnaby's Cockatoo nestlings and all were killed. After the fire there was no significant difference in the fate of large hollow-bearing trees situated in uncleared vegetation and in paddocks.

We predicted that, if only natural events that damage trees are considered, 80% of the 141 large hollow-bearing trees standing at Coomallo Creek in 2013 would still be standing at the end of 2125. However, when human activities such as agricultural clearing and

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fire are also taken into account only about 29% would be standing at the end of 2125. However, although a large hollow-bearing tree may still be extant in 2125, that does not mean that it will contain a hollow suitable for use by Carnaby's Cockatoo. For example, 48 hollows (which represented 19% of hollow trees marked) were repaired by us or by volunteers from Birds Australia (now BirdLife Australia) as some damage had rendered the hollows unsuitable for use. Renovations were carried out when time permitted and involved repairs such as placing sheets of tin over holes in the sides and/or raising the floors with sterile woodchips. Fifteen of these renovated hollows were used at least once in 2012 or 2013 and another 15 were used in both years.

What are the conservation implications of this long-term study of one breeding population of Carnaby's Cockatoo? Over successive breeding seasons female Carnaby's Cockatoos will favour the same hollow they used the previous season, provided they were successful the previous year and the hollow was available when they return. They select hollows in proportion to availability, and not on any preferences for particular tree species, nor on particular aspect. They will nest in any hollow provided it is large enough for them to access.

At Coomallo Creek and throughout much of the range of Carnaby's Cockatoo, large hollow-bearing trees are being lost or destroyed at a greater rate than they are being created. While a large hollow-bearing tree may stand for hundreds of years, internal changes to any hollows they bear may have rendered them unsuitable for use by cockatoos. The rate of loss of trees and suitable hollows means two conservation actions need to be carried out. The first is extensive revegetation and regeneration of eucalypt woodland in Carnaby's Cockatoo breeding areas. This is a long-term measure as any revegetation and regeneration will not be large enough to support a hollow suitable for a black cockatoo for over 150 years. The second action is the maintenance of existing hollows to ensure they are repaired as soon as they become derelict. Without regular maintenance, existing hollows will be lost at a rate that is unsustainable. This may require the covering of holes in the side of the trunk, raising the floor with sterile woodchips or clearing out shards of wood that have fallen to the floor from inside the hollow. In addition, the number of available hollows may need to be boosted by installing artificial hollows that have a floor diameter of around 400mm and a depth of at least 1m. We are conducting a trial of 60 artificial hollows at Coomallo Creek at present and will be reporting on the results of this trial in the near future.

Who undertakes revegetation and hollow maintenance and who pays? The owner of the property on which the woodland occurs is the obvious source of maintenance. In the case of conservation reserves in the Crown estate, this should be the responsibility of the managing agency. In the case of private property, on which a considerable extent of woodland used by Carnaby's Cockatoo for breeding exists, it could be the property owner. However, this is beyond the duty of care that society has the right to expect of property owners without adequate compensation for their time and money. The debate about who does what and who pays for it is one that needs to be had soon as without stronger protection of existing woodland, including paddock trees, renovation of existing hollows, and extensive revegetation and regeneration of woodland, the future for those species dependent on large hollow-bearing trees is bleak.

Readers interested in the detailed results and discussion should consult the original paper. For further information contact Denis Saunders at denis.saunders@csiro.au

[* For references, contact Editor]

Denis Saunders works with CSIRO, Peter Mawson with the Perth Zoo and Rick Dawson with Parks and Wildlife.

BLACK COCKATOO FRIDAY

Avril Baxter

On Friday 13th June, the Peel-Harvey Catchment Council, South West Catchments Council, BirdLife Western Australia and *Land for Wildlife* delivered a workshop on black cockatoos, aptly named 'Black Cockatoo Friday'. Gaps in our knowledge of black cockatoos in the region were highlighted. West of Narrogin, all three species of black cockatoos – the Forest Red-tail, Carnaby's and Baudin's Cockatoos can be found, but our knowledge of their movements is very limited. We have some data from the Great Cocky Count, held in April each year, about where they might roost, but where do they breed?

Hugh Finn, from BirdLife Western Australia, described some of the signs which might indicate breeding activity. For example, early in the breeding season at dawn, mid-morning and dusk, a single male bird in flight may be seen - he will be bringing food to the female who is incubating the eggs. Follow that bird!

In a cleared agricultural landscape, finding adequate nesting hollows within 2km of a water supply and preferably within 6km of a food source can be difficult.

Francis Smit, from Landcare Serpentine-Jarrahdale, spoke of the group's success in developing the Cockatube® nesting box. These nest boxes are made from recycled polypipe, have internally fitted metal ladders and hardwood sacrificial timber posts. Black cockatoos have successfully fledged in these artificial nesting boxes. Whilst they are most successful if placed in areas where cockatoos are already breeding, the boxes have successfully extended their breeding ranges.

Could we provide breeding sites for black cockatoos in the Narrogin area? *Land for Wildlife* members Jane and Marcus Dyke who, during their *Land for Wildlife* site visit, reported white-tailed black cockatoos feeding in the pine and marri trees around their house, agreed to have Cockatube® nesting boxes installed on their property.

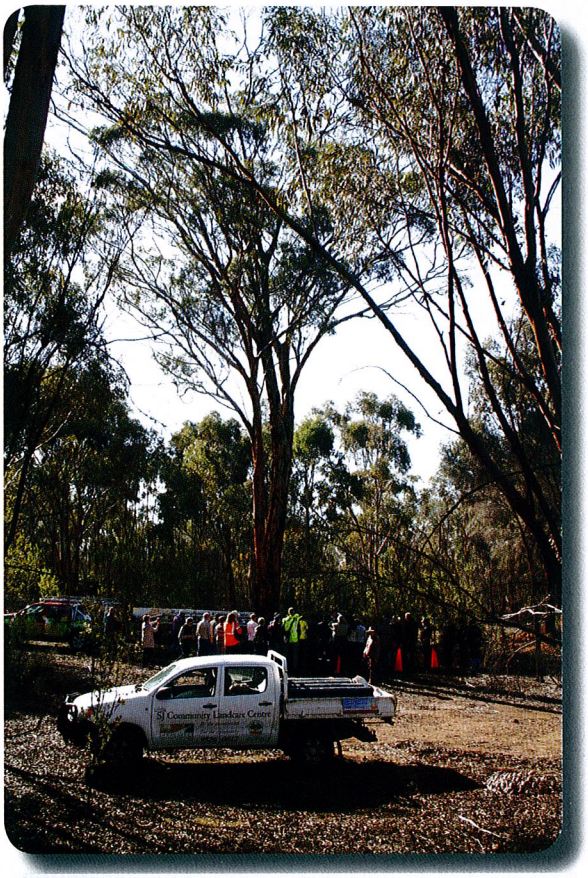
Our next task was to find a suitable site where five nesting boxes could be installed. Trees needed to be easily accessible by a cherry picker, have an open canopy and be tall enough so that the nest box could be installed at least 10m from the ground on the north-eastern side of the tree to reduce exposure to adverse weather and be in a vertical position to deter invasion by feral bees.

Brown Mallets on a laterite ridge surrounded by a shrubland dominated by banksia and hakea shrubs proved to be the ideal spot.

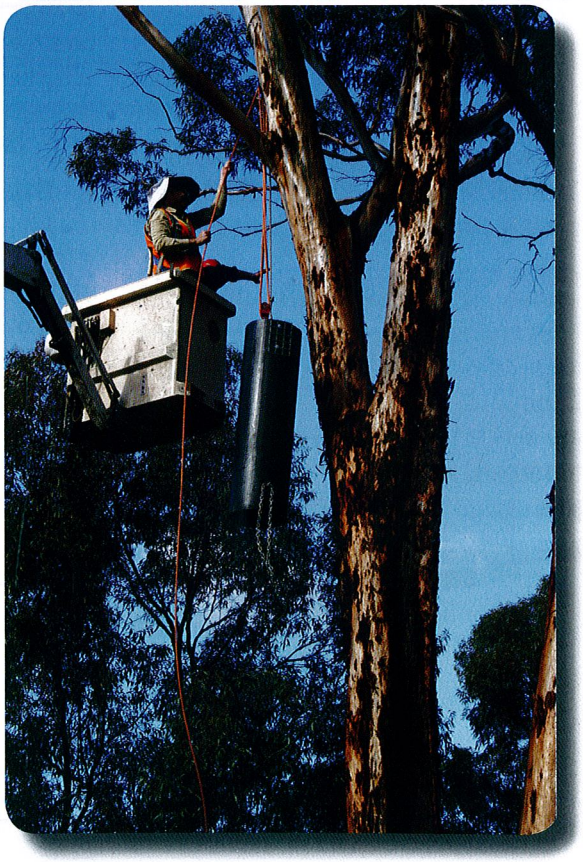
Jane and Marcus will now monitor these nest boxes to see who makes use of them.

If you spot black cockatoos in your area, please register these sightings with BirdLife Western Australia on their website: http://www.birdlife.org.au/projects/carnabys-black-cockatoo-recovery/breeding-range-survey.

Although this website is mainly focused on their breeding range i.e. sightings from July to December, they also welcome reports from the wheatbelt area through January to June.



Above: Over 40 people watch the installation of a Cockatube® onto a fine Brown Mallet.



Below: The Cockatube® nears its destination. Photos: Avril Baxter

BIOSECURITY: PROTECTING WESTERN AUSTRALIA'S AGRICULTURE AND FOOD SECTOR AND THE ENVIRONMENT

Rebecca Heath and Emily Lewis

Western Wildlife *readers may be aware of recent changes in biosecurity legislation and regulations. This article explains those changes; including how community groups are getting more involved and how declared pests are managed.*

Biosecurity and Agriculture Management Act 2007

Western Australia's defences against potentially devastating pests and diseases were strengthened with the *Biosecurity and Agriculture Management Act 2007* (BAM Act) coming into effect on 1st May 2013. The BAM Act replaces 16 older Acts and 27 sets of regulations with one Act and nine sets of regulations. The BAM Act modernises the law to better serve businesses and communities, and can facilitate greater co-operation between government, landholders, industry and the community.

As an example, groups that control pests that impact on public as well as private interests can receive formal recognition as Recognised Biosecurity Groups (RBGs). As an RBG, a rate - known as the Declared Pest Rate - can be raised from private landholdings in prescribed areas by the Minister for Agriculture and Food on request, and matched by the State Government. The funds are used to carry out programs to control established declared pests. These control programs are identified by the RBGs, in consultation with government, to address pests that are a priority for their area.

The Declared Pest Rate is being applied for the first time in 2014/15 in pastoral areas, replacing the Agriculture Protection Rate that operated for many years. Other groups are currently preparing to form as RBGs in the South West Land Division. The strength of RBGs is in enabling adjacent landholders to cooperate at a landscape scale, under community leadership with government in a supporting role.

Industry Funding Schemes (IFSs) are another mechanism under the BAM Act that enable industries to raise funds for the control of identified pests and diseases that threaten the profitability or competitiveness of their industry. Three IFSs are currently operational - grains, seeds and hay; sheep and goats; and cattle - with each scheme overseen by an Industry Management Committee. The committees identify priority pests and diseases to tackle, based on feedback from industry, and collect contributions from participants in the schemes to fund actions.

