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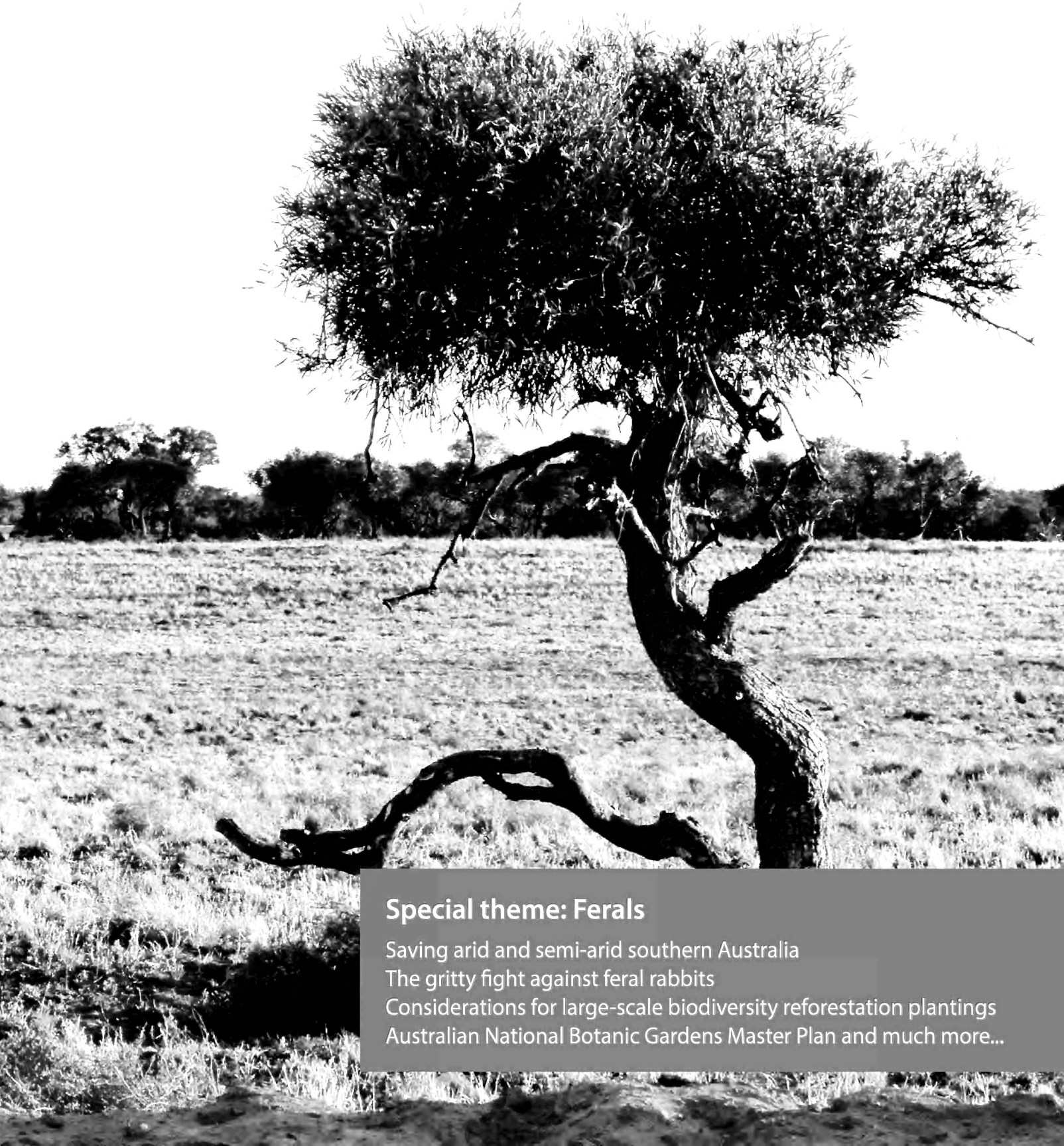

Special theme: Ferals

Saving arid and semi-arid southern Australia
The gritty fight against feral rabbits
Considerations for large-scale biodiversity reforestation plantings
Australian National Botanic Gardens Master Plan and much more...

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Front cover: *Alectryon olefolius* adult with browsed canopy. Photo: Mark Tozer.

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Contributing to *Australasian Plant Conservation*

Australasian Plant Conservation is a forum for information exchange for all those involved in plant conservation: please use it to share your work with others. Articles, information snippets, details of new publications or research, and diary dates are welcome. General articles on any plant conservation issue are most welcome.

The deadline for the December 2015 – February 2016 issue is Friday 6 November 2015. The special theme for the issue is *Cryptogams*. Please contact the editor, Paul Adam, if you are intending to submit an article: editor@anpc.asn.au

Authors are encouraged to submit images with articles or information. Please submit images in electronic format, resolution needs to be at least 300 dpi, at least the size that they are to be published, in tif, jpg or gif format. Guidelines for authors are at: http://www.anpc.asn.au/sites/default/files/apc/APCGuideContrib.pdf.

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This issue

Regular features

The production of this edition of *Australasian Plant Conservation* was supported by the **NSW Environmental Trust** through its Lead Environmental Community Groups program.

From the editor

PAUL ADAM

The Spring 2015 issue of *Australasian Plant Conservation* is my first as editor, and I would like to thank my predecessor, Huw Morgan, for all his work over the last few years in producing issues of high interest and relevance. *Australasian Plant Conservation* is an important medium for providing information to, and for stimulating discussion amongst, the membership; and is also the visible presence of the Network and its activities for the broader community.

The previous issue was the first in the new format, which I hope readers have found attractive and easy to read. I congratulate our graphic designer Siobhan Duffy and our dedicated office staff, Jo Lynch and Carly Westbye for all work required to bring the new format into being.

The theme of this issue is Ferals, which constitute a major threat to many Australian ecosystems, and present severe practical difficulties to restoration of vegetation across large areas of the continent. It is pleasing that we have three articles which focus on semi-arid and arid Australia, which make up much of our wide, brown land but which are not often the focus of landscape scale restoration. Limiting the depredation of feral animals in restoration projects can be an expensive and frustrating task. Chris Macris and his colleagues point to the potential for an innovative new approach, and it will be interesting to learn in the future of the outcomes of the trials. I would hope that future issues will contain further articles on feral problems as, unfortunately, the diversity of feral species and their impacts continues to grow.

On a related issue, I discuss hybrids and hybridisation as a challenge to plant conservation. This has been somewhat of a sleeper, where basic documentation is limited and there are opportunities for citizen scientists, to pick up on the theme of the last issue, to make an important contribution. Dan Cole and Greg Siepen provide a further instalment to their large scale reafforestation series by discussing project management, a topic not only relevant to large scale projects but to many of the diverse activities in which members are involved.

Anne Cochrane provides an introduction to the Australian Seed Bank Partnership, which we hope will be the first of regular contributions about the Partnership and its work.

The major sponsor and supporter of the ANPC for many years has been the Australian National Botanic Gardens. We are very pleased to include an introduction to the Garden's new Master Plan, a major step forward in the development of one of Australia's most important and exciting botanical institutions.

As we enter an El Nino period, this coming summer across much of the continent is likely to be hot and dry, a challenge both to plants and for fieldwork. As respite I hope you can find a shady tree under which you can read this issue in the middle of the day while waiting for cooler conditions to return.

Saving arid and semi-arid southern Australia after over 150 years of exotic grazing pressure: have we got the time and the will?

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Groves of trees and shrubs characterise the arid and semi-arid parts of Australia. They provide important structural diversity and resources upon which many other plants and animals depend. These include nectar, nesting substrates, shelter from predators, woody debris and a range of other habitat features. They are also important in regulating the flux and capture of moisture, nutrients and soil particles through arid landscapes. Importantly, these trees and shrubs (or perennial plants) are the only elements of arid ecosystems that maintain all of these functions through extended droughts, which recur through decadal and century time scales. While the decline and extinction of critical weight range mammals is seen as a major ecological issue in arid Australia, the concurrent loss of perennial plants is blurred by the longevity of the adult plants, masking the ongoing extinction debt that is occurring due to recruitment failure in these systems. We are witnessing the blurry catastrophe of Janzen (1986) and a quintessential expression of shifting baseline syndrome through successive human generations (Papworth *et al*. 2009).

Since the 1850s a series of introductions of exotic herbivores to Australia have significantly affected plant recruitment and survival (Pickard 1991). There is now a substantial body of research based on the use of selective exclosure fencing and long-term survival studies of adults and seedlings/juveniles that supports the argument that grazing by introduced sheep, rabbits and goats, in particular, has eliminated or greatly reduced recruitment in a range of palatable perennial plant species with life spans varying from 30->200 years. Unlike the critical weight range mammals, none of these plant species have yet gone globally extinct since the introduction of the exotic grazers (although many local populations have been lost). The different rates of response in the mammals and plants can be attributed to contrasting life histories. Whereas juvenile and adult mammals were vulnerable to predation by foxes and cats and loss of habitat, juvenile plants were much more susceptible to herbivores than adult plants, as the adults have protective bark and hold at least some of their foliage above the browse reach of the animals. Secondly, critical weight range mammals rarely live for more than a decade, whereas many perennial plants live for decades or centuries. This means that the plant populations have a much greater capacity to persist under adverse conditions, even if their attrition is hastened by land degradation associated with overgrazing.

The key questions for conservation management in these ecosystems are: i) can we effectively initiate and maintain plant recruitment; ii) how long do new plants need before they become large enough to have some resilience to exotic grazers; and iii) just how long have conservation managers got left before the remaining long-lived plants disappear from arid landscapes, and a secondary cascade of decline occurs in dependent fauna and flora? Already, significant adult tree mortality through drought and heat stress has been identified as an issue in arid *Acacia* species in Australia and elsewhere around the globe (Allen *et al*. 2010). It looks like the time for effective management action may be running out.

How widespread is this problem?

The problem of overgrazing by livestock and feral animals has been recognised since the turn of the nineteenth century (Pickard 1991), but the lessons of the Royal Commission in 1901 on the condition of the Western Division of NSW have not been learnt. Since that time ecologists have quantified impacts of exotic grazers in a range of studies across northwestern Victoria, western NSW, western Queensland and northeastern South Australia, and have demonstrated adverse grazing impacts on recruitment in long-lived plants. Recent work on cattle impacts on a rare *Acacia* in central Australia has highlighted that this is an issue for palatable arid trees and shrubs in central Australia as well (Nano *et al.* 2012).

Key examples of species impacted by exotic herbivores

The trees and shrubs that dominate the semi-arid and arid deserts comprise several main plant groups, all of which contain species palatable to exotic grazers. The iconic acacias are a widespread and important perennial component of these ecosystems, with mulgas the widespread dominants of many vegetation

communities. To date, over 25 arid acacias have been shown to be impacted by exotic herbivores, including threatened species such as *Acacia carneorum* and *A. peuce*, threatened ecological communities such as *Acacia loderi* shrubland (Fig.1), *A. melvillei* shrubland, Brigalow-Gidgee (*A. harpophylla-A. cambagei*) woodland/shrubland and Myall Woodland, along with widespread species such as Mulgas (*A. aneura* group), *A. oswaldii*, *A. burkittii* and *A. ligulata*. The dominants of some broad ecological communities impacted by grazers include Belah (*Casuarina pauper*), Rosewood (*Alectryon oleifolius*) (Fig. 2) and *Callitris gracilis* subsp. *murrayensis*. Members of the Proteaceae are also at risk, particularly hakeas, including *Hakea leucoptera* and *H. tephrosperma*, along with other species such as *Apophyllum anomulum, Atriplex* spp., *Exocarpus aphyllus*, *Templetonia egena* and even the less palatable *Myoporum platycarpum*. These species regenerate either by seed alone (canopy held or soil seed banks) or a combination of seed and vegetative root suckers, and may dominate ecological communities over thousands of square kilometres.

What we need to do

A new style of proactive pastoral management is needed, whereby sheep and cattle densities are significantly reduced in the early stages of extended droughts and important periods of plant recruitment. This will not only relieve pressure on the perennial plants, but maintain the resilience and productivity of the rangeland soils and ground vegetation.

Fencing at the local scale can eliminate grazing impacts for individual stands of a species and this strategy has been widely implemented for a range of threatened plants. Separate studies in Koonamore in SA, Kinchega National Park in western NSW and in arid Western Australia suggest it may take several decades before any recruits are large enough to be able to escape or withstand grazing from exotic herbivores (e.g. Sinclair 2005). Hence, a long term commitment to fencing and maintenance is needed, along with concurrent control of exotic herbivore populations in unfenced areas.

While exclosure fencing may protect individual species or some patches of woodland, broadscale control of rabbits, goats, pigs and camels is needed. This can be achieved through a number of means including baiting, shooting, mustering and, for rabbits, biological controls such as new releases of calicivirus and other species-specific diseases. In pastoral lands, management of access to stored water is critical. This can be regulated by fences and gates to prevent access by feral herbivores when paddocks are spelled from livestock. In many private and public conservation lands, artificial watering points are being decommissioned to reduce populations of herbivores.

The slow life histories of perennial plants in the arid zone provide something of a buffer to reinitiate ongoing recruitment from long-lived adult trees before they disappear from our landscapes. Some species will also have a buffer in a long-lived soil seed bank. However, we may be reaching the limits of these buffers, as global warming and an increased likelihood of severe drought may accelerate adult plant mortality leading to a rapid loss of sensitive tree or shrub species. Glimpses of this worst case scenario were evident during the Millenium drought which saw spectacular crashes in adult plants in some acacias, including the widespread *A. oswaldii* and the threatened *A. carneorum* (Fig. 3) (Nano *et al*. 2012).

Figure 1: Declining stand of *Acacia loderi* shrubland. Photo: Tony Auld.

Figure 2: *Alectryon oleifolius* adult with browsed canopy. Photo: Mark Tozer.

Figure 3: Widespread adult plant death and canopy decline in *Acacia carneorum* in western NSW in response to drought. Taken in a dust storm in April 2008. Photo: Tony Auld.

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The gritty fight against feral rabbits: testing the effectiveness of a browsing deterrent (Sen-Tree™) on native grassy-groundcovers

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Introduction

Greening Australia (GA) has established a trial site with the aim of determining if a browsing deterrent (Sen-Tree™) is an effective means of repelling feral Leporids (rabbits and hares) from establishing herbaceous grassy-ground cover species. The trial, funded by Urban Growth NSW, will benchmark the performance of the product against tree guarding, seek to determine if a re-application of the product after four weeks is beneficial, and finally, examine if the browsing deterrent effect of the product is the same across nine different species.

Background

The focus area of our trial was The Ponds, NSW (in Sydney's North West), where restoration initiatives conducted by GA on behalf of Urban Growth NSW have been negatively impacted by feral Leporid activity for over a decade (pers. comm Rowan Wood). These impacts are exacerbated by the edge effects and disturbance regimes associated with peri-urban development. One such problem area was a north-facing roadside batter, gently sloping towards and bordering a five hectare remnant stand of Cumberland Plain Woodland (an Ecologically Endangered Community). Frustratingly, this area had been left devastated by feral Leporids shortly following revegetation on a number of occasions.

In order to achieve key deliverables desired by the client (i.e. establishment of tubestock planting), GA undertook research to determine how best to tackle the issue of rabbits and hares at this site. Browsing deterrents were identified as potentially offering a practical, ethical and lower-cost financial alternative to traditional forms of rabbit control (Miller *et al.* 2009; Cooke *et al.* 2013). The three main forms of deterring browsing are: physical barriers (i.e. various forms of commercially available tree guards); biological barriers (e.g. companion planting with 'nurse crops') and chemical browsing deterrents. Greening Australia found that, although effective at excluding browsing, tree guards were not an economical means to protect dense grassy-groundcover plantings at field-scale. In respect to biological barriers no data was available concerning what might be appropriate nurse crops which could serve this function in this region.

However, a previous study by Miller *et al.* (2008) highlighted a promising chemical browsing deterrent called Sen-Tree™ (SureGro). This finding led to our decision to design a field experiment at our Ponds restoration project site to trial the effectiveness of Sen-Tree™ on ground covers in a native landscaping context.

Sen-Tree™ Browsing Deterrent

Sen-Tree™ is an egg-based compound which is added to an adhesive polymer and sprayed onto the foliage of the plant. Once semi-dry, the foliage of the plant is sprinkled with silicone carbide grit via the supplied hand applicator. The manufacturer (SureGro) claims that this combination of odour and grit have 'a recurring deterrent effect through learned association.' (http://www.suregro.com/Sen-TreeTM-browsing-deterrent-en/). An Australian Pesticides and Veterinary Medicines Authority (APVMA) approval (permit number: 80151) was requested and approved for the use of the product in this specific application during the trial period. Please note, this product is currently only registered under the APVMA for use Australia-wide on specific tree species (refer to APVMA, product number 51933). Any further use on non-registered plants would require a new APVMA permit.

Experimental design

The stratified experimental design encompassed four treatments, which were allocated randomly across 16 25m^2 plots (four plots per treatment). The treatments were:

- An initial post-planting foliar application of Sen-Tree™ to all plants within the plot;
- As above, plus a second foliar application four weeks later to all plants within the plot;
- Installation of plant guards to all plants within the plot comprising of: one standard thickness biodegradable tree guard, one SureGro Recycled Paper Weed Mat and three Bamboo Tree Guard Stakes per plant; and
- Untreated control areas.

The species used in the study were**:** Scented Top Grass (*Capillipedium parviflorum),* Barbed Wire Grass *(Cymbopogon refractus),* Blue Flax-Lily (*Dianella revoluta*), Shorthair Plumegrass *(Dichelachne micrantha*), Forest Hedgehog Grass (*Echinopogon ovatus*), Spiny-headed Matt-rush (*Lomandra longifolia*), Tussock Grass (*Poa labillardieri*), Wallaby Grass (*Rytidosperma tenuius*) and Kangaroo Grass (*Themeda triandra*). Ten plants per species were planted in each plot**,** with the exception being Spiny-headed Matt-rush (20 plants per plot), for a total of 100 plants per plot, and at a fixed density of four plants per m^2.

Data collection

Treatments were monitoring on five occasions at three week intervals between December 2014 and February 2015. Plant height, presence/absence of browsing and percentage vegetative cover (both exotic and native) were measured/observed. All measures excluding percentage cover were made on three randomly selected plants per species per plot per monitoring event. Percentage cover (of both native and exotic grasses and broad leaved species) for the entire plot area was estimated using the Braun-Blanquet cover-abundance scale.

Project Officer Evan Freame mixing Sen-Tree™ prior to application. Photo: Chris Macris.

