A charity fostering scientific research into the biology and cultivation of the Australian flora

Research Matters

Newsletter of the Australian Flora Foundation

July 2016

Inside

Biodiversity legislation review

In May 2016, the NSW Government released a draft Biodiversity Conservation Bill and a draft Local Land Services (Amendment) Bill for public consultation and comment. The AFF submitted the letter below in response to the proposed changes. The call for submissions closed on 28 June and over 5,500 comments were received. It is intended that, subject to Parliament passing the proposed changes, the NSW Government will enact some of the provisions as early as January 2017 with the intention to start full legislative changes from July 2017. More information can be found at: https://www.landmanagement.nsw.gov.au

Proposed land clearing legislation – Biodiversity Conservation Bill 2016 and Local Land Services Bill 2016

21st June 2016

The Hon. Mike Baird, MP
Premier of New South Wales
GPO Box 5341
SYDNEY NSW 2001

Dear Premier

The Australian Flora Foundation strongly opposes the enactment of the Biodiversity Conservation Bill 2016 and the Local Land Services Bill 2016 in their present form as they will weaken the present protection of biodiversity in New South Wales.

The Australian Flora Foundation is a charity that provides funding for scientific research into Australia's flora. We have a particular interest in conservation of Australian plant diversity, particularly where there are threats from climate change.

The proposed legislation virtually ignores climate change. Research has proven that land clearing reduces rainfall, increases the duration of droughts and exacerbates El Niño. The draft legislation lists human-caused climate change as a key threatening process for biodiversity but does not deal with this threat, with only two references to climate change in the 213 pages of the draft legislation.

The legislation should recognize that climate change is a threat to biodiversity, and indeed to our generally accepted way of life.

The proposed legislation would promote major increases in land clearing, and consequently would counteract Australian Government moves to restrict land clearing as a means of reducing the impacts of global climate change. Increasing emissions by removing

restrictions on land clearing would directly contradict Australia's recent signing of the Paris Climate Agreement. Australia should meet its international obligations.

Other areas in your government's proposals that greatly concern us are:

- The role of the Minister for the Environment would be diminished. Important decisions on biodiversity should be the role and prerogative of the Minister for the Environment.
- There would be no requirement for like-for-like offsets, and developers would be able to pay money into a fund in exchange for destroying habitat.
- Mining site rehabilitation should be an accepted responsibility of mining companies, not an action for which such companies could claim biodiversity offset credits.
- A failure to follow proper consultation processes should invalidate planning instruments or decisions.
- The expansion of the use of 'self-assessable' codes would allow landholders to clear vegetation with little oversight.
- Areas of high conservation value must have absolute protection and should not be available for land clearing and development.
- The draft legislation should at least maintain the environmental standards of the existing legislation.

The provisions in the proposed legislation are less stringent, less evidence-based and less accountable, and remove many of this state's long-held environmental protections. They are a serious backward step for environmental law and policy in New South Wales.

We consider that any new legislation should be aimed at reducing the clearing of native vegetation in New South Wales, rather than increasing it.

Yours sincerely

Peter Goodwin
President
Australian Flora Foundation Inc.

Myrtle Rust in Australia

Michelle Leishman, Katherine Berthon and Laura Fernandez
Department of Biological Sciences, Macquarie University, New South Wales

In April 2010 the exotic rust fungus *Puccinia psidii* was detected in the Central Coast region of NSW. *Puccinia psidii* is a fungus in the order Uredinales native to Central and South America. It is commonly called 'Myrtle Rust', although other common names are 'Eucalyptus Rust' and 'Guava Rust'. *Puccinia psidii* exclusively attacks species of the Myrtaceae family, particularly the young growing tissues of plants such as newly deployed leaves, floral buds, fruits and coppice. Symptoms can range from no symptoms or purple flecks in resistant plants, through to yellow spore pustules on the leaves, stems and branches in susceptible species, to defoliation and even death in the most vulnerable species. Given the dominance of species in the family Myrtaceae in Australia (1,646 species in 70 genera), Myrtle Rust has the potential to significantly affect vegetation composition and species abundance widely across the continent.

