

**AUSTRALIAN NETWORK for PLANT CONSERVATION
INC**

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Australian Network for Plant Conservation 8th National Conference
 28 September to 1 October 2010
 Perth, Western Australia

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Front cover

From top:

Calytrix breviseta. Photo: Andrew Crawford
 Vegetation monitoring Photo: Melanie Smith
Verticordia albida. Photo: Andrew Crawford
Banksia montana. Photo: Greg Freebury
Jacksonia pungens. Photo: Andrew Crawford

Disclaimer

The opinions expressed in this document are the views of the individual authors and do not necessarily reflect those of the Australian Network for Plant Conservation.



Table of contents

<i>Welcome from the ANPC</i>	3
<i>Acknowledgements</i>	4
Sponsors	4
Organising Committee	5
<i>Social Functions</i>	6
<i>Site map</i>	7
<i>Information</i>	8
<i>Program</i>	9
Monday 27 September	9
Tuesday 28 September	9
Wednesday 29 September	11
Thursday 30 September	13
Friday 1 October	14
<i>Oral Paper Abstracts</i>	15
Index by theme	15
<i>Poster abstracts</i>	40
<i>Friday workshops</i>	47



Welcome from the ANPC

Welcome to the 8th national conference of the Australian Network for Plant Conservation, on the theme of 'Planning Conservation to Achieving Restoration'.

This is the second ANPC Conference to be held in Perth. We are glad to be meeting again in Australia's most biodiverse State, and one with a rich culture of conservation practice.

I'd like to thank the conference sponsors who have made this event possible: the **WA Department of Environment and Conservation**; **Mattiske Consulting**; the **Taxonomy Research & Information Network** (TRIN); and **Alcoa**. These organisations contribute to plant conservation on many fronts, and recognise the value of supporting closer linkage of people in science, management, community and industry – linkage which is part of ANPC's unique role.

2011 will be the ANPC's twentieth year of working to conserve Australia's flora. The face of plant conservation in Australia has changed, although none of the challenges have yet been overcome. There are more organisations now, though few others are dedicated specifically to conserving flora. The funding scene has changed, but not necessarily improved. We have seen a welcome shift in investment to a more regional and perhaps a more strategic approach, although there is still an inadequate focus on biodiversity and an inadequate level of investment. We have seen the survival of the Landcare movement, with its unique blend of communication and action across sectoral divides. We have also seen the rise of non-government organisations dedicated to acquiring and rehabilitating land for biodiversity.

A feature of the last 20 years has been acceptance by governments of the need for biodiversity conservation planning. Political commitment has waxed and waned, but there is a level of policy and planning greater than ever before. There are however many challenges in translating this into effective conservation practice, and governments are not always good at achieving that translation. Core problems include the short-term, non-strategic nature of funding cycles; a lack of commitment to sustaining and nurturing the community NGO sector at anything more than a subsistence level; and often an unwillingness to commit to the elimination of threatening processes, rather than just their management. These higher-level problems need to be addressed by the whole conservation sector.

Our themes for this conference, however, are more focussed. As always, we are trying to bring together some of the best on-ground experience with the most relevant science and policy thinking. Some of our themes relate to areas where Western Australia has particularly rich experience – notably 'Engaging Industry' and 'The Role of Taxonomy', for which the minerals boom and the unique WA flora are the backdrop. The themes of 'Seeds and Genes for Restoration' and 'Soil Health and Restoration' complement ANPC's past work through our technical publications and a national forum. And the overarching themes of 'Conservation Planning' and 'Planning for Climate Change' are areas where governments and industry need our ideas and some reality checks.

Workshops topics include interactive plant identification tools (an under-used resource), and where ANPC should now take its pioneering work on standards for the translocation of threatened species. These and other workshops will be an opportunity for the exchange of experience, theory and practice.

This is going to be a great conference, and I would like to convey the thanks of the ANPC membership to the conference organising committee: in WA, Dave Coates, Leonie Monks, Shelley McArthur, Melanie Smith, Helena Mills, Ben Miller, Katherine Downes, Grant Wardell-Johnson, and in our national office Merryl Bradley and Sue Mathams. Their hard work typifies the dedication which has sustained ANPC for the last two decades.

Bob Makinson
President
Australian Network for Plant Conservation Inc.



Acknowledgements

Sponsors

Thank you to the conference sponsors:

- Department of Environment and Conservation
- Mattiske Consulting
- Taxonomy Research & Information Network
- Alcoa of Australia Ltd

Platinum



Silver



Bronze



australia's aluminium

Organising Committee

David Coates	Senior Principal Research Scientist, Department of Environment and Conservation, WA
Leonie Monks	Research Scientist, Department of Environment and Conservation, WA
Shelley McArthur	Technical Officer, Department of Environment and Conservation, WA
Melanie Smith	Senior Botanist Department of Environment and Conservation, WA
Katherine Downes	Honorary Visiting Research Fellow, Curtin University, WA
Helena Mills	Project Coordinator, SWAE Demonstration Area, WWF, WA
Grant Wardell-Johnson	Associate Professor, Biodiversity & Climate Change, Curtin University of Technology, WA
Ben Miller	Ecologist, Botanic Gardens and Parks Authority, WA
Bob Makinson	Conservation Botanist, Botanic Gardens Trust, NSW
Sue Mathams	Project Manager, Australian Network for Plant Conservation, ACT
Merryl Bradley	Office Manager, Australian Network for Plant Conservation, ACT

Additional Organisational Support

Thank you to the people behind the scenes who have provided support for the conference. Particularly the staff from the Department of Environment and Conservation and the Botanic Gardens Parks Authority and Siobhan Duffy of the CSIRO Plant Industry visual resources unit.



Social Functions

Welcome Reception

The Welcome Reception will be held in the Department of Environment and Conservation's new Conservation Science Centre on the evening of Monday the 27th of September.

Registration: Essential for catering purposes.

Date: Monday 27th September

Time: 6pm – 8pm

Location: West Australian Conservation Science Centre, Dept of Environment and Conservation

Address: 17 Dick Perry Avenue, Kensington.

Conference Dinner

The formal Conference Dinner will be held on the evening of Wednesday 29th of September at the Pagoda Restaurant and Bar, Como. Please see Conference Staff for directions to the venue. Dress: neat casual.

Registration: Required.

Date: Wednesday 29th September

Time: 7pm

Location: Pagoda Restaurant and Ballroom, Esplanade River Suites.

Address: 112 Melville Parade, Como

Informal Evening

Following the Mid-conference Fieldtrips on Thursday the 30th of September, there will be a casual BBQ and Pizza dinner at the new West Australian Conservation Science Centre.

Registration: Essential for catering purposes.

Date: Thursday 30th September

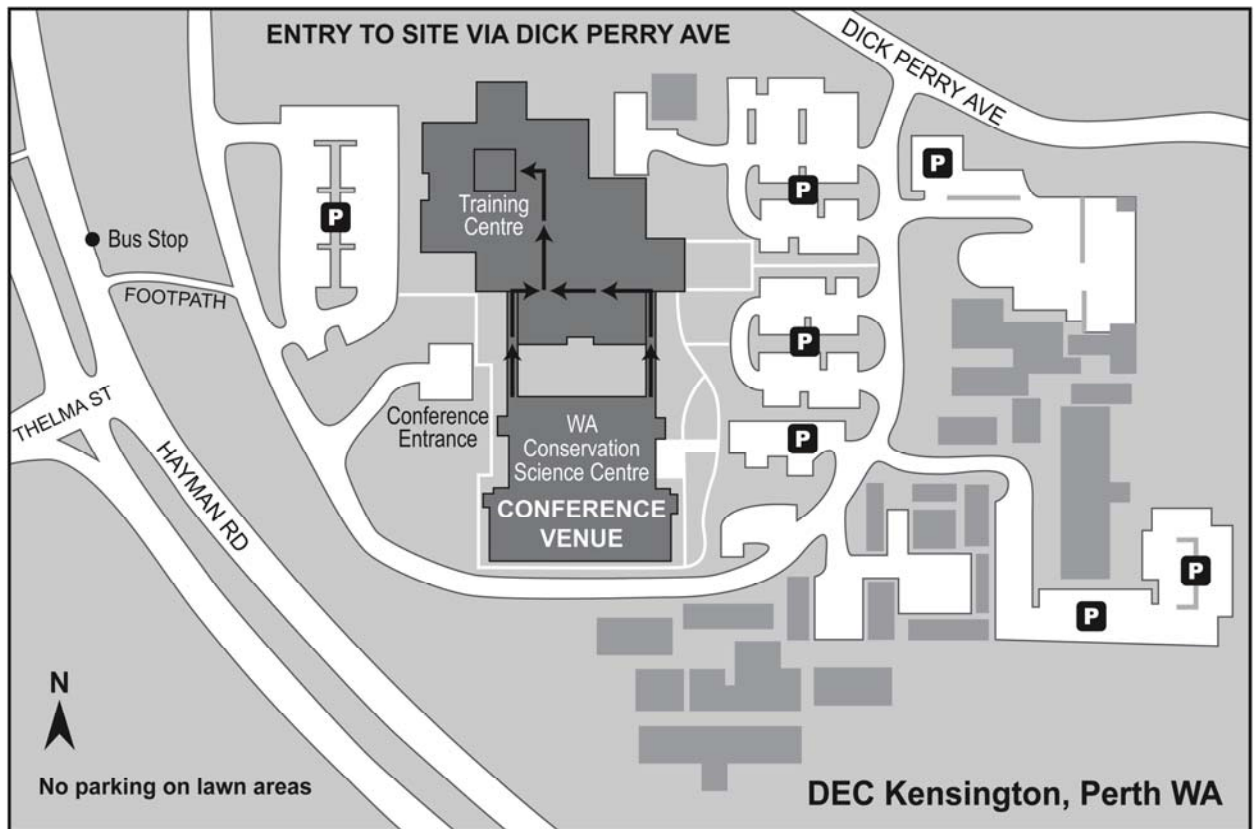
Time: 5:30pm

Location: West Australian Conservation Science Centre, Dept of Environment and Conservation

Address: 17 Dick Perry Avenue, Kensington.



Site map



Please note: This is a non smoking venue. There are designated outdoor smoking areas.

Parking

Parking in the complex is free and has no time limit. Parking is allowed along one side of the ring road but definitely **no** parking on lawn areas.

Public Transport

Buses 33 and 35 from the City stop just before the intersection of Thelma and Hayman Rd.

From the Fremantle area Bus No 106 travels straight up Canning Hwy. Change at Canning Bridge train Station to Bus No 100 and travel to the intersection of Hayman Rd and Kent St.

Information

Tourist Information

Western Australian Visitor Centre: 469 Wellington Street (corner of Forrest Place and Wellington Street), (08) 9483 1111

www.wavisitorcentre.com

Medical and emergencies

Royal Perth Hospital

(Emergencies) 197 Wellington St, Perth (08) 9224 2244

Perth After - Hours GP Clinic

(Opposite the Royal Perth Hospital Emergency Department) Corner Lord and Goderich Streets, East Perth (08) 9202 1660

Clinic Hours

- Monday-Friday 6:00pm - 10:30pm
- Saturday 12:00pm - 10:30pm
- Sunday 10:00am - 10:30pm,
- Public Holidays 10:00am - 10:30pm.

South Perth 7 Day Chemist

143 Canning Highway, South Perth, (08) 9474 1958 . Open 7am-10pm.

In case of emergency contact details

Business hours: Department of Environment and Conservation reception: (08) 9334 0333 – messages will be passed onto conference attendees.

After hours: David Coates 0439 969 404

Program

Monday 27 September

(Queen's Birthday Public Holiday, WA)

5:00-6:00	Registration
6:00-8:00	Welcome Reception - West Australian Conservation Science Centre

Tuesday 28 September

8:15-8:50	Registration	
Welcome		
Location: West Australian Conservation Science Centre		
8:50 – 9:20	Welcome	Acknowledgement of Country Bob Makinson Keiran McNamara
Plenary session: Chair: David Coates		
Location: West Australian Conservation Science Centre		
9:20-9:55	Innovation Ecology – the restoration ecology toolkit for Australian ecosystems	Kingsley Dixon
9:55-10:30	Novel ecosystems and no-analogue climates: implications for management and policy in a rapidly changing world	Richard Hobbs
10:30-11:00	Morning tea	
Concurrent sessions		
	Conservation Planning (2A) Chair: Helena Mills Location: Training Centre	Soil Health (2B) Chair: Ben Miller Location: West Australian Conservation Science Centre
11:00-11:20	Bob Pressey Making the transition from regional-scale conservation design to local-scale conservation action	Suzanne Prober Soil nutrients and ecological restoration of temperate Australian ecosystems
11:20-11:40	Karan Coombe- Smith A Big Slice of Flora Pie, the Alinytjara Wilurara NRM Region, managing threatened flora across 250,000 square kilometres	Katarzyna Bialkowski Chemical and biochemical properties of the soil as tools for monitoring woodland degradation and restoration
11:40-12:00	Kathryn Steel Granite flora of Southern Queensland – Recovery planning in action	Anna Napier Rehabilitation in deep sand in a mine east of Albany, Western Australia
12:00-12:20	Erica Shedley Fire response of threatened flora – what have we learned?	Mark Tibbett The curious effects of mycorrhizas on the phosphorus nutrition and seedling establishment in the Jarrah forests of Western Australia
12:20-12:40	Andrea Kramer Assessing botanical capacity in the United States: gaps identified and strategic recommendations made to maximize conservation success	Discussion
12:40-1:40	Lunch	



	Conservation Planning (3A) Chair: Helena Mills Location: Training Centre	Taxonomy (3B) Chair: Bob Makinson Location: West Australian Conservation Science Centre
1:40-2:00	Ladislav Mucina Vegetation mapping in service of biodiversity conservation: global perspective and WA prospects	Kevin Thiele Taxonomy and the conservation community: Where are we at and where are we going
2:00-2:20	Tricia Hogbin Progressing from single species recovery planning to multi-species recovery across the landscape: A case study from the Hunter Valley – NSW	Kelly Shepherd The importance of targeted taxonomy for plant conservation
2:20-2:40	Discussion	Chris Howard Do we need a more rigorous scientific process for the listing of threatened species?
2:40-3:00	Kate Brown Managing Geraldton Carnation Weed (<i>Euphorbia terracina</i>) in the woodlands, wetlands and heathlands of the Swan Coastal Plain	Juliet Wege Taxonomic turmoil in the Triggerplants: implications for conservation management
3:00-3:20	Bob Dixon Controlling weeds on translocation sites: strategies, solutions and probable short term costs to the environment	Terry Macfarlane Recent recognition of unexpected richness of <i>Wurmbea</i> in Midwest, Murchison and Gascoyne rangelands
3:20-3:50	Afternoon tea	
	General 4(A) Chair: Leonie Monks Location: Training Centre	Taxonomy 4(B) Chair: Bob Makinson Location: West Australian Conservation Science Centre
3:50-4:10	Ben Miller Modelling species distributions improves understanding of the ecological, translocation and restoration requirements of two rare Banded Ironstone Formation (BIF) endemic species	Judy West The role of taxonomy in conservation
4:10-4:30	Katinka Ruthrof Ecological, social and economic filters: hurdles of restoration and planning for the future	Michael Moody Molecular taxonomy as a conservation tool: testing species hypotheses in the biodiversity hotspot of southwest Western Australia
4:30-4:50	Pieter Poot Improving the success of species translocations: is there a need for removal of existing vegetation?	Ryonen Butcher Weighing up the numbers: case studies in the use of numerical taxonomy for resolving conservation-listed taxa in south-west Western Australia
4:50-5:10	Joel Collins The role of fire in the persistence of threatened flora in the Western Australian wheatbelt – <i>Pityrodia scabra</i> case study	Greg Keighery Hidden treasures; recognising, conserving and rehabilitation consequences of localised variants of widespread species of the Perth area
5:10-5:30	Rachael Nasplezes Wetland best practice in production systems in the Great Barrier Reef catchment	Discussion

Wednesday 29 September

8:15-9:00	Registration	
Concurrent sessions		
	Climate Change (5A) Chair: TBA Location: Training Centre	Seeds and Genes 5(B) Chair: David Coates Location: West Australian Conservation Science Centre
9:00 – 9:10	TBA Housekeeping	David Coates Housekeeping
9:10-9:30	Colin Yates Planning for climate change: the adaptation/mitigation challenge	Linda Broadhurst Do genetic bottlenecks occur during the restoration process?
9:30-9:50	Terry Macfarlane An interesting plant community of hypo-saline seasonal lakes in the Muir-Unicup catchment, Western Australia	Melissa Millar Spatial genetic structure in a rare Banded Ironstone endemic: implications for restoration.
9:50-10:10	Anne Cochrane Defining temperature thresholds for germination: What can they tell us about species vulnerability to a changing climate?	Paul Nevill Conservation genetics of <i>Acacia karina</i> , a narrow-range species endemic to the Banded Ironstone Ranges of the Midwest region of Western Australia
10:10-10:30	Grant Wardell-Johnson The challenges for climate change adaptation in old stable landscapes	Michalíe Foley Population size effects on genetic pattern and process in <i>Banksia ilicifolia</i> : Consequences for conservation and ecological restoration
10:30-10:50	Discussion	Andrea Kodym <i>In vitro</i> propagation of ecological keystone sedge species
10:50-11:20	Morning tea	
	Industry (6A) Chair: Mark Richardson Location: Training Centre	Seeds and Genes Chair: David Coates Location: West Australian Conservation Science Centre
11:20-11:40	Libby Matiske Engaging with Industry in plant conservation – The State of Play in 2010	Margaret Byrne Restoring and maintaining genetic connections in a landscape context
11:40-12:00	Chris Howard The Bulahdelah Bypass: challenges to orchid conservation	Donna Bradbury Adaptive genetic diversity among Tuart (<i>Eucalyptus gomphocephala</i>) populations, and implications for ecological restoration
12:00-12:20	Susan Dempster Urban landscapes supporting plant conservation	Paul Gibson Roy Genetic rescue of <i>Rutidosis leptorrhynchoides</i> by creating new and viable populations initiated from seed sourced from small and large populations of the same ploidy level, bulked-up using Seed Production methods and reintroduced by direct seeding
12:20-12:40	Stephen van Leeuwen Minimising uncertainty by maximising knowledge: Examples from Western Australia of how partnerships with industry deliver enduring value for sustainable development and biodiversity conservation	Justin Jonson Ecological restoration in Gondwana Link
12:40-1:00	Discussion	John Koch The use of local provenance for Alcoa's mine restoration in the jarrah forest; does it matter?
1:00-2:00	Lunch	



	General 7(A) Chair: Sally Jacka Location: Training Centre	Seeds and Genes 7(B) Chair: David Coates Location: West Australian Conservation Science Centre
2:00-2:20	Katherine Downes Diversity in the Kangaroo Paw family	Siegy Krauss A practical genetic contribution towards best-practise seed-sourcing guidelines for ecological restoration
2:20-2:40	Eric Bunn Biotechnology and conservation of critically endangered plants in a biodiverse region – the south west of Western Australia	David Venning Seed Industry Accreditation - A project by the Revegetation Industry Association of WA
2:40-3:00	Anja Kaczmarczyk Correlation of membrane composition to cryopreservation results in selected plant species	Andrea Kramer Ecological genetics of <i>Penstemon</i> in the Great Basin, U.S.A.
3:00-3:20	Mark Brundrett Working with community groups to conserve threatened orchids in the WA wheatbelt	Dylan Korczynskyj Re-establishing a recalcitrant species following mining: <i>Macrozamia riedlei</i>
3:20-3:40	Peter Scott Adaptive management for the containment and eradication of <i>Phytophthora cinnamomi</i> infestations within native plant communities from the Fitzgerald River National Park	Ann Smithson Adaptation and restoration - should we source seeds locally, or not?
3:40-4:10	Afternoon tea	
4:10-5:00	Poster Session (8)	
	<p>Louisa Cockram, Kristina Hufford, Siegy Krauss, Erik Veneklaas Genetic consequences of mixing seed provenances in ecological restoration using field trials to test for Home Site Advantage and Outbreeding Depression in West Australian Stylidiaceae</p> <p>Lucy Commander, David Merritt, Kingsley Dixon. Improving restoration efficiency through understanding seed ecology</p> <p>C. E. Crane, S. Barrett, B. L. Shearer, C. P. Dunne Comparison of the impacts of plant canker disease and climate on Proteaceae and evaluation of selected fungicides as a management tool for canker control in the declared rare flora <i>Banksia verticillata</i> and <i>Lambertia orbifolia</i></p> <p>Peter Cuneo and Michelle R Leishman Managing feral olives and restoring endangered bushland – how can we maximise restoration success?</p> <p>Allison Frith and Cathy Offord Investigation into the germination and propagation of <i>Persoonia pauciflora</i> P.H. Weston</p> <p>R. Dillon, E. Adams, S. Barrett & A. Cochrane An adaptive management strategy helps recover endangered Western Australian flora</p> <p>Nola Hancock Local Provenance: Is the traditional paradigm in restoration ecology still relevant under climate change and fragmentation?</p> <p>R. Huston, P. Dufty, P. G. Ladd The ongoing recovery of <i>Acacia chapmanii</i> subsp <i>australis</i> in Drummond Nature Reserve: A case study in adaptive management</p> <p>Sally Jacka Tweed Shire riparian vine weed control strategy</p> <p>N. Murdock, L. Cockram, C. Woolard, S. Reiffer and L. Matiske Helicopter surveys as an efficient survey method for the Declared Rare Flora, <i>Conospermum toddii</i>, in the Great Victoria Desert</p> <p>Gemma Phelan, Catherine Page and Alanna Chant New recruits for the loveable Triggerplant (<i>Stylidium amabile</i>)</p> <p>B. L. Shearer, C. E. Crane and J. A. Cochrane Prioritisation of <i>Lambertia</i> taxa for conservation according to the threat posed by <i>Phytophthora cinnamomi</i></p> <p>Lucy Sutherland Australian Seed Bank Partnership</p> <p>Linda Thomson, Reta Carleton, Chris Newell and George Lullfitz Market driven micropropagation of WA plants for landscaping, revegetation and horticulture industries</p>	
7:00	Conference Dinner - Pagoda Restaurant and Bar, Como	



Thursday 30 September

8:15-9:00	Registration
Concurrent field trips	
9:00-5:00	Trip 1 - North eastern woodlands, shrublands and kwongan heathlands
9:00-5:00	Trip 2 - Swan Coastal Plain wetlands and woodlands restoration programs
9:00-5:00	Trip 3 - South to post-mining forest restoration and Darling Range woodlands, shrublands and heathlands
5.30 – late	Casual BBQ and Pizza dinner in the West Australian Conservation Science Centre

Field trip details

Lunch, morning tea and afternoon tea refreshments are provided on all field trips.

Please wear sturdy covered shoes, and bring a hat, rain protection, sunscreen, insect repellent and a water bottle.

We will provide backup sunscreen and insect repellent and water for refilling water bottles.

Field trip itineraries

Trip 1 - North eastern woodlands, shrublands and kwongan heathlands including:

- Chittering Valley Wandoo and York Gum communities,
- Mogumber, claypans, Banksia woodland threatened ecological communities and dieback affected areas
- Moore River National Park and diverse coastal kwongan heath communities.

Field trip leaders: Helena Mills and Greg Keighery

Trip 2 - Swan Coastal Plain wetlands and woodlands restoration programs including:

- Paganoni Swamp , one of the most significant conservation reserves in the metropolitan region south of the Swan River
- Lowlands – Private property, the only intact fringing vegetation left along the Serpentine River.
- Restoration of the Threatened Ecological Community (Marri over grass trees) at the Burnside Nature Reserve near Dwellingup
- Max. 21 participants

Field trip leader: Kate Brown

Trip 3 - South to post-mining forest restoration and Darling Range woodlands, shrublands and heathlands including:

- The Darling Range northern Jarrah (*Eucalyptus marginata*) forest communities.
- Alcoa's Huntly Mine - the largest bauxite mine in the world - where you will view active mining operations, and Alcoa's ecological restoration in the Jarrah forest.
- The diverse woodlands, shrublands, heathlands and wetlands of the Darling Range Wandoo National Park

Field trip leader: David Coates



Friday 1 October

8:15-9:00	Registration	
Concurrent workshop sessions		
9:00-9:10	Housekeeping	Housekeeping
9:10-10:30	Using Interactive Identification Keys - Plant Identification (9A) Facilitator: Kevin Thiele Location: Training Centre	What price quality restoration plant stock? (9B) Facilitator: David Hancock Location: West Australian Conservation Science Centre
10:30-11:00	Morning tea	
11:00-12:30	Using Interactive Identification Keys - Plant Identification (continued) (10A) Facilitator: Kevin Thiele Location: Training Centre	NatureMap 10(B) Facilitator: Paul Gioia Location: West Australian Conservation Science Centre
12:30-1:30	Lunch	
1:30-3:00	Seeds: From Collection to Germination (11A) Facilitator: Katherine Downes Location: Training Centre	Plant Translocation (10B) Facilitators: Leonie Monks & Tricia Hogbin Location: West Australian Conservation Science Centre
3:00-3:30	Afternoon tea	
3:30-4:10	General discussion and close	

Oral Paper Abstracts

Index by theme

Climate Change

An interesting plant community of hypo-saline seasonal lakes in the Muir-Unicup catchment, Western Australia _____	28
Defining temperature thresholds for germination: What can they tell us about species vulnerability to a changing climate? _____	20
Planning for climate change: the adaptation/mitigation challenge _____	39
The challenges for climate change adaptation in old stable landscapes _____	38

Conservation Planning

A Big Slice of Flora Pie, the Alinytjara Wilurara NRM Region, managing threatened flora across 250,000 square kilometres _____	21
Assessing botanical capacity in the United States: gaps identified and strategic recommendations made to maximize conservation success _____	27
Fire response of threatened flora – what have we learned? _____	35
Granite flora of Southern Queensland – Recovery planning in action _____	36
Making the transition from regional-scale conservation design to local-scale conservation action _____	33
Managing Geraldton Carnation Weed (<i>Euphorbia terracina</i>), in the woodlands, wetlands and heathlands of the Swan Coastal Plain _____	18
Novel ecosystems and no-analogue climates: implications for management and policy in a rapidly changing world _____	23
Progressing from single species recovery planning to multi-species recovery across the landscape: A case study from the Hunter Valley – NSW _____	23
Vegetation mapping in service of biodiversity conservation: Global perspective and WA prospects _____	31

General

Adaptive management for the containment and eradication of <i>Phytophthora cinnamomi</i> infestations within native plant communities from the Fitzgerald River National Park _____	34
Biotechnology and conservation of critically endangered plants in a biodiverse region – the south west of Western Australia _____	19
Controlling weeds on translocation sites: strategies, solutions and probable short term costs to the environment _____	22
Correlation of membrane composition to cryopreservation results in selected plant species _____	25
Diversity in the Kangaroo Paw family _____	22
Ecological, social and economic filters: hurdles of restoration and planning for the future _____	34
Improving the success of species translocations: is there a need for removal of existing vegetation? _____	33
Modelling species' distributions improves understanding of the ecological, translocation and restoration requirements of two rare Banded Ironstone Formation (BIF) endemic species _____	30
The role of fire in the persistence of threatened flora in the Western Australian Wheatbelt – <i>Pityrodia scabra</i> case study _____	20
Wetland best practice in production systems in the Great Barrier Reef catchment _____	31
Working with community groups to conserve threatened orchids in the WA wheatbelt _____	18

Industry

Engaging with industry in plant conservation – The State of Play in 2010 _____	29
Minimising uncertainty by maximising knowledge: Examples from Western Australia of how partnerships with industry deliver enduring value for sustainable development and biodiversity conservation _____	37
The Bulahdelah Bypass: challenges to orchid conservation _____	24
Urban landscapes supporting plant conservation _____	21

Seeds and Genes

A practical genetic contribution towards best-practise seed-sourcing guidelines for ecological restoration _____	28
Adaptation and restoration - should we source seeds locally, or not? _____	36
Adaptive genetic diversity among Tuart (<i>Eucalyptus gomphocephala</i>) populations and implications for ecological restoration _____	17
Conservation genetics of <i>Acacia karina</i> , a narrow-range species endemic to the Banded Ironstone Ranges of the Midwest region of Western Australia _____	32
Do genetic bottlenecks occur during the restoration process? _____	17
Ecological restoration in Gondwana Link _____	25
Ecological genetics of <i>Penstemon</i> in the Great Basin, U.S.A. _____	28
Genetic rescue of <i>Rutidosia leptorrhynchoides</i> by creating new and viable populations initiated from seed sourced from small and large populations of the same ploidy level, bulked-up using Seed Production methods and reintroduced by direct seeding _____	23
Innovation Ecology – the restoration ecology toolkit for Australian ecosystems _____	22
<i>In vitro</i> propagation of ecological keystone sedge species _____	26
Populations size effects on genetic pattern and process in <i>Banksia ilicifolia</i> : Consequences for conservation and ecological restoration _____	23
Re-establishing a recalcitrant species following mining: <i>Macrozamia riedlei</i> _____	27
Restoring and maintaining genetic connections in a landscape context _____	20
Seed Industry Accreditation - A project by the Revegetation Industry Association of WA _____	38
Spatial genetic structure in a rare banded ironstone endemic: implications for restoration _____	29
The use of local provenance for Alcoa's mine restoration in the Jarrah forest; does it matter? _____	26

Soil Health

Chemical and biochemical properties of the soil as tools for monitoring woodland degradation and restoration _____	17
Rehabilitation in deep sand in a mine east of Albany, Western Australia _____	31
Soil nutrients and ecological restoration of temperate Australian ecosystems _____	33
The curious effects of mycorrhizas on the phosphorus nutrition and seedling establishment in the Jarrah forests of Western Australia _____	37

Taxonomy

Do we need a more rigorous scientific process for the listing of threatened species? _____	24
Hidden treasures; recognising, conserving and rehabilitation consequences of localised variants of widespread species of the Perth area _____	26
Molecular taxonomy as a conservation tool, testing species hypotheses in the biodiversity hotspot of southwest Western Australia _____	30
Recent recognition of unexpected richness of <i>Wurmbea</i> in Midwest, Murchison and Gascoyne rangelands _____	29
Taxonomic turmoil in the Triggerplants: implications for conservation management _____	38
Taxonomy and the conservation community: Where are we at and where are we going _____	36
The importance of targeted taxonomy for plant conservation _____	35
The role of taxonomy in conservation _____	39
Weighing up the numbers: case studies in the use of numerical taxonomy for resolving conservation-listed taxa in south-west Western Australia _____	19



Abstracts are listed in alphabetical order of first author's surname.

Chemical and biochemical properties of the soil as tools for monitoring woodland degradation and restoration

Katarzyna Bialkowski

Murdoch University, South Street, Murdoch WA 6150

Forest certification is encouraging Australian plantation companies to manage biodiversity within their estates. This generally requires protecting and managing the native forest and woodland remnants as they provide important habitat for fauna and flora in a plantation landscape. However, many remnants have been degraded by soil nutrient enrichment and weed invasion, and so support less native biodiversity. We investigated the suitability of a range of chemical and biological measures to monitor the condition of the soil in woodland remnants so that the degradation process, as well as the effectiveness of restoration treatments, could be quantitatively assessed. The remnants were within *Eucalyptus globulus* plantations from south western Western Australia. Small-scale, short-term trials were conducted: clearing, artificial fertilisation and assisting weed invasion were used in the degradation trial; herbicides (glyphosate and simazine) and mulching with plantation harvest residue were used in the restoration trial. Soil potassium, ammonium and nitrate content, basal respiration and β -glucosidase activity showed potential to detect changes in soils caused by these treatments. Effects were evaluated by comparison with reference sites: intact native woodland (undisturbed reference) and pasture (disturbed reference). Fertilisation, both alone and with grass invasion, but not clearing or grass alone, had negative effects on soil properties after only a few months in a degradation trial. Glyphosate, but not mulching, significantly improved the condition of the soil in restoration trial. We demonstrated that the combination of a few chemical and biological soil properties can be used for quantitative and sensitive monitoring of the in condition native woodland remnants.

Adaptive genetic diversity among Tuart (*Eucalyptus gomphocephala*) populations and implications for ecological restoration

Donna Bradbury^{1,2}, Siegy Krauss^{1,2}, Ann Smithson^{1,2} and Erik Veneklaas^{1,3}

1. School of Plant Biology, The University of Western Australia
2. Botanic Gardens & Parks Authority, Fraser Avenue, West Perth WA 6005.
3. Centre of Excellence for Climate Change, Woodland and Forest Health

Tuart (*Eucalyptus gomphocephala*) is a forest and woodland tree that occurs exclusively on the Swan Coastal Plain of Western Australia. Tuart communities are of high ecological and conservation value, but widespread canopy decline and clearing has required significant restoration efforts. Tuart populations only mass-flower every 5-8 years, which makes local collection of ample seeds difficult year after year. It has been advocated that, rather than a strict maintenance of local provenance, seeds should be collected more widely to increase genetic diversity, equipping populations with the variation to adapt to environmental change. While this may avoid some problems associated with exclusive local provenance collections, it is known that neutral genetic markers are not adequate predictors of 'adaptability' because they do not occur in functional genes.

For this reason, we have developed functional genetic markers for *Eucalyptus* (EST-SSRs) that are homologous with candidate genes for flowering, pathogen defence and other processes that are likely to be important for adaptation to environmental change. These functional markers, as well as neutral markers, are being screened among natural populations to detect functional versus neutral Tuart population genetic structure and diversity. We are coupling this research with a field-based reciprocal transplant trial, which after one year has not revealed significant local adaptation for seed emergence, seedling survival or growth among six Tuart provenances. Visual condition scores, however, have indicated that northern provenances were less stressed following summer than southern provenances. Implications of these results for seed collection and Tuart restoration will be discussed.

Do genetic bottlenecks occur during the restoration process?

Linda Broadhurst

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Restoring landscapes with high quality, genetically diverse seed is critical for ensuring that these new populations have the genetic arsenal required to meet the challenges of rapidly changing environments.



Several stages during the restoration process have the potential to inadvertently create genetic bottlenecks and produce poor biodiversity outcomes. For example, collecting and deploying seed with a low genetic base may lead to inbreeding and poor quality seed. Space and resource limitation in a production nursery may also reduce levels of genetic diversity available for planting which in the longer term, as these seedlings become reproductive adults, may be even further eroded by mate-limitation and increased selfing. Under these circumstances the long term persistence of these populations is likely to be limited. Each of these possible scenarios was investigated in yellow box (*Eucalyptus melliodora*), a key restoration species that has been extensively cleared across south eastern Australia. Data regarding the genetic diversity in seed collections, seedlings grown through a production nursery, and that being produced by restored populations will be presented and discussed.

Managing Geraldton Carnation Weed (*Euphorbia terracina*), in the woodlands, wetlands and heathlands of the Swan Coastal Plain

Kate Brown, Julia Cullity, Grazyna Paczkowska and Karen Bettink,

Department of Environment and Conservation, Swan Region, PO Box 1167, Bentley Delivery Centre WA 6983.

Geraldton Carnation Weed (*Euphorbia terracina*), an invasive perennial herb, is a major threat to remnant woodlands, wetlands and heathlands of the Swan Coastal Plain. A series of studies over the last 5 years have monitored the effectiveness of established control methods, investigated more effective alternatives as well as studying the resilience and recovery of invaded plant communities. Work has focused on sites of high conservation value where invasion by Geraldton Carnation Weed is a key threatening process.

In threatened sedgeland that occur in Holocene dune swales at Point Becher near Rockingham, south of Perth, trials were carried out with the herbicide Logran® at 12.5g/100L. Cover of Geraldton Carnation Weed decreased significantly in the first year and went from an average of 19.2 % in 2005 before treatment, to less than 0.4% in 2008. Concurrently there was an increase in the cover of native species particularly the sedge *Ficinia nodosa* and the rush *Baumea juncea*. In July 2009 similar trials were established in comparatively species rich coastal heathlands north of Perth and preliminary results will be discussed.

Work at Paganoni Swamp has focused on monitoring the effectiveness of established control methods to prevent spread of Geraldton Carnation Weed into one of the most significant conservation reserves in the metropolitan region south of the Swan River. The 700 hectare site protects a mosaic of Tuart /Banksia Woodlands and low-lying wetlands. The results of this work will be presented.

In addition to these studies, as part of a strategic management approach, a regional plan focusing on gaining an understanding of the distribution of Geraldton Carnation Weed and protecting key biodiversity sites from invasion has been produced.

Working with community groups to conserve threatened orchids in the WA wheatbelt

Mark Brundrett

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The Wheatbelt Orchid Rescue (WOR) project is a Lotterywest funded collaboration between the WA Native Orchid Study and Conservation Group (WANOSCG), the WA Department of Environment and Conservation, the Friends of Kings Park and the University of Western Australia. This project is helping to conserve endangered orchids in the WA wheatbelt by obtaining knowledge required for sustainable management and directly contributing to recovery actions. Surveys utilizing WANOSCG members provided accurate population and habitat size data for the Granite Spider, Ballerina, William's Spider, Lonely Hammer and Underground Orchids (*Caladenia graniticola*, *C. melanema*, *C. williamsiae*, *Drakaea isolata*, *Rhizanthella gardneri*). Permanent transects measured annual fluctuations in emergent orchids and threats to populations. Numbers of plants that emerge and flower varied substantially from year to year, as rates of pollination (0-85%) and grazing (5-50%) varied with species and habitat. Key threats to these orchids include very small habitat areas, herbivory, infrequent pollination and salinity. Knowledge gained is being used to update recovery plans and guide conservation actions.

Seed baiting experiments, where orchid seeds germinate over soil organic matter, identified potential orchid habitats and investigated the role of mycorrhizal fungi. Research in terrestrial orchid seed germination resulted in a new method for non-sterile seedling production that was more rapid and efficient than germination in sterile culture. "Translocation pouches" were designed to protect tiny

seedlings during acclimation in the incubator nursery or field. It is anticipated that more efficient production of orchid seedlings will facilitate translocation programs for endangered species and result in a better understanding of orchid seedling growth and nutrition. Translocation trials with seedlings of rare and common orchids are underway.

Biotechnology and conservation of critically endangered plants in a biodiverse region – the south west of Western Australia

Eric Bunn

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The unique flora of the South West Australian Floristic Region (SWAFR) - a recognized world plant biodiversity hotspot - with over 7000 indigenous taxa and high endemism (~ 50 %) has undergone considerable anthropogenic alteration of the landscape post-European settlement. Extensive clearing for agriculture, weed and feral animal incursions in the SWAFR have impacted severely on natural ecosystem services and most declared endangered flora (DRF) are from this region. Of a total of some 2,800 Western Australian species requiring conservation over 400 DRF are gazetted for Western Australia, of which approximately 120 are critically endangered (CR). Climatic change (including decreasing rainfall) is already impacting on the SWAFR incurring additional stresses on a region already under pressure. Biotechnology is playing a key role in the fight to save endangered species threatened with imminent extinction. Conservation research can draw on molecular, *in vitro* and cryogenic technologies to achieve this. In emergency situations remaining individual plants of endangered species can be micropropagated and maintained *ex situ* permanently in culture collections and/or cryopreserved. Genetic fingerprinting technology can be harnessed to identify key genotypes for *in vitro* culture/cryopreservation that can ensure sufficient genetic representation for restoration sites and also provide early warning of inbreeding depression among offspring in repatriated populations. Bridging between biotechnology and conservation has the potential to save many critically endangered plants in a biodiverse region such as the SWAFR, as has been demonstrated with a number of CR taxa to date.

Weighing up the numbers: case studies in the use of numerical taxonomy for resolving conservation-listed taxa in south-west Western Australia

Ryonen Butcher, Rob Davis, Neil Gibson and Juliet Wege

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The South-West Australian Floristic Region (SWAFR) is renowned for its floral biodiversity and the high degree of endemism of its species, many of which have evolved relatively recently. Just over 8,000 native plant taxa occur in the SWAFR, approximately 24% of which are conservation-listed. Approximately 14% of these conservation-listed taxa have not yet been formally described and named, with the majority lacking descriptive and ecological information essential for their management.

While some informally-named taxa are relatively distinctive, many fall within difficult complexes where taxonomic boundaries are defined by subtle differences in morphology or unique combinations of characters, and are obscured by continuous or overlapping measurement values and intra-taxon polymorphism. Where the intricate associations between taxa are difficult to unravel using traditional taxonomic approaches, numerical taxonomy can be employed to objectively assess the utility of characters for defining and discriminating taxa, and to identify groups of samples which may be discrete entities. Numerical taxonomic methods range from simple analyses of variance in key characters within and between taxa through to multivariate morphometric analyses, where cluster analysis and ordination can be used to reduce complex patterns of morphological variation within and between taxa into more easily interpretable graphical representations of similarity.

This talk will provide an overview of how numerical taxonomy (especially morphometric analysis) has been employed within the Western Australian Herbarium for investigating putatively new, or poorly defined, conservation taxa in *Marianthus* (Pittosporaceae), *Ptilotus* (Amaranthaceae), *Synaphea* (Proteaceae) and *Tetratheca* (Elaeocarpaceae). The conservation outcomes of each study will be discussed.

Restoring and maintaining genetic connections in a landscape context

Margaret Byrne, Colin Yates, David Coates, Carole Elliott, Neil Gibson, Jane Sampson and Melissa Millar

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Gene flow among populations is a fundamental evolutionary process for maintenance of genetic cohesiveness in species. Restoration programs can restore and/or maintain gene flow to ensure continued genetic connectivity within a species in a given landscape. Landscape design configurations that maximise genetic connectivity will enhance ecological process and landscape functioning thus contributing to persistence of populations within fragmented landscapes.

Recent studies on pollen dispersal have demonstrated significant gene flow across the landscape for many species. Paternity assignment has shown that up to 65% of seed can be sired by pollen immigration from plants outside the population. This pollen dispersal has been recorded over distances of up to 5 km in south-western Australia. Pollen dispersal studies show that genetic connectivity can be maintained in fragmented landscapes, and that small remnant populations and paddock trees make important contributions to genetic connectivity. Knowledge of pollen dispersal patterns can be used in landscape design for configuration of populations that maximise genetic connectivity.

Maintenance of gene flow across the landscape is an important consideration for restoration programs, but may not always be beneficial. Extensive pollen dispersal can be detrimental when it involves a source of foreign genes in the landscape, such as plantings that use non-local but related taxa. Such activities should be conducted within a risk management framework to ensure that these programs achieve rehabilitation outcomes without negative impacts on remnant patches of biodiversity.

Defining temperature thresholds for germination: What can they tell us about species vulnerability to a changing climate?

A. Cochrane

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Temperature is arguably one of the most important climatic variables influencing seeds and seedlings since it synchronises germination to environmental conditions most suitable for seedling establishment. Germination is an important life history phase for obligate seeding species, and failure to germinate after disturbance events may mean local population extinction. Seeds will germinate over a range of temperatures, with thresholds above and below which little or no germination will occur. Under climate warming scenarios temperatures are forecast to rise between 2-5°C. If species have specific temperature requirements for germination then climate warming could cause a mismatch between temperatures seeds experience and temperatures over which germination is able to occur. Such a mismatch in the germination niche of obligate seeding species could render them vulnerable to decline and extinction.

Using a temperature gradient plate more than 45 Western Australian native species were temperature profiled for germination. Some geographically restricted species were found to have wide thermal tolerance for germination, suggesting that temperature for germination is not a constraining factor to population persistence or possible range extension under predicted climate warming. Such species appear to be pre-adapted to warmer temperatures for germination and may be less of a conservation concern than those with narrow thermal tolerances. This novel seed-based predictive tool should help improve management efficiency for prioritising conservation actions, influencing choice of populations and sites for species reintroductions and restoration into novel environments.

The role of fire in the persistence of threatened flora in the Western Australian Wheatbelt – *Pityrodia scabra* case study

Joel Collins

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The Department of Environment and Conservation's Central Wheatbelt District covers 21% of the internationally recognised South West biodiversity hotspot. The District contains 94 known threatened flora species which are listed as declared rare flora under the Wildlife Conservation Act 1950. Of the species listed as critically endangered 67% are endemic to the region. These species are highly localised to specific habitats and often represented by small populations that are in decline. The use of



site specific recruitment burns as a recovery action has been beneficial for fire dependent species to regenerate and persist in the highly fragmented landscape.

The Wyalkatchem Foxglove (*Pityrodia scabra*) is currently listed as critically endangered and at risk of extinction. Strategic burning within the populations during 2006-2010 has successfully promoted recruitment of seedlings that have reached reproductive maturity. The use of fire as a recruitment mechanism is a key component of the overall management of threatened flora in the wheatbelt.

A Big Slice of Flora Pie, the Alinytjara Wilurara NRM Region, managing threatened flora across 250,000 square kilometres

Karan Coombe-Smith

Alinytjara Wilurara NRM Board, 321 Goodwood Road, Kings Park SA 5034

The Alinytjara Wilurara Natural Resources Management Region covers 250,000km² in arguably the most pristine, arid and remote landscapes of South Australia. The region has over fifty plant species of national and state conservation significance. This includes species that do not have sufficient data to be effectively rated, as well as species that have not had their occurrence at sites confirmed for many years. The threatened flora in the region cover a range of genera and forms - orchids, forbs, daisies, fire-dependant legumes, chenopods, flowering bushes, mallees and aquatic plants. And the habitats they occupy vary from the edge of the Nullarbor cliffs to the highest ranges in South Australia and the driest deserts. But, for the region's threatened flora species, there remain many unknowns. The area of distribution, populations and total numbers are not known. Threats have not been fully assessed. Levels of recruitment and survival in the face of risks such as fire, feral animals and weeds are generally unknown, as are the impacts likely under a changing climate.

With limited resources the Alinytjara Wilurara NRM Board is working hard to prioritise its on-ground assessment and conservation activities to get the best conservation outcomes possible. However, the region presents many challenges including prioritising species with limited information; logistics of working in a remote and arid region; taking a landscape approach to management while conserving site-specific threatened flora; and considering the issue of refugia in a changing climate. Truly, 'a big slice of flora pie'.

Urban landscapes supporting plant conservation

Susan Dempster

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Engaging with industry can provide opportunities to utilise specialist expertise and experience in conservation and restoration projects, and form valuable partnerships which can achieve successful outcomes. Whether it's botanical consultants identifying conservation values through survey work or mining companies managing restored land on their leases, there are many avenues to engage industry. This topic seeks to discuss the challenges of identifying the 'who, what, how, why and when' of industry involvement in plant conservation.

Community awareness of sustainability and the importance of preserving our biodiversity is driving change. A questioning of the collective industries 'modus operandi' that identify, grow, supply, install and manage indigenous plants for sustainable community landscapes, identifies barriers in protecting plant conservation in urban developments.

These barriers are observed from urban developments through to handover to Local Government. In general, current community landscapes are not suited to our environment, or sustainable. The indigenous plant horticulture industry is constrained by accepted norms in various connected industries. The supply chain supporting the existing horticultural industry is not set up to develop and support the widespread uptake of indigenous plants into community and domestic landscapes. This is in fact causing significant restrictions to the growth of the indigenous plant horticultural industry. As a result, new community landscapes that set out to incorporate local plants, fail at a time when public demand for environmentally sustainable development is becoming de rigueur.

To ensure changes and indigenous plants are embraced, the barriers need to be addressed from policy through to the management of landscapes and bushlands. When these barriers are embraced the urban development industry will be an enormous resource to assist in plant conservation and biodiversity protection. Achievement of this goal will improve environmental outcomes for urban development and connected industries to ensure local biodiversity is protected and a 'Sense of Place' is created.



It is the connection of the relevant horticultural industries and the urban development industry that will provide significant support to sustainable plant conservation within the local municipalities.

Controlling weeds on translocation sites: strategies, solutions and probable short term costs to the environment

I R (Bob) Dixon

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One of the main limitations to successful translocations, especially on degraded sites, is weed control. You will not eradicate all weeds; therefore you should aim to control/eradicate the most damaging/aggressive species and learn to live with others as long as they do not impact severely on indigenous species. To reduce weed problems you need to plan and develop strategies which will assist management e.g. choose a well vegetated site with a good indigenous species soil seedbank that is weed free or contains easy to control weeds, hand weed now or later when few weeds are present (can cause more disturbance = more weeds), use selective herbicides, non-selective herbicides use for spot spraying, blanket spraying may be necessary therefore use a less damaging herbicide, are pre-emergent herbicides appropriate.

Solutions to weed control vary from site to site and species to species and it may take several years to develop a solution (spray trials using non-selective herbicides at lower rates over the rare as well as other indigenous species)

Short term costs to the environment may well be necessary to achieve long term aims, these may include using a herbicide that will cause severe off-target damage to indigenous species, are you prepared to accept this, will these species recruit again from the soil seedbank or can you reintroduce them.

Innovation Ecology – the restoration ecology toolkit for Australian ecosystems

Kingsley Dixon

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Across rural and urban Australia, there is a growing demand for restoration-ready solutions for repatriation and restoration of ecologically damaged and dysfunctional ecosystems. With 48% of continental Australia now disturbed by humans, intervention will be necessary if we are to reinstate a level of ecological functionality. Realising the 'restoration toolkit' for these landscapes will be critical if Australia is to achieve solutions that deliver effective, timely and technologically achievable outcomes. Here I present the core concept of Innovation Ecology based on an integrated program of research focused on actualisation of seed as the most effective vehicle for delivery of large-scale and cost-effective ecological restoration. Why is wild seed research so important? Current leading practice can achieve only small returns on seed investment with up to 96% loss of seed directed to restoration for some programs. This represents significant wastage of seed resources and a drain on wild seed sources. I will review the current and future capabilities in technology innovation (in three core areas of Restoration Seedbanking, Germination-on-Demand and Seed Enablement) and highlight key developments and future research that will be necessary if we are to achieve environmental repair on a scale that matters.

Diversity in the Kangaroo Paw family

K.S. Downes

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Kangaroo Paws are iconic Western Australian species, with *Anigozanthos manglesii* subsp. *manglesii* (Haemodoraceae) being the state floral emblem. Many Kangaroo Paws grown in gardens are hybrids that have been specifically bred for floral traits and disease resistance. Thus, some people may be unfamiliar with all of the species found in the wild. This short talk will provide a pictorial guide to many *Anigozanthos* taxa as well as other Western Australian genera within this family. This will allow an appreciation of the differences in flower and seed morphology between the different taxa. In addition, the ecology of *Anigozanthos* will be considered. Most *Anigozanthos* species are more abundant after fire, but can be divided into short-lived fire ephemerals and longer-lived species. Particular habitat requirements and species distributions will also be discussed.



Populations size effects on genetic pattern and process in *Banksia illicifolia*: Consequences for conservation and ecological restoration

Michalíe Foley, Siegfried Krauss

Botanic Gardens & Parks Authority, Fraser Avenue, West Perth WA 6005

With the increasing desire of the community to own new houses, *Banksia* woodlands within the biodiversity hotspot of the Southwest of Western Australia are invariably in the ideal areas for housing estate development whether close to the major city or in up and coming rural communities. This pressure of increased human encroachment has reduced population size and increased isolation which can be associated with a suite of genetic problems including loss of genetically differentiated populations, increased inbreeding and loss of genetic variation due to genetic drift.

This project focuses on exploring genetic structure and the underlying genetic processes in a species that is disjunct in its distribution, *Banksia illicifolia*. This common widespread species will serve as a model for understanding gene flow processes in a fragmented environment. This is achieved through the use of microsatellite markers and paternity analysis of large and small populations within the metropolitan area. With this knowledge of pollen dispersal it can be seen whether features such as roads, houses and gardens act as barriers and corridors. It can also inform land managers and housing estate developers on how new development should be designed to allow for populations of plants (common and rare) to be sustainable for the future.

Genetic rescue of *Rutidosia leptorrhynchoides* by creating new and viable populations initiated from seed sourced from small and large populations of the same ploidy level, bulked-up using Seed Production methods and reintroduced by direct seeding

Paul Gibson Roy

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Rutidosia leptorrhynchoides, a multi-stemmed, herbaceous perennial is an Asteraceous species endemic within the broader temperate grassland communities of south-eastern grassland. It is listed as threatened under Victoria's Flora and Fauna Guarantee Act (1998) and as endangered under the Commonwealth's Environment Protection and Biodiversity Conservation Act (1999). The Grassy Groundcover Research Project (GGRP) has for some time been investigating the reconstruction of species-rich grassland by direct seeding with considerable success. In 2008 it initiated a new project in partnership with VicRoads (Western Region) to reconnect high quality roadside grassland remnants on the Glenelg Highway near Wickliffe in Victoria's south west. These remnants were separated by non-endemic native tree plantations. The goal was to reseed these areas with complex seed mixtures following the removal of trees. A further goal was to reintroduce new populations of *Rutidosia*. To do this, seed from a nearby (3 km) small (n=26) remnant tetraploid population was combined with seed from larger (n>5000) population (also tetraploid) located approximately 100 km away to produce a Seed Production crop (n = 500). *Rutidosia* was direct-seeded as part of the larger program in spring of 2009. Subsequent surveys show that seedling emergence is widespread and consistent and that populations of > 1000 individuals have been established. Earlier GGRP sowings show that survival from individuals present at this point post-seeding is largely maintained (given appropriate management regimes). This project aimed to reconstruct species rich grassland and establish new populations of *Rutidosia leptorrhynchoides*. While still early in the reestablishment-phase, it is likely that both goals will be achieved.

Novel ecosystems and no-analogue climates: implications for management and policy in a rapidly changing world

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Changes in climate and other environmental conditions are combining with changes in species distributions and combinations to create entirely new environmental domains and ecological communities. Hence we are increasingly experiencing climatic and disturbance events outwith the historic range and observing increasing evidence of novel biotic assemblages and interactions which behave in unpredictable ways. We are only just becoming aware of the implications of this for ecosystem management and policy. I discuss these phenomena, drawing on examples from Australia



and elsewhere, and explore the need for radically different approaches to management and policy in the future.

Progressing from single species recovery planning to multi-species recovery across the landscape: A case study from the Hunter Valley – NSW

Tricia Hogbin

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The native vegetation of the lower Hunter Valley has been extensively cleared since European settlement, with less than 30% now remaining. Consequently, the area supports numerous threatened species, with 65 threatened entities, including ten plant taxa and nine ecological communities.

The Department of Environment, Climate Change and Water commenced an active threatened flora recovery program in the region in 2005, initially focussing on a few single species and ecological communities. In late 2009 the focus expanded to developing the Cessnock Biodiversity Conservation Program, which seeks to address the conservation needs of all 65 threatened entities across a 70,000 ha study area.

I will present an overview of the methodology used to develop the program and will evaluate its effectiveness to date. In summary, we (i) developed a landscape conservation plan prioritising areas for protection, restoration and revegetation across the landscape; and (ii) identified targeted focus areas addressing the conservation requirements of those entities not adequately conserved through the landscape approach. One of the main objectives of the program is to promote collaboration and community involvement in threatened species recovery. Consequently, it was decided to present the program as a poster style plan, identifying priorities geographically across the landscape. This innovative approach has been well received by other public authorities and the community and is already influencing the targeting of funding for on-ground works and has initiated a number of partnerships.

Do we need a more rigorous scientific process for the listing of threatened species?

Chris Howard

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The financial cost that threatened species legislation imposes on development is usually considerable. In one example, an upgrade to the Pacific Highway on the NSW north coast has faced financial liability and delays due to the presence of a number of threatened species associated with the proposed route. Three species of Helmet Orchid occurred in the path of the highway upgrade and while *Corybas barbarae* and *C. aconitiflorus* are ubiquitous along the eastern coast of Australia, *C. dowlingii* is restricted to the highway upgrade site and a small number of sites to the south. As such, *C. dowlingii* is listed as 'Endangered' (NSW TSC Act 1995) and the populations associated with the highway upgrade route required translocating before construction. Prior to a translocation deadline in 2009 we hypothesised that *C. dowlingii* may not be a truly distinctive species, but rather a variant of *C. aconitiflorus* as floral morphology and colouration of these two species is remarkably similar. Comparisons of molecular data between all three species indicated that *C. dowlingii* was indeed indistinguishable from *C. aconitiflorus*. However, as this finding had not been published in peer reviewed literature prior to the translocation deadline, legislation required that the affected colonies of the invalid *C. dowlingii* still be translocated. Financial costs due to erroneous listing of threatened species are unreasonable. We argue that when morphological similarity is present between a nominated species and its congeners, the listing process should only advance if adequate research exists which proves the validity of the nominated species.

The Bulahdelah Bypass: challenges to orchid conservation

Chris Howard

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With growing public infrastructure development, scientific investigations are increasingly being sought to provide outcomes that counteract the effects of development on ecosystems. The advancement of a NSW Roads and Traffic Authority (NSW RTA) upgrade to the Pacific Highway at Bulahdelah on the

NSW north coast is currently affected due to the presence of three threatened terrestrial orchid species (*Cryptostylis hunteriana*, *Rhizanthella slateri* and *Corybas dowlingii*) associated with the proposed route. In compliance with relevant federal and state legislation, the NSW RTA is funding a conservation research project to offset the effects of the highway upgrade which aims to conserve and perpetuate these orchid species in the affected area. As part of this research project an orchid management plan was formulated stipulating that populations of these threatened orchid species within the proposed road footprint be translocated to unaffected areas. Translocation of these orchids required a comprehensive knowledge of their phenology, plus an understanding of the associations with their mycorrhizae, pollinators and with other vegetation. The interaction between science and industry required for this research project further compounds the complexities of its biological aspects. While initial translocation data is encouraging, appropriate land availability for translocations, governance matters (tenure and management) and the responsibility for long term monitoring are challenges to the success of the project. The research is being undertaken by the Centre for Plant Biodiversity Research, a collaboration between CSIRO and the Australian National Botanic Gardens.

Ecological restoration in Gondwana Link

Justin Jonson

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The Fitz-Stirling operational zone of Gondwana Link is defined as the area of fragmented native remnant vegetation located between the Stirling Ranges National Park and the Fitzgerald River National Park. Over the last 5 years, a number of on-ground revegetation works have been undertaken to protect and restore the ecological health and resilience of this relatively intact landscape. On-ground works have been diverse in their objectives, methods, and quality of results, and much has been learned along the way. Research and development has occurred in areas related to direct seeding of native plants, integration of local plant and seed collection knowledge into re-vegetation projects, and more detailed site planning to ensure that seeds are sown in correct soil types and landscape positions. Hundreds of hectares have now been seeded over many different soil types, using different seed mixes, and experiencing different seasons. The result has been the establishment thousands of native plant species now growing on previously cleared lands. Building on the lessons learned from these efforts, with an ongoing goal toward improvement and innovation, new approaches to re-establishing plant communities which reflect the natural mosaic of local native vegetation associations found in the region are beginning to be achieved. Through working closely with seed collectors, and drawing from the theory presented in the literature, restoration efforts are improving in their delivery of well planned functional plant systems.

Correlation of membrane composition to cryopreservation results in selected plant species

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Cryopreservation is the method of choice for long-term storage of vegetatively propagated plant material which is generally achieved through the use of shoot apices derived from aseptically grown plant tissue cultures. *Loxocarya cinerea* (Restionaceae) is a dioecious long-lived rhizomatous species important in land restoration for the bauxite mining companies Alcoa and Worsley Alumina as it is a locally common (dominant) native species that once established significantly reduces soil erosion. *L. cinerea* is currently maintained and propagated via tissue culture at significant expense due to the general lack of seeds and very low success through cutting or division propagation. Nevertheless, *in vitro* culture is labour intensive and costly for on-going maintenance with accidental contamination and somaclonal variation being additional concerns. The aim of this project is to develop a successful cryopreservation method for the preservation of key genotypes of *L. cinerea* through (a) investigating membrane composition and impact on cryopreservation success; (b) constructing computer generated membrane models and; (c) utilising these models for improved understanding of cryopreservation processes with the outcome of developing computer-aided tools for greater efficiency in generating cryopreservation protocols.



Currently, vitrification approaches are developed and optimized empirically for each species undergoing cryopreservation through trial and error experiments that are time consuming and labour intensive. In trying to understand why some species are amenable to cryopreservation, while others are not we describe some of our preliminary findings concerning some of the biochemical attributes of cryotolerant and cryosensitive species through characterisation of plant membranes (sterols, phospholipids) and sugars.

Hidden treasures; recognising, conserving and rehabilitation consequences of localised variants of widespread species of the Perth area

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Detailed surveys over the past two decades have documented that the Flora of the Swan Coastal Plain contains over 2,000 native plant taxa, with over 1300 in the Perth Metropolitan area. Of these species, approximately 10-15% of what are considered widespread and well conserved have distinctive ecotypes, confined to distinctive soil types and habitats, especially wetlands.

Studies are showing that many of these variants are highly localised with many morphologically distinct from other variants. These variants are normally distinct and do not intergrade with "normal" widespread forms. This raises both significant taxonomic and provenance issues for rehabilitation and conservation planning. To limit the loss of genetic variation in these species more complex reserve planning is required and simple area extent is inadequate for sourcing local propagation materials.

A series of species will be used to illustrate these issues (*Acacia pulchella*, *Callitris preissii*, *Eucalyptus gomphocephala*, *Philothea spicata* and *Aponogeton hexatepalus*). Currently the authors are completing the compiling of a detailed annotated checklist of the flora of the Swan Coastal Plain which will detail the composition, variation and conservation status of the vascular flora to aid selection of provenance materials and conservation of this variation.

The use of local provenance for Alcoa's mine restoration in the Jarrah forest; does it matter?

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Alcoa has been using local provenance plant material for mine restoration in the Jarrah forest since 1991. Broadcast seeds, potted seedlings, cuttings and tissue culture are all used to restore plant species after mining. The provenance zones for two mines (formerly four) have been defined based mainly on geographical, soils, rainfall and plant community characteristics, but more recently DNA analysis has been used to delineate geographical distances for genetic differentiation. But how important is it to use local provenance in such a radically altered environment as a rehabilitated mine? Two examples are given which show that the use of local provenance is important for ecological restoration. Minesite provenance trial plantings from 1987-1990 of the dominant overstorey tree (Jarrah) show strong local provenance adaptation when measured as growth, form and survival. Non-local provenances showed significantly poorer growth, form and survival. Using local provenance also insures practitioners against the ravages of taxonomic revisions. An example is given of the mistaken use of the wrong species following a taxonomic revision and renaming. This mistake would not have occurred if the local provenance of this species (now *Dryandra lindleyana* subsp. *sylvestris*) had been used.

***In vitro* propagation of ecological keystone sedge species**

Andrea Kodym

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Our research addresses the problem that many character plant species cannot be returned to restoration sites because of the lack of efficient propagation methods. Several *Lepidosperma* and *Gahnia* species (Cyperaceae) possess unresolved dormancy and are also not responsive to vegetative propagation via division. *In vitro* techniques are being investigated as a means of producing large quantities of planting material while retaining appropriate levels of genetic diversity. Seeds of



Lepidosperma concavum, *L. laterale* and *L. longitudinale*, *Gahnia trifida* and *G. filum* germinated *in vitro* after removal of the pericarp and successfully established in the nursery. Germination ranged from 60–91% depending on the species and occurred within 7 to 18 days on 1/2MS media supplemented with zeatin and GA₃. As a tool for mass propagation, somatic embryogenesis was initiated in *Lepidosperma laterale*. Embryogenic callus was induced from immature seed and from *in vitro*-grown seedlings on medium containing 2,4-D alone or in combination with zeatin. Induction was 16% and 100% respectively within 6 weeks. High rates of conversion of plants were achieved on charcoal medium followed by BAP or TDZ media. In *Gahnia radula*, no viable seed was found amongst several Victorian populations. The species is highly rhizomatous and a study using microsatellites has been undertaken to determine levels of genetic diversity within and between populations.

Re-establishing a recalcitrant species following mining: *Macrozamia riedlei*

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Successful re-vegetation following mining is variable and is dependent on the type of exploration and subsequent rehabilitation approach, the intrinsic characteristics of the landscape, and the species concerned. Alcoa works to return the endemic understorey species, *Macrozamia riedlei*, to its bauxite mined sites in the northern jarrah forest of southwestern Australia through hand seeding. However, re-establishment of this species has proven difficult. Plant density, cover, size and biomass measurements collected from mined and unmined sites were used to establish the survival and growth of this recalcitrant species. The density of *M. riedlei* was low on mined sites (<100 plants.ha⁻¹) in contrast to unmined forest (500–1395 plants.ha⁻¹), and reflects seeding rates and plant survival. The survival of *M. riedlei* on mined sites declined with time since seeding ($r^2=0.205$, $p=0.015$) and plant growth, measured as the change in plant cover over time, was inconsistent between sites. However, the very small size of plants on all mined sites, even after 15 years, suggested poor growth. Plant biomass and size were positively correlated with age, confirming that plants on the mined sites were growing, albeit at a slow rate (e.g. for above ground biomass, $r^2=0.182$, $p=0.005$). The rapid growth of other understorey and overstorey species on the mined sites (70% and 60–70% cover respectively after 12 years) suggested a level of competition that would negatively impact establishment success of *M. riedlei*. However, the positive influence of fire on the growth of *M. riedlei* showed potential for ameliorating the negative impact of overcrowding.

Assessing botanical capacity in the United States: gaps identified and strategic recommendations made to maximize conservation success

Andrea Kramer

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The botanical community plays a mission-critical role in researching, conserving, and sustainably managing the world's plant diversity and resources. Botanical expertise is required to address current and future grand challenges and issues, including climate change mitigation, land management and wildlife habitat restoration, understanding the provision of ecosystem services, management and control of invasive species, and the conservation and recovery of rare species. Despite the fundamental role botanical capacity plays in tackling each of these issues, a recently published report in the United States reveals severe shortages of botanists at government agencies, a wave of upcoming retirements, and an alarming decline in botanical degree programs and course offerings at the nation's colleges and universities. The result of a year-long project which surveyed nearly 1,700 members of the United States botanical community, this report describes how private sector organizations are helping to fill identified gaps in capacity being created by declines in the academic and government sectors, and urges action across all sectors to work more strategically to more effectively pool resources and ensure program sustainability and conservation success into the future. While this project focused on the United States, its results illustrate how any nation's science, sustainability, and land management agenda will suffer, opportunities to economically and efficiently solve environmental challenges will be lost, and public and private lands will continue to degrade if botanical capacity is not valued, understood, and sufficiently supported.



Ecological genetics of *Penstemon* in the Great Basin, U.S.A.

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Ecological genetics research was carried out on multiple populations of three common forb species in the Great Basin (*Penstemon deustus*, *P. pachyphyllus*, and *P. rostriflorus*) to understand the interacting effects of geographic isolation, distance, topography, climate, and pollination syndrome on population genetic differentiation of each species. Research included microsatellite DNA analysis, common garden studies, and experimental crosses to test for inbreeding and outbreeding depression in different species and populations. Results revealed significant genetic diversity and divergence among populations in both neutral and potentially adaptive genetic traits for all three species, but there were striking differences in study results depending upon the primary pollinator of each species. The hummingbird-pollinated species had much greater gene flow among populations than the two bee-pollinated species, but this greater gene flow did not translate to lower divergence in quantitative traits. However, the first generation of experimental crosses spanning increasing geographic and genetic distances revealed both inbreeding and outbreeding depression in progeny of the bee-pollinated *P. pachyphyllus*, which had the highest degree of population divergence. No negative fitness effects were identified in first generation crosses of the hummingbird-pollinated *P. rostriflorus*. While additional research on these and similar species is urgently needed, these results provide insight into the development of seed transfer zones and can help guide the movement and mixing of seeds for different forb species being used in ecological restoration efforts.

A practical genetic contribution towards best-practise seed-sourcing guidelines for ecological restoration

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Whilst there remains an on-going need to research the consequences of seed-sourcing decisions associated with the provenance and properties of source populations, restoration practitioners urgently require practical and specific seed-sourcing guidelines to achieve key objectives for current ecological restoration activities. To address this practical need, we have utilized powerful molecular markers, an efficient sampling approach and novel statistical procedures to generate data on spatial genetic structure for many species associated with ecological restoration projects in south-west Australia. A general finding of significant genetic structure, a positive association between geographic and genetic distance, and marked population differentiation, reiterates the importance of local provenance sourcing of genetically diverse seed. For restored populations, there is a need to achieve functionality, self-sustainability and resilience for long-term viability in the face of environmental challenges. Genetic monitoring provides a powerful tool to assess this objective, through a comparison of patterns of mating, pollen dispersal and genetic diversity of offspring in, and genetic connectivity among, restored and undisturbed populations, and through a genetic assessment of the delivery of pollinator services for effective pollination. An example is presented with a keystone *Banksia* species, from which general principles are identified.

An interesting plant community of hypo-saline seasonal lakes in the Muir-Unicup catchment, Western Australia

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The Muir-Unicup Recovery Catchment near Manjimup, Western Australia, has a variety of wetlands including a number of shallow, seasonally wet brackish or hypo-saline lakes. When dry these lakes are bare but when wet they support a dense community of aquatic plants that has been little-studied in this region. These lakes are demanding habitats, drying out completely in summer, wetting up to varying levels in accordance with rainfall, fluctuating in depth, high in pH, and low in salinity when full and becoming progressively more saline as the water dries out through evaporation. A specialized assembly of a small number of annual or geophytic macrophyte species occupies these lakes, providing shelter and food, directly or as an algal substrate, for invertebrates, and grazing for waterbirds. The plants include species of *Ruppia*, *Lepilaena*, *Chara*, *Lamprothamnium*, *Trithuria*, *Triglochin*, and two species of the aquatic liverwort genus *Riella* that has not been known in WA previously. At least two of these plants are either recently named or as yet un-named, which emphasizes the limited study that this community



has received. Topics discussed concerning this community include the degree of naturalness of the Muir-Unicup occurrences, other occurrences and similar communities, the individual distributions of the component plant species, the phylogenetic relationships of the species, evolutionary and historical implications of the existence of this community, and conservation of these wetlands and their biota.

Recent recognition of unexpected richness of *Wurmbea* in Midwest, Murchison and Gascoyne rangelands

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Wurmbea (Colchicaceae) is a genus of geophytes that survive summer as underground corms, come up in winter, and flower at different times, depending on the species, from autumn to spring but mostly in winter. Most Australian species of *Wurmbea* are endemic to Western Australia where they have been considered to be concentrated in the south west forest, coast and agricultural areas with only a few in the arid zone. Field work in recent years has shown an unexpectedly large number of species in the rangelands of the Midwest, Murchison and Gascoyne, including the adjacent coast. It is likely, given the remoteness of these places, that additional species will be discovered. Most of these species are undescribed, with poorly known distributions. Several are currently known from single locations, with some potentially threatened by grazing and mining. They often grow on hills or rocky surfaces in harsh environments and are highly dependent for growth and flowering on adequate and appropriately timed rains. We illustrate a selection of the species, their habitats and distributional range, and discuss some conservation issues concerning land use that these recent discoveries raise.

Engaging with industry in plant conservation – The State of Play in 2010

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A review of the role of Industry in plant conservation reflects a shift in the definition and management of plant conservation issues in Western Australia and Australia. Whilst this review will concentrate on the last few decades, a historical context will also be given of changes in the industry and perceptions of the roles and responsibilities of different groups in 2010.

There is no doubt that increasing legal requirements for undertaking comprehensive, adequate and representative surveys have assisted in the changes that have occurred. Without industry and independent consultants many of these issues would not have been clarified and the regulators would have been in more difficult positions in terms of determining environmental outcomes. In many instances research efforts are not necessarily driven by development activities.

Industry groups have assisted in increasing our knowledge of plant species and communities. The information collated on variations in plant species, plant communities, site preferences through aerial interpretations, geographical extent and regeneration strategies have assisted in many phases of planning improved environmental outcomes. Examples include the recent improvement in knowledge of species such as *Conospermum toddii* and some of the priority species on the Yellow Sandplain communities east of Kalgoorlie through a range of regional studies undertaken by consultants in cooperation with the Department of Environment and Conservation, Energy and Minerals Australia and the Tropicana Joint Venture.

Spatial genetic structure in a rare banded ironstone endemic: implications for restoration

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Acacia woodmaniorum is a sprawling, prickly shrub with high substrate specificity for the rock crevices of a highly restricted series of hematite/magnetite-rich outcrops currently covered by mining leases. In order to assess species genetic diversity and spatial genetic structure we sampled 573 plants from 33 locations across the species range and genotyped individuals at 15 microsatellite loci. Despite its rarity *A. woodmaniorum* is not genetically depauperate. The species maintains a high degree of allelic diversity ($P = 95.15$, $A = 4.33$, $H_e = 0.531$, $H_o = 0.529$), the majority of which (69%) occurs within



individuals so that diversity is correlated to population size. Genetic differentiation among populations increases with geographic distance ($P = 0.001$, $R^2 = 0.0688$) but remains low ($F_{ST} = 0.0977$, or 24% of species diversity), suggesting that significant levels of gene flow are maintained among populations via pollen or seed dispersal. The Blue Hills population and the three most westerly populations of the main range contain 12.56% of the species total allelic diversity and 44.90% of private alleles. These are also the populations most likely to be impacted by mining activities. Loss of this diversity may directly impact the species capacity for future adaptation and persistence and, given their location within the species range, may also adversely affect the maintenance of genetic continuity among populations. We suggest comprehensive seed collection from these populations and a restoration program that considers geographic positioning in the landscape.

Modelling species' distributions improves understanding of the ecological, translocation and restoration requirements of two rare Banded Ironstone Formation (BIF) endemic species

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The distribution of any taxon results from evolutionary, ecological and historical processes operating across a range of spatial and temporal scales. Modelling the distribution of rare plant species can help to identify factors limiting their distribution as well as likely sites for survey for new populations, the location and attributes of ideal sites for translocation programs, and environmental requirements for restoration sites. It can also provide valuable insights into species' interactions with disturbance regimes and threats as well as provide specific testable hypotheses in relation to their environmental interactions and limitations.

The distributions of *Darwinia masonii* (Myrtaceae) and *Lepidosperma gibsonii* (Cyperaceae) were modelled using a maximum entropy approach in MaxEnt. Models were derived from >900 presence records for each species, together with environmental data on geology, fire history, aspect, solar radiation receipt, slope, slope curvature and elevation for a 12 × 8 km area incorporating the species' known distributions. *D. masonii* and *L. gibsonii* are Declared Rare Flora endemic to the region of the Mt Gibson BIF range – which is subject to mining development.

Model outputs identify fascinating differences in the behaviour and environment interactions of the two co-occurring species. They identify environmental parameters limiting growth for one species and provide insights into the ecological requirements of both species, including their differing degrees of niche occupancy. In turn, these suggest differing likelihoods of success for translocation programs and differing requirements for restoration. Studies of the ecophysiology, demography and fire responses are underway to answer research questions raised by the model predictions.

Molecular taxonomy as a conservation tool, testing species hypotheses in the biodiversity hotspot of southwest Western Australia

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Taxonomy, through species delimitation, plays an essential role in conservation given the high status designated to "rare species" in worldwide conservation legislation. Species delimitation of plants is primarily based on morphological descriptors, which sometimes come with levels of uncertainty, especially regarding species complexes where continuity or intergradation of character states is common. "Cryptic species" also pose challenges where long term geographic isolation along with habitat and/or climatic differences would hypothesise species delimitation, but clear morphological variation is lacking. DNA data provide a viable source to test our species hypotheses and provide valuable insight into the designation of conservation entities. Molecular systematic studies of two West Australian species complexes (1. *Petrophile brevifolia* and 2. *Myriophyllum petraeum*) demonstrate the utility of molecular taxonomy in cases of morphological uncertainty with conservation implications. Both are endemic to the Southwest Floristic Region (SWFR) with *P. brevifolia* representing a complex with a continuous distribution across a wide geographic range and *M. petraeum* representing a complex with several disjunct populations in the granite outcrop system. Molecular results support and clarify species delimitations hypothesized from a mosaic of morphology, geography, habitat and/or phenology in these complexes. These results, along with a growing international literature in molecular systematics testing species hypotheses, support an increased use of DNA based data as a conservation tool into the future,

not only for taxonomy, but also to explore "genetic diversity" as part of Australian conservation legislation.

Vegetation mapping in service of biodiversity conservation: Global perspective and WA prospects

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Vegetation mapping is an essential tool of biological survey and they are excellent surrogates for biodiversity patterns at various scales of complexity. Vegetation maps inform biodiversity conservation at various scales: they stratify regions into manageable spatial units, aid identification of potential conservation areas, allow for setting conservation targets (what proportion of the extant cover of various vegetation types should be protected?), and assist in identification of rare and endangered ecosystems and habitats of rare flora. Several European, American and African examples of using vegetation mapping to answer biodiversity conservation challenges are discussed. Vegetation mapping is a core procedure in vegetation condition assessment. European and Australian experience in this specific application is briefly reviewed and compared. Western Australia faces new challenges putting the accumulated spatial biodiversity information (distribution of species, local/regional centers of diversity and endemism, fine-scale vegetation mapping etc.) into service of the state-wide biodiversity conservation targets. The legendary structure-based mapping by J.S. Beard, still quite well informative at coarse (state-wide) scale, does not match the requirements of modern biodiversity management at regional and local scales. New vegetation mapping products, reflecting the ecological and evolutionary matrix at regional and local scales, are needed. This paper outlines in brief this new task and reports on progress of the new vegetation mapping programme in WA.

Rehabilitation in deep sand in a mine east of Albany, Western Australia

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A sand mine has been established approximately 70 km east of Albany in a deep, white sand formation. The vegetation of the mine area is relatively intact, despite previous grazing and fires, and supports a *Eucalyptus staeri*, *Banksia attenuata* overstorey over a dense and diverse range of shrubs and sedges.

The Notice of Intent for the mine approval committed the owners to small areas of clearing each year, followed by rehabilitation as soon as practicable. The rehabilitation was to occur via topsoil stripping and replacement but there were no specific compliance requirements in relation to land shaping or vegetative success.

The mine operator commenced rehabilitation in 1996/7 and monitoring of rehabilitation quality has occurred generally annually since 2002. The rehabilitation has achieved good success in terms of biodiversity and coverage with some interesting exceptions. The paper considers the restoration issues, and the outcomes achieved, in a region where few rehabilitation attempts of this scale have been made.

Wetland best practice in production systems in the Great Barrier Reef catchment

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The Burnett Mary Region of Queensland's mid-north coast covers an area of 62,842 square kilometres, and contains some of the state's most diverse wetland areas, with a mix of subtropical, temperate and tropical ecosystems. All of the catchments within this region feed directly into the Great Barrier Reef Marine Park, a protected off shore marine zone that extends north to Cairns.

Evidence over the past few decades has shown a system-wide decline of coral reefs in the Great Barrier Reef (Bellwood *et al.*, 2004), with evidence increasingly pointing to a combination of natural events and neighboring land use pressure through increased sediment and nutrient flows as the likely cause (Fabricius *et al.* 2003; Telesnicki *et al.* 1995). Research in Queensland's coastal catchments indicates

large quantities of sediments and associated nutrients and pesticides are washed from agricultural areas into rivers, streams and groundwater (Layden 2008).

Wetlands are an integral part of our landscape providing a multitude of natural values and services. They hold diverse environmental and biodiversity values, providing essential habitat for fish, water bird and plant species. They have historical and cultural significance for both indigenous and non-indigenous Australians, and they have widely recognized educational and recreational values.

It is not always the case that wetlands are recognized for their value in terms of farm productivity. Correctly managed wetlands can provide significant benefits for farm productivity. This includes erosion and flood management, seasonal foraging, shelter belts, pest management, increased groundwater recharge, improved irrigation and stock water, increased land values and increased farm biodiversity.

Reef Rescue is a five year, \$200 million partnership (Government, industry and Natural Resource Management groups) aimed at reducing the amounts of sediment, fertilisers and pesticides reaching the Great Barrier Reef lagoon. For the Burnett Mary Regional Group, Reef Rescue includes engaging with the four targeted industry groups; Dairy, Horticulture, Grazing and Cane, to provide extension support to landholders and industry field officers. Incorporating wetlands into this initiative has allowed for landholders to recognize the importance of managing on-farm natural resources, and the additional values wetlands can provide within a farm production system.

Wetland projects that have been carried out by landholders within the Burnett Mary region under Reef Rescue include;

- Fencing of riparian zones and freshwater palustrine wetlands to decrease grazing pressure
- Provision of off-creek watering
- Installation of treatment-train structures such as settling ponds and sediment traps
- Reinstating wetlands within the landscape
- Restoration of riparian zones
- Remediation of farm crossings to decrease effects on fish migration

This year Reef Rescue has again provided incentive funds for wetlands, and the challenge remains to continue educating landholders on the importance of wetlands within the landscape and how these systems can and should be integrated into production system management.

Conservation genetics of *Acacia karina*, a narrow-range species endemic to the Banded Ironstone Ranges of the Midwest region of Western Australia

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The Midwest region of Western Australia has an exceptionally high diversity of *Acacia* species, many with a restricted distribution and high conservation value. The area is also the focus of mineral exploration and extraction, creating a conflict between economic and biodiversity values. *Acacia karina* Maslin is a recently described, narrow-range, conservation priority-listed species endemic to the Blue Hill Banded Ironstone Ranges of the Midwest region of south-west Western Australia. The species is directly impacted by mining activities on Mt Karara and the surrounding area. We are undertaking a conservation genetic study to assess the impact of mining activities on genetic diversity and key population processes such as mating, within this species, and to provide a genetic basis for its management and conservation. Genetic variation at nuclear microsatellite markers has been assessed within and among 20 populations of *A. karina*. Weak but significant genetic structure has been found across the range of *A. karina*. Mating system studies have revealed high outcrossing in these populations, emphasizing the importance of pollen dispersal and pollinators in impacted populations. Preliminary results from a common garden study of seedlings grown from wild collected seeds have revealed a genetic basis to the patterns of morphological variation detected. Results are interpreted in the context of the future management of genetic diversity and processes of impacted populations of *A. karina*.



Improving the success of species translocations: is there a need for removal of existing vegetation?

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Although natural recruitment in many south-west ecosystems in WA depends on major disturbances such as fire, which temporally reduce competition and increase available resources, rare flora translocations are often into mature habitat. In this talk I will present the results from a case study on rare and common *Hakea* species (Proteaceae) from contrasting habitats in the SW of Western Australia. Glasshouse experiments showed that two rare *Hakea* species, which are restricted to shallow-soil ironstone communities, had a specialized root system morphology that is likely to increase their chance to locate cracks and crevices in the underlying rock. This would greatly increase their chances to access water before the onset of summer drought and thus give them a competitive advantage. A subsequent transplant experiment in the ironstone habitat, in which small patches of existing vegetation were removed, showed that the ironstone species had much higher survival rates than the common species. I believe that competition for cracks is a major selection force in these shallow soil environments and that removal of some existing vegetation may be a prerequisite for translocation success.

Making the transition from regional-scale conservation design to local-scale conservation action

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The process of systematic conservation planning involves many important transitions. Following the design stage, conservation areas on paper or computer screens must be turned into actions on the ground or in the water, shaped by cost, effectiveness and local acceptability. This transition has been difficult for conservation planners, requiring the reconciliation of two spatial scales of analysis and decision-making and even two worldviews. Yet, both regional-scale design and local-scale action are crucial to achieving conservation goals, and both have complementary strengths and limitations. Regional designs have three main advantages. First, they allow planners to consider the relationships between individual areas, including complementarity and connectivity, so that systems are more than the sum of their parts. Second, they allow planners to explore spatial and temporal options for conservation. Third, they facilitate integration of conservation priorities into initiatives with broader objectives, including land use planning. The disadvantage of regional designs, with numerous potential causes, is their poor record of translation into local actions. Local actions, typically not guided by regional designs, have several related advantages. They are motivated, understood and supported by local communities. They are also informed by detailed knowledge of biodiversity and socio-economic variables that is impossible to collect consistently across most planning regions. The disadvantages of local actions include their tendency to form collections rather than systems. Reconciling these two scales of operation requires new thinking and new tools but also new institutional arrangements. These and other implications are discussed.

Soil nutrients and ecological restoration of temperate Australian ecosystems

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Many Australian ecosystems have evolved under characteristically low soil nutrient levels. In this talk I will emphasize the importance of attention to soil nutrients for ecological restoration, in the light of changes to soil nutrient levels that can occur during degradation. In some environments, especially agricultural landscapes, enrichment of nutrients such as available nitrogen or phosphorus often occurs through grazing, fertilization, or other disturbance, leading to weed invasion and loss of native plant species. In these circumstances, successful restoration is dependent on depletion of soil nutrients. This can be difficult to achieve, but emerging approaches include topsoil stripping, biomass removal (cropping), carbon addition and importantly, re-establishment of native species that lock-up excess nutrients. These techniques are unlikely to be appropriate everywhere, however. In other environments, water and nitrogen availability are major limits to plant growth and can constrain effective restoration. A



number of workers have shown that natural patterns of heterogeneity in semi-arid landscapes, such as patches of litter or trees, facilitate concentration of nutrients and water into resource-rich patches where plants can grow more effectively. Disruption of these patterns, e.g. through overgrazing, can result in 'leakage' of nutrients and water from the system. Restoration approaches in semi-arid environments thus focus on restoring 'soil functional fertility', by restoring the capacity of the landscape to capture and store water and nutrients. To conclude, it is important to understand how soil nutrient levels have changed in candidate restoration areas, as this can determine whether nutrient-depleting or nutrient-conserving approaches to restoration are needed.

Ecological, social and economic filters: hurdles of restoration and planning for the future

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Since European settlement, public lands - for example, National Parks - have been degraded by various anthropogenic disturbances which have resulted in significant changes to the ecosystem structure and function. This large-scale degradation has led to a growing desire to develop techniques to restore these lands. Given the enormous and challenging task of undertaking restoration, we wanted to highlight the various challenges that are encountered when undertaking restoration on public lands, using the Ludlow Tuart Forest National Park as a case study. Restoration activities within the Ludlow Tuart Forest are now in the fourth year. The first year began with small scale restoration trials and has now expanded to 10-20 ha per annum with simultaneous restoration research embedded to drive the following year of restoration activities. Restoration on public lands faces enormous challenges. Many of these can be explained through ecological, social and economic filters. However, one of the most interesting and surprising hurdles encountered is the lack of involvement of the public in the on-ground restoration of public lands. This is a particularly challenging hurdle that needs to be overcome in order to undertake larger scale restoration on public lands. Awareness of these various filters and hurdles can assist with longer term planning of the restoration process. Sharing some of the economic, social and ecological filters and hurdles that we encountered will assist other managers and researchers looking at planning larger-scale restoration of degraded public lands.

Adaptive management for the containment and eradication of *Phytophthora cinnamomi* infestations within native plant communities from the Fitzgerald River National Park

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The introduced plant pathogen *Phytophthora cinnamomi* is a 'Key Threatening Process to Australia's Biodiversity' and has major impacts on many ecosystems, particularly in southwest Australia. Although the pathogen is widespread, significant high conservation value ecosystems are still non-infested and require substantial protection. In contrast with most other large reserves in the southwest of Western Australia, the Fitzgerald River National Park (FRNP) biosphere remains relatively unaffected by *P. cinnamomi*. However three discrete infestations, including a series of small infestations (less than 3 ha) off Pabelup drive, are located within the Park boundaries and pose a significant threat to the biodiversity values of this internationally recognised biosphere.

Recently *P. cinnamomi* has been successfully eradicated on a small experimental scale from Cape Riche near the FRNP that has a similar native plant community and environmental conditions (Dunstan *et al.* 2010). This current project aims to further develop this eradication technique to contain and eradicate the Pabelup infestation, by scaling up the different control techniques and adapting the approach to account for the differences in site conditions and the epidemiology of the pathogen.

The project has significant management challenges that include: difficulty in mapping the occurrence of the pathogen; surface water movement that could transport the pathogen; variable soil characteristics, topography, vegetation and hydrology; and animal vectors. An adaptive management approach has been utilised that will employ additional new techniques to manage the site, including: feral animal exclusion fences; digital elevation models and hydrology projections; the removal of localized host plants

that can harbour the pathogen; and geo-textile membranes to capture and treat pathogen inoculum in the surface water, while limiting the ability of surface water to pool and inoculum levels to increase.

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Fire response of threatened flora – what have we learned?

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The management of threatened flora in Western Australia during wildfires and prescribed burns has been hampered by a lack of knowledge about how they respond to fire. In addition, it is becoming increasingly evident that many of these species require a disturbance event to regenerate and by protecting them from fire we may be limiting their opportunities for long term survival.

This project aims to collate and analyse the monitoring data for threatened species that have been burnt and determine their fire response category. Data has been accessed from the DEC corporate threatened flora monitoring database (DEFL), district records, recruitment burns, fire history GIS analysis and information in published scientific papers, books and personal observations. This dataset will help to quantify the variation in responses related to fire intensity, season, population and site.

The reliability of some monitoring information is uncertain due to discrepancies with fire history records, the proportion of the population that was burnt, if at all, and the lack of consistent monitoring of burnt populations until first flowering and reliable fruiting. There are many gaps in the data.

From initial analysis, the majority of threatened species responded to fire by re-seeding while about a quarter responded by re-sprouting, with variations in fire response between populations. A surprising proportion of species responded to soil disturbance without fire while some showed no response to fire and failed to regenerate. This information will be used to develop fire management guidelines for individual species and for the fire response categories identified.

The importance of targeted taxonomy for plant conservation

Kelly A. Shepherd

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If the names are unknown knowledge of the things also perishes, Linnaeus (1751)

In contrast to the clichéd image of an outmoded science in steady decline, plant taxonomy in a biodiverse state like Western Australia remains as relevant today as ever. New taxa are constantly being discovered as taxonomists work with collections lodged in herbaria and undertake targeted field work. In more recent times, methods such as DNA sequencing and morphometric analyses are being employed to resolve more intractable taxonomic conundrums. A large number of potentially new species, many of which are of conservation concern, have also been discovered through surveys associated with mineral exploration during the recent mining boom. The naming and describing of these potentially new species is central to their conservation. While phrase-names are included on the State's plant census and listed online via FloraBase, there is often little other information publicly available about these plants. Thus, land managers may struggle to recognise these new taxa let alone have the necessary data to ensure their appropriate management. A lack of resourcing also hinders the timely resolution of their taxonomic status. In the face of ongoing development activity and the large number of unnamed species of conservation concern in Western Australia, the Department of Environment and Conservation has provided focused funding in recent years for field work and targeted taxonomy through Specific Nature Conservation Projects. This, in combination with increased collaboration with land managers and consultants, has resulted in a more timely resolution of many new species.

Adaptation and restoration - should we source seeds locally, or not?

Ann Smithson

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South-western Western Australia is a world biodiversity hotspot, characteristically harbouring large numbers of species, often with restricted ranges. Large scale projects aim to restore hundreds of hectares of this biodiverse vegetation each year, following activities such as mining, with seed as the main resource used to achieve such restorations. Since seed is often obtained from remnant native vegetation it is often a highly limited resource, and habitat specificity and adaptation to local climatic conditions may further restrict seed sourcing opportunities. In this talk, I will explore how adaptation is spatially structured in south west Western Australia, using two species of native Jarrah forest understorey legumes as model species, one which is morphologically uniform, the other morphologically diverse. I will also discuss whether adaptability is predictable using genetic markers. Should seed sourcing decisions in a biodiversity hotspot should continue to be based around the concept of local adaptation?

Granite flora of Southern Queensland – Recovery planning in action

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The Stanthorpe Plateau is a sub-region at the northern extent of the New England Tablelands of eastern Australia. The plateau experiences a relatively cool climate compared to south-east Queensland due to elevations between 600-1500m. A high degree of habitat diversity results from unique topography and climatic characteristics.

The recovery and conservation of rare and threatened flora of the granite belt on the Stanthorpe Plateau has been the subject of much attention in the past decade, with strong partnerships developing between local community representatives, the regional NRM body, NGOs and government agents. The Queensland Murray Darling Committee has committed to a long term *Granite Flora Program* since 2005, providing seed funding to establish the Stanthorpe Rare Wildflower Consortium. Through this Consortium, the Stanthorpe Plateau Rare Flora Recovery Plan 2007-2011 was presented in 2006. The Recovery Plan has since directed around \$130,000 of public investment into extensive community awareness and skill raising activities, strategic conservation planning and incentives for action with councils and private land owners.

In 2009/10 a further \$175,000 *Caring for our Country* project pulled together considerable conservation outcomes for 28 priority flora species and their communities in the Granite Belt. This latest project was successful in delivering a range of outputs all focussed around better defining the ecological range, threats, conservation and management needs of the target species.

The presentation will highlight the successes of the *CfoC* project, and how community participation and ownership are key components in successful conservation projects. I will also discuss future investment and management actions needed to deliver the ultimate goal of recovery planning – that these plants are no longer deemed endangered but are being managed for self-sustaining populations.

Taxonomy and the conservation community: Where are we at and where are we going

Kevin Thiele

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Taxonomy – the science of delimiting and naming taxa of living organisms – provides a critical underpinning framework for the whole of biology, particularly for conservation. Without adequate understanding of the taxa that occur in nature, and without names which allow information on those taxa to be communicated effectively, conservation at the species level cannot proceed. Taxonomy increasingly is becoming reactive to the needs to conservation; at the Western Australian Herbarium, for example, considerable taxonomic work is targeted and prioritised to support conservation, increasing both the relevance of taxonomy and the effectiveness of conservation. Conversely, however, taxonomy is a mature science and must be free to progress as a science, with the implication that at times such progress will be inconvenient for users. Recent and ongoing advances in our knowledge of the



relationships of plants, for example, are resulting in substantial taxonomic reassignments, and consequent name changes, in some groups. These changes are sometimes criticized as un-necessary, costly, and disruptive. However, while stability and convenience are important short term goals, in the long term stability implies stasis in knowledge, and this will harm all sciences that rely on the framework knowledge provided by taxonomy. While taxonomic research may greatly inform conservation questions, the outcomes of taxonomy should not be too closely guided by desired conservation goals. This paper will focus on the opportunities, costs and limitations of a close linkage between taxonomy and conservation, and will discuss the implications for taxonomy of the partnership with conservation planning and practice.

The curious effects of mycorrhizas on the phosphorus nutrition and seedling establishment in the Jarrah forests of Western Australia

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Mycorrhizas are a vital symbiosis for many plants of the mega-diverse western Australian Jarrah forests. The soils of the Jarrah forest are ancient and phosphorus is the key limiting nutrient because it is sparingly available in the highly weathered (Fe/Al rich) regolith. Despite the P-fixing nature of many WA soils, phosphorus can become toxic to some functionally important native (and endemic) Australian trees, including the Jarrah tree itself (*Eucalyptus marginata*). Mycorrhizas seem to have a curious and sometimes unexpected effect on the nutrition and growth of their host plants in these soils and ecosystems that will be reviewed in my paper.

Many Western Australian tree species form dual symbioses with both ecto- and arbuscular mycorrhizal (AM) fungi, with AM relationships being prevalent in seedlings. In this presentation I will explore recent evidence that arbuscular mycorrhizas have an important role in regulating plant P uptake in the early stage of tree growth and that managing soils for early AM symbiosis may be important for some P sensitive plants.

Another ecologically important aspect of arbuscular mycorrhizal symbiosis is the proliferation of mycelial networks that colonise the roots of more than one plant, thereby forming a below-ground network linking (potentially) numerous plant roots with common fungal hyphae. I will also examine whether the presence of an established network of common mycorrhizal hyphae would affect the emergence of seedlings of key species from the Jarrah forests.

Minimising uncertainty by maximising knowledge: Examples from Western Australia of how partnerships with industry deliver enduring value for sustainable development and biodiversity conservation

Stephen van Leeuwen

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Western Australia is unequivocally an economic hotspot that is fundamental to our Nation's economic wealth and prosperity. In recent years the State has contributed well over 15% of GDP to the Australian economy and with the current growth in resource development this figure is expected to approach in excess of 25% in 2010. Commensurately, the State also has a wealth of biodiversity as demonstrated internationally by the south-west being recognised as a global biodiversity hot spot and nationally through harbouring eight of the 15 national terrestrial biodiversity hotspots.

Knowledge critical for land use and conservation planning includes knowing what biodiversity we have, where it is and why it is where it is. Similarly, understanding how the many elements of biodiversity interact and a comprehension of the processes that threaten biodiversity are also critical to maintaining biodiversity and the ecosystem processes that support sustainable development. In Western Australia finding persistent solutions to documenting biodiversity, mitigating threats and ultimately managing the risks to economic development and biodiversity conservation is often beyond the capabilities of any single group be they in the public or private sectors, especially when competition for financial resources and intellectual capital is intense.

Under these circumstances productive and enduring solutions to mitigate risks and minimise uncertainty have been delivered through the development of collaborative partnerships between government and industry. Such partnerships are founded on rigorous science that delivers credible outputs which inform resource developers, land-use planners and biodiversity managers on how sustainable development can proceed.



This presentation will cite several botanical examples, mostly from the Pilbara, of how engagement with industry has delivered significant knowledge dividends that inform resource development, land-use planning and biodiversity management. The examples will demonstrate that the outputs from engagement convey enduring value for industry via providing greater certainty and simultaneously delivering immense worth to the community through informing land-use planning and biodiversity management activities.

Seed Industry Accreditation - A project by the Revegetation Industry Association of WA

David Venning

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RIAWA was formed in 2002. It brought together stakeholders from many different segments of the industry in order to improve standards/quality of revegetation through providing a professional forum for exchange of knowledge and information, whilst also working to set up effective working guidelines.

The RIAWA management committee (formed of representatives from the commercial, government and research sectors) has, over the years, worked closely with Florabank at a federal level and supported their efforts to establish nation-wide accreditation standards for the seed industry. In WA there has been significant pressure from stakeholder groups to establish a State system. Whilst no other state in Australia has a formal accreditation process, here in WA it is seen as a critical requirement to support the on-going sustainability and quality standards of the seed industry.

With this in mind the RIAWA committee has now embarked on a formal Accreditation project which culminated recently in a two day forum attended by the full committee and other industry experts and a representative from DEC. A draft plan has been designed. An accreditation officer has been appointed to assist in the preparation and operation of the process. It is estimated that the system will be completed by mid 2011.

RIAWA would like the opportunity to update the conference delegates on this important industry initiative.

The challenges for climate change adaptation in old stable landscapes

Grant Wardell-Johnson

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Anthropogenic climate change threatens the Earth's biota and human society. In Australia, the subdued landscape of the south-western Australian (SWWA) global biodiversity hotspot is already experiencing climate change, with predictions for further warming and drying in the area. The scale of the problem is outlined, with particular reference to Mediterranean environments generally, and south-western forested ecosystems in particular. The urgent need for societal engagement is then briefly outlined, given both the levels of warming already committed, and the limits to society's adaptation capacity. Climate change adaptation options in subdued landscapes are then discussed, including the identification and management of climate change refugia. By identifying areas that are most likely to act as refugia for the biota under projected climate change, adaptation and conservation activities can be focused where they will provide greatest benefit. A multidisciplinary team in SWWA has developed a methodology to determine whether granite outcrops and their fringing environments in SWWA will act as refugia in the face of anticipated climate change. Our approach examines the environmental characteristics of granite outcrops, phylogeographic patterns, resource availability, and the resilience of granite outcrop plant communities and fringing vegetation compared to that of the wider landscape. This integrated, transdisciplinary approach is examining the role of granite outcrops as safe havens for the biota in the face of climate change, and is applicable for the more general identification of climate refuges. Our approach also provides a mechanism to determine appropriate management actions.

Taxonomic turmoil in the Triggerplants: implications for conservation management

Juliet Wege

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The Triggerplant genus *Stylidium* Sw. (Stylidiaceae) has been the subject of a prolific phase of taxonomic research over the past two decades in which more than 100 new species have been recognised. This genus is now known to comprise more than 300 taxa, however, unlike many other large and iconic Australian plant genera, a modern taxonomic revision has yet to be completed. Consequently, a significant amount of taxonomic information is not readily accessible to conservation practitioners and other stakeholders. The absence of a robust taxonomic framework has meant that collections housed at the Western Australian Herbarium (PERTH) have often been inaccurately identified, which in turn has led to a poor understanding of the distribution, rarity and ecological requirements of many species. This has serious implications for conservation management, particularly in south-west Western Australia, a region with a rich and highly endemic Triggerplant flora that includes more than 60 conservation-listed taxa. Recent research has focussed on sorting and correctly identifying herbarium collections—a process that has not only dramatically improved our scientific understanding of many taxa, but has led to the discovery of a range of new conservation-listed species. Many of these have been unrepresented in the PERTH collection until recently despite the existence of historical collections at various national and international herbaria, highlighting the ongoing importance of botanical surveys in Western Australia. A project is underway to produce an electronic key to *Stylidium* in southern Australia and species fact sheets. Together these will revolutionise conservation management of our Triggerplant flora.

The role of taxonomy in conservation

Judy West

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Taxonomy and species conservation are inextricably linked. Taxonomy is a vibrant and exciting branch of biology with clear relevance to current conservation challenges, playing a role in conservation biology and conservation practices at various levels. Basic taxonomic knowledge of species in a particular region is important for the local conservation practitioner with responsibility for uncommon or iconic species that the community considers important. In cases of exploitation such as in the fishing or mining industries, knowledge of evolutionary relationships (beta taxonomy) can be critical to decision-making. Conservation management of a threatened species or control of an invasive taxon warrants knowledge of the biology of the organism (gamma taxonomy), such as understanding evolutionary rates and trends, population genetics and intra-population structure. Australian examples well illustrate these interactions.

Taxonomy is also important in the conservation policy arena where species lists can be used for conservation planning – e.g. estimates of species richness or endemism, or where an individual legislated threatened species influences conservation decisions. There are certain complexities of the application of taxonomy to conservation in, for example the units of taxonomy to be recognised, and the units chosen for conservation planning recognising the dynamic aspects of natural systems. There is room for improvement in the interactions between these two fields of biology but it will require enhanced collaboration between conservation biologists, taxonomists and legislators. Additionally, there is a need for accelerated delivery of the results of taxonomic investigations and greater emphasis on the translation of information for conservation outcomes.

Planning for climate change: the adaptation/mitigation challenge

Colin Yates

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Widespread land transformation, habitat fragmentation and invasive species continue to cause loss of biodiversity. Anthropogenic climate change is a further stress which directly affects biodiversity through its fundamental influence on biological processes and indirectly by exacerbating existing threats. Reducing or stabilizing greenhouse gas emissions may slow global warming, but past emissions will continue to contribute to unavoidable warming and related changes in climate for at least a century to come. The temperature at which global warming will finally stop depends primarily on the total amount of CO₂ released into the atmosphere since industrialization. The sooner emissions stop the lower the warming will be. Deep and long lasting cuts in CO₂ emissions will need to be made in the coming decades to limit global mean air temperature to 2°C above pre-industrial by 2100. With obvious signs of difficulties in achieving effective mitigation world-wide in the short term at least, there is a high probability of warming exceeding 2°C, a threshold often considered as dangerous for society and the environment.



Clearly urgent action is needed on mitigating greenhouse gas emissions, but with inevitable climate change expected there is an urgent need for initiatives and actions that reduce the vulnerability of natural and human systems against expected climate change impacts. This will be challenging for biodiversity conservation because decisions will need to be made against a backdrop of uncertainty about the magnitude and rate of climate change, the climate tolerances and adaptive capacity of species, the resilience of ecosystems and the extent to which climate and other ecological factors control the population and range dynamics of species. This talk discusses these issues in the context of research being undertaken on climate change and biodiversity in Mediterranean climate south-west Western Australia.

Poster abstracts

Genetic consequences of mixing seed provenances in ecological restoration using field trials to test for Home Site Advantage and Outbreeding Depression in West Australian Stylidiaceae

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Ecological restoration and revegetation of degraded habitats usually requires the collection, movement and mixing of large amounts of native seed. Spatial and temporal variation in the environment combined with natural selection may result in multiple, genetically distinct ecotypes within a single species. Current restoration guidelines strongly recommend using local sources to maximize local adaptation and prevent outbreeding depression. Maladaptation and outbreeding depression are thought to be negative consequences of introducing non-local provenance seed into restoration, but there are very few studies to assess both simultaneously, and none in SouthWest WA. In this study, I am testing the strength of local adaptation and outbreeding depression using *Stylidium hispidum*, the White Butterfly Trigger Plant. *Stylidium hispidum* flowers from August to October and set seed within 6 weeks of pollination. Plant material for the genetic study was collected from 4 populations distributed within the Jarrah Forest along a 100 km latitudinal gradient. Selected material was used in a plant breeding trial to test for home site advantage and outbreeding depression in a field situation. AFLP analysis showed that only populations with the highest geographical distance were significantly different. Experiments in controlled conditions showed no difference in germination percentages but a 50% lower survival of long-distance intraspecific hybrids compared to short-distance intraspecific hybrids. Although field trials have only just been established the trial supports the use of local provenance seed in restoration programs, in order to avoid negative consequences of outbreeding depression.

Improving restoration efficiency through understanding seed ecology

Lucy Commander, David Merritt, Kingsley Dixon.

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Many restoration projects start with seeds, whether for direct seeding or seedling production. If good quality seed batches are used, propagation methods are known, and seed storage conditions are appropriate, then we can increase the efficiency of seed use and increase the species diversity in restored mining areas. Our research focuses on seeds from the arid zone of Western Australia, given the lack of seed knowledge and prevalence of mining.

Climate plays a major role in seed ecology as temperature and moisture cue germination and drive dormancy loss. We investigated germination rate across a range of temperatures (10-35°C) to determine capacity of seeds to rapidly respond to moisture pulses, as water may only be available in the soil for short periods. Non-dormant seeds are able to take advantage of this soil moisture as they germinate quickly (time to 50% germination is 1-3 days) at optimum incubation temperatures (25 to 35°C).

Relative proportions of dormancy types were similar to those described for hot deserts; i.e. there are few non-dormant species, and physical and physiological dormancy predominate. The environment is fire-prone and the active compound in smoke, karrikinolide, promoted germination of dormant seeds of several species. To alleviate physiological dormancy we used warm and dry (after-ripening), warm and wet or alternating dry and wet storage, conditions that mimic those experienced by seeds in the soil.



Dormancy loss was (at least partly) achieved by after-ripening or alternating dry and wet storage. The results of this study will guide restoration efforts in arid Australia.

Comparison of the impacts of plant canker disease and climate on Proteaceae and evaluation of selected fungicides as a management tool for canker control in the declared rare flora *Banksia verticillata* and *Lambertia orbifolia*

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The contribution of canker-causing fungi to stem and branch death in South Western Australia is not well documented or understood. Two declared rare flora *Banksia verticillata* and *Lambertia orbifolia* are currently being severely impacted by canker disease. To quantify and monitor canker severity and impact, permanent transects have been established in *Banksia baxteri*, *B. coccinea*, *B. verticillata* and *Lambertia orbifolia* with 1620 individuals assessed across 32 sites. Individual cankers have been cultured and preliminary analysis indicates the most frequently isolated pathogenic fