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Western Wildlife

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NEWSLETTER OF THE LAND FOR WILDLIFE SCHEME

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RECENT MEGA-TSUNAMIS IN THE SHARK BAY, PILBARA AND KIMBERLEY AREAS OF WESTERN AUSTRALIA

Phillip E. Playford

I first became interested in tsunamis along the Western Australian coast in 1997, while sailing in a small boat beside Legendre Island in the Dampier Archipelago (off Dampier). Huge limestone blocks could be seen lying on the flat surface of the island, behind low coastal cliffs, and I speculated that a major tsunami could have been the cause. Then in 2009, while passing beside Koks Island (off Carnarvon) on board the STS *Leeuwin*, I saw many large blocks lying on the elevated flat surface of the island and guessed that they were similarly deposited by a major tsunami.

It was not until 2010, when conducting field work for a forthcoming book on the geology of Shark Bay, that I was able to investigate these and other boulder deposits, and show that they are the products of mega-tsunamis that struck the coast between Dirk Hartog Island and Legendre Island during the past few thousand years. I also identified similar deposits while on voyages around the Kimberley coast on the *True North*.

Most of the tsunami deposits consist of large limestone blocks, some weighing up to 700 tonnes, lying on flat limestone surfaces on Dirk Hartog, Dorre, Bernier, and Koks Islands in Shark Bay, Point Quobba on the mainland, Barrow and

Above: The northwest coast of Legendre Island, showing erosion of the cliff face by a mega-tsunami, with many blocks of limestone scattered over the land surface behind the cliff and extending up to 300 m inland. Below: View of the north coast of Legendre Island, showing huge blocks lying on the limestone surface. The largest of these blocks is 12.5 m long and weighs about 600 tonnes. Photos: Phillip Playford

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Editorial

Greetings all!

The newly named Department of Parks and Wildlife (DPaW) is now settling down after its re-organisation. I hope none of you have had any problems getting in touch with *LFW* during the change-over. Claire Hall and myself have moved office (though still within the Kensington complex) and I am pleased to say that our telephone numbers remain the same. This means that the standard *LFW* phone contact on all our publications (which is my phone number) will still be useable.

Thank you so much to all those *LFWers* who responded to a request from *LFW* staff to provide a brief summary of how much time you spend on bushland management or revegetation on a weekly or annual basis. It is astonishing, and very inspiring, to get some idea how much is being done by dedicated people such as yourselves. This is illustrated by some members' stories in this issue. Check out how thorough Julie and Duncan Williamson's weed control is, for example, while Greg and Maxine Marston prove that revegetation will bring the smaller birds back. It just takes time.

There is also a short article about property owners in Dandaragan giving researchers from Murdoch University access to their land for ongoing studies. This is a great collaboration both for the individual research and also for science in Western Australia generally. Just another example of how *LFWers* are contributing to biodiversity conservation. Thank you, folks!

Our television screens are frequently filled with news reports of disasters – avalanches, earthquakes, volcanoes, tsunamis – often from far-away places, and we tend to think, rather complacently, that "nothing like that could happen here!" Well, something could, and has … not so long ago, either! Read Phil Playford's article about mega-tsunamis along our northern and north-western coastline. Scary stuff!

National and international figures

Peter Johnson, *LFW* Coordinator in Victoria, has been putting together some figures for *LFW* nationally. Currently the programme operates in all states except South Australia, though it is not run in quite the same way in each jurisdiction. Currently there are 12,729 full members, who collectively manage nearly 2 million ha of land, of which 777,203 is 'retained habitat' (what we call '*LFW* sites'). This does not include people whose properties have been registered as Interim (or 'working towards registration' in the east) or those who have not yet been visited and assessed. Pretty impressive, eh! Don't forget, if you are travelling around Australia, why not contact the State *LFW* Coordinators and get the contacts for properties you could visit. It would be a great way to meet the locals! I would be happy to give you the Coordinators' contact details.

In New Zealand, their pilot *LFW* scheme has got away to a good start, with 12 properties registered. In addition, they have just started a *Gardens for Wildlife* scheme.

Penny Hussey

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WONDERFUL - BUT WET - WALKS!

Cherie Kemp

In June, Busselton Naturalists' Club members and *Land For Wildlife* Officer Cherie Kemp to visit two *Land For Wildlife* properties in the south-west. Bernie Masters, President of the Busselton Naturalist Club, asked if the members could visit some *LFW* properties to see how the landowners managed their habitat for wildlife in the south-west region.

There were originally three property visits planned, although due to the heavy rainfall, thunder storms and lightning, the third property visit, Yelverton Brook Chalets, was cancelled. We shall visit that one at another time.

The first *LFW* property visited was '*Heronsbrook*' in Margaret River, owned by Mike and Mary McCall. The property has been registered with *LFW* since 2000 and Mike and Mary have methodically worked on the rehabilitation of a farmland property. They have rehabilitated creeklines, dams and paddocks, as well as planted some vines and olive orchards. I've carried out revisits to the property in 2006 and 2012 and always enjoy seeing how much has changed over that time.

The birdlife is amazing, including the wetland birds which were loving the inclement weather – good for ducks! Mike and Mary have liaised with the local wildlife rehabilitators and the Department of Parks and Wildlife to release a variety of wildlife onto their property. They have placed a feral-proof fence around the perimeter and conduct ongoing feral animal control inside the fenced area.

The Busselton Naturalists' Club members enjoyed a walk around the property looking at a variety of interests; including native gardens, birdlife, wetland birds, bandicoot and woylie scratchings.

Above: rain can't dim the beauty of Heronsbrook.
Below: there's always something of interest on granite rocks. Photos: Cherie Kemp

The second property was the Covell property in Cowaramup, registered in 2011 and revisited in 2013. It has natural bushland in excellent condition, a wonderful granite outcrop and threatened flora and fauna including Black Cockatoos and Wambengers. Phil Covell was very kind to show us his treasured family granite outcrop and orchids along the way.

Although everyone was thoroughly drenched by the end of the day, it was a fantastic day with the members asking if they could do some spring wildflower walks on more *LFW* properties later in the year.

Thank you to Bernie Masters, Mike and Mary McCall and Phil Covell – the day was very special!

Cherie Kemp

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Mega-tsunamis

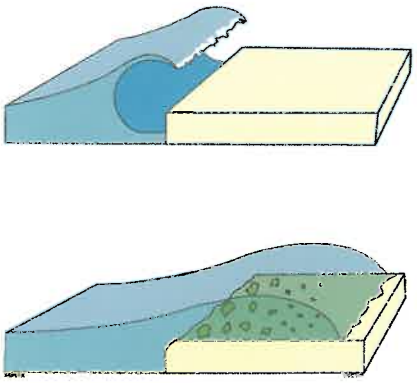

Diagram illustrating a tsunami wave crashing onto a limestone cliff, tearing off parts of the cliff face and depositing large boulders on the land surface. Illustration: P. Playford

Legendre Islands in the Pilbara.

The literature on tsunamis shows that the differentiation between storm and tsunami deposits has been controversial. Some authorities claim that waves generated by cyclonic storms can lift boulders weighing as much as 95 tonnes onto cliff tops up to 15 m high. Others have maintained that storm waves can barely move 20-tonne boulders, and heavier boulders can only be lifted and transported by tsunami waves. However, most of the tsunami deposits described here involve very much larger blocks (weighing up to 700 tonnes) and these have to be tsunami deposits. Indeed they are among the largest such deposits known in the world.

There is evidence that at least two mega-tsunamis struck Dirk Hartog Island during the past few thousand years, in the form of waves at least 20 m high, with run-ups (heights reached above sea level) of about 30–35 m. The largest block on the island, weighing at least 700 tonnes, is situated 6.5 km south of Cape Inscription (see adjacent photo). Interestingly, this had already become a tourist attraction, known locally as 'The Block'. Many visitors must have scratched their heads wondering how it had got there!

The tsunami deposits are especially well represented on Legendre Island, where radiocarbon results suggest that a mega-tsunami struck the island about 2900 years ago. It scattered large boulders as far as 300 m behind the cliff and to elevations of as much as 15 m (see photos on page 1).

Boulder deposits also occur along much of the west coast of Barrow Island, reaching elevations of up to 10 m. The boulders there are much smaller than those in the Shark Bay area and on Legendre Island, and it could be argued they might be massive storm deposits. However, it is significant to note that a very intense tropical cyclone, Cyclone Olivia, passed directly over Barrow Island on 10 April 1996, producing the biggest wind gust (408 km/hr) ever recorded on Earth. Despite its extreme strength, this cyclone had no discernible effects on existing boulder deposits, nor is it known to have resulted in any new boulder deposits. Consequently it seems clear that these Barrow Island deposits are also tsunami derived.

Many siliceous-sandstone boulder deposits occur along the Kimberley coast, and are interpreted to be the products of tsunamis. It seems likely that much of the intricately sculpted coastline of the Kimberley is due to the impacts, over many millions of years, of mega-tsunamis originating in the active seismic zone fringing Indonesia,.

The origins of the mega-tsunami deposits in the Pilbara and Shark Bay areas are uncertain; possible sources include local faulting, submarine slumping on the continental slope, asteroid impacts in the Indian Ocean, and submarine volcanic activity.

The evidence of major tsunamis during the last few thousand years leads to consideration of their possible impacts on Aboriginal people and native fauna. In some low-lying areas tsunamis may have caused the deaths of thousands of people and animals then living in coastal areas. Tsunamis are also likely to have eliminated the native fauna on low-lying islands, such as Legendre Island, or they may have allowed one or several species to survive in the higher islands, such as those in Shark Bay. Could a tsunami have been responsible for the fortuitous survival of only one marsupial (the Quokka) on Rottnest Island and a different marsupial (the Tamar Wallaby) on Garden Island and the Wallabi Group of the Abrolhos Islands?

'The Block', near Cape Inscription, beside the west coast of Dirk Hartog Island. This limestone block weighs more than 700 tonnes and was wrenched from the top of the shoreline cliff by a mega-tsunami. Photo: Phillip Playford.

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Mega-tsunamis

The stories of some Aboriginal people tell of the inundation of coastal areas by large waves. One recorded account tells of the near-extinction of a coastal community in the Kimberley region, as a result of a big wave that struck there about a century ago. Aubrey Tigan, an Aboriginal elder of the Lombadina community, recounted that when he was young his grandfather had told him that many years before a huge wave had swept over the Montgomery Islands (140 km east northeast of Lombadina), killing all but two of the 300 people who lived there.

Column marking a fault zone at Cape Domett (near Wyndham), showing two sandstone boulders, carried there by a mega-tsunami, perched near the top of the column about 15 m above sea level. Photo: Phillip Playford

Tsunamis must have been the largest catastrophic events experienced in Western Australia during the last few thousand years. If a major tsunami were to be experienced here today it could have devastating consequences for coastal towns and industries along the coast. Such an event could occur tomorrow, or many centuries ahead; no one knows.

Dr Phillip Playford is a retired Director of the WA Geological Survey, with a specific interest in the landforms of the North West and the Kimberley.

MARRI DECLINE RESEARCH PROJECT

Fiona Falconer

On a *Land For Wildlife* revisit to the Kennedy property, '*Creighton Park*', Dandaragan, last July (2012) I noted an alarming decline in health of Marri (*Corymbia calophylla*). The property is located within an important breeding and foraging area for Carnaby's Cockatoo.

I contacted the Centre of Excellence for Climate Change, Woodland and Forest Health (CECCWFH) at Murdoch University to obtain information about research into Marri decline. Eastern Hills NRM were very helpful in providing further information. Ingrid Krockenburger (Moore Catchment NRMO, Northern Agricultural Catchments Council) then negotiated with Giles Hardy from CECCWFH to have some sampling of declining Marri carried out in the Moora/Dandaragan area.

A PhD candidate, Louise Croeser, from CECCWFH was looking for sites for her project investigating Marri decline looking at *Phytophthora* sp. as predisposing trees to canker. Louise was looking for Marris on disturbed areas such as next to a road or a paddock, as well as Marris that grow on more natural sites with the two sites adjacent to each other. The Kennedy *LFW* property was an ideal site for sampling. There are Marris on disturbed areas (paddocks) and also in a large bushland remnant. We also knew that when the first *LFW* visit was made in 1997, plant health at *LFW* sites was described as 'good' and showing 'no signs of stress'. Photos taken of Marri on the property in 1997 (although black and white) show healthy-looking trees with intact canopies.

I contacted the landholders to see whether they would agree to research sites being selected on their property and for soil sampling to be undertaken. They were happy for the work to go ahead. The first sampling was done in November 2012 with 20 holes dug and soil samples collected. Let us hope that this project will contribute to understanding how to limit the spread of this devastating pathogen.

It is really helpful for research scientists to be able to work with keen and interested landholders.

Fiona Falconer is a **LFW** *Officer based at Coorow. For contact details, see page 2.*

Prof. Giles Hardy indicating a 'bullseye' form of canker infestation on Marri at Meelup, near Busselton. This is a distinctive form of the canker, and perhaps the easiest to recognise, but any Marris where the bark appears to be exploding outwards from the trunk, accompanied by excessive amounts of kino oozing from the trunk, is likely to be indicative of a canker infestation. Photo: Cherie Kemp

PLEASE NOTE: If you change your postal address, phone number or email, please let *LFW* know.

RESTORING JARRAH FOREST GEOPHYTES

David Willyams

Geophytes are terrestrial plants that have their buds below the soil surface and have underground storage organs such as tubers, tuberous roots, rhizomes, bulbs and corms. This life form is a common adaptation within the flora of the south-west.

Over one third of all plants in the upland jarrah forest are geophytes (70 geophytes in a flora of 272 species). This is a globally high number for this life form. They occur in a wide range of families and genera and are a highly variable set of plants.

Geophytes also made up the largest group of understorey plants in the northern jarrah forest that were absent from Alcoa of Australia's rehabilitated bauxite mines and proved to be a powerful focus for propagation and restoration research.

Geophytes have high functional values in the jarrah forest ecosystem. The geophytic life form is especially advantageous where seasonal drought is combined with low nutrient soils. Plants die back above-ground during the dry season, then rapidly resprout from their long-lived underground organs when the wet season starts.

Geophytes also improve soil structure and reduce soil erosion during the expansion of their underground storage organs, especially rhizatomous spreading species e.g. bracken fern, dryland rushes and sedges.

They are also the plant life form least affected by fire. Much of their above-ground growth occurs outside the normal fire season and the underground buds are protected from fire damage. Fire promotes the vegetative expansion, flowering, seed production and seed germination of many jarrah forest geophytes. The energy stored in the underground organs allows geophytes to rapidly produce new shoots after a fire, before other plant types can recover. In the first weeks after a fire these new shoots are a critical life-sustaining food for grazing native animals.

A large part of most geophyte biomass is below ground, for example, Clematis pubescens, *with its tuberous roots being half the total biomass.*

The most numerous plant in the forest (*Tetraria capillaris*, Hair Sedge) is a geophyte. This sedge is a major food source for the western grey kangaroo. With grasses being less common than in eastern Australia, the dryland rushes and sedges supply jarrah forest macropods with one of their primary food sources.

Globally the underground storage organs of many geophytes are important animal and human foods. While several species were eaten in the past, jarrah forest geophytes are seldom used as human food today. Native animal consumption of their underground storage organs is poorly studied, but is presumed to have been important. Feral pig destruction of large areas of geophytes (especially orchids and bracken) is of current concern.

Will geophytes self-colonise newly fenced jarrah forest remnants that were previously grazed? Several geophyte species will self-establish (e.g. some orchids) as the ecosystem improves, however, most geophytes will take decades or even centuries to self-establish.

Prolonged absence of fire combined with grazing may have led to declines in geophyte populations. As long lived plants, geophytes typically produce few viable and germinable seeds in any one year. The jarrah forest soil seed bank is thus generally deficient in geophyte species seeds, being dominated instead by reseeder plant species seeds. To re-establish many geophyte species will therefore require *ex situ* propagation and then planting into restoration sites.

Alcoa's Marrinup nursery has developed propagation methods that produce sufficient plants for large scale restoration. We call 10 of the 70 geophyte species in the upland jarrah forest 'backbone species' for restoration, as they are both widespread and structurally significant. All ten species establish and grow well in mine restoration sites and assist in the development of a more biodiverse understorey. These 'backbone species' occupy major niches (thus excluding weeds) and create new microhabitats.