Myrtle Rust has spread quickly since it was first detected in 2010. It has extended along the east coast of Australia and has been recorded as far north as the Tiwi Islands in the Northern Territory and south into Tasmania. In Victoria and Tasmania, Myrtle Rust has so far only been recorded in parks and gardens. At least 340 native Australian Myrtaceae are known to be susceptible to the disease, with only 3% of tested species showing signs of resistance. Highly susceptible genera include *Agonis*, *Austromyrtus*, *Callistemon*, *Eucalyptus*, *Leptospermum*, *Melaleuca* and *Rhodamnia*. Myrtle Rust is known to have infected at least 218 new hosts in the wild and caused severe declines in previously dominant species such as the key rainforest species of the east coast *Rhodamnia rubescens* (Brush Turpentine) and *Rhodomyrtus psidioides* (Native Guava). The wetland keystone species *Melaleuca quinquenervia* (Broad-leaved Paperbark) is also a highly susceptible species. The potentially significant threat of *P. psidii* to the native and endemic flora of Australia has been recognised through the listing of 'Introduction and establishment of Exotic Rust Fungi of the order Pucciniales pathogenic on plants of the family Myrtaceae' as a Key Threatening Process under the NSW Threatened Species Conservation Act 1995.

Researchers at the NSW Department of Primary Industries, Queensland Department of Agriculture and Fisheries, Royal Botanic Gardens and Domain Trust and Macquarie University have been working to understand the distribution and impact of Myrtle Rust, while research on host susceptibility has also been undertaken at the University of Sydney, University of Tasmania and CSIRO.

However much work on understanding the long-term impacts of Myrtle Rust remains to be done. Macquarie University PhD student Laura Fernandez recently conducted a survey of natural resource managers on the occurrence of Myrtle Rust and recorded several new host species and new LGAs where Myrtle Rust occurs. At least 400 species of Myrtaceae are known to be in the current range of Myrtle Rust in NSW alone, including 56 threatened species. The majority (>66%) of species have not been tested for susceptibility, with several complete genera remaining untested. It is also likely that Myrtle Rust may limit post-fire regeneration due to the susceptibility of new growth. Mortality of susceptible species may also result in changes in species composition, potentially including invasion by exotic plant species into canopy gaps. Much more research is needed on potential impacts of Myrtle Rust as well as a nationally co-ordinated approach to management and mitigation of this pest species.

For further information
https://www.environment.gov.au/biodiversity/invasive-species/diseases-fungi-and-parasites/myrtle-rust

http://www.dpi.nsw.gov.au/content/biosecurity/plant/myrtle-rust

http://invasives.org.au/project/myrtle-rust/

Grafting Australian native plants – the cutting graft method

By Phil Trickett*

Any gardener who has tried to grow some of the spectacular Western Australian plants outside their natural environment knows all too well the difficulty in keeping these plants alive for more than a few months. Grafting onto hardy eastern Australia rootstocks has long been touted as the answer to this problem. However, the cost and time involved in producing grafted plants commercially has been a huge brake on their development and availability. These plants are often priced at two to three times the price of non-grafted plants, resulting in both limited demand and consequential reduced supply.

Most commercial grafting to-date has concentrated on the genus *Grevillea*, and many successful long-lived plants have been produced. Despite these successes, the supply of grafted native plants in NSW and Queensland nurseries is currently negligible. Grafted *Corymbia ficifolia* and related hybrids, *Eremophila nivea* and the odd *Grevillea*, if you are lucky, are pretty well the limit of expectation when visiting nurseries in these states. Expectations are

slightly higher in Victoria and South Australia, but depend on a few specialist grafters.

So what can we do to encourage the availability of grafted native plants for our gardens? One option is to use a simpler, less resource intensive method of grafting with the potential to increase the supply, diversity and range of grafted plants, at a lower cost. This method is where the scion is grafted onto a cutting of the rootstock and the resulting graft is processed as a cutting, called a cutting graft. Although not widely used, the cutting graft method has a number of advantages for professional grafters and is also suitable for the home gardener wanting to graft:

- the time and effort growing stock seedlings needed for the 'traditional' method is eliminated, which is likely to encourage more grafting;
- growers can choose a rootstock from their own garden, from a plant which is proven to be vigorous and hardy in their conditions;
- given practise, cutting grafts are easier and quicker to process than 'traditional' grafts.

The most common method of grafting in current use is to graft the scion (the plant being grafted onto the rootstock) onto a rooted seedling. This is the method most used by professional grafters of Australian native plants. A major cost of this method is the production of rootstock seedlings ready for grafting. The main advantage of this method is that the grafted plant is ready to plant out slightly quicker than cutting grafts.

This article focuses on the alternative method of the cutting graft. Wider use of this technique would allow for greater experimentation and production among grafters of native plants. I produce cutting grafts using the wedge technique for a large range of species within the genera *Grevillea*, *Hakea*, *Banksia*, *Dryandra*, *Eremophila*, *Isopogon* and *Pimelea*. I graft all year round and I continue to experiment on 'new' species, depending on the availability of scion material. My techniques are the result of many years of experimentation and learning from other growers, and I continue to develop them. Here are the three most vital parts of my method for successfully producing cutting grafts.