A portion of the trial site at the time of establishment. Photo: Stefan Kruger.

Examples of detrimental rabbit grazing to Spiny-headed Matt-rush (left) and Tussock Grass (right). Photo: Chris Macris.

Summary comments

This study is not yet concluded, so findings will be reported at a later stage. However, we feel it demonstrates it is feasible to establish field-based trials to analyse practical issues relating to restoration; in this case a cost-benefit analysis of two forms of browsing deterrent. While the outcomes in relation to herbivore effects are to be determined, GA found that substituting tree guards with Sen-Tree™ reduces project costs by 45% through lower material and labour costs. If, at the completion of this study, Sen-Tree™ is revealed to be as effective as plant guarding there would be a strong case for its wider use in field scale restoration projects establishing small herbaceous grassy-groundcover species.

In relation to Sen-Tree™, by examining growth and herbivory rates, this study also hopes to determine if a second application of the product is beneficial enough to warrant the cost of doing so. Our prediction is that without a second application, the feral Leporids will continue to supress groundcovers (particularly grasses) by consuming only new, untreated growth. If this proves to be the case it might suggest that the smell-taste-association imparted by the product is not as strong as the manufacturer assumes.

Finally, and importantly, the study will help us determine if Sen-Tree™ performs differently on each of the species included in the trial. We originally anticipated it may be less effective on species characterised by smaller juvenile leaf blades such as Tussock Grass because there is less surface area for the glue/grit mix to adhere to, and more effective on wider bladed species such as Spiny-headed Matt-rush. This remains to be determined.

Acknowledgements

The authors wish to thank Urban Growth NSW for project funding, Dr. Paul Gibson-Roy for reviewing this submission, and the GA team whom contributed to making this trial a reality.

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The use of aerial survey to support rabbit control and native vegetation regeneration on the Hay Plains of NSW

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In late July and early August 2015 an aerial survey was conducted to accurately quantify the area of land effected by, and the population density of, the European Rabbit (*Oryctolagus cuniculus*). The surveyed area covered 122,000 ha south of the Murrumbidgee River to the Murrumbidgee Local Government Area (LGA) southern boundary, between the townships of Carrathool and Hay in NSW. By using this aerial platform other species of interest could also be mapped simultaneously, these included Weeping Myall (*Acacia pendula*) Woodland, Sandhill Pine Woodland, Black Box (*Eucalyptus largiflorens*) and the invasive weed African Boxthorn (*Lycium ferocissimum*).

New technology

Helicopter aerial surveying of the area was adopted to definitively identify and accurately record the GPS coordinates of all rabbit warrens and use the information to strategically target control efforts that maximise effectiveness. Two video cameras with 4K Ultra-HD resolution were mounted on each side of the helicopter, that matched the same wide angle oblique views of the two observers seated in the rear cabin with doors removed. Tablet computers connected wirelessly to monitor the video feed and record GPS trails of the helicopter track. Mathematical algorithms were developed to improve the accuracy of the observed data points across the 500m swath of video footage. This system was the first of its kind to be used in Australia and provides a clearer visible image when reviewing the video footage.

Rabbits on the Hay Plains

Rabbits established themselves over 140 years ago in the sandy soils of prior and ancestral streams, and associated sand hills that make up the geomorphology of the surveyed area. The rabbit was well suited to the environment as the sandy soils could be easily dug to create large interconnected warrens. The scale of their establishment across broadacre properties ranging from 10,000 to >50,000 hectares has made effective control strategies very difficult predominantly due to the financial cost of harbour destruction. Grazing by rabbits, particularly of seedlings, has contributed to overall land degradation by preventing regeneration of the native vegetation.

Weeping Myall Woodlands

Weeping Myall Woodlands are listed as an endangered ecological community (EEC) under the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act). Chenopods, such as saltbushes, native cotton bushes, bluebushes, goosefoots and copperburrs, were originally an important component of the Weeping Myall Woodland understorey. As chenopods are generally highly palatable, they have largely disappeared in areas that have been grazed by stock and/or rabbits for substantial periods of time (NSW Scientific Committee 2005; White *et al.* 2002). Changes in land use particularly sheep grazing to cattle farming systems is a significant threat to the future recovery of the ecological community.

Sandhill Pine Woodlands

The effect rabbits have had on Sandhill Pine Woodlands, which is listed as an EEC under the NSW Threatened Species Conservation Act 1995 is evident throughout the region with little to no regeneration of native plant species (Figure 1). The dominant tree species, when a tree layer is present is White Cypress Pine (*Callitris glaucophylla*), either in pure stands or with a range of other less abundant trees or tall shrubs. The condition of the woodlands varies from no remaining pines or

Endangered Ecological Community: Sandhill Pine Woodland severely impacted by rabbits. Photo: Suzie Holbery.

shrubs, replaced by annual grasses through to good stands of White Cypress Pine on Oolambeyan National Park. Rosewoods (*Alectryon oleifolius*) are present in conjunction with White Cypress Pine in some sandhills in the area, however a browse line is clearly visible from grazing stock. Much of the original understorey has been grazed out, replaced by short-lived perennial and annual grasses and herbs, many of them introduced species.

Practical applications for the survey results

With the warrens accurately mapped through the survey, collaborative pest management programs are being developed for the landholders with the support of Local Land Services' Biosecurity Officers. This has included project development to access funding aimed to support ratepayers with their management programs.

The data collected on woodlands and vegetation is being used to identify suitable areas for current and future projects aimed at restoring threatened plant species in the region. The video imagery and photographic footage collected during the survey will remain a valuable resource for comparison with historical data and as a measure of success for restoration efforts.

Conclusion

There is no question that rabbits and livestock are significantly impeding restoration efforts of these EECs. It is imperative that all re-vegetation is done with long term rabbit control and livestock exclusion. This comes at a considerable financial cost, which has contributed to the continued decline of the native vegetation in the area. The aerial survey has provided an extremely valuable resource to ensure current and future funding is used efficiently to get maximum impact.

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Saltbush plantation currently under threat and partly destroyed by rabbits. Photo: Suzie Holbery.

Australian National Botanic Gardens – Master Plan

www.anbg.gov.au/gardens

The Master Plan for the Australian National Botanic Gardens was launched on the 25 June 2015 by the Hon. Bob Baldwin, Parliamentary Secretary for the Minister for the Environment. The launch included the announcement of $5 million funding over the next three years to start the implementation of the plan.

The Master Plan provides the framework for the Gardens' future infrastructure needs supporting enhanced visitor experiences, and advanced horticulture and research capabilities over the next 20 years. It gives a long-term vision that will ensure the Gardens remain at the forefront of contemporary gardens world-wide.

A key objective of the Master Plan is to develop new infrastructure and attractions to support the growth of the Gardens' visitor experiences, educational and recreational opportunities without impacting on the precious living collection. The Master Plan focuses on the following precincts of the Gardens:

Core Precinct: aim of this area is to focus on welcoming visitors, enabling them to quickly orientate themselves and plan their visit. Emphasis has been placed on developing a central hub featuring the Visitor Centre, Cafe and Function Centre, Event Amphitheatre and Nature Play Terrace.

Northern Precinct: a range of functions will be consolidated into a new integrated-service zone, including the new National Seed Bank and maintenance depot.

Bushland Precinct: this zone will focus on ecotourism and a treetop adventure course, utilising the bushland setting. An initial development will be a walking track that links to the National Arboretum.

Implementation of the Master Plan will enhance the character of the Gardens. It will integrate the existing landscape with the built environment. Utilising the existing footprint of our current buildings, it will not impact on the living collection.

The Master Plan will create new memorable experiences and visitor destinations such as the Nature Play Terrace situated in the core precinct, attracting families and engaging children in educational and adventure play.

A new Conservatory will be constructed near the Visitor Centre, which through its outstanding architectural design will become an iconic feature of the Gardens. It will display plants from Australia's tropics as well as threatened species, and provide spaces for educational and visitor experiences.

A key objective of the plan is to deliver increased horticultural and research capabilities such as the new National Seed Bank – a world class facility commensurate with the Gardens' international best practice in seed banking, reflecting the critical importance of the work that is undertaken there.

A planned program of public art will be integrated into the landscape to add layers of meaning and content for visitors.

The Master Plan will be implemented over a 20 year period, or sooner if funding becomes available, with many projects planned to be undertaken in the next five years. To bring the Master Plan to fruition we will be establishing a range of fundraising campaigns supported by capital funding from Parks Australia.

The completed Master Plan provides creative and sustainable directions for the Australian National Botanic Gardens that will greatly improve a most valuable cultural asset.

The full Master Plan report can be downloaded at www.anbg.gov.au/gardens/about/management/master-plan

Rangeland vegetation recovery with feral goat control

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Background

Semi-arid and arid rangelands represent approximately 85% of Western Australia and have supported the densest populations of goats in Australia. Goats arrived in Western Australia around 1870 and were first declared as vermin in 1928. Goats are thought to degrade ecosystem function by reducing plant establishment and growth, leaf litter, cryptogams, organic carbon, nutrients and water infiltration. Additionally, soil compaction and erosion increase.

Goats can thrive in the harsh environment of the rangelands. With a high reproductive potential, goats can quickly increase population densities after control activities. Even in a highly degraded landscape, the reproductive potential is maintained and therefore the ecosystem can be severely impacted before goat reproduction is compromised (Fletcher 1991).

Able to consume the majority of plant species in pastoral Australia, goats graze species avoided by other large herbivores, and poisonous and bitter species. Their efficient digestive system allows for a high tolerance to herbivore-deterrent chemicals and a relatively low requirement for water. They have a broad diet and an ability to selectively eat specific parts of plants. Goats eat foliage, twigs, bark, fruit, seeds, flowers, plant litter and fungi and readily browse to a height of two metres. The diet of feral goats is influenced by the quality and quantity of food available at any given time, as well as palatability. Goats and cattle have been shown to commonly select woody forage over grass when both are on offer, in contrast to kangaroos which primarily target grasses, particularly in dry periods.

Iron ore in the Gascoyne-Murchison rangelands is mined from banded ironstone formations that often have high biodiversity values, including short-range endemic and threatened species. With feral goat control proposed as an environmental offset for the resources industry, the effects of goat control on ecosystem recovery warrants investigation. Goat control activities are expensive and it is necessary to know whether they will result in perennial vegetation recovery, in order to have confidence that funds are being used effectively. Few feral herbivore control programs in Australia have monitored long-term effectiveness or cost-efficiency.

Research

Initial research in the Gascoyne-Murchison rangelands investigated vegetation recovery after a period of approximately two years of goat control (Hartley 2010). Four sites with varying goat population densities in similar habitat were selected. This variation could indicate a threshold to which goat numbers need to be reduced to enable vegetation recovery. It was hypothesised that there would be a negative relationship between herbivore abundance and plant biomass due to grazing. Goat-exclusion (fenced) areas were established to simulate comprehensive goat control. Inside and outside the exclusion areas, data was collected on plant recruitment and biomass, and herbivore scats were collected as a measure of herbivore abundance.

The rangelands are a complex and abiotic-dependent system, making detection of change difficult. Research has shown that areas completely void of grazing pressure by use of exclosures can result in vegetation changes not directly related to herbivory, as vegetation dynamics on this level are largely unpredictable. The use of exclosure fencing may therefore be limited. However the technique in association with herbivore monitoring provides confidence that the focus variable (grazing) was controlled.

Perennial species are more indicative of long-term changes in the rangelands, whilst annuals provide an indication of conditions in the short-term. The species assessed in this study were Warty Fuchsia Bush *Eremophila latrobei*, Seaheath *Frankenia pauciflora*, Cotton Bush *Ptilotus obovatus*, *P. schwartzii* and *Solanum lasiophyllum*. The Western Australian Rangeland Monitoring System (WARMS) provides both short-term and long-term assessments of ecological processes in pastoral regions, with a strong bias towards productivity characteristics (Holm *et al.*). Measuring flora biomass and population change, using the WARMS and 'Adelaide Technique', were used to assess initial responses to reduced grazing pressure.

Plant biomass assessments provide an indication of the species' ability to survive under grazing conditions. The Adelaide Technique (Andrew *et al.*) provides an estimate of forage available to herbivores. A leafy branch is selected and cut from a selected species, typical of the habit and foliar density of the trees within the study area. Visual estimation is used to determine how many multiples of the reference branch equate to the biomass on plants of the same species. The dry weight of the leaves and forage on the reference is multiplied by the estimated number of equivalents on each plant to calculate the available forage for all individuals. Andrew *et al.* (1981) compared the use of the Adelaide Technique, plant dimension measurements and a capacitance probe for reliably estimating forage. Whilst dimension measurements are easy and fast, the Adelaide Technique was found to be the most accurate and practical method, especially when including the assessment of vegetation not grazed or under different grazing pressures.

Findings

The research found that exclusion fences were effective in controlling goat abundance. Further, native herbivores, such as kangaroos, did not increase with a reduction in goat abundance. Fencing may therefore be a valuable management technique for protecting valuable vegetation communities and refugia from the impacts of grazing. However, the reduction of feral goat abundance did not necessarily result in an improvement of vegetation system health within a two-year period, using plant biomass, recruitment and mortality as measures.

The most influential variable to vegetation change, and feral goat abundance, was site. For goat abundance, the site influence was a result of management activities and the presence of reliable water sources. For vegetation, site differences were most likely attributed to rainfall. With climatic conditions stimulating rapid growth or decline in forage, this effect is capable of masking the much less prominent effect of grazing in the short-term. Populations may naturally increase with rainfall and decrease with drought, however if the pressure of significant grazing impacts from feral goats reduces the ability of flora to improve in condition and reproduce, then the population may decline in the long-term.

Historical disturbances, including grazing, can be as influential to perennial plant populations as the current environment. Historical heavy grazing that may have resulted in ecosystem dysfunction may be limiting plants' ability to respond to reduced pressure or may have already removed sensitive species that cannot survive under such conditions. Restoration planting trials inside and outside exclosures may provide more immediate responses for the studied species. Monitoring for the recolonisation or increased abundance of flora that are currently locally extinct or rare, may be an improved assessment of ecosystem health.

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Reflecting on Feral Status

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Setting the scene

In an earlier edition of APC I presented my Hobart conference paper titled "In Defence of Weeds and Ferals" (Gibson-Roy 2015). In it I argued that humans had degraded and simplified the planet's ecological systems to such a point that we now suffer from predictable consequences, including those related to species we term ferals and weeds. So in this Feral-themed edition I was encouraged by a friend to pursue this argument further.

Broadly speaking, ferals are described as wild animals or animals that have returned to the wild from a domesticated state. Based on this quite open understanding, a feral animal might reside in the wild but may not necessarily create negative impacts for other species or humans, in that they may be sub dominant and functional contributors to an ecosystem. However, the NSW government (http://www.environment.nsw.gov.au/edresources/FeralAnimalsAndWeeds.htm) tightens this definition somewhat, illustrating how ferals are more likely to be perceived by our sector (and the public). They regard animals that have arrived in Australia since the First Fleet, and which have escaped into the bush (read: wild), to be pests. Examples would include cats, carp, cane toads, dogs (but not dingoes), foxes, goats, pigs and rabbits. Escapees of this ilk can also become pests in farming landscapes, competing for resources.

Moving energy across large landscapes: power line towers stretched across the Basalt Plain near Cressy Victoria. Photo: Paul Gibson-Roy.

However, true pest status for any feral species is typically accomplished by combinations of:

- weight of number;
- capacity to spread; and
- overall negative impact on native species or agriculture.

Deeper reflection

Here is the rub, and perhaps the elephant in the room (a sad analogy because as we know elephants are fast leaving the room/planet). If we consider the true measure of ferals as largely determined by these aforementioned attributes perhaps we should be more introspective before pointing the finger. For the sake of a balanced discussion, I urge the reader to consider humans as simply another species and categorise their behaviour using the key attributes of feralness.

On number

There are an awful lot of us. Remarkably, 10,000 years ago there were less than 2 million humans on the planet. By 200 years ago this had grown to 1 billion. Now there are 7 billion. This is projected to rise to 10 billion and level off later this century (Roser 2015). Prior to 1850, famine, disease and simple technologies kept our numbers low and slow growing, although our impacts on the terrestrial biosphere were still profound. Even simple technologies such as the use of fire and rudimentary weapons, like spears and clubs, were enough to transform landscapes and exterminate countless species (Ellis 2011).

On spread

Humans have an un-paralleled capacity to spread. The ancestors of modern humans evolved in Africa up to 2.5 million year ago and developed the means to migrate north and prosper in the European/Asian continent (Burnenhult 1993). Then around 200 thousand years ago what we now term anatomically modern humans (*Homo sapiens sapiens*) evolved in southern Africa. This group succeeded in a way none of the other hominids did because they were able to act as a cohesive social unit (Marean 2015). With this organising capacity and keen intelligence, and after 100 thousand years consolidating within Africa, they began an inexorable spread to all parts of the globe. So virulent were modern humans that not only did all manner of species (including most mega fauna) disappear in their wake, so too did any of the archaic hominid cousins they encountered.

This lead Marean (2015) to conclude that what may have initially started as migration involving small numbers of a minor ecosystem player turned into the most consequential event in the history of the planet.

On impact

We can increase in number and range, but are our impacts large? Are we a functional contributor or an ecosystem dominator? The evidence would suggest the latter. Ellis (2011) suggests that any organism in sufficiently large numbers has the potential to transform or disrupt ecosystems - as is exemplified by rabbit or locust plagues. So what about ours? Marean (2015) stated that the inexorable spread of modern humans was in all instances associated with massive ecological change. Ellis (2011) argues such change cannot be explained by population size alone. The evidence of human-transformed ecosystems shows that we are profoundly different from other species. We are ecosystem engineers at a planetary scale and we do so with a clear and co-ordinated purpose using increasingly sophisticated technologies. This is evidenced in the fact that almost 50% of the planet's land surface has been cleared or transformed for agricultural production or forestry, and a further 7% is occupied by cities, roads, railways, mines etc. (Hooke *et al.* 2012). And it is clear we will continue to spread and transform. Consider our current federal government's objective to develop Australia's north. They envisage that what has for long been viewed as the 'last frontier' should instead be seen as the 'new frontier' enabling (among other things) the doubling of Australia's agricultural output (http://www.liberal.org.au/2030-vision-developing-northern-australia).

Conclusion

Humans are amazing (to borrow loosely from Alex Loyd). For better or worse we have transformed the world to a point that for huge numbers of our kind, existence is no longer a daily struggle for warmth, sustenance or health (although for equally huge numbers it remains so).

Low diversity landscapes: monoculture crop (Canola) and single species paddock trees (red gums) near Chatsworth Victoria. Photo: Paul Gibson-Roy.

Modern mixed farming systems: sheep grazing and wind turbines near Ararat Victoria. Photo: Paul Gibson-Roy.

Humans have brought into being things that never before existed (e.g. mathematics, art, music and complex language) and extended our direct experience from the quantum to the far reaches of the universe. However, for the planet's other biota the cost of our rise has been high and in most cases tragic. So what of ferals? I believe that our species overwhelmingly meets the criteria set by us for describing a feral animal. While it is unlikely humans *en masse* will ever put the good of other species above their own, perhaps by recognising and taking ownership of our true selves, we might in future act more in ways that moderate these inevitable impacts rather than continually increasing them.

It may be perceived by some as semantics, but it is my hope that our sector, populated by academics, conservationists, farmers, land managers, restorationists, researchers and others, can be more honest and reflective about pressing environmental issues, including reflecting honestly on the true nature of weeds and ferals. If we fail in this, we risk falling into the trap of presenting a façade of science over a blinkered human-centric world view. What hope then for the broader populace who rightly look to us for understanding and guidance on these vitally important matters? Indeed, what hope for the planet?

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Considerations for large-scale biodiversity reforestation plantings. Part 5: project management

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Introduction

This article is the fifth in a series discussing considerations needed in large-scale tree planting for biodiversity outcomes. We focus this project management article primarily on the contractor and the activities and initiatives required to successfully deliver such projects. We briefly cover some aspects where improvements are suggested for the future management of projects in the emerging industry of ecological restoration.

Project management – key tasks

Project managing a large-scale reforestation project can be complex and will typically require establishing and maintaining relationships for consecutive years with the client, community groups and other stakeholders along with private landholders such as farmers. Project management incorporates a raft of tasks including but not limited to:

- Preparing and submitting tenders and quotes.
- Financial management (budgets including contingency).
- Preparing operations reports (e.g. OHSE, spray records).
- Preparing performance reports for mortality audits, replants, weed cover, monitoring, and photo points.
- Procurement of materials and subcontractors.
- Coordination of subcontractor works.
- Prioritising project works, including for each management zone.
- Scheduling (target and rotate management zones).
- Conducting pre and post maintenance inspections (e.g. reviewing subcontractor works, vegetation and tree protection exclusion zones, erosion and sedimentation risks and controls, fence lines and vandalism etc).
- Risk management and contingency planning (negotiation with client and contractors).
- Implementing site hygiene (e.g. wash down areas).
- Proactively planning replants, if required.
- Reviewing and adapting maintenance methodology, if required.
- Coordinating community planting events, if required.
- Facilitating volunteers, if required (see future article).

Project management often starts at the competitive tender stage. Photo: Dan Cole.

Project management – inception to completion

A forest restoration project has numerous stages that require management from the upfront inputs of tendering to land tenure through to maintenance and monitoring. A considerable advantage is having consistency with personnel in key roles such as project management. Historical knowledge of the site(s) and stakeholders over time enables informed decisions that benefit the project. A management team that has a connection to the project will often develop a strong commitment to delivering quality restoration outcomes.

Managing timeframes and resources

Projects at scale will require a well resourced internal team and sub-contractors who are well-versed across disciplines such as ecology, GIS, silviculture and horticulture. It may be difficult for management to have all the skills and knowledge required to design and deliver a project at scale, however the

Contract growing requires coordination to ensure the volume and quality of plant supply. Photo: Dan Cole.

procurement of expertise at the right stage and time is critical. This could include a GIS specialist to undertake preliminary site assessment mapping and provide 'as implemented' mapping on project completion. Understanding timeframes and the resources required will ensure deliverables are on time and therefore associated revenue.

Contract growing – plant procurement

Plant procurement is essential for large-scale projects and will require a commitment of time and personnel, to coordinate with nurseries and ensure supply to mitigate risks such as species shortfalls. This role is required to establish contract growing agreements, manage substitutions, inspect stock, organise deliveries to site and coordinate supply from multiple nurseries.

Adequate lead-times for provenance seed collection and tube production should be negotiated and agreed with the nurseries. This may take six months or longer for difficult to source and propagate species. In general strong relationships with production nurseries are important as implementation can be dependent on a number of factors and delays can occur. For instance site-specific factors such as impeded access and local environmental conditions (e.g. extended dry period) may affect timing and extent of seed collection.

Plant orders must coincide with the planting periods as much as practicable, as native tubestock has a finite shelf life. Plant procurement risks will be covered in the forthcoming risk management and contingency planning article.

Contractor and client communication

Unlike infrastructure projects where there are deliverables such as constructed elements that can be readily assessed, forest restoration at scale has limitations in how success can be measured. Restoration contracts are typically very prescriptive to ensure the quality of delivery and to protect the parties involved.

However, there should be flexibility in the contract agreements for the contractor to be able to adapt to site-specific changes and seasonal challenges. In turn a collaborative process with effective communication and room for negotiation between the client and contractor including sub-contractors can be invaluable for restoration projects. For example, due to landscape and weather variables that can impact on an emerging forest there needs to flexibility as some circumstances may be beyond the control of all parties.

Adaptive management

Project management must be capable of identifying change and transitions in the emerging forest and adapt methodologies if required. This could include selecting the plant species to be implemented in future plantings or adjusting weed management techniques. It is important to be able to identify and intervene when there is a negative change such as a perverse new weed incursion or new pest infestation (e.g. myrtle rust). Adaptive management will enable a diversity of approaches to be used if unforeseen disturbances occur and prevail. Natural systems are not static but complex and dynamic and project management must embrace the changes as an emerging forest develops. This may include changing the restoration trajectory from the intended reference system.

Future management considerations for large-scale reforestation

Location and landscape presentation – community expectations

Reforestation at scale often has a large impact on the landscape and with the local community's perception of it. Adjoining landholders will want to understand the extent of the project and the likely visual and management impacts that may eventuate. Communicating the objectives of the project can garner support for it. Beyond client relationships, stakeholder engagement and the time involved is often underestimated and should generally be improved throughout the industry.

A collaborative approach is required with effective communication between client and contractor(s). Photo: Dan Cole.

In urban reforestation projects such as those adjoining parks and riparian zones there will often be community expectations for a high level of maintenance in these public spaces. In turn, weed management and slashing/mowing regimes will often need to be intensive in this urban and natural interface. The restoration plan and maintenance period of the contract needs to be sufficient to support an intensive maintenance regime. Likewise the project manager of the contractor needs to meet these public expectations to enhance community support.

Increased restoration timeframes

There needs to be longer restoration timeframes to reinstate biodiverse forests. Maintenance over a five year period instead of the common two year contracts will allow progressive implementation targeting favorable landscape conditions which should increase the project's success.

Research and communicating outcomes

Ecological restoration is an emerging industry requiring continual research across ecosystems throughout all bioregions. The outcomes from forest restoration projects needs to be better communicated throughout the industry including both successes and failures. Research and increased communication will improve future management approaches and methodologies and advance the science of restoration ecology.

Concluding summary

Understanding the contract details, key deliverables and performance indicators and the various stages these are required to be met in a large-scale reforestation project is an essential component of project management. Appropriate resourcing is critical to meet the project timeframes and project management will need to include a multi-disciplined team. Effective contractor and client communication with flexibility to negotiate on unforeseen issues and challenges will assist to avoid disputes and underpin successful project delivery. In the next issue we examine landholder and community engagement.

The shock of the new?

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Stace *et al.* (2015) is a handsome large format book, in every way, a weighty tome, and a reflection of the work of generations of very observant field botanists who have pored minutely over almost all of the British Isles. My purpose here is not to provide a detailed review of the book, but to reflect on the implications of hybridisation for plant conservation.

Many vascular plants form hybrids in the wild, and even more can be hybridised experimentally in cultivation. The *Hybrid flora of the British Isles* contains detailed accounts of 909 taxa.

It is of considerable importance to human survival that the vast majority of crop species are polyploid. Many are allopolyploid and therefore a result of hybridisation, although some are autopolyploid. Understanding the genetic history and development of crops is important to explaining their productivity and to the success of continuing plant breeding programs (Paterson and Wendel 2015). Outside agriculture, there are numerous examples of hybrids occurring in the wild, some arising from the mixing of species as a result of responses to environmental change, others as a consequence of the introduction (accidental or deliberate) of related species, or from the escape of hybrids from horticulture, or in a few cases the deliberate assisted establishment of known hybrids.

Australian botanists have not, in general, given a great deal of attention to hybrids. The British Isles have small flora and a long established and still thriving natural history tradition. These factors may be responsible for the interest in recognising numerous apomictic microspecies and in the detection and documentation of hybrids in the wild.

Historically, putative hybrids were recognised by being morphologically intermediate between 'good' species. In Europe in the early 19th century, large numbers of intermediates were documented in some taxonomic groups, for example in the willows (*Salix),* of which a large number are discussed in Stace *et al*. (2015), many of them triple hybrids.

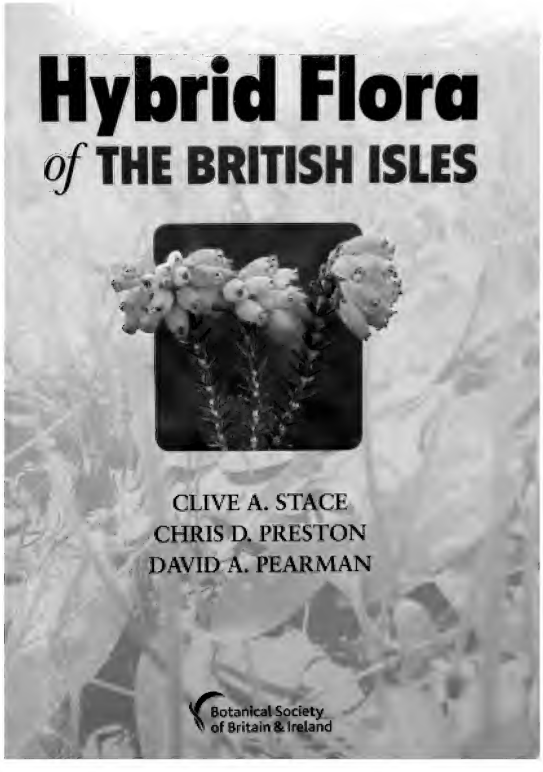
With the development of an understanding of chromosomes and their behaviour, karyological analysis enabled the hybrid nature of a number of 'species' to be confirmed. In Australia there was a strong tradition of chromosome studies to elucidate the origin and evolution of endemic taxa, associated first with Professor Spencer Smith-White at Sydney University and then with Associate Professor Sid James at UWA (Hopper 1996).

With the advent of molecular genetics global interest in the study of karyotypes has declined, but chromosome studies provide many valuable insights which are still of relevance today. DNA technologies, particularly genomics, have significantly advanced the detection of hybrids, and analysis of chloroplast DNA now permits recognition of the maternal parent in the original cross.

In Australia, the first observations of intermediates between *Eucalyptus* species were made by George Caley in the early 19th century, and numerous hybrids have been recognised subsequently in the genus. In some cases the distinction between otherwise apparently distinctive species breaks down over large areas. For example, the Sydney Blue Gum *Eucalyptus saligna*, and Bangalay, *Eucalyptus botryoides*, are, in their type form, very different from each other. However, south of Sydney it is unlikely that there are any pure *E. saligna*, with local populations exhibiting greater or lesser similarity to one of the two species, as a result of the production of hybrid swarms through introgression between *E. botryoides* and *E. saligna* x *E. botryoides* hybrids.

What are the implications for conservation?

Some of the hybrids documented in Stace *et al.* (2015) have been recorded in the wild on very few occasions, sometimes only once; others are widespread and abundant, as for example *Spartina anglica*, which as a result of deliberate introduction has become a major invasive species at localities around the world, including in Tasmania and Victoria. Should rare hybrids between native species be recognised in schedules of threatened species? Opinions may well differ, but it is not a matter which has been given much consideration, and it is certainly not something which is readily captured in current legislation. Many (not all) hybrids are sterile, incapable of sexual reproduction. They might thus be regarded as, at best, temporary denizens of the landscape and thus not worthy of conservation concern. From a zoological perspective this might be a justifiable position, but for botanists the situation is more complicated. In the absence of sexual reproduction, individual specimens of long-lived hybrids may survive for extended periods, in the case of trees for perhaps hundreds of years, so that at the very local scale such an individual might be a significant component of its ecosystem. An asexual hybrid may be capable of spreading vegetatively, so that over time a clone could come to occupy a large area, and in some cases widespread dispersion by various forms of vegetative propagule may occur.



Hybrid Flora of the British Isles. Botanical Society of the Britain and Ireland, Bristol. ISBN 978-0-901158-48-2. 501pp.

However, even if there are reasons in some instances to support giving conservation status to hybrids, is such an option available? This may lead us into murky and untested waters.

Hybrid entities may not yet have been given formal names. In some jurisdictions this may create a barrier to listing, but within Australia there are many examples of listed threatened plants being referred to by collecting numbers or locality, so the absence of formal taxonomic recognition is not an impediment. However, the very fact that they are hybrids could be a more serious issue. The commonwealth *Environmental Protection and Biodiversity Conservation Act* (1999) specifically adopts, in its definitions, the biological species concept. The existence of hybrids could be used to deny separate species status to the hybrid and both parents, even if, separately recognised, one or more of the entities might qualify for threatened species status. The biological species concept is an hypothesis, which we predict will be met by entities recognised as species. However, the majority of species have been described from dead specimens, and the number of cases where experimental breeding studies have been performed is relatively small. In the event of any legal challenge to the listing of species, whether an entity satisfies the biological species concept could be an issue. The New South Wales *Threatened Species Conservation Act* (1995) does not prescribe a particular species concept, so listing under the current New South Wales legislation is probably less vulnerable to challenge.

A number of introduced hybrids have become important environmental weeds, and in the future more recently developed garden hybrids might add to the number of invasive plants in bushland.

The Coral Tree, *Erythrina* x *sykesii* is a triploid hybrid, although its parentage and place of origin remain uncertain. It is sterile and does not set viable seed. However fragments of plants are capable of regrowth, and a major means of spread is from garden waste disposed of by dumping in the bush. It has large flowers which produce copious nectar flows, attractive to birds. Removing coral trees from urban bushland is sometimes opposed by local residents who value the attractive flowers and their associated birds.

A widely planted urban street tree in temperate Australia is the London Plant Tree, which is generally thought to be a hybrid of the Oriental and American Plane. However, unlike the Coral Tree it is said to produce viable seed, although despite many years of looking I have yet to see a seedling. Compared with other common introduced street trees, London Planes represent a minimal threat to bushland. In Sydney an interesting phenomenon in the last few decades has been the colonisation of many plane trees by native mistletoe, a phenomenon readily observed in winter, but masked by foliage in summer.

Movement of species, either naturally or by human agency, or new interactions with changing pollinator assemblages can result in the breakdown of species' identity through hybridisation. There are now examples where hybridisation between a rare and introduced species, or native species that have recently become weedy due to human induced habitat disturbance, has resulted in the rapid decline or even extinction of the rare species (Levin *et al.* 1996). In Britain a much discussed example involves hybridisation between the native British Bluebell (*Hyacinthoides non-scripta*) and the introduced Spanish Bluebell (*H. hispanica*) (Kohn *et al.* 2009). Native Bluebell is one of Britain's conservation icons, so that its loss of identity is a matter of public concern. In Australia widespread planting of *Grevillea* species outside their natural range, and development of many cultivars, coupled with a large pool of potential pollinators, may make identification of individual plants in near urban areas difficult.

Hybridisation is one of the many aspects of invasion of exotic species into bushland discussed in Carr's (1993) masterly review – still one of the best available accounts of the range of impacts of feral plants.

Coral Tree (*Erythrina* x *sykesii*) inflorescence. Photo: Paul Adam

The *Eucalyptis saligna x E.botryoides* example discussed above has implications for choice of planting stock for restoration projects in areas where such hybrid swarms occur. It will be important to specify local provenance rather than using 'pure' species from nurseries.

Periods of environmental change and disturbance have, over historical and geological time, promoted the movement of species across landscapes and this may have been accompanied by hybridisation. There is widespread recognition that in the face of predicted climate change the survival of many species will require changes in distribution, either from natural or human facilitated movement. Different species are likely to move at different rates, so that new combinations of species will arise with the potential for new hybrids to emerge and the genetic integrity of some currently existing species to be lost. However, the increase in genetic diversity arising from hybridisation may provide scope for the natural selection of forms, or even new species, better adapted to new environmental conditions than the parents.

Hybrids and hybridisation may be both conservation threat and conservation opportunity and both threats and opportunities require consideration in the development of policies and the implementation of strategies. The existence of hybrids is not something that can be ignored by conservationists.

Acknowledgements

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Introducing the Australian Seed Bank Partnership

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I would like to introduce the Australian Seed Bank Partnership (ASBP) to the readers of this issue of the Australian Network for Plant Conservation's *Australasian Plant Conservation* bulletin. I write this inaugural ASBP contribution as a committee member of both the ASBP and the ANPC. In addition, I represent the ANPC on the ASBP National Steering Committee whilst managing Western Australia's Threatened Flora Seed Centre, one of the first Australian seed banks established for conserving rare and threatened species.

The Australian Seed Bank Partnership (ASBP) is a program of the Council of Heads of Botanic Gardens Inc. (CHABG Inc.) that unites the expertise of a range of government and non-government organisations from across Australia's states and territories, including the Royal Botanic Gardens Kew. The partnership is a national effort to conserve Australia's native plant diversity through collaborative and sustainable seed collecting, banking, research and knowledge sharing.

Collecting and storing seed in seed banks is one of the most powerful ways to combat the global decline of plant diversity. It offers an insurance policy against the loss of plant species and provides genetic material for scientific research and for species recovery. The Australian Network for Plant Conservation Inc. is a member of this important seed conservation partnership.

The Australian Seed Bank Partnership has a national program set around the goals of valuing, understanding and conserving Australia's native plant diversity. A major initiative is the 1000 Species Project. This 10 year project aims for partners to collect and bank seed from those species not represented or else under-represented in Australian seed banks, with a focus on species that are endangered, endemic or of economic importance. The project also aims to broaden the genetic diversity of the collections by collecting from multiple populations across each species' geographic range. This project will see an increase in the diversity of species safe-guarded in Australian seed banks as well as duplication of collections at the Kew seed bank. In the past 3 years seed bank members have collected and banked around half of the overall 1000 species. These collections undergo various tests to build our understanding of the seed biology of native species. This type of information is critical to plant conservation efforts such as threatened species recovery and the restoration of plant communities.

Another successful initiative of the ASBP is the Australian Seed Bank online. This virtual seedbank is a searchable database provided through the Atlas of Living Australia http://asbp.ala.org.au/ and provides access to Australia's conservation seed bank collections for sharing and analysis using a range of Atlas of Living Australia tools.

The Partnership's Restoring Diversity Project in its early stages of development. Twenty-four plant families have been identified that comprise the understorey in diverse landscapes across Australia and for which achievable germination is problematic. One of the aims of this project is to address knowledge gaps in these challenging taxa.

In March next year, the ASBP is organising the National Seed Science Forum, which is hosted by one of its members, the Australian Botanic Garden Mount Annan, Sydney, in collaboration with the ANPC and the Australian Grains Genebank. This forum will bring together leading botanical and agricultural institutions, seed scientists, and conservation and restoration experts to share ideas that showcase the importance of seed science to the future of plant conservation and food security in Australia. Further details about the National Seed Science Forum and the ASBP's projects can be found on the ASBP website http://seedpartnership.org.au/

Over the coming years the members of the Australian Seed Bank Partnership look forward to providing the readers of *Australasian Plant Conservation* with regular updates on what we do, where we go and some of the important uses of the native seed we collect. The Partnership works with various Associates on a range of conservation projects that contribute to our mission and vision. If organisations or individuals are interested in working with the Partnership, please contact the secretariat (E: coordinator@seedpartnership.org.au; Phone +61(0) 262509473).

ANPC Member Profile

Isobel Crawford

Isobel Crawford demonstrating how to collect a plant specimen at the ANPC's Wimmera plant identification workshop in 2013. Photo: Tricia Hogbin

What is your current position?

I'm a consultant botanist and work for state agencies on rare or threatened species, as well as weed species, and for environmental consultancies helping to assess proposed development sites.

What are you working on at the moment?

I'm working on the plant collections from recent jobs on grassy box-gum woodland sites. I am lucky as I am able to collect from areas ecologists don't normally have access to, such as private and agricultural land. These often contain threatened species and ecological communities, so I usually find something interesting. One of the recent sites revealed the largest recorded population of a threatened semi-parasitic herbaceous species.

How did you end up working in plant conservation?

My mother was an early inspiration. Jean grew up in Sydney and came to love its rich Hawkesbury sandstone flora. She was also one of the first people in Canberra to have a native garden in the 1950s, when it was still very unfashionable. I remember people walking past and exclaiming with puzzling shock and disbelief 'What no lawn! Where are the roses'? I was also a brownie as a child and to earn one of my badges, I collected, pressed and named plants in an exercise book.

My parents had numerous scientist friends and we spent many weekends at the Gilmours' farm, (now part of Tidbinbilla Nature Reserve) digging out thistles and blackberries, managing cattle and enjoying the bush. I have also been an intermittent member of the National Parks Association of the ACT since childhood, and went on bushwalks led by botanists, geologists and entomologists who not only were experts in their field, but also could explain their subject well. We didn't just go on walks to get from A to B. It was a privileged upbringing. I particularly remember walks led by Nancy Burbidge, Curator at what is now the Australian National Herbarium (ANH). Nancy could be somewhat acerbic with adults, but was endlessly patient with children seeking to know more about plants.

This all makes me wonder why I took so long to become a botanist! In 1970, after an Arts degree at ANU, I moved to Perth and worked at the University library for a year, and lived next to Kings Park where I loved exploring the natural bushland areas. Then I returned to Canberra and trained as a librarian (in Canberra at that time, many women were teachers or librarians!). I worked for 10 years at CSIRO libraries. This included looking after the herbarium library collection.

I was gradually becoming more and more interested in plants, and did Botany 1 and Chemistry 1 at ANU, with exceptional teachers such as Lindsay Pryor and Helen Hewson, and then transferred to the University of Canberra's (UC) Vegetation and Wildlife Management degree.

Between 1984-87 I was joint warden at BirdLife Australia's Rotamah Island Bird Observatory in eastern Victoria with Tony Howard. Although it wasn't part of the job, I tried to collect every plant on the island for the ANH with copies for the Melbourne herbarium. The first plant collections I ever made were from Booligal in western NSW while on one of Sonia Tidemann's bird courses, in the 1970s.

When I finally completed my degree in 1990, I was asked by UC's Will Osborne to map Kangaroo Grass (*Themeda triandra*) grasslands in Gungahlin (in northern Canberra) for the ACT Government. Awareness was growing of the threatened animal species that some grasslands supported, such as the Striped Legless Lizard *Delma impar*, and many more grasslands in Canberra were being zoned for residential areas. So I wandered from hill to hill looking with binoculars for patches of russet brown *Themeda triandra*, then seen as the main indicator species for *Delma impar*. I was lucky enough to be developing skills in grass identification at the time that Natural Temperate Grasslands were becoming a conservation focus in Australia. This penchant for non-petalloid monocotyledons has gradually expanded to include sedges and rushes.

How long have you been involved with the ANPC?

I have been a member of the ANPC since 2005. In 1991, I was employed by the ANPC on a short term contract to prepare a list of the threatened species that were then in cultivation in botanic gardens throughout Australia. I have also presented at some of the recent ANPC Plant Indentification workshops such as in Canberra and Horsham in 2013.

Are you involved in any volunteer activities?

I attend monthly working bees of the Friends of Black Mountain, and identify plants for various parkcare groups in Canberra. I am membership officer for Friends of Grasslands and co-coordinator of the Dickson Wetland Carers Group helping look after a constructed wetland which provides wonderful habitat for water birds and frogs, as well as for people and dogs!

Workshops

Rangelands Paddock Walk near Hay, NSW

SALLY WARE[1]* AND MARTIN DRIVER[2]

[1] Riverina Local Land Services, Hay. [2] ANPC, Canberra
*Email: sally.ware@lls.nsw.gov.au

A day in the paddock in early October after significant winter rain with local ANPC ecologist and property owner Martin Driver was always going to be informative. Relatively mild weather was an added bonus and many of the native plants were still in flower or were setting seed.

After a brief discussion at the Hay Local Land Services (LLS) office that included a native plant display and an overview of Western NSW plant identification resources and reference material, and how to use them, the Rangelands Paddock Walk commenced in a stand of Bladder Saltbush (*Atriplex vesicaria*) south of McCormick's Bore on the Hay Stock Route. After identification of the key plants in the area and a chat about their utilization, values and response to grazing, the convoy moved down the Jerilderie Road to a 1950's remnant Sandhill Pine Woodland exclosure site where only a few old White Cypress Pines (*Callitris glaucophylla*) remained, with little regeneration evident. This endangered ecological community was once dominant on the sandy rises in the area and is a target vegetation community for a suite of new conservation projects being put together in the western Riverina by project partners including LLS, ANPC, Greening Australia and Landcare.

ANPC Project Manager, Martin Driver (centre), discussing a Bladder Saltbush (*Atriplex vesicaria*) community on the recent Rangelands Paddock Walk. Photo: Sally Ware

Next stop was to view a small clump of 100 year old Prickly Bottlebrush (*Callistemon brachyandrus*) plants, one of only three sites known in the district. These and other shrubs were also once much more common along old stream beds across the plains and prompted ideas of initiating a new targeted conservation program for the region.

Arriving at Martin's property "Barrabool", the first site visited was a 60 hectare area which was direct seeded twenty years ago with Old Man Saltbush (*Atriplex nummularia)*. Planted with wide row spacings, this site provides valuable stock feed with numerous annual and perennial grass varieties growing between the rows. Seeding rare Plains Grass (*Austrostipa aristiglumis)* was then viewed before visiting a small revegetated Old Man Saltbush and Boree (*Acacia pendula*) paddock.

Next stop was a Sandhill Pine Woodland revegetation site containing many varieties of shrubs, wattles and trees including regenerating Rosewoods (*Alectryon oleifolius*), with the regeneration initiated accidentally after ripping the area for rabbits which caused suckering from the broken parent tree roots. Other sites visited included an inland River Red Gum (*Eucalyptus camaldulensis)* regeneration area near an original dam and the sighting of a large, rare Native Jasmine (*Jasminum lineare*) climbing an ancient pine.

The Rangelands Paddock Walk was attended by Riverina Local Land Services (LLS) staff, local Landcare staff, landholders and local community members. Another paddock walk with Martin is planned for November and interested people need to contact Sally Ware by email on sally.ware@lls.nsw.gov.au or by mobile on 0429307627.

News

Public Inquiry into the Register of Environmental Organisations

JO LYNCH

Australian Network for Plant Conservation Inc. Email: business@anpc.asn.au

On Friday the 18th of September, the ANPC attended a public hearing in Canberra with the House of Representatives Standing Committee on the Environment, regarding this inquiry into the tax deductibility of donations to environmental groups that engage in advocacy. The ANPC strongly supports the existing arrangements surrounding the Register of Environmental Organisations, including the related tax concession benefits. Although the ANPC is not a campaign organisation, and not even primarily an advocacy organisation, we do play a specific advocacy role when the need arises – as with what we believe were constructive submissions to the recent Senate Biosecurity Inquiry. Also we support the right of other environmental organisations to undertake advocacy without fear of reducing their fundraising ability. As Australian Conservation Foundation CEO Kelly O'Shanassy commented recently, "Some of Australia's most important environmental outcomes – protecting places like the Great Barrier Reef, Kakadu and the Kimberley – have only been achieved when Australia's conservation organisations have informed the community and advocated for the protection of these great national assets."

http://www.anpc.asn.au/news

A new seed exchange collaboration

TOBY GOLSON, SENIOR HORTICULTURALIST

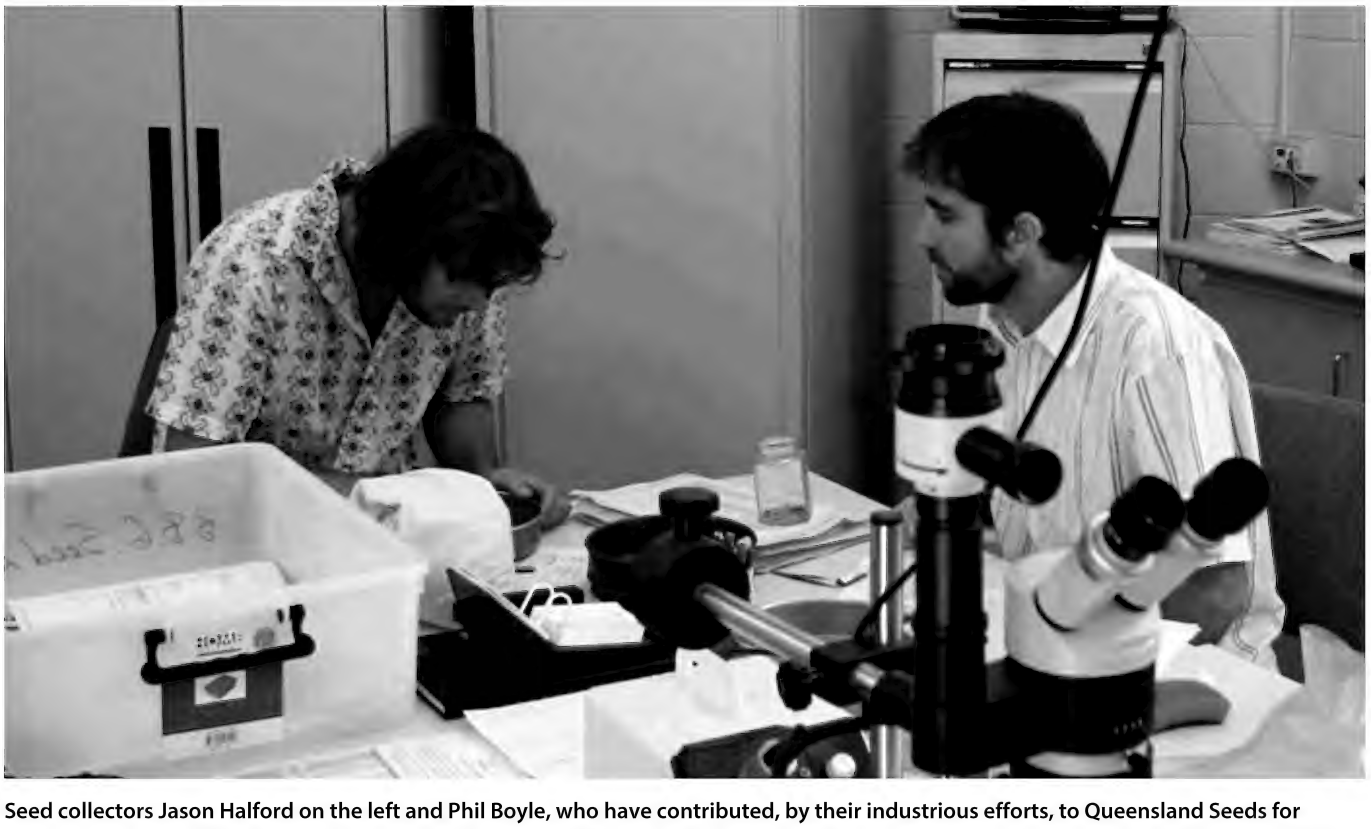
Australian National Botanic Gardens. Email: toby.golson@environment.gov.au

The Australian National Botanic Gardens (ANBG) in Canberra has established both formal and informal partnerships with a number of regional botanic gardens over the last several years. We highly value the contributions of these existing partner gardens (such as Mackay and Tondoon Botanic Gardens in Queensland as well as Lismore Rainforest and Wollongong Botanic Gardens in NSW), particularly in providing genetic material to mitigate the risk to listed threatened species by establishing additional ex situ holdings in our living and seed bank collections in Canberra.

Following a productive discussion between ANBG's Living Collection Curator David Taylor and the Curator of Brisbane Botanic Gardens (BBG) Dale Arvidsson, ANBG and BBG are now similarly sharing genetic material. The BBG Conservation Seed Bank has now been in operation for 10 years and has over that time collected the genetic material (germplasm) of almost 1,000 taxa from all across Queensland. One of the major drivers in enabling this relationship is the role of the Australian Seed Bank Partnership which provides funding for many of the seed collecting projects that produce the genetic material for exchange. In addition, the Australian Seed Bank Online portal (see: http://www.seedpartnership.org.au/initiatives/australianseedbank) gives access to each Botanic Garden's current holdings, thereby allowing rapid and comprehensive assessments by the requesting institution.

Both Botanic Gardens are acutely aware of not wanting to impose unnecessary burdens on our partners and are keen to see partnerships operating in a low resource input fashion, while still following material transfer regulations. Most importantly, we hope that this initiative will result in better security for both the threatened and other species involved as well as make a practical difference to their long term conservation.

Anyone wishing to know details or to discuss potential collaborations should contact toby.golson@environment.gov.au, or by phone on 02 62509513.



Seed collectors Jason Halford on the left and Phil Boyle, who have contributed, by their industrious efforts, to Queensland Seeds for Life, the key agency for seed banking and seed research of Queensland plants (comprising a partnership between the Brisbane Botanic Gardens, Griffith University and the University of Queensland, with support from the Millennium Seed Bank, RBG Kew, U.K., Queensland Herbarium and Greening Australia Queensland) and partner in the Australian Seed Bank Partnership.

Research Roundup

COMPILED BY KIRSTEN COWLEY

Centre for Plant Biodiversity Research, Canberra. Email: Kirsten.Cowley@csiro.au

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Contributions to Research Roundup are welcome, and should be sent to Kirsten Cowley at the above email address using an email subject heading "APC Research Roundup" or similar. Their inclusion will be subject to available space.

Do you have a friend or colleague passionate about plant conservation? If so, share this Special Offer!

If they join the ANPC *before 31 December 2015, they will not only receive membership for the 2016 calendar year, they will also receive all four 2015 editions of Australasian Plant Conservation, as well as help us better promote and improve plant conservation in Australia!

Please let them know they can download the 2016 membership form at www.anpc.asn.au/membership or contact the ANPC Office (see inside front cover) to find out more.

Thanks for sharing!

SAVE THE DATE

The ANPC is delighted to announce that the 11th Australasian Plant Conservation Conference (APCC11) will be held in Melbourne from the 15th - 18th November 2016, in collaboration with La Trobe University and the Royal Botanic Gardens Victoria.

APCC11
11th Australasian Plant Conservation Conference 2016

Australian Network for Plant Conservation Inc

LA TROBE UNIVERSITY AUSTRALIA

ROYAL BOTANIC GARDENS VICTORIA

ANPC conferences and forums provide:

- presentations on the latest findings relevant to plant conservation and native vegetation rehabilitation;
- practical workshops on ecologically sound techniques;
- field visits demonstrating plant conservation in action;
- social activities to enhance networking.

More details on APCC11 will be provided in the near future. Keep up to date at
www.anpc.asn.au/conferences/2016
ANPC members receive discounts on the registration fees.
http://www.anpc.asn.au/membership

http://www.anpc.asn.au/conferences/2016

Silver Banksia survey out now!

ww.anpc.asn.au/banksias

Are you interested in the conservation and restoration of Silver Banksia (*Banksia marginata*) across regional Victoria and south-western NSW?

The ANPC is aiming to document the location and distribution of known relict or remnant populations of Silver Banksia across this range, where it has undergone considerable decline since European settlement. This has occurred due to grazing by domestic and feral animals, damage from rabbits, the destruction of rabbit warrens, and wildfire.

However, you can help. If you know of any Silver Banksia locations in the target region, please complete the Silver Banksia survey which can be downloaded at **www.anpc.asn.au/banksias**. Or if you know someone who may be interested in this project, please share this information.

With the help of the Norman Wettenhall Foundation, the **Bring Back the Banksias** project will assist in improving the conservation status of this iconic species. The collated information will be used to select sites and populations for future genetic research, which will help guide seed collection strategies for the establishment of Seed Production Areas, as well as future restoration works to conserve and protect the remaining populations.

For more information, go to:
www.anpc.asn.au/banksias
If you have any further questions please contact ANPC Project Manager, Martin Driver, on Ph. 0400170957 or email projects@anpc.asn.au.

PLEASE RETURN ALL RESPONSES TO:
anpc@anpc.asn.au
by COB Friday 20 November 2015

Credit: Banksia marginata, Illabarook Rail Line Nature Conservation Reserve, Victoria, Australia . https://commons.wikimedia.org/wiki/File:Banksia_marginata_tree_lone_IRL.JPG

Australian Network for Plant Conservation Inc

THE NORMAN WETTENHALL FOUNDATION