Before propagating and restoring geophytes it is best to investigate each species' wild biology and environmental requirements. The focus can then be on species that are likely to establish in the current ecosystem conditions. Knowing when each geophyte species produces ripe seed or spores is an important part of propagation success.

There is no single best method for growing these plants. Alcoa's Marrinup nursery had to develop different propagation methods for each geophyte species they investigated. A wide range of propagation methods were developed

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Geophytes

Table: The ten backbone geophytes used by Alcoa in mine site rehabilitation in the northern jarrah forest

Species	Family	Height	Storage Organ	Revegetation Propagule
Chamaescilla corymbosa	Anthericaceae	20 cm	Root tuber	Seed
Cyathochaeta avenacea	Cyperaceae	50 cm	Rhizome	Seed &/or seedlings
Lepidosperma squamatum	Cyperaceae	1 m	Rhizome	Seedlings or Clump transfers
Tetraria capillaris	Cyperaceae	1 m	Rhizome	Seedlings or Clump transfers
Pteridium esculentum	Dennstaedtiace	2 m	Rhizome	Clump transfers
Clematis pubescens	Ranunculaceae	1 to 3 m	Root tuber	Large seedlings
Loxocarya cinerea	Restionaceae	30 cm	Rhizome	Seedlings or Clump transfers
Xanthorrhoea gracilis	Xanthorrhoeace	1 m	Root tuber	Large seedlings
Xanthorrhoea preissii	Xanthorrhoeace	1 to 3 m	Root tuber	Large seedlings
Macrozamia riedlei	Zamiaceae	1 to 3 m	Root tuber	Sprouted or buried seeds

including seed germination, seedling production, cuttings, divisions and micropropagation. A key part of the research was to produce a variety of propagules of each species for field evaluation.

The geophytes planted in Alcoa's jarrah forest restoration now establish well, but during the research phase there were several setbacks that had to be overcome.

Due to high kangaroo grazing pressure, some of the dryland rush and sedge geophytes required grazing protection to ensure good establishment.

The smallest nursery-grown plants had poor survival during the first summer drought. It was discovered that all study species investigated relied heavily on their underground storage organs for dry season survival. Marrinup nursery now produces larger plants than are typically produced by nurseries. These larger plants have higher restoration survival and spread.

Long-term monitoring of geophyte restoration is essential, to assess whether the new populations are sustainable. We have found that long-term spread and seed production are good geophyte sustainability measures. All of the ten 'backbone species' have survived in the restored jarrah forest for more than 10 years. Their spread rates are good, but slower than the initial over-enthusiastic predictions, which were based on the rapid post-fire regrowth observed in burnt forest. Geophytes' initial rapid growth in restoration sites is not sustained for more than a few years. Once the new forest establishes the planted jarrah forest geophytes return to the slow growth they maintain between forest fires. This behaviour is a key part of their strategy for long life in the forest.

Geophytes are an important part of the Jarrah forest understorey and their restoration to disturbed areas is essential for ecosystem health and biodiversity.

Dr David Willyams is the Propagation and Revegetation Research Officer for Alcoa of Australia based at their Marrinup nursery and Mine Environmental Department. For a full list of the geophytes of the upland jarrah forest or for jarrah forest propagation and restoration information, contact David on: david.willyams@alcoa.com.au

All photos: David Willyams

Geophytes are among the very first jarrah forest plants to recover after fire; eg a Clematis pubescens *vine flowering on top of newly sprouted bracken fronds.*

Above: A range of geophytes growing in ALCOA's Marrinup nursery
Below: Agrostocrinum scabrum

KEEPING WEEDS UNDER CONTROL ON A FOUR HECTARE BUSH BLOCK

Julie and Duncan Williamson

We live in the centre of a 'pre-European' bush block in rural Yallingup, untouched other than by selective logging some 60 years ago. It is 90% laterite over granite with Jarrah/Marri; the remaining 10% is sand where banksia, sheoak and peppermint are more prominent. The house is located in the centre on what used to be the old logging track. We have unused (ungrazed) paddock on one side and three bush blocks on the other three, two similar to ours in size (one sandy, one swamp) and the other parkland-cleared. There are fire breaks on three sides.

Our property is *LFW* registered and covenanted with the National Trust. We are also part of an ongoing project with Kings Park and have regular visits from a member there who is doing a study of gompholobiums, specifically *Gompholobium polymorphum*, but we also have several subspecies.

The three big maintenance tasks we have are weeding, dieback control and bushfire hazard reduction. The majority of this is weeding, which includes 2.1 km of firebreak around the subdivision so the shire graders do not need to attend, with the consequent dieback issues.

Leaves are like gold dust to us, as we have found them to be the best method of preventing weeds from taking hold. Leaf litter under our canopy is maintained at a very low depth naturally as it is healthy forest floor with well-drained soil, so typically it is 5 cm deep. However, the areas that once required clearing have enthusiastically filled with every type of local weed imaginable. This did get to the point of becoming unmanageable and required weekly attendance.

Above: Weeds germinating on bare ground. Below: Leaf litter suppresses weeds. Photos: Julie Williamson

At every leaf drop we rake up leaves from our driveway, track and around the house and we pile them up on bare patches or areas that we have burnt on a rotation such as under grass trees. It is a lifestyle, and weeding is now part of our daily lives. On fine days we allocate thirty minutes over lunchtime to wander out to newly discovered patches and we enjoy the fresh air and getting exercise as we bag up Cape Weed and Blowfly Grass. Each month brings a new weed selection. Your eye becomes trained in whichever one you are targeting.

Weekends are more concentrated with specific areas targeted. From early June through to late October we are weeding, and from December to April we are leaf collecting and spreading. We believe we have eradicated about 70% of weeds so far.

The adjoining paddocks are the biggest problem as they are full with just about every weed known to the south-west. The kangaroos are numerous, probably around 50 or more and they eat various weeds and then come into the bush to sleep, graze and poo. As a side project we planted roo poo to see what came up. Some germinated 14 weeds each. Roo poo deposited on leaf litter rarely takes hold; it just breaks down and disappears but almost always takes hold if it falls on bare earth. Inevitably attached to the end of a pulled weed is a roo poo.

We do all weeding in the bush by hand. The Blowfly Grass is down by two thirds. The Guildford Grass is a problem due to the toxic poison required to eradicate it so digging that up isn't easy. Cape Weed is under control. The worst is Couch Grass as it is very difficult to remove without disturbing the soil. We haven't found many weedy wattles, less than a dozen in seven years. Roundup Biactive is used on the firebreaks which kills everything other than Guildford Grass, Arums and Couch.

Dieback is present on two borders, and is managed by spraying (using the Busselton Dieback Working Group's 400L trailer*) and injecting. There are boot cleaning stations on paths, and standard signage.

When the Shire brought in strict Building Protection Zone requirements, we spent between 100-200 hours a summer trying to comply by clearing all leaves around the house. This just encouraged grass weeds, which are a great fire hazard! We have since scaled this back, and installed a sprinkler system that can wet the area with 15,000 litres of water an hour for at least three hours. We could fill a newsletter on this subject!

We also monitor tree health, and are undergoing a trial using phosphite and nutrient plugs in our Marri trees. These are very expensive with an

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BIRD BANDING AT 'WALDJA'

Greg and Maxine Marston

Greg in the revegetated creekline, next to the bird banding site.

Photo: Avril Baxter

'*Waldja*' is a 1ha semi-rural block adjacent to the Boddington town boundary on the lower southern slope of the Hotham River valley. We named the property after a Noongar dialect word for the Wedge-tailed Eagle, a frequently-observed resident species that effortlessly patrols our skies in search of the next meal. *Waldja* was part of a small development originally excised from an adjacent sheep farm in the 1970s. The previous owner continued agisting sheep on the block. When we bought the property in 1994, the vegetation consisted of a number of mature remnant Wandoo, Marri and Jam trees, some planted *Eucalyptus camaldulensis* and *E. resinifera* trees and a grass understorey.

As weekend warriors for the first 10 years, relaxation time away from paid work in Perth was the principal objective, however it soon became apparent we needed an understorey to provide a better vegetation structure for our avian population. Being a licensed bird bander presented an opportunity to have my own home-based banding project to determine what avian changes occur with revegetation growth. More specifically, revegetating a small seasonal drainage line coming off a large granite outcrop and flowing through the western side of the property would provide bird shelter and food habitat as well as reduce some of the minor flooding and soil bogging tendency we had experienced up to this time.

Revegetation of the drainage line was started in 2000, using a mixture of Western Australian and Australian native shrub plants. Plant selection was based on providing some flowering presence over a 12-month period to complement a few remnant and planted trees. Initial and annual measurements of all understorey plants are taken in mid-autumn to provide a volumetric vegetation growth index. A photo point looking north from the back boundary along the drainage line was used as a visual monitor of understorey growth. Monthly bird banding and two 20-minute bird counts (early morning and late afternoon) are used to measure avian activity.

In 2013, vegetation growth has long hidden the photo point view of the drainage line. Plant replacement and infill is an ongoing process with particular emphasis on self propagated *Hakea* species to attract our iconic and endangered Carnaby's Cockatoo. It is a privilege to see and hear these cockatoos noisily feeding on nuts from our planted *H. petiolaris* and *H. undulata* bushes (see note on p. 17).

Understorey shrub growth and bird activity between the first year 2000-01 (financial year) and 2012-13 is summarised in the table below. Bird counts are further categorised into tree, understorey shrub and ground strata birds.

Although the table shows a small increase in bird count numbers, the main changes are a reduction of bird numbers in the tree stratum e.g. Australian Ringneck Parrots, and significant increase in the understorey shrub and ground strata. Addition of an understorey shrub stratum has proved very beneficial in increasing bird activity on *Waldja*, particularly from the honeyeater and insectivore guilds.

	2000/01	2012/13	% Change
Shrub vol. (m^3)	120	2228	+1757
# Banded birds	37	171	+362
# Counted birds	288	317	+10
Tree	204	146	-28
Shrub	83	165	+99
Ground	1	6	+500

OBSERVING SEASONAL CHANGES - A TASK FOR ALL THE SENSES

Wayne Gill

Originally I was going to word this article from a 'weeding for wildlife' angle due to the fact that weeding, specifically hand weeding, is an important part of property maintenance, and is often the time when I personally make many wildlife observations. Being quiet and still when outside enjoying our beautiful properties, means that natural interactions will just happen around you. As such, weeding could be sold as one of the more enjoyable parts of being a *Land for Wildlifer* as it makes us privy to the lives of other creatures we share the space with. Then the more I thought about it, I realised that observing the seasonal fluctuations of fauna and flora is an activity which involves all the senses at different times of day and night. Allow me to elaborate.

Late last year, while weeding the grasses out of my garlic crop, I heard a bird call that was familiar to me, but unusual for my area. Once I managed to locate the position of the caller high in the canopy of a mature Swamp Yate, I was excited to have a new fauna record for my property. A budgerigar ... no, two ... no, four of them were here on the south coast. Checking their distribution in some of the literature I noted that they were well south of their known range. I then started to doubt my identification as it was some distance away and looking into the light. However, later in the week I saw a dozen of them at close quarters, walking around feeding amongst the samphire, which confirmed my original identification.

Prior to the budgies we had a flock of up to 400 Tree Martins which had been hanging around for several weeks (see photo). They would spend the whole day hawking for tiny insects just above the

canopy of the trees whilst chortling and whirring melodiously in flight. Just as quickly as they seemed to appear, they were gone again until next time. Previous to that were the Purple-crowned Lorikeets screeching through the bush. They come to feed on the flowering Tuarts lining the driveway. These are just a few of the many examples of birds that will suddenly appear based on some slight environmental cue and then disappear just as quickly. I now try to record the appearance of such species on the calendar each year so I know when to expect them next year. This includes the first cackling of Sacred Kingfishers in spring which this year was early on the 1st of August. The brief appearance of White-naped Honeyeaters, the seasonal melody of White-winged Trillers, Rufous Whistlers and Golden Whistlers ... the list goes on.

This fluctuation in species is not just restricted to birds, as a similar observation resulted in recording a new frog species for my property based on the calls I hear at night. I am used to the plucking call of the Banjo Frog, the mournful whooping of Moaning Frogs and various other resident frog calls. However this "new" call which is a fast oscillating rattle had me intrigued. I listened to a CD of frog calls wondering whether what I was hearing was either the Turtle Frog or the White-footed Trilling Frog, but it was not them. Urged on by my need to identify what I was hearing, I listened to some different calls and found it. I now have a record of Sand Frogs (*Helioporus psammophilus*) on my *LFW* property, and a new call in my mental bank for future reference.

The point is, as seasons change, the plants which are in flower, the birds, reptiles, frogs and mammals all fluctuate accordingly. Over time if one is patient and observant one can become familiar with these fluctuations and look forward to them as the year progresses. Being out enjoying the dynamic change within our *LFW* properties provides a treat for all the senses which should be regularly embraced ... even if it is just the feeling of satisfaction by pulling up those winter weeds ...

Wayne Gill is LFWO at Esperance

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Keeping weeds under control

average tree costing $18. Nutrient plugs do appear to be helping. The tree monitoring and treating takes about two hours a week.

On the positive side we have a wide variety of birds including the Western Spinebill, Splendid Blue Wrens, WesternYellow Robin, Rufus Treecreepers and Red Capped Parrots with occasional visits from Western Rosellas and Elegant Parrots. At last bird count we recorded 47 species. We are currently up to around 300 species of shrubs/grasses/ground covers but this is an ongoing project as new species are added to the list each year. We currently have located 21 species of orchid.

*The trailer can be borrowed at a minimal cost for use by land holders in the City of Busselton area. You can book the trailer by emailing julie@rotherbridge.com.au with your preferred date. You will need your own tank water supply.

Death of ash trees in Europe

A worrying trend is emerging in Europe – ash trees are being killed by a fungal disease which first appeared in Poland in the 1990s and is moving rapidly through most eastern, central and northern European countries*. It is almost always fatal to all age classes of trees.

Common Ash (*Fraxinus excelsior*) is a widespread tree ranging from Iraq to Ireland and southern Scandinavia to northern Spain. It is a keystone species in many European woodlands. The pathogen causing Ash Dieback is a newly-described fungus (ascomycete) species, *Hymenoscyphus psuedoalbidus*. It is not known why this disease has suddenly erupted in such a lethal manner, but the suddenness of its appearance would seem to indicate that it was introduced to Europe – but from where? Currently its spores are being spread by wind and human agency.

More research is needed, but it may be too late now to save Common Ash from extinction across the whole of its range. There are many more species of ash in Asia and North America, could the disease spread to them? Or did it originate on one of them and perhaps have been moved thorough the plant nursery trade?

In Norse mythology Yggdrasil, the great ash tree, holds the universe together with its mighty roots and branches. The three Norns sit among its branches, spinning the fate of all humans. They must be very concerned about this current trend.

[*for ref. contact Editor]

Soil seed bank diversity and fire for regeneration

Many remnants in agricultural lands appear to have lost shrub and ground layer species, sometimes becoming little except trees and weed grasses. But are the original species still on site, as seeds in the soil seed bank? We know that many native seeds are very long-lived, and *LFWOs* often recommend trying a small 'heap burn' or application of 'smoked water' to see if the soil seed bank can be stimulated into action. Some researchers in South Australia recently set up experiments to see what was present in the soil, and how it might affect site management*.

They took soil from sites in grazed and ungrazed mallee vegetation on Kangaroo Island and, in the laboratory, tested for germination under various regimes of smoke, heat and un-treated controls. Both native plants and weeds came up, and nearly 50% of the native plants were not visible in the above-ground vegetation, including 12 rare or threatened species and three species previously unrecorded from Kangaroo Island. This is very encouraging. However, 30% of the plants that germinated were weeds, including some very aggressive ones. It was noticeable that the ungrazed sites had more native species, but everywhere had weeds, which also showed increased germination after smoke and heat.

So this partially answers our query – yes, there are likely to be useful species in the soil seed bank. But competition from weeds is potentially a problem when fire is used as a management tool to regenerate understorey.[*for ref: contact Editor]

Bush detective

Who lives behind the curtain?

I came across this curtain-like web whilst assessing a *LFW* site in Mundaring. As I was intrigued to find out what had made the web, I asked spider expert Barbara York Main what it could be. She replied: "Looks like the web of a *Cethegus* mygalomorph spider, commonly called 'curtain-web' spiders, in the family Dipluridae. It is related to the trapdoor spiders, that is, it is in the group Mygalomorphae. It is our only web-weaving representative of the group. It has a shallow burrow under the soil-coated strands of silk and has a spread sheet on the ground which snares crawling insects and sometimes flying insects also get tangled in the curtain-like strands. Don't get bitten!"

Curtain-web spiders build their webs over shallow burrows against tree stumps, the bases of shrubs and in the shelter of road banks and natural rocky overhangs. *C. fugax* is common in the jarrah forest and woodlands of southern WA and although no bites have been recorded it is best to leave them alone.

Claire Hall

THE SOUTH WEST - A REGION FOR GLOBAL CONSERVATION

Ken Atkins

Some of WA's stunning biodiversity, this is in Wyalkatchem Nature Reserve. The central plant is Xanthorrhoea nana. *Photo: Penny Hussey*

The south-west of Western Australia is known by those who live here (us) as being a special place – a great place to live, but also a place of high and unique biodiversity value that continues to amaze us whenever we look somewhere new.

We used to be known as the 'Wildflower State' and proudly displayed this on our car number plates. But time moves on and we start to take things for granted – such as just how special our bit of the Earth really is.

Global biodiversity hotspots

British environmentalist Norman Myers listed the south-west of WA as one of 25 'global biodiversity hotspots' in 1999. These are those areas of the Earth where there was a high level of biodiversity, but also a high level of habitat loss - based on a region supporting over 1,500 species of endemic flora, and having lost 70% or more of its natural vegetation cover.

In 2004, this list was expanded to 34 – with south west WA still being the only listed biodiversity hotspot in Australia.

Subsequently, one new hotspot was added in 2011, the 'Forests of eastern Australia', which became the second Australian global hotspot. So our reign as the only global hotspot in Australia came to an end. But being in a hotspot region is not necessarily a good thing as our high floral richness is under threat due to the extensive land clearing, and other threatening processes, many of which are also related to the human occupation of this region.

Flora conservation in Mediterranean climate regions

The south west of WA is in a Mediterranean climate zone. Other Mediterranean climate zones are found in South Africa (which is why we have so many of their plants naturalised in our bush), Chile, California, and of course, the region around the Mediterranean Sea. These regions are also listed as global biodiversity hotspots reflecting their flora diversity and long history of intensive human occupation.

Spanish botanist Filipe Lozano (from the Complutense University of Madrid) began a project of analysing the processes affecting the flora of Spain to see if he could determine any trends in the threatening processes which have caused threatened flora to change their threat status.

The World Conservation Union (IUCN – International Union for the Conservation of Nature) has an established set of criteria for classifying threatened species into threat categories (critically endangered, endangered and vulnerable), commonly known as the species Red List. By looking at the species changes between these categories over a period of time, and the processes that contributed to these changes, Felipe hoped to identify the nature of changes affecting threatened flora in Spain.

He then posed the question – how do the processes affecting flora compare to similar regions around the world?

Felipe visited Perth and contacted Kingsley Dixon (Botanic Gardens and Parks Authority) and myself to see if he could undertake the same analysis on the south west WA threatened flora and compare this with Spain. Aaron Sims from the Californian Native Plant Society was also enlisted to participate in the study to give three Mediterranean flora hotspots to compare.

It was thus that a long distance collaboration was started with the aim of analysing very different data sets and information in a manner that would give a consistent interpretation of changes to the conservation status

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Global conservation

of threatened flora in our respective regions.

The analysis of change in flora threat categories

To standardise the data, changes were assessed over a similar time frame – 2000 to 2008 for Spain and WA, and 2001 to 2010 for California. Reasons for changes to threat categories (up or down) were categorised as: changes in the criteria used by IUCN over that time; improved knowledge of the species; discovery of new populations; conservation activities; and taxonomy (i.e. combining or splitting taxa).

Threatening processes were identified for each flora species, and these were then categorised into groups based on whether they were caused by humans, the time span over which the threat was operating, and the degree of impact on the habitat.

It was then just a case of analysing the information available for 432 WA species, 1,040 Spanish species and 1,392 Californian species! Fortunately, Andrew Brown, DPaW's Threatened Flora Coordinator, was able to fill in the threat information and reason for changes in the threat categories for each WA species, which greatly assisted the analysis.

The outcome of this analysis* showed some differences between the three regions, which reflected their time of settlement, threatening processes and knowledge of their flora, including:

- 34% of the WA flora had a change in status. The majority of changes (24% of species) were due to improved knowledge, while minor changes were due to the discovery of new populations (4%), taxonomy (3%) and conservation actions (3%).
- The Spanish flora had a greater proportion of their species change conservation status (57%), with again knowledge being a major contributor, and 9% changing due to conservation actions.
- The Californian flora showed least change (10% of species), with discovery of new populations and new knowledge being the main reasons (5% and 4% respectively) and only 3 species changing due to conservation actions (0.2%).
- The most significant reason across all regions was the discovery of new populations of the flora – and this was the only statistically significant reason in WA.
- Evidence of land use intensification was identified in each region as a threat, which in WA were threats such as land clearing, mining and transport.
- Spain and California also had a high incidence of threats such as herbivory and recreation; while the highest incidence of threats in WA were processes such as lack of habitat, fire, weeds and pathogens (e.g. *Phytophthora* dieback, see photos below).

Conclusions for flora conservation

The conclusions of this study were that the identified threats to the flora were not having as significant an impact on changes to their conservation status as improvements in knowledge – including discovery of new populations, inventory of existing populations and changes in taxonomic status of species or subspecies.

In WA, this is a well known issue, with our flora still being relatively poorly known when compared to other similarly developed regions of the world. It is for this reason that the Department of Parks and Wildlife maintains the Priority Flora list to enable conservation attention to be focused on poorly known flora that appear to be rare or threatened. This list contains those species that are only known from few locations and thus may be at risk, but require more survey work to confirm if they meet the IUCN criteria as threatened flora; plus those species that are rare but not deemed threatened, and thus are being monitored.

Currently the Priority Flora list contains nearly 3,000 species – which is 24% of the total native flora for WA! New species are continually being discovered and described, with during 2012–13, 105 new flora names published and 283 vascular

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The effects of Phytophthora *on a heath community dominated by Scarlet Banksia (*Banksia coccinea*).*
1. A healthy stand of Scarlet Banksia 2. Soon after the disease has struck, a thicket of dead banksia. 3. The end result, after fire, a totally changed vegetation community.
Photos: Ken Atkins

plant names added to the WA census of plant names by the WA Herbarium.

From the study, improvement of knowledge was also far more significant in changing conservation status than the effects of conservation actions (excluding survey work) which may be surprising (and discouraging), but this is also a reflection of three important points.

Firstly, the IUCN criteria for assigning flora to threat categories are used for all flora and fauna species worldwide, and are thus broadly based to account for this great range of biological and ecological characteristics of species. It can thus take considerable change in status of a species to move it between categories.

The second factor is the relatively short time frame of this study (10 years) relative to the generational time for many flora species, and the time required to achieve the conservation outcomes relative to the IUCN criteria.

Thirdly, many flora are naturally rare, especially in WA. Conservation of these species firstly seeks to maintain or maximise their habitat and prevent a decline in their status. True 'recovery' of these species to a lower level of threat is thus a long-term objective that often seeks to expand the species outside their natural areas of occupancy.

Thus, while improvements in knowledge are important for better determining the conservation status of the WA flora, the process of recovery actions and planned conservation outcomes needs to be considered over a much longer time frame than 10 years. In fact, we should be using a time frame of multiple decades for planning and undertaking flora recovery actions.

Threatening processes that occur in WA including salinity, weeds and *Phytophthora* dieback are insidious in nature, and while not causing dramatic impacts as occurs with land clearing (although *Phytophthora*

Translocating a rare plant into a new site to increase its chances of survival. Photo: Leonie Monks

certainly can where infestations occur), they do have a longer-term serious impact on our flora as the habitat degrades and seed banks are exhausted. Continuation of programmes reducing the impact of these major threats is thus essential if we are going to prevent catastrophic loss of our flora over a longer time period.

This study has thus demonstrated some of the underlying principles of flora conservation in WA that we need to be aware of when setting realistic targets for our flora conservation programmes.

We still live in the 'Wildflower State', and the efforts of so many dedicated people managing their special bushland and undertaking specific flora conservation programmes will help keep it that way – but it is a long-term project that we are all signed up to.

Dr Ken Atkins is Manager, Species and Communities Branch, DPaW. He can be contacted on: ken.atkins@dpaw.wa.gov.au for reference.*

Melaleuca steedmanni, *a beautiful plant from the northern wheatbelt kwongan. Photo: Penny Hussey.*

Can you help please?

Near-coastal members from Northampton to Esperance will know of the weed Geraldton Carnation Weed, *Euphorbia terracina*. Department of Agriculture and Food WA's entomologist Cameron Brumley has identified what appears to be a new aphid on this plant.

Aphis tirucallis *on* Euphorbia terracina. *Photo: DAFWA*

Most euphorbias have unpleasant white sap and, as a consequence, are very seldom attacked by sap-sucking insects. So it is rather interesting to find this infestation – have we a potential biological control for this annoying weed? Cameron would like to know how widespread it is.

If you have got this weed on your block, or a roadside or reserve near you, could you please go out and have a look for aphids? If you find any, please could you phone DAFWA's Pest and Disease Information Service on freecall 1800 084 881. Cameron will then follow it up directly with you. A photograph would be very helpful.

PLEASE NOTE: If you change your postal address, phone number or email, please let *LFW* know.

BRIDAL CREEPER - IS IT UNDER CONTROL?

Kathryn Batchelor

Not so long ago Bridal Creeper (*Asparagus asparagoides*) in WA was nearly everywhere. It dominated the degraded flora of southern national parks and would stretch along the roadsides between south-west country towns. A prolific fruiter favoured by birds, there was no stopping it unless there was a long-term commitment to herbicide. That was until 1999, when the bridal creeper leafhopper was released, followed by the more successful bridal creeper rust fungus in 2001.

What biological control delivered with these organisms was an alternative to herbicide and some hope. But hope for what? If it was eradication, then you're barking up the wrong tree. It's not in an organism's best interest to wipe out its host plant. But they did have a job, and that was to cause disease and suffering to a plant way out of balance with the ecosystem. And in my opinion, they delivered just that.

Firstly, a brief history. CSIRO starting looking into the biological control of Bridal Creeper in the 1990s. Four organisms were identified; a leafhopper, a rust fungus, a beetle and seed wasp. In 1996 the Cooperative Research Centre (CRC) for Weed Management Systems funded the host specificity trials of all four, ending with the approval to release the leafhopper, rust and beetle. The first two are widespread in Australia, the beetle being established at three sites near Perth. The seed wasp was most likely to be a general asparagus seed wasp and aside from being difficult to work with, the money for biological control was drying up and was best put toward redistributing the two agents that showed the most impact.

From 2001-05, the rust and leafhopper were spread widely thanks to a quick release method and school leafhopper breeding programs. For community awareness and involvement in weed management, this project gets an A. But what couldn't be communicated at the time, was what to expect. These organisms were brand new to Australia. What people wanted was no more Bridal Creeper and bushland restored to its original glory. So, eight years after the CRC stopped funding Bridal Creeper research, why can people still see this plant, and in some places, lots of it?

Well, it's because there is a lag time of 2-3 months when Bridal Creeper starts shooting after the first rains and when the conditions are just right to coax the rust out of its dormant over-summer form. The leafhopper is on the scene from the start, but the eggs and adults are quite heavily parasitised by native wasps so that population growth is retarded. The rust, when it appears, starts to cause disease straight away, and tricks the plant into thinking it is producing shoots and leaves, when instead, that energy goes into feeding the rust. So the more Bridal Creeper→ the more substrate for rust→ the more disease. At infestations with both agents, the Bridal Creeper biomass has reduced, but it won't disappear. In most of WA, there is a lot less Bridal Creeper, but not more native bushland. This is because Bridal Creeper has been a scar on the landscape for decades, the native seedbank is spent and the receding Bridal Creeper just freed up space for more weeds, some worse than the plant they replaced.

So what's next? Well, there's good news and bad news. To end on a high, I will start with the bad. Australia has another biotype of Bridal Creeper – the Eastern Cape form and the rust and leafhopper don't like it. Discovered in 2004, it's widespread and intermingled with Western Cape form (the one we know well) from the Adelaide hills through to western Victoria. Since that time, NRM funds have gone toward mapping its distribution and using herbicide to reduce its range. It's not present in Western Australia – we've looked. The good news is that now the entire genus of *Asparagus* to which Bridal Creeper belongs has been declared Weeds of National Significance and targets for biological control. Not that there is funding lined up for projects, but it means that a whole layer of bureaucracy to start working on these weeds has been removed. So *Asparagus scandens*, *A. declinatus* (Bridal Veil), *A. densiflorus*, *A. plumosus*, the Eastern Cape form of *A. asparagoides* – all major weeds in different parts of Australia – are now on the biological control radar.

Finally and before you ask for your last five minutes back, here is what I think you should do about Bridal Creeper. If it is your only bugbear and a little is still too much, then spray with herbicide, but do it before the rust takes hold as a diseased plant doesn't translocate herbicide to tubers very well. If you have lots of weeds, Bridal Creeper being one, let the agents do their thing and put your back into those weeds for which there is no fairy dust. Bridal Creeper is always going to be part of the landscape, but at least it no longer rules it.

Kathryn Batchelor is a Research Officer, CSIRO Sustainable Ecosystem Sciences, Floreat, WA.

CARNABY'S COCKATOO - IS IT A RAIN BIRD?

Denis A. Saunders

There are two species of black cockatoo with white tail bands in south-western Australia. Until the 1970s they were regarded as one species called the White-tailed Black Cockatoo. Detailed ecological, behavioural and taxonomic studies in the late 1960s and early 1970s established that there are two taxa, distinct morphologically and ecologically. The obvious external difference was that one has a long upper bill and the other a shorter one. The long-billed form is called Baudin's Cockatoo (*Calyptorhynchus baudinii*) and the short-billed form Carnaby's Cockatoo (*C. latirostris*). The range of Baudin's Cockatoo encompasses the forests of the southwest in the area contained roughly from the coast to a line between Perth and Albany. Carnaby's Cockatoo's range encompassed the area roughly within a line between Kalbarri-Merredin-east of Esperance and the coast. Its range overlaps that of Baudin's Cockatoo in the forested south-west. Carnaby's Cockatoo has undergone a major contraction in range and abundance over the past 50-60 years and is now classified as endangered by state, federal and international authorities.

Noongar people knew Carnaby's Cockatoo under a range of names: "Ngoolyoo" (Northampton); "Ngoolya" (Midlands); "Oo-Lack" (Perth); "Ngol-ye-nuk" (Avon River); "Woo-lock" (Albany); and "Gnular" (Pallinup River). While the names differed, Noongar people regarded the species as a 'rain bird' because the bird's movements were believed to be related to rainfall. Early European settlers also regarded the bird as a harbinger of rain, possibly as a result of Noongar knowledge.

Is there any truth in this belief in Carnaby's Cockatoo being a 'rain bird'? Two recently published scientific papers* demonstrate clearly that there is a strong synchrony between autumn rainfall and appearance of the birds in their breeding areas and commencement of egg-laying. The movements to their breeding areas and breeding takes place in late winter and early spring; that is, the wettest period of the year. The first paper exploring this relationship is by myself and three colleagues and published in *Biological Conservation**. This paper analysed data from detailed studies of the breeding biology of Carnaby's Cockatoo at two locations in the wheatbelt; Coomallo Creek (northern wheatbelt) and Manmanning (central wheatbelt). The second paper, by Coorow farmer Alison Doley and myself, has been accepted for publication in *Pacific Conservation Biology**. This paper reports on a long-term dataset of the birds of '*Koobabbie*' (northern wheatbelt) collected by Alison and John Doley, which was used to examine the relationship between arrival dates of Carnaby's Cockatoo at *Koobabbie* and autumn rainfall. The relevant findings of these papers are summarised below.

Egg laying and rainfall

The breeding population of Carnaby's Cockatoo at Coomallo Creek has been studied in detail since 1969. From then until the late 1970s the area was visited nearly every week during the breeding season (July to January). During each visit as many active nest hollows were examined as possible and the contents noted. Nestlings were measured and weighed. They were then aged using the length of the folded left wing compared with a growth curve derived from data obtained from nestlings of known age. After ageing the nestlings, laying dates were extrapolated. From the late 1970s the Coomallo Creek breeding population was monitored at various intervals to the present. Over 45 years (1969 to 2013) the population has been monitored 26 times, including every year from 2009. There was a period from 1997 to 2008 (inclusive) when no monitoring was done. The breeding population at Manmanning was monitored from 1969 to 1976 during which period the area was visited nearly weekly during the breeding season. The Manmanning population was extirpated by 1977 and to my knowledge the species has not bred there since.

Data on laying dates in both areas were collated into numbers of eggs laid each week. The earliest laying commenced at Coomallo Creek was the first week in July and the latest was in the last week in August; a difference of seven weeks. There was no trend in commencement in laying over the 45 years. At Manmanning, the earliest laying commenced was the first week in August and the latest the first week in September.

Commencement of laying each season was mathematically modelled against rainfall. Rainfall figures were obtained from the Bureau of Meteorology for Badgingarra Research Station. This site was chosen as both populations spend the non-breeding season (February to June) on the coastal plain either north or south of Badgingarra. Various models using different periods for rainfall were fitted to the data. The best fit for Coomallo Creek data was with total rainfall in the first half of autumn, February to April. The wetter the first half of autumn, the earlier Carnaby's Cockatoo will commence laying. At Coomallo Creek a 100 mm increase in total rainfall in the first half of autumn results in a five-week reduction in

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commencement of laying. The best fit for the data from Manmanning was with total autumn rainfall May to June. A 100 mm increase in total autumn rainfall resulted in a reduction of three weeks in commencement of laying at Manmanning.

The length of the laying period each season varied from 10 weeks in 1994 to 21 weeks in 1974 at Coomallo Creek and five weeks in 1976 to nine weeks in 1972 at Manmanning. At Coomallo Creek the earlier the birds started laying, the longer the period over which eggs were laid. There was no such trend at Manmanning.

Populations are made up of individuals and it is important to know how individuals time the laying of their eggs. This was established for 95 individually marked females from Coomallo Creek and 15 from Manmanning. Basically the majority of females laid their first egg approximately at the same stage of the breeding season over successive breeding seasons. That is, a female who laid early in the season is likely to continue to do so over her breeding life.

Autumn rainfall and breeding

Another dataset bears out the relationship between autumn rainfall and breeding in Carnaby's Cockatoo. The data come from Alison Doley and her late husband John. They collected data from May 1987 until the present on every species of bird that they recorded each week on *Koobabbie*, their 7,173ha property in the Waddy Forest district of the northern wheatbelt. Carnaby's Cockatoo was a regular breeding visitor to *Koobabbie* arriving in late winter, breeding and leaving in mid-summer. While some Carnaby's Cockatoo nesting attempts were monitored on *Koobabbie*, there were no data on commencement of laying as were available at Coomallo Creek and Manmanning. In lieu of commencement of laying, week of arrival on the property was used to look for any synchrony with rainfall. The best fit for arrival weeks was with total autumn rainfall at Badgingarra Research Station. The rainfall from this station was again chosen as it is likely the birds from *Koobabbie* spend their non-breeding season in the same area as the birds from Coomallo Creek. The earliest birds arrived was the third week in June and the latest the first week in August. A 100 mm increase in autumn rainfall results in a reduction of arrival of two weeks.

Discussion

It is clear from the results of these studies that Carnaby's Cockatoo is using autumn rainfall as a cue to time its breeding and it can be classified as a 'rain bird'. It is well known that birds time their breeding so that they maximise the chances of successfully rearing young. That is, they need to have ample resources at the time when the demand for food is at its greatest. Carnaby's Cockatoo lives in an environment of great climatic variability. For example, during the 45-year study at Coomallo Creek, in 1974, the wettest year, rainfall was 126% of the long-term mean and in 1994 (the driest) it was only 65% of the long term mean. Carnaby's Cockatoo feeds on seed of the Proteaceae and rainfall is an important determinant of flowering and subsequent seed set. So it makes good biological sense for Carnaby's

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FEASTING ON HAKEA SEEDS

While banding at home in August, I watched a group of 20-odd Baudin's having a feed on young Marris just behind our back fence in the adjacent farm property and on our small creek line. I then happened to notice one eating *Hakea petiolaris* just inside our property with another sitting on a fence dropper. They looked like aberrant Baudin's, particularly the male fence sitter. It was not until they moved to another *H. petiolaris* and I could readily see the upper mandible while they tackled the nuts that I realised they were in fact a male and female Carnaby's. The pair were very quiet except for the nut crunching. The male quite often perched in a nearby jam tree while the 'missus' fed and later, would come and join her in the same bush or another nearby *H. petiolaris*. Their feeding started about 0820 through to 1310hrs when they were mobbed by a Red Wattlebird and they flew across the road to the Hotham River riparian zone. The pair returned to our block at about 1430 hrs and continued feeding on *H. petiolaris* nuts and then a *H. undulata*, staying until 1720 hours when they departed, probably eastwards.

Greg Marston, Boddington

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Rain bird

Cockatoo to use rainfall as a cue to finetune the timing of its movements to the breeding areas and for egg laying. What is also obvious from the Coomallo Creek data is that there is no indication that egg laying is commencing any later or earlier this century than it did in the 1970s or 1980s.

Whatever cue is used to time breeding, in individuals this must set in train a series of physiological and behavioural changes to cause the birds to move to the breeding areas and enable breeding. Individuals will differ in the timing of their response to any cues. This is illustrated by the timing of laying of individually marked females. They do respond differently and so laying is spread over a considerable time. At Coomallo Creek, females laying later in the season have been as successful as females laying earlier. In fact, in 1974 one nest hollow was used successfully by two pairs. The first laid in July and fledged their young in November. The second pair laid in December and fledged their young in early March. This hollow was occupied for eight and a half months. At present there is no obvious advantage to laying at a particular time in the breeding season. However, that may change due to the impacts of predicted changes to the climate of south-western Australia.

At Manmanning in the 1970s, birds laying later in the season were rarely successful. I pointed out in a paper published in *Ibis** that the combination of onset of hot summer weather and fragmentation of native vegetation meant that the birds had to spend longer foraging for food at a time when foraging time was reducing, because they could not move when the temperature was over the mid-30s. So when demand for food was highest, foraging time was reduced and birds had to forage further afield having depleted food close to their nest hollows. In addition, the impacts of extreme temperatures on Carnaby's Cockatoo were demonstrated with the mass deaths on 6th January 2010 at Hopetoun and Munglinup.

Predictions for the climate of southwestern Australia are for it to be hotter and drier with more extreme events. If these predictions are accurate, then Carnaby's Cockatoo may have problems, in that birds laying in the latter part of the breeding season may find their breeding success much lower than those laying in the earlier part of the season. If they are having to contend with extremely hot days when demands for food are highest, they may not have sufficient time available in the cool part of the day to supply their own energy demands as well as provide for a growing nestling. The circumstances that the birds at Manmanning found themselves in may apply over much of the range of Carnaby's Cockatoo with unfortunate consequences for the species.

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

[For references, contact Editor]*

A NOISY AWAKENING!

One August morning I was awoken to a ruckus outside and when I went to investigate I found this Marri tree next to the house full of squawking cockatoos, who were biting off the immature nuts and dropping them on the ground. At first glance it looked like there might be about 15 of them, but once I started counting them, there were more than 20 at any one time. After a while I also noticed that some of them were breaking open the nuts with their beaks. All the while, the cockatoos were coming and going between this tree and one on the neighbour's property. This gave me a good look at the underside of their tails to see if any of them had any paint markings on them, but none of them did. Their performance carried on long enough for me to race inside to get my iPad and then take several photos.

We rarely have cockatoos stop to feed on our property. Usually, they announce their presence as they fly over the property from east to west in the morning and back the other way in the evening.

It was a delight to observe them at close range on that morning.

Jayne Hogan Bullsbrook

The wonderful world of fungi

Freezing cold winds did not deter 18 keen naturalists on the lookout for fungi germinated by the recent rains. In just over an hour, the group was well rewarded by photographing over 50 different species of fungi in a 300 metre walk through sheoak woodland at Lance Mudgway's property near Wagin.

Fungi are very interesting, being neither plants nor animals. They are all around us and even within us. They can be deadly or delicious, hallucinogenic or medicinal. They are great nutrient recyclers, helping plants take up nutrients from decomposing material.

The typical fruiting body that we see is the end of the fungal life cycle where spores are released to begin the process all over again. The main growing body is the mycelium, a tangled network of threads spreading through the soil, wood, manure or whatever substrate the fungi are growing on.

Every season you find different species of fungi. Some respond to fire, others to rain. They rarely come up in the same spot.

It is estimated that there are many more species of fungi in Australia than plants and that only 10% of them have been named.

With the help of Heather Adamson, *LFWO* from Mandurah, species photographed on the day are being identified and target species added to the National Australian Fungimap database.

Avril Baxter

An old landscape altered, but not lost

On a chilly evening in July more than 100 people braved the elements to hear Prof. Steve Hopper talk about last year's expedition in the footsteps of Robert Austin.

This talk was first given in Perth, but Albany-based *LFWO* Dorothy Redreau suggested a repeat presentation in Albany. Steve was agreeable and Paula Phillips from UWA put the program together and did the logistics. Dorothy helped promote it through *LFW* contacts.

Steve's talk had everyone wanting to get out and about. The team that followed in the footsteps of the expedition included a Noongar elder whose insights were quite profound and clearly showed the importance and value of Noongar cultural practices to conservation.

Although many of the landscapes were recognisable, the comparisons between artists' impressions and photographs had Steve scratching his head a bit. Quite a bit of artistic license was taken, since those on the original expedition were not just visitors, but residents of WA.

Many of the plants noted by Austin's expedition were discovered by Steve's party. In many instances the landscape was virtually unchanged and many sites looked as though they were waiting for the Noongars to return. Sadly, many of these places have now been left without their custodians.

The talk left many wishing that they too had been on the expedition and around the campfire at night. **Dorothy Redreau and Sylvia Leighton are now considering a two-day event to celebrate and explore the natural environment east of Albany and would be interested in any historical references. Please contact them if you are able to assist.**

Dorothy Redreau

Coming event

Our *Gardening for Wildlife* workshop with Sabrina Hahn (*LFW* members only)

will be held this year on Sunday 20th October

in Bridgetown

and will focus on: *how to entice and support local wildlife in your garden.*

Essential you contact *LFWO* Sheila Howat asap for details and bookings.

The observation below, related to the geophyte story and Steve's talk, highlights the increasing problems faced by our changing ecosystem.

Feral pigs and *Haemodorum* bulbs on granite

While driving to Perth from Albany last autumn in the jarrah forest, I saw something I'd not previously encountered in four decades of travelling the Southwest Australian Floristic Region – a mature feral pig as roadkill. Although a single observation, I wondered if this was a sign of an increasing population.

I have seen, on several occasions in the past decade, evidence of animals digging up species-rich herbfields on the shallow soils of granite outcrops in the northern jarrah forest. On each occasion, the bloodroot *Haemodorum simplex* was a common bulb in the herbfield, and traces of its red bulbs and discarded leaves were strewn around.

Feral pigs seem to be the most likely agent of this destructive harvest, which can often account for many square metres of complete soil upheaval. Further observations and research on this new threat to biodiversity on granite outcrops are needed.

Stephen D. Hopper, UWA Albany

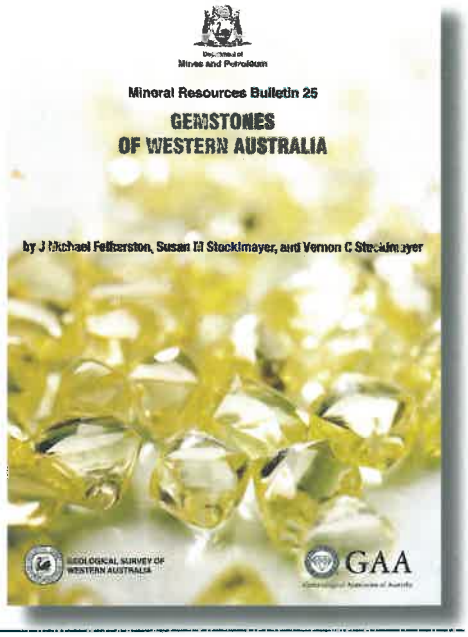
New books

Gemstones of Western Australia

J. Michael Featherstone, Susan M. Stocklmayer and Vernon C. Stocklmayer

Mineral Resources Bulletin 25, Geological Survey of Western Australia, 2013.

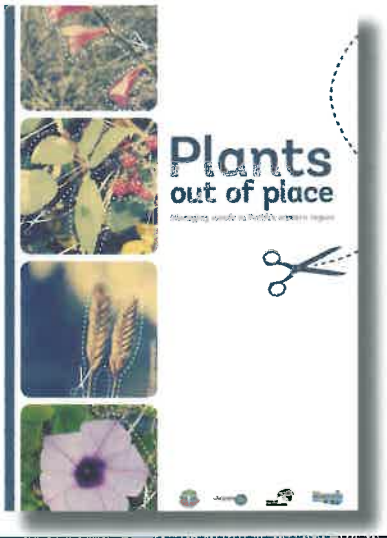
$50.00



Are you a fossicker? Or do you just love gems and jewellery? Are you inspired to craft beautiful ornaments from natural materials? If you answer 'yes' to any of these, you will find a lot of enjoyment in reading this comprehensive description of the gorgeous things you can find in WA. It discusses the history and quality of nearly all occurrences of decorative-quality material, with detailed geological maps and generalised locations of where they are found. Mind you, most of these are covered by mining leases, but should you want to extract material, there is a section on obtaining mining leases. There is also a bit on survival in the bush – lest your zeal for finding another diamond pipe might cause you to do a perish in our harsh outback!

This book will inspire you to travel widely in WA and to look more closely at the rocks underfoot. It also reminded me that I should do something with my Kennedy Range fossil wood and Mookaite pebbles, instead of leaving them as a multicoloured pavement in the garden!

Penny Hussey



Plants out of place: Managing weeds in Perth's eastern region

Jane Brook Catchment Group and the Eastern Hills Environmental Management team

Shire of Mundaring. 2013.

Free to Shire residents

The Shire of Mundaring and the Eastern Hills environmental management team have come up with another goody – a little booklet that simply and clearly identifies the most troublesome bushland and roadside weeds in the Eastern Hills, and how to control them. Congratulations to all concerned!

The booklet is obtainable from the Shire Offices or from libraries. When local residents pick up their own copy, think also of one for your friends in Kalamunda, Swan, or out towards York, Northam and Toodyay – or indeed, anywhere in the Hills. Enjoy – and then get out there, weeding!

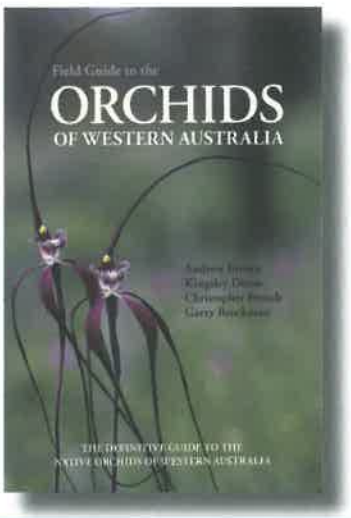
Penny Hussey

Field Guide to the Orchids of Western Australia

Andrew Brown, Kingsley Dixon, Christopher French and Garry Brockman

Simon Neville Publications. 2013.

$54.95 Available from good bookstores.



Orchid enthusiasts will recognise Andrew Brown's name from earlier books and articles in Western Wildlife. *This one is a real* tour de force, *providing photos and descriptions for all 39 genera and 430 orchid species currently known to occur in Western Australia, together with subspecies, hybrids etc. This is the first time all the known Western Australian orchids, both temperate and sub-tropical, have been represented photographically in a single publication.*

It is a superb book, and a genuine field guide too, in that it is not too big to fit in the glove box when you head out into the bush. If you haven't selected a Christmas present yet – well, here's an idea!

Penny Hussey

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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