Key steps for successful cutting grafts

- Scion (plant being grafted): Choose firm, semi-hard scion material. New tip growth should be avoided as this will tend to wilt quickly resulting in the graft failing.
- Stock: Take a cutting of your chosen stock plant from a plant growing in your garden. This cutting should be chosen to match the diameter of the scion material and should be around 4–5 cm in length. Remove all leaves from the stock

cutting, apart from one leaf at the very tip of the cutting. All other leaves can be removed – don't strip the bark when removing leaves. Keeping the top leaf is vital to prevent any 'dieback' around the graft union.

- Soak stock and scion cuttings in a bleach solution (1 part bleach to 8 parts water) for a few seconds then rinse in water and pat dry with paper towel. This prevents any fungal issues developing while the graft takes.

Choosing your stock plant species

Which species should be used as stock plants for cutting grafts? There are four main criteria I use. The chosen species:

- should be hardy to your conditions;
- must be long-term compatible with the scion being grafted;
- must strike roots readily, ideally in a period less than 3 months; and
- should be a non-lignotuberous species to avoid the problem of the grafted plants resprouting below the graft.

Here are some examples of species which satisfy these criteria for the main genera currently grafted:

Grevillea – 'Carrington Cross', 'Burgundy Blaze', 'Bronze Rambler'
Hakea – Hakea salicifolia
Isopogon/*Petrophile – Isopogon anethifolius*, *I. mnoraifolius*
Banksia – Banksia integrifolia, *B. cunninghamii*
Eremophila – Myoporum acuminatum, *M. insulare*, *M. montanum*
Pimelea – Pimelea ligustrina, *P. ferruginea*

Key requirements in successfully raising cutting grafts

The actual grafting is only one part of the process for successfully producing cutting grafts. The conditions provided to these grafts as they undergo the twin processes of the graft taking and the stock producing roots are equally critical to the success of the graft. Sub-standard conditions can very easily wipe out an entire production of grafts in one day! Key dangers are the death of the stock or scion, fungal disease, and incorrect levels of light, warmth and humidity. So what are the things to consider in providing optimal conditions for successful grafts?

- Recognise that each species being grafted requires different levels of humidity. For example *Isopogon cuneatus* only requires the protection offered by shadehouses, whereas *Grevillea leptobotrys* requires the very high humidity provided by a glasshouse under misting for at least the first month after grafting. Trial and error is the only real way to determine the level of humidity needed. However, a rough rule of thumb

is that flat, more leathery leaves such as those on *Isopogon cuneatus* or *Banksia media* require less humidity than the fine, terete leaved species such as *Grevillea leptobotrys* or *Grevillea dielsiana*.

- The correct light and heat are vital, and the variation in temperature throughout the year needs to be tempered through shading/temperature reduction measures,
- Ensure that the cutting mix does not become too wet or too dry. Both will result in the death of the stock plant before roots are formed.
- Once roots have formed, plants should be potted on using a potting mix with high air porosity. Perlite can be added to commercial potting mixes that may retain too much moisture and compromise plants successfully growing on after potting up. Protection from direct summer sunlight and strong winds is important at this stage.



Above are some young cutting grafts where the graft has successfully taken and roots have formed on the rootstock. Each image clearly illustrates one leaf only at the top of the stock plant.

Left is a mature *Isopogon cuneatus*, grafted using the cutting graft technique. Why isn't this spectacular plant widely available as a grafted plant in nurseries? The cutting graft technique has the potential to produce these in large quantities at a far lower price than currently charged for grafted plants. Let's hope we see commercial growers of Australian native plants experiment with this technique, so that in the near future more of our spectacular plants become available to our gardeners.

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*About the author

Following a 30 year career in the Australian Public Service in Canberra working in population, health and education statistics, Phil Trickett retired in 2010 with his wife Catriona to the South Coast of NSW.

Phil and Catriona chose a 2 ha property to continue their dream of propagating and growing Australian plants. Their property was originally rainforest and has rich, volcanic soil. As a result, they have plenty of rainfall and do they not need to water after planting.

Phil has spent the last decade experimenting with grafting native plants. A particular passion of his is to graft Western Australian Banksias – his successful technique currently spans 31 species. Grafted plants show tremendous vigour, resulting in excellent specimen plants. Along with more than 60 species of *Banksia*, his garden comprises more than 90 *Hakea* species, 43 *Eremophila* species, 17 *Isopogon* species and 35 *Grevillea* species. Most of these are grafted.