Declared pests and the Western Australian Organism List

The Western Australian Organism List (WAOL), which was launched on 1st May 2013, publishes the status of organisms that have been declared under the BAM Act. Organisms are grouped into four main classifications: declared pests (section 22); permitted (section 11); prohibited (section 12); permitted requiring a permit (73, BAM Regulations 2013).

A declared pest is an organism that has been assessed as having potentially adverse effects on industry and/or the environment, or the potential for establishment or spread. All prohibited organisms are declared pests.

Organisms that are not listed on the WAOL (i.e. unlisted) have not been declared by the Minister for Agriculture and Food as permitted, prohibited or as declared pests. Unlisted organisms cannot be imported to WA, except with a permit. Information is available on the Department of Agriculture and Food (DAFWA) website regarding the import and keeping of organisms and their potential carriers. The *Wildlife Conservation Act 1950* also requires import permits to be issued for fauna by Department of Parks and Wildlife.

It is the responsibility of the owner of the land to ensure all declared pests are managed on that land. An effective biosecurity system that protects our State from the negative impacts of pests, weeds and diseases requires support and action from all West Australians. We all have a responsibility to make sure we are aware of the issues, report anything unusual and undertake the necessary measures to prevent the introduction and spread of pests, weeds and diseases. In doing so, we will contribute toward the preservation of our unique environment, vibrant economy and lifestyle.

For more information on any of the above please contact:

Biosecurity and Agriculture Management Act 2007

Emily Lewis

DAFWA

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Emergency Animal Diseases: 1800 675 888

Pest and Disease Information Service (PaDIS): 1800 084 881
enquiries@agric.wa.gov.au

More information on the BAM Act can be found at www.agric.wa.gov.au/bam/biosecurity-and-agriculture-management-western-australia

The WAOL can be accessed from www.agric.wa.gov.au/bam/western-australian-organism-list-waol

"Environmental Weeds: past, present and future"

Friday 28th November 2014 8.30 am to 4.30 pm

Murdoch University

Cost: $15.00

Old stagers like myself, who have been involved with bushland care for many years, may remember a conference held in July 1994 at Murdoch University entitled *Invasive weeds and regenerating ecosystems in Western Australia.* It was organised by the Wildflower Society, together with Murdoch University, Kings Park and the Australian Association of Bush Regenerators. The proceedings were published in 1995. It was a very successful event, leading directly to initiatives that saw, among other things, the adoption of a State Weeds Strategy, the writing of *Western Weeds* and also the formation of the community group the Environmental Weeds Action Network (EWAN).

The twentieth anniversary seemed a good time to look back and consider what has been achieved in that time. Some interesting things are happening at present, with the government responding to the WA Auditor General's report into how plant and animal pests are managed (Report 18, December 2013), and people are still adjusting to the implications of WA's *Biosecurity and Agriculture Management Act 2007.* We also want to consider what future can be seen for managing environmental weeds in WA. An exciting range of speakers has been lined up.

Anyone interested in the management of environmental weeds, at whatever scale, from your backyard to the world, will find something of interest in this event.

For further information, contact EWAN by email: enquiries@environmentalweedsactionnetwork.org.au

Penny Hussey for **Environmental Weeds Action Network**

MOTHER OF MILLIONS

Garden plants often hop the fence and start spreading out into the surrounding countryside. One example is this Mother of Millions, *Bryophyllum x houghtonii*, photographed recently near Coolgardie.

The plant gets its common name from the fact that each of the succulent leaves grows dozens of young plants along the edges. These drop off, and can grow where they fall. This species, and a couple more in the same genus, are serious bushland weeds in Queensland. When the population is small, as this one is, it is possible to exterminate it – that is the most efficient way to deal with new weeds.

Who says we don't have epiphytes! David Cousins of DAFWA spotted this Arum 10 metres up in a Karri at Boranup, presumably grown from a seed that had passed through a bird. The whole scene is very pretty, but do we really want our Karri forest changed this much?

LOOKING FOR ERICA

Dorothy Redreau

After Alex George read about Spanish Heath in *Western Wildlife* 17/3, he wrote to the Editor to say "Further, *re* the article on *Erica lusitanica* near Denmark, there's another species naturalised at Shannon. *Erica* expert Ted Oliver from South Africa identified it as *E. bacchans* and there's no record at the Herbarium."

Dorothy Redreau (*LFW*O) and Diane Harwood (local weed expert) undertook a quest to find the population and possibly another on Muir Highway and to collect specimens for the Herbarium. Further instructions from Alex helped pinpoint the location and Jackie Manning provided the coordinates for the Muir Highway population. At Shannon the results were spectacular, with a well-established population found, however we weren't so lucky with the Muir Highway collection, not realising that it was probably some way into the forest south of the highway.

The Shannon population is on the site of a mill town which closed in 1968; other garden remnants include fruit trees, eastern states wattles, broom, and a pine plantation. The *Erica* has spread but has not yet moved very far, though it is quite dense downslope from what appears to be the original population.

Since the area is so degraded, one option is to leave it and monitor closely. However this course of action will give the plant even more chance to naturalise and it is already doing very well with lots of seedlings that flower in the first year and all ages looking very healthy. In the event of any earth works to the area or other disturbance such as fire, this will need very careful management.

Another concern is that this plant looks so like a native that it may be mistaken by visitors for a wildflower and be inadvertently spread by enthusiasts.

Diane advises that:

Managing an isolated outbreak of a suspected or known serious environmental weed is a step-by-step process.

- First find the vesting of the land concerned and map the outbreak. Advise the land manager if necessary.
- Consider markers to determine spread over time.
- Confirm the identification of the plant.
- Consider the history of the site.
- Determine when the weed was first sighted and how it might have been bought in.
- Document the condition of the surrounding vegetation.
- Consider the likely future use of the area, as earth works or fire may impact on management plans. The imperative is not to encourage or allow the plant to spread.
- Care should be taken if removing plants to prevent spilling seed.
- In case of fire, take advantage of the rapid germination typical of weeds to target them as soon as they germinate.
- If 'leave and monitor' is the chosen action, then have some system in place for when the unexpected happens such as fire, beautification, change of land use etc.

As this article is being written, plans are being drawn up for work on the site. This information has proven to be timely and will be used to inform the planning process.

Within Shannon townsite, Diane Harwood surveys the population that forms the shrub layer beneath the trees. It is dense, contains many seedlings and, as can be seen from the photograph below, is a rather beautiful plant. Photos: Dorothy Redreau.

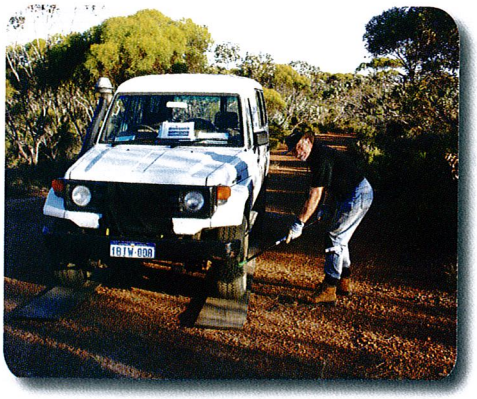
DIEBACK PROTECTION ON LFW PROPERTIES

Dorothy Redreau

Eddy and Donna Wajon own two bush blocks, *Mondurup View* 47ha (Tenterden) and *Chingarrup Sanctuary* 576 ha (Boxwood Hill). They actively manage them for conservation. This includes revegetation and carefully monitoring and recording species.

Eddy and Donna have seen Honey Possums and Western Whipbirds in the revegetation that has been established on Chingarrup and are carefully monitoring the return of life to Mondurup, which was completely burnt in a bushfire in December 2003.

The Wajons have installed dieback hygiene stations on both properties as part of the stewardship of the land and these provide an excellent model for those with dieback-sensitive bushland. A dry cleaning method is used to remove soil from the wheels and undercarriage of vehicles entering the property.



Photos: D. Redreau

The hygiene stations can be easily replicated for about $400, less if you have any materials to hand or assistance from your local landcare organisations. The signs were provided by NRM (would cost about $150). Other materials were a padlock ($15), used conveyor belt ($200) and brushes, bucket etc ($40).

This project is a partnership between the Wajons, Green Skills, South Coast NRM and Fitzgerald Biosphere Group.

DIEBACK-INFESTED BANKSIA WOODLANDS AFFECT BIRD SPECIES DIVERSITY

Infestations of *Phytophthora* dieback in banksia woodlands severely change plant species composition and diversity. A recent paper by a number of researchers from different institutions in Perth investigated how this would affect bird use*. It was found to have a major effect, especially on nectarivores, due presumably to far fewer nectar-producing plants. The results show that the pathogen is a serious threat to avian biodiversity. Since there is at present no known way to eliminate the pathogen, managers are urged to take all precautions possible to prevent its spread.

[*For reference, contact Editor.]

NEW VIDEO ON PHOSPHITE INJECTION

The Shire of Kalamunda and the Dieback Working Group are proud to present a new informative video outlining the steps involved in applying Phosphite to trees at risk from *Phytophthora* Dieback.

Produced by local media company Paperslate and featuring Glenn Tuffnell from Dieback Treatment Services, this video is an excellent resource for bushcare volunteers and students to learn how to undertake phosphite stem-injection.

- What it is – A short instructional video available online. It can be downloaded at home or work on your computer, or when you are out and about using a smartphone (just search 'Dieback Stem Injection').
- What it does – The video outlines the steps for injecting trees with Phosphite, to help protect them from the impact of *Phytophthora* Dieback.
- Where you can get it – Shire of Kalamunda's 'Dieback Management' webpage, or YouTube (just search 'Dieback Stem Injection').
- What it costs – Free. It was produced by Shire of Kalamunda with funding from the Dieback Working Group and is aimed at individuals, students or groups undertaking *Phytophthora* Dieback management in Western Australia.

Check out the new video on the Shire of Kalamunda website or on YouTube (please feel free to leave a comment or rate our page if you wish!)

Michael (Mick) Davis
Environmental Friends Group Officer, Shire of Kalamunda
mick.davis@kalamunda.wa.gov.au

MORE KULIN PLANTS IDENTIFIED

Avril Baxter

Work has been progressing at the Kulin Regional Herbarium on identifying plants collected during our Kulin Flowers field day in October 2013.

Along with the original 170 plants collected and pressed during the field days, enthusiastic regional herbarium volunteer Robin Campbell has revisited the site twice and identified another 64 species.

We now have 234 plant samples of which 189 have been positively identified.

Robin is very impressed by the support from the State Herbarium through their online tools and staff. "The Western Australia State Herbarium's Florabase is invaluable to flora enthusiasts in regional WA. Our Blackall and Grieve bibles are still good references but they are now out of date so Florabase helps get us closer to a correct identification.

"Our next step is to the top-class botanists at Kensington; we greatly appreciate their willingness to help us bushies, no matter how overloaded they are. Show them a blurry photo or a withered leaf and they give you a name!"

- Robin can be contacted on 0499 624 038 or robin.campbell@westnet.com.cu
- A draft copy of the species list can be obtained from Claire Hall by calling 9334 0427 or claire.hall@dpaw.wa.gov.au
- Florabase can be accessed at http://florabase.dpaw.wa.gov.au/

Table 1: Categories of species collected

Trees	Eucalyptus and mallees	7
	Other families	9
Shrubs	Tall > 1.5 m	18
	Medium 1 – 1.5 m	21
	Small < 1 m	67
Orchids		6
Creepers, twinners		5
Perennials		43
Annuals		28
Sedges, rushes		20
Grasses		8
Weeds		14

Above: Ground layer diversity in sandplain. Photo: Alex George

Above: Randall's sandplain. Photo: Robin Campbell
Below: Beaufortia micrantha *var.* puberula. *Photo : Trish Medlen*

Below: Hakea lehmanniana *Blue Hakea Photo: Robin Campbell.*

THE MINERS' EGG TURNS INTO A REAL BUSTARD!

Tasha Hennings

Kanyana Wildlife Rehabilitation Centre has been taking care of local animals for years and has increasingly been receiving admissions from more distant locations.

In late February, workers at Christmas Creek mine in the Pilbara found an abandoned egg – not part of their normal working day! They wrapped up the large green egg and flew it down to Kanyana in Lesmurdie. Nobody in Kanyana was certain what bird was inside and later that day the chirping indicated it was having trouble hatching. Volunteers helped it to break out of the egg by removing some of the shell and out popped a hatchling bustard.

I took the baby bird under my wing as Kanyana Wildlife's Hospital Manager. It thrived and grew rapidly. The plan was for it to go back to its home range in the Pilbara for release as soon as it was able to feed and fly by itself. Meanwhile, the gawky juvenile was named 'Dozer'.

The experience of raising Dozer was a lesson in manners. Bustards can be really emotional youngsters, and we learnt quickly to ensure that she had plenty of company during her waking hours. She quickly grew out of the enclosures we had available and the weather started to cool as winter came on. She was also reaching 800g so we found a carer up north who could continue the rehabilitation in a larger enclosure and in the correct climate for bustards.

Above: Dozer as a chick.
Photo: Tasha Henning
On right: Dozer as a teenager.
Photo Rose Best

Rose Best from the Pilbara Wildlife Carers Association was willing to take on the responsibility, and in early April, Dozer was flown back to her local area. She has spent the past few months with Rose and is almost ready for release.

Bustards are Australia's largest flying birds. They prefer to walk around but, if threatened, are capable of superb, powerful flight. They are a Priority Species, vulnerable to predation by foxes and feral cats. Their home range is in the inland grasslands and semi-desert areas throughout Australia.

If you would like to know more about Dozer, or the native fauna breeding and rehabilitation work that Kanyana does, you can contact us by email: info@kanyanawildlife.org.au or visit our website: www.kanyanawildlife.org.au

WEB-BASED ACACIA IDENTIFICATION

The latest version of the WATTLE identification key for Australian *Acacia* species is now available on the web at LucidCentral: http://www.lucidcentral.org. To locate the key from the LucidCentral home page select Keys/Search for a key and enter WATTLE in the search box.

There are two options for playing the WATTLE 2.2 key; I advise choosing the second, 'Lucid Java Applet Player'. Click on 'use this version' and it will be downloaded onto your computer. If you have problems opening the player, then you may have to install the most recent version of Java, which is also available at the LucidCentral.

WATTLE ver. 2.2 includes 1,274 taxa, which is 109 more than in the original version of WATTLE that was published in 2001. For most taxa, links are provided to the following set of information:

- description
- images
- map
- nomenclature

I find that the most efficient way to undertake an identification with WATTLE is to answer as many of the questions as you can from the default Fast Find character set (which appears when you first start the key), then load the All Taxa subset and run Best.

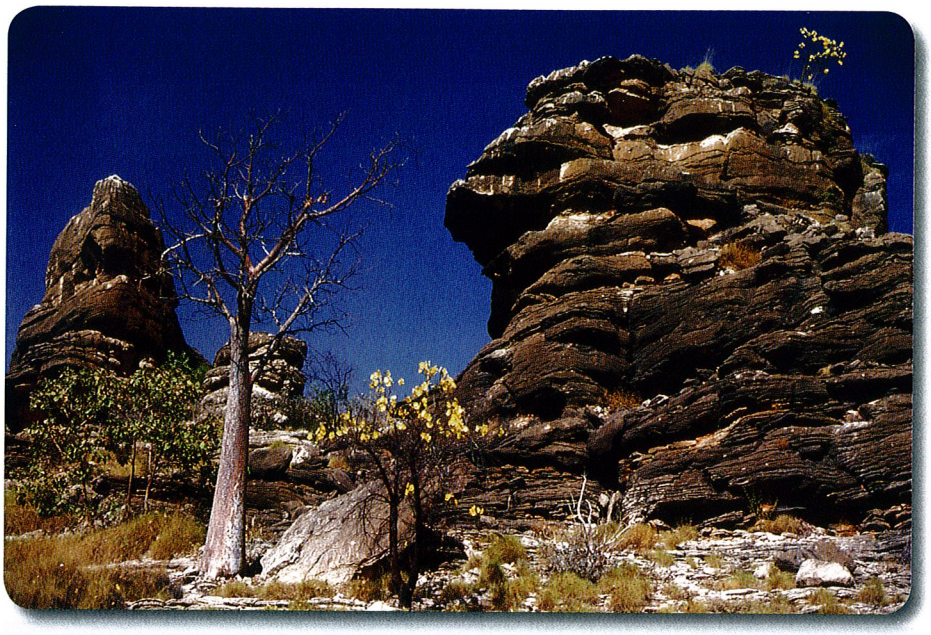
I do have other information that might be helpful to users, and if you find errors in WATTLE 2 or have problems identifying specimens, then I would love to hear from you because I intend to maintain the currency of the data and to provide regular updates.

Bruce Maslin, WA Herbarium email: bruce.maslin@dpaw.wa.gov.au

THE BOAB: BEAUTIFUL AND BIZARRE

Penny Hussey

Go to the Kimberley, and the western edge of the Northern Territory, and you will find one of the most unusual-looking of all trees – the Boab (or Baobab). Bottle-trunked, stubby-armed and with huge, gourd-like fruit, there's nothing else quite like it – well, except for its relatives in Africa and Madagascar.



A young Boab in the Oscar Range. The yellow flowering bushes are Cochlosperum fraseri. *Photo: Penny Hussey*

Baobabs are in the family Bombacaceae, which has some 200 species of mostly trees (some shrubs) in 20-30 genera. They are widespread in tropical countries, especially tropical America. There are eight species of Baobabs and they are in the genus *Adansonia*. This name was given by Linnaeus to honour the French naturalist Michel Adanson who saw this tree during his travels in Senegal between 1748-54. It greatly impressed him, and he wrote a long screed about it, including the fact that he drank an infusion of the leaves to cure himself of fever. He calculated that one large tree, some 30 feet in diameter, must be (then) 5,150 years old! The leaves are palmate, with leaflets spread like the fingers of a hand, so the African Baobab is called *A. digitata*. It is widespread in Africa, and all parts of the tree are used by local people in a multitude of ways.

Madagascar is the centre of diversity for the genus, it has six species, three of which are endangered, mostly by clearing for farming.

The final species, *A. gregorii*, is found in northern Australia. It is a large, swollen-stemmed deciduous tree, with digitate leaves, large white flowers and large fruits. The specific name was given to it by Baron Frederick von Müeller, to commemorate the surveyor Sir Augustus Charles Gregory who was the leader of the North Australian Exploring Expedition in 1855-6, on which Müeller was the botanist.

Many African farmsteads, such as this one near Tongo in northern Ghana, take advantage of the shade and other services provided by mature Baobab trees. Photo: Penny Hussey

Boabs are very useful trees. The fruits have black seeds embedded in white pith. Both can be eaten (the pith apparently tastes like sherbert) while the seeds can be pounded and made into a kind of bread. Bark from the roots can be beaten and used to make string. Hollows in the trunk or branches may hold water, and can be used for an emergency supply during drought. Cattlemen lop the young branches as emergency fodder for cattle. The outside of the ripe fruits is carved to make souvenirs for tourists. And there are odder uses – everyone must have heard of the 'Gaol Tree' near Derby!

Baobabs have soft bark, easy to carve. When Adanson was in Senegal, he recorded seeing trees

The bark is easy to carve and the tree carries on growing regardless, hence this record of Philip Parker King's exploration of the Kimberley coastline in the cutter HMC Mermaid in 1820. One of the crew recorded their campsite at Careening Bay by cutting into this Boab. Photo: Kevin Kenneally

carved by visiting Europeans, one in the 15th and the other in the 16th century. In September 1820, Lt. Phillip Parker King commanded the cutter "Mermaid" on a mission to chart that portion of the northern Australian coastline that had not been surveyed by Mathew Flinders, and needed somewhere to repair a leak. He beached the cutter at a suitable spot they named Careening Bay. While there, one of the crew carved the date and name of their vessel on a Boab trunk – now a tourist destination. King did not find Careening Bay a particularly comfortable campsite. He recorded in his diary: "Small lizards, centipedes and scorpions were numerous about our encampment; and the trees and bushes about the tents were infested with myriads of hornets and other insects, particularly mosquitoes and small sandflies, which annoyed us very much in the evening."

If you can't get to the Kimberley to see Boabs in the wild, you could always have a look at the transplanted specimens in Kings Park. Truly a tree to awe and inspire!

Illustration from "The Treasury of Botany", pub. 1866.

NEW BEARD VEGETATION MAP FOR WA

Between 1964 and 1981, John Beard, assisted by a number of dedicated botanists, mapped the pre-European vegetation of most of Western Australia at a scale of 1:250,000. Francis Smith mapped the existing vegetation (as of the early 1970's) of the far south-western corner. A new publication acknowledges the extraordinary vision and commitment of John Beard in providing WA with a comprehensive vegetation map.

A colour vegetation map for WA has been produced from the digitising of the Beard mapping, interpreting Smith's mapping across cleared areas. Over 900 vegetation associations were classified, largely following the framework developed by Beard, into 50 major vegetation types, five categories of bare and poorly-vegetated ground and 20 vegetation mosaics. The memoir explains how the data were derived and describes the units of vegetation shown on the map with the aid of individual distribution maps and photographs, as well as the relationship to bioregions and other details.

The 1:3,000,000 scale map gives a general impression of the vegetation of the State, as well as aspects of the geological, geomorphological and climatic patterns. It demonstrates the relationship between the vegetation and the bioregions. It provides one of the vegetation base-layers for NatureMap http://naturemap.dpaw.wa.gov.au. This more complex underlying spatial data layer (available from DAFWA: gis@agric.wa.gov.au) is currently being used for a wide range of research and planning purposes, including the on-going development of the terrestrial conservation reserve system.

The report and map is available as a download from http://www.dpaw.wa.gov.au/cswajournal

Copies have been sent to all Parks and Wildlife's regional and district offices. There are a limited number of hard copies and maps available from Science and Conservation Division.

If you would like a hard copy, and would use it for work, including landcare planning or teaching for example, contact Judith.Harvey@dpaw.wa.gov.au and a copy can be sent to your nearest Parks and Wildlife office for you to collect.

STUDY REVEALS CARBON POTENTIAL OF SALINE LAND

Mike Clarke

A study has revealed how much carbon can be stored in salt tolerant trees and shrubs. The collaborative project between the Department of Agriculture and Food (DAFWA), the Northern Agricultural Catchments Council (NACC) and the Forest Products Commission (FPC), is providing a greater understanding of the opportunities and threats that carbon farming may bring for salinity management.

Traditionally saline land management has been dominated by saltbush pastures, however with the emergence of carbon farming there may be a new economic driver for salinity management. Species such *Eucalyptus sargentii* (Salt River Gum), *E. spathulata* (Swamp Mallet) and *Casuarina obesa* (Swamp Sheoak), are just some of the naturally salt tolerant trees that produce significant biomass on our Wheatbelt saline soils.

Six sites have been studied on farms ranging from west of Three Springs to north of Perenjori and south to Pithara. All of the plantings were over 10 years old and on private property. Over 5000 trees and shrubs were measured and over 300 were destructively sampled, weighed and the samples dried to determine the carbon content. This has enabled equations to be developed that can estimate the biomass or carbon mass of the trees and shrubs from the diameter of a tree's trunk or from crown volume measurements of shrubs.

The calculations have recently been completed and the main findings thus far include:

- Saline areas can sequester substantial amounts of carbon. The access to moisture and use of salt tolerant species seem to be the main reasons for this.
- There was considerable variation in carbon sequestration between species and planting layouts. Ranging between 121 tonnes CO_2-e/ha after 23 years on an alley planting of trees to 8 tonnes CO_2-e/ha after 11 years on a grazed saltbush paddock.
- Planting saline areas provides considerable co-benefits such as wildlife habitat, mitigating land degradation and fodder reserves for grazing.
- Our data was generally estimating higher rates of carbon sequestration than the FullCAM model is suggesting. FullCAM is the calculation engine which supports the estimation of carbon stock change in Australia's forest and agricultural systems.
- Sale of carbon credits may provide modest levels of income from otherwise unproductive land.

Crested Bronzewings' nest in *Melaleuca lateriflora*. Photo: A. Killen, NACC

Mistletoe Birds' nest in *Eucalyptus spathulata*. Photo: A. Killen, NACC

A big surprise was the amount of birds that were observed, not only feeding in the plantings but nesting as well. Four nests were found during our sampling program, including a Mistletoe Bird nest in an *E. spathulata*, a Yellow-rumped Thornbill in *Melaleuca thyoides*, a Crested Bronzewing in *M. lateriflora* and a Red-capped Robin in a regenerating *Acacia* species.

Further analysis of the data will reveal more information on the carbon sequestration of individual species related to salinity levels. The plots will become long-term monitoring sites for future measurements as the trees grow over time. The knowledge gained and information products developed from this project will allow landholders, government and industry to make informed decisions about carbon farming on our saline land. Operating funding for the project has been provided through the State Natural Resource Management Program.

Detailed results from the study will be released later this year. For more information contact Mike Clarke at DAFWA, Geraldton at mike.clarke@agric.wa.gov.au

Mike Clarke is Development Officer, Northern Agricultural Region, DAFWA, Geraldton.

[Note: The start of this project was recorded in *Western Wildlife* 14/4, in October 2010. Editor]

THE SPOTTED JEZEBEL BUTTERFLY AND PARASITIC PLANTS

Fiona Falconer

Walking through the bush on a sunny afternoon in late June, I spotted a butterfly depositing eggs on sandalwood leaves. It was a Spotted Jezebel, *Delias aganippe*, also known as the Wood White or Red-spotted Jezebel. A few weeks later, in August at a different area of bush, there were Spotted Jezebels emerging from pupal cases on quandong trees.

What is the connection between the Spotted Jezebel and parasitic plants? The female Spotted Jezebel searches out specific larval food plants on which to deposit her eggs. In Australia, the larval food plants grow as parasitic trees and shrubs from the genus *Santalum* (including Sandalwood *S. spicatum* and Quandong *S. acuminatum*), the genus *Amyema* (Mistletoes) and the genus *Exocarpus* (Ballarts). *Delias* butterflies obtain toxic properties through their parasitic host plants and the butterflies are poisonous to some degree throughout their life cycle. The poisons from the parasitic host plants that are retained in their bodies provide some protection against vertebrate predation. The bright red and yellow coloured spotting on the wings is a warning to predators such as birds of the presence of poisons. However, it is thought that the Spotted Jezebel is not very poisonous compared to other *Delias* species. The pupae have been described as mimicking a large bird dropping, a further disincentive to becoming a meal!

Spotted Jezebel butterfly and eggs on Sandalwood leaves.

Most people know of Sandalwood, the fragrant wood being a valuable export, with the first shipment of four tons to the Far East back in 1845. A few old Sandalwood trees left on our property led us to randomly plant seed amongst remnant vegetation where there are suitable host plants. While the Sandalwood trees may have commercial value one day, the plantings have been done as much for their intrinsic values to wildlife and landcare.

Spotted Jezebel butterflies newly emerged from pupal cases (arrowed) on a Quandong.

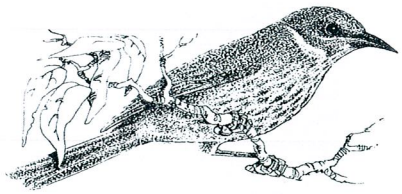
The larval food plant can be different from the plant the butterfly collects nectar from. These butterflies often feed from flowers of eucalypts and mistletoe. At the site where the butterflies were emerging, York Gums, *Eucalytus loxophleba*, Graceful Honeymyrtle, *Melaleuca radula* and *M. sclerophylla* were flowering at this time.

RESPONSE OF BIRDS TO FIRE IN THE GREAT WESTERN WOODLANDS

Readers of *Western Wildlife* will be aware that Emeritus Professor Harry Recher (Edith Cowan University) and his colleague Ted Davis from Boston University, USA, have been studying birds in WA's Great Western Woodlands for many years (see WW 15/2 and 15/4). In a recent paper* they looked at the response of birds to wildfire.

As expected, bird numbers and diversity were far fewer in burnt than in unburnt areas, as the birds would only utilise an area when the resources they needed were present – which may take years for flowers to be produced, for example. However, some of the survey records from unburnt areas were in even-aged stands estimated to be 30-50 years post-fire or logging, and even in these the bird diversity was lower than in mature woodland. They suggest that these arid-zone woodlands may take more than 100 years to recover from a fire, and warn that an increase in fire frequency (including for fuel reduction purposes) will have long-term adverse impacts on regional biodiversity.

[*For reference, contact Editor.]



Nectar eaters, such as this Yellow-plumed Honeyeater, may be advesely affected by increased fire frequency.

Illustration from Atlas of Australian Birds.

New books

For lovers of carnivorous plants - two new huge (but gorgeous!) publications provide amazing detail and stunning photographs for the true specialist.

Carnivorous plants and their habitats: Volume 1 and 2

McPherson S.

Globally, 17 genera of plants have been proven to include carnivorous species, found on all continents except Antarctica. In total there are 724 species – not just the sundews (for which WA is a centre of diversity) but pitcher plants, bladderworts, snap traps, butterworts and others.

The introduction states: "This two volume work is intended to provide a visually rich overview of the natural history, traditional uses, biology, diversity, distribution and conservation status of carnivorous plant genera. The habitats and wild ecology of each genus is profiled to provide horticulturalists with an understanding of the specific conditions that carnivorous plants are adapted to in the wild."

The volumes have chapters on the scientific discovery of carnivory in plants (including some fascinating historical jibes at Charles Darwin), their evolution, habitats and associated life. Then follows detailed descriptions of the 17 genera and finally a chapter on their future. The plants are not described or illustrated as individual species, but rather grouped and discussed around features in common.

This is not a field guide. But it is a compendium of fascinating snippets of information about this group of extraordinary plants, illustrated by outstanding photographs. There is lots of information about the Albany Pitcher Plant, for example, as well as sundews. This is a book for the specialist - or people who just like beautiful books.

Carnivorous Plants of Australia: Magnum Opus Vol. 1, 2 and 3

Allen Lowrie

Did you know that Australia is home to over one third of all the carnivorous plant species currently recognised world wide? Allen Lowrie has spent much of the last 50 years travelling Australia to observe and photograph them; many readers will already have his previous three volumes. Well, these new volumes are VAST, his life's work to date, and truly a 'magnum opus'. Huge in size and scope, lavishly illustrated with photos, drawings and maps, every one of Australia's 240 taxa are described and illustrated with multiple images. In addition, there are chapters on the types of plants and their habitats, as well as a section giving biographies of all the botanists who have named any of these species.

A very helpful feature is the detailed keys for identification, including photos to illustrate the distinguishing features.

This is a tour de force, a work of love, and something to cause the rest of us to gasp in awe at the work involved.

Penny Hussey

Both of these books are published by Redfern Natural History Publications, Poole, England. If you are interested in obtaining copies, contact www.redfernnaturalhistory.com for details of supply.

Melaleucas: their botany, essential oils and uses

Brophy J.J., Craven L.A. and Doran J.C.

ACIAR Monograph No. 156.

Australian Centre for International Agricultural Research, Canberra 2013

Contact aciar@aciar.gov.au for details of supply.

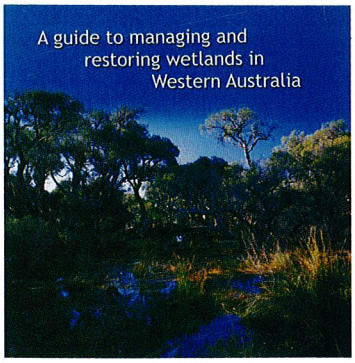
This large, A4 format book describes and illustrates 290 Melaleuca *species, including 51 species that were previously in the genus* Callistemon *(Bottlebrushes) but are now called melaleucas. The majority of these are Australian, but a few do occur in Indonesia, New Caledonia and Lord Howe Island. Within Australia, the south-western corner of WA is the centre of diversity.*

Introductory chapters discuss distribution, uses, propagation and management including disease, but the bulk of the volume is taken up by accounts of individual species, arranged alphabetically. These are clear, with distribution maps and excellent photographs of flowers. A feature is a detailed description of the essential oils that each contains.

It is not a field guide, however, as there is no key nor is there an easy way to look up what may occur in your area, so you have to search the book to find an image that corresponds to your specimen. Another failing, in my mind, is that, apart from a single paragraph in an introductory chapter, the common names of the species are not given.

Nevertheless, for anyone especially interested in melaleucas, this book would be a worthwhile addition to their library.

Penny Hussey



A new on-line guide

"A guide to managing and restoring wetlands in Western Australia" is available for download free at www.dpaw.wa.gov.au/wetlandguide. The guide describes WA's wetlands, and provides practical guidance on common management challenges, as well as monitoring, protection and management planning. It covers a wide range of wetland types, including those that are waterlogged or inundated permanently, seasonally or intermittently; but not waterways, estuaries or artificial wetlands such as dams.

Justine Lawn

This newsletter is a compendium of articles written by many different people. The views expressed are those of the authors, not necessarily those of the Department of Parks and Wildlife.

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