Phil and Catriona have been members of the Australian Native Plant Society (ANPS) for 18 years, and have been active members of the *Banksia*, *Dryandra*, *Hakea*, *Eremophila* and *Isopogon*/*Petrophile* Study Groups of ANPS. We have recently taken over leadership of the *Isopogon*/*Petrophile* Study Group.

Utricularia species of the Howard Springs Site of Conservation Significance, Darwin

Sean Bellairs*
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The Top End Native Garden Open (TENGO) was held in Girraween on 29 May 2016. The property is located in the Howard Sand Plains Site of Conservation Significance, which is within in the Darwin Rural Area. *Eucalyptus* woodland around the house sloped down into sand sheet dominated by *Melaleuca* spp., *Banksia dentata* and *Verticordia cunninghamii* with an understory of herbs and sedges. Among the herbs flowering on the property were seven carnivorous *Utricularia* species (*U. chrysantha*, *U. gibba*, *U. hamiltonii*, *U. holtzei*, *U. kamienskii*, *U. nivea*, *U. quinquedentata*). *Utricularia gibba* is a bright, yellow-flowered, aquatic species while the others were rooted in moist or waterlogged sand.

The very high diversity of *Utricularia* on sand sheet near Howard Springs is internationally recognised (Taylor 1989). Of the

approximately 239 known species of *Utricularia*, 66 occur in Australia, where they are found in all states and territories. The highest number of species is Australia is found in the Northern Territory (41 species) and 26 species have herbarium specimens recorded from the 264 km^2 area Howard Sand Plains Site of Conservation Significance. Among the species of *Utricularia* in the region are two threatened species, *U. dunstaniae* and *U. singeriana*.

Just 2 weeks prior to TENGO, Greening Australia and the Top End Native Plant Society organised a field day and guided walk nearby on sand sheet near the Humpty Doo Golf Club. There we saw a small population of the threatened species, *Utricularia dunstaniae* flowering in shallow water. Other species observed included *U. leptoplectra* with its pair of long, rabbit-ear shaped petals; coloured royal blue on one side and bright yellow on the reverse. Lemon yellow-flowered *U. aurea* grew in moist sand along with the tiny white flowered *U. holtzei*. The variety of flower sizes, shapes and colours within the members of this genus is amazing. The online document, "The genus *Utricularia* in the Northern Territory", provides photos of most of the local species (website details provided below). Other carnivorous plants also occur in the area including *Aldrovanda vesiculosa*, *Byblis aquatica* and several species of *Drosera* (Northern Territory Herbarium, 2015).

Top left: *Utricularia leptoplectra*; bottom left: *Utricularia dunstaniae*; typical habitat of *Utricularia* in Howard Springs Site of Conservation Significance, Darwin.

Unfortunately the area of globally significant *Utricularia* diversity is exposed to many threats. Within the Howard Sand Plains, it is estimated that only about 32 km^2 is not substantially disturbed and remains as suitable habitat for *Utricularia*. Within this area, only 8.5 km^2 contains high diversity habitat (Liddle *et al*. 2013; NTEPA 2015) but none of this restricted area is within a conservation reserve. Urban development exposes the area to increased fire, weeds and recreational activity from off-road vehicles, all of which impacts the unique environment in which *Utricularia* grows.

Utricularia thrives in low nutrient soil and seasonal waterlogged conditions of the sand sheet. Saturated sandy soil or shallow water allows *Utricularia* plants to trap aquatic prey using bladder-like traps on the roots. These are triggered when microscopic prey, such as protists and small invertebrates, touch hairs on the traps, causing the empty trap to open and suck in water along with the animal. They are then digested inside the trap. Increased nutrient levels associated with rural gardens and horticulture could result in other plants being able to invade the sand sheets and *Utricularia* succumbing to competition.

Disruption to water flows has also been found to impact the abundance *Utricularia* and it appears that many months of seepage from adjacent woodland across the sand sheet is required for plants to grow and flower. Another major threat is sand extraction; the Howard Sand Plains sands are the closest commercial source of sand to the Darwin area and demand for sand for construction activities has greatly increased in recent years.

Unfortunately we know little about the biology of these species and lack the knowledge to recreate diverse *Utricularia* habitat that supports the original diversity of species after sand extraction. Raising awareness of these diminutive but inimitable plants through open gardens and field days is a small step in the right direction for ensuring their conservation.

For further information

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https://www.greeningaustralia.org.au/uploads/related-downloads/Howard-Sand-Plains-Vegetation-communities.pdf
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http://eflora.nt.gov.au/viewfile?file_id=3965
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*About the author
Sean Bellairs is a Senior Lecturer in the School of Environment and Research Institute for the Environment and Livelihoods at the Charles Darwin University. His research areas focus on utilisation of native flora and restoration of native flora on disturbed lands. His research currently includes investigations into the ecology and commercial potential of Australian native rices, rainforest restoration, control of weed seed banks and sustainability of savanna on gold and uranium mine waste rock dumps. Prior to coming to Darwin 14 years ago, he was a Senior Research Officer investigating native vegetation establishment on mine sites around Australia at the Centre for Mined Land Rehabilitation, University of Queensland. He also had a three year post-doctoral position with CSIRO investigating grain growth and early biomass development in wheat. His PhD at the University of Western Australia investigated seed sources and seedling establishment patterns following mineral sand mining in Western Australia.

Indigenous Land and Food Knowledge – a field study to raise cultural awareness

Tina Bell
Faculty of Agriculture and Environment, University of Sydney

In July, my colleagues from the University of Sydney, Peter Ampt, Jessica Maley, Rebecca Cross and I took a group of 14 staff and students on an inaugural field trip associated with our new unit of study, Indigenous Land and Food Knowledge. We had been planning this course for the past 18 months and we were excited that it was finally happening but nervous about how it would be received.

The unit aims to promote understanding of land and food knowledge for students to develop skills in identifying and developing opportunities for Indigenous engagement in land management and food production. We explore the importance of the Indigenous estate and examine Indigenous knowledge to engage with contemporary realities of land management and food production for

the sustainability of communities living on Country. Emphasis is placed on identifying opportunities for economic activities based on land and food management for the communities visited during the field trip. With the places we visit and the people we meet we help the students understand the complex situation around living on Country and the social, environmental and political pressures that are impacting on Indigenous communities.

Our trip started in Darwin with a talk by Dr Sean Bellairs about some of the natural landforms and native plants in the area (see previous article). This was followed by a tour led by Dr Payi Linda Ford of Twin Hills, a cattle station managed by the Twin Hill Aboriginal Corporation on behalf of its traditional owners. The property is a 375 km^2 pastoral enterprise located on the edge of the Litchfield National Park. We heard that the main function of the cattle station was for agistment with 10,000 head currently on-site. Twin Hills was presented as an example of a thriving Indigenous business making use of western-style agriculture. On the flood plains of the property we encountered *Banksia dentata* (Tropical Banksia), from which the old seed cones were used as firebrands. Linda told us that the central part of flower cones that did not form any follicles was once used in nasal piercings by women in the local Indigenous population. She also showed us how to find fibres used for plaiting dilly bags from *Pandanus spiralis* (Screw Palm). Linda demonstrated how the flowers of *Grevillea refracta* (Silver-leaf Grevillea) are pulled straight off the tree and vigorously sucked for their nectar. Linda's ancestral country includes parts of Litchfield National Park so we visited the series of freshwater pools that have formed at the base of Wangi Falls. This popular swimming spot is a special place for Indigenous women.

From Darwin we drove to Katherine to visit a farm run by the Kalano Community Association Inc. This association has been operating for 39 years and is an Indigenous community-based organisation with 240 members. It provides a range of services in housing, health, education and employment and runs two commercial operations – Kalano Community Store and Kalano Farm. The farm is a 67 ha property located just north of the Katherine River and the fertile flood plain soil provides ideal conditions for growing tomatoes and vegetables. Produce from the farm is mostly sold to the local supermarkets in Katherine and Darwin with some produce transported as far as Adelaide. Kalano Farm was presented as an example of an Indigenous community making use of western-style horticulture. Here we helped members of the community grade and sort tomatoes collected the day before and discuss potential additions for their enterprise.

On our way from Katherine to Kununurra in Western Australia we began seeing trees of the iconic species, *Adansonia gregorii* or Boab. At this time of the year, most individuals had lost their leaves unless they had access to ground water or grew close to a river. We

later learnt that the pith of large woody fruit is edible when fresh, as are tuberous roots, and the leaves have medicinal properties. As part of the prescribed assessment for the course, one group of students have decided to research the potential for commercial production of this species by a local indigenous community in Kununurra.

In Kununurra we explored the range of opportunities afforded by the Ord Irrigation Scheme. In 1959 a grant from the Commonwealth Government was finally approved allowing the Western Australian Government to start work on the massive Ord Irrigation Scheme. The construction of the Kununurra Diversion Dam across the Ord River was completed in 1963 and marked the completion of the first stage of the Ord Irrigation Scheme. The major capital investment also led to the establishment of the town of Kununurra which was built as the service centre for the scheme. During the wet season the gates open to allow the flood waters to pass through, limiting flooding of adjacent agricultural land. During the dry season the gates close to allow water storage and diversion to the irrigation channel, ensuring a year-round supply of water.

In 1967, the Commonwealth Government provided another grant, this time for the construction of the Ord River Dam to form Lake Argyle as a major storage reservoir. Lake Argyle has a volume of 5,641 GL (equivalent to more than 11 Sydney Harbours) and is one of the world's largest manmade water bodies. The Ord River Dam was completed in 1972 and the permanent water supply to Lake Kununurra enabled the development for irrigated land on the adjacent Packsaddle Plain.

In the early 1990's, it was decided that a hydroelectric power station would be built at the base of the Main Ord Dam. To guarantee a reliable supply of energy, a higher water level was needed to be maintained in Lake Argyle. By building a weir across the spillway, the volume could be almost doubled to 10,763 GL (increasing the capacity to 21 Sydney Harbours). Ord Stage 2 is now under development and the current farmed area of approximately 12,500 ha is likely to increase to 45,000 ha. Work began in 2009 with the second main irrigation channel. Potential farming land related to Ord Stage 2 involves land owned by Indigenous communities so the opportunities for agricultural enterprises were explored during the field trip.

We visited the Mirima Dawang Woorlab-gerring Language and Culture Centre in Kunnunurra and, among other things, we learnt about local native food plants. Apart from Boab, other important Indigenous plant food sources include *Carissa lanceolata* (Conkerberry) which has small black berries that taste like plums; the globular fruit of *Ficus racemosa* (Cluster Fig) borne on short stalks on stems and branches and *Marsdenia australis* or Bush Banana. One of the most distinctive species in flower at this time of

year is *Cochlospermum fraseri* (Kapok Tree) with bright yellow flowers that stand out as the tree has no leaves at this time of year. It is often referred to as a calendar plant as flowering indicates when the eggs of freshwater crocodiles can be collected. The hard woody fruit of this species is not edible.

Top left: *Banksia dentata* with broad, saw-tooth edged leaves and a small specimen of *Pandanus spiralis*; bottom left: fruit of *Marsdenia australis*, the Bush Banana, a climbing perennial with the inner layer of young fruit tasting like raw peas; right: an enormous Boab in the grounds of a popular caravan park in Katherine reportedly to be more than 1000 years old.

While in Kununurra we visited Tropical Forestry Services. This company was founded in 1997 following successful government trials of plantations of Indian Sandalwood (*Santalum album*) in the Ord River Irrigation Area (ORIA) of Western Australia. Sandalwood is a hemiparasitic tree that 'taps into' roots of host trees via haustoria. *Santalum album* is not native to Australia but two species, *S. spicatum* and *S. acuminatum*, grow in southern Western Australia and are occasionally wild harvested for oil production. We were shown around the largest area of Indian sandalwood plantation in the world (10,500 ha planted to date). Our tour also included propagation and processing areas. After 15 years of growth of the parasitic tree on a number of different host plants, the first commercial harvest was done in 2014. To give you an idea of the worth of this crop, the carving industry in China will pay more than US$500,000 per tonne of Indian Sandalwood.

Left: Plantation Sandalwood, *Santalum alba*; middle top: the remaining stump of recently harvested Sandalwood showing dark oil-bearing heartwood and outer light non-oil bearing sapwood; middle bottom; short poles of Sandalwood ready for export for the carving market, each pole is potentially worth $500–1000; right top root stumps of Sandalwood are also used for carving; right bottom: trunks of Sandalwood trees awaiting processing.

Students were encouraged to gauge their feelings about their growing knowledge of Indigenous communities by recording their thoughts in a reflective journal. Discussions of what they saw during the day often went on well into the night. I was impressed with the inquisitive nature of the students and they asked questions of me that tested my botanical knowledge. I am proud to report that the field trip was judged to be an outstanding success.

Final project reports

Both of the projects described below were funded by the Australian Flora Foundation. Full reports of these and other projects funded by AFF are available at: http://www.aff.org.au/

The dynamics of formation and dissipation of patches associated with fallen logs in a chenopod shrubland of southern Australia

Alexandra S Bowman and José M Facelli
School of Earth and Environmental Sciences, University of Adelaide, South Australia

Submitted December 2015

Project summary

Resource heterogeneity is a prominent feature of arid ecosystems, yet little is known about the dynamics of patch formation or their

dissipation. We aimed to assess patch formation and dissipation associated with introducing and removing fallen logs. We introduced logs and artificial logs to open spaces and assessed changes to soil nutrient contents and annual plant communities after three years. Pairs of fallen logs were also selected and one of each pair was removed. We deployed soil temperature and moisture probes and collected soil samples to determine dissipation of soil nutrient contents and soil seed bank over one year. Three years was not long enough to change soil nutrient contents or annual plant communities when introducing logs, but unplanned destocking had strong effects on soil nutrient contents. The removal of logs produced immediate changes to the soil microclimate, but accumulated nutrients and seeds in the soil remained after one year. Patch formation next to logs occurs between 3 and 12 years in situ. Additionally, the removal of logs creates patches that are unique to any others, but the role of this new patch type in the system is unknown, as is the length of its persistence.

Aims of the project

The objectives of the study were to assess the dissipation and formation of patches associated with fallen logs with a focus on short term effects on soil properties. The research was conducted at the Middleback Field Research Centre in South Australia. The key questions were: (i) are there any changes in soil microclimate after removal of a fallen log over a one year period, and (ii) are there any changes to soil nutrients and annual plant communities associated with the introduction of fallen logs into open spaces over three years. In addition, artificial logs (PVC pipes) of similar diameter to

the natural logs were introduced to determine if the decomposition of log material contributed to the formation of patches.

Conclusions

The research showed patch formation and dissipation to be more complex than originally anticipated. Patch accumulation did not occur within a 3 year period, yet logs are known to create patches at 12 years *in situ*, suggesting that a log patch develops roughly between 3 and 12 years. After removing a log we found immediate changes to soil microclimate, but soil seed bank and soil nutrients continued to persist unchanged for at least a year. Given that the site had little topographic gradient, few large rainfall events (none of them torrential) and low or no grazing present, it was not surprising that soil nutrients and seed banks were unchanged. Faster rates of dissipation are predicted to be found from removed patches in areas with greater topographic gradient and higher stocking rates. Changes in microclimate conditions were highly unexpected, particularly regarding soil volumetric water content.

The removal of a fallen log creates a patch that is unique in the environment and very different to any others in the system, as areas of log removal still retain some properties of the patch, but develop some new ones. More information is needed about the role of this patch type and about length of persistence. Given other patch types take several years to dissipate it is important to continue to monitor how this patch type changes with time. The dynamics of formation and dissipation of patches depend on the patch forming entity, yet there are still many questions unanswered about the dynamics of patchiness. Given the prevalence of grazing in arid lands this remains an important area for future research, as fallen logs are a patch forming entity which assist in the preservation of Australian flora in degraded arid systems. Ultimately a general model of patch formation and dissipation in arid lands is required for enhancing our ability to manage and restore these fragile ecosystems.

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Identifying cost-effective reforestation approaches for biodiversity conservation and carbon sequestration in southern Australia

Corey JA Bradshaw and Briony Horner
The University of Adelaide and Succession Ecology Pty. Ltd., South Australia

Submitted February 2016

Project summary

The aim of this project was to determine the reforestation approach that maximises the native biodiversity found in Mallee bushland

regrowth in South Australia, while simultaneously maximising carbon sequestration. A long-term reforestation experiment was implemented to test six approaches – three biodiversity treatments: (1) monoculture, (2) low diversity, (3) high diversity; and two planting densities: (1) high and (2) low – for reforesting deforested land into secondary shrubland and woodland complexes at Monarto Zoo, South Australia. Monitoring is continuing for key taxa (vegetation, invertebrates, small mammals, reptiles) and carbon pools were assessed prior to reforestation and throughout the regeneration process. This study is unique in its experimental assessment of temperate Australian reforestation for biodiversity conservation and in the collection of baseline data. This study will eventually result in guidelines for woodland/shrubland reforestation as an economically viable land use for landholders.

This project was funded by the Australian Research Council, with co-funding from the Australian Flora Foundation, South Australia Department of Environment, Water and Natural Resources and Zoos SA. Research began in 2013 at Monarto Zoo, South Australia. Staff from Zoos SA was mostly responsible for the day-to-day monitoring, propagation, planting, watering and general care of the site. The project site is located in a single soil type of approximately 20 ha of previously cleared agricultural land at Monarto Zoological Park, South Australia.

Biodiversity-density treatments

The two principal manipulations were: (1) a three-level biodiversity and (2) a two-level planting density treatment. Each plot was assigned randomly one of six replanting treatments or one of two controls so that each block has a single, randomly ordered representative of each treatment. Species were chosen on the basis of availability of propagating material (seed), germination success and seedling survival in both the nursery and the field. A series of harvest plots (for carbon sequestration measurements) were also been established in areas adjacent to the experimental plots.

The three-level biodiversity treatments included:

1. Native tree monoculture (low-diversity, LD; one species): *Eucalyptus porosa* (Mallee Box)
2. Low-diversity mixed culture (medium-diversity, MD; three species): *Eucalyptus porosa*, *Acacia rhigiophylla* (Dagger-leaf Wattle), *Enchylaena tomentosa* (Ruby Saltbush)
3. High-diversity mixed culture (high-diversity, HD; 10 species): *Eucalyptus porosa*, *E. leucoxylon* (South Australian Blue Gum), *Melaleuca acuminata* (Mallee Honey Myrtle), *Acacia rhigiophylla*, *A. brachybotrya* (Grey Mulga Bush), *Pomaderris paniculosa* (Pomaderris), *Enchylaena tomentosa*, *Rhagodia crassifolia* (Fleshy Saltbush), *Prostanthera aspalathoides* (Scarlet Mintbush), *Maireana brevifolia* (Shortleaf Bluebush)

Each of the three biodiversity treatments was planted at two densities:

1. High-density plantings (Hd) tubestock spaced at 1.5 m apart
2. Low-density plantings (Ld) tubestock spaced 3 m apart

Two control plots included in each block were:

1. Grass management, mow twice per year
2. No manipulation

Each plant was assigned a code according to the location on a grid system to enable ease of monitoring, recording of plant death and for growth measurement.

On-going monitoring includes:

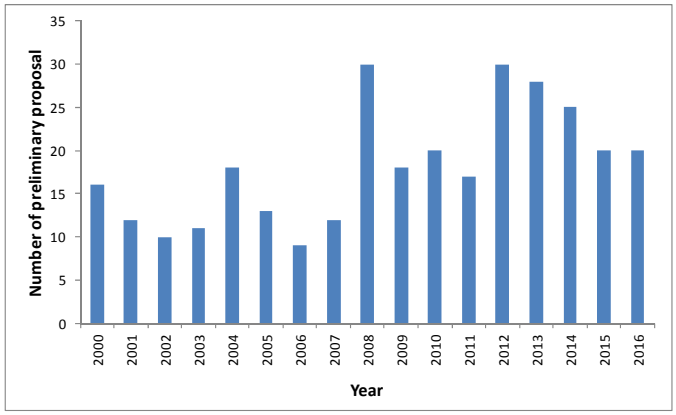
- Plant surveys before and after first planting
- Invertebrates, including native and introduced bees
- Reptiles
- Small mammals (as by-catch of pitfall trapping)
- Soil carbon

Future plans

Given the slow growth rates of Mallee-type vegetation, we expect that monitoring will need to continue for a minimum of 15–20 years before the full extent of the ideal planting scenarios are known. We are currently seeking additional funding for ongoing monitoring at a reduced frequency (perhaps bi-annually) so we can build a long-term database of vegetation growth and biodiversity use.

Australian Flora Foundation research proposals in 2016

The highlight of the May 2016 meeting of the AFF was a discussion of the latest round of research proposals. A total of 20 proposals were received and seven have been asked for full proposals for consideration at our next meeting. An estimated amount of $60,500 will be available for distribution amongst the successful proposals. Since 2000, the number of research proposals submitted each year has remained about the same with an average of 18 (see graph below). The number of projects funded each year generally ranges from three to six and these are funded for 1–2 years.



We believe that the end result of AFF funding has been the generation of considerable new knowledge in priority areas chosen by the AFF. The results can be seen at http://www.aff.org.au/

About us

The Australian Flora Foundation is an Australian not-for-profit charity dedicated to fostering scientific research into Australia's flora. It is totally independent. All members of the Council and the Scientific Committee give their time freely as volunteers.

Each year the Australian Flora Foundation provides funding for a number of grants for research into the biology and cultivation of the Australian flora. While the grants are not usually large, they are

often vital in enabling such projects to be undertaken. Many of the researchers are honours or postgraduate students, and their success with an Australian Flora Foundation grant hopefully stimulates their interest in researching Australia's unique and diverse plants throughout their careers.

This work is only made possible by the generous support of donors and benefactors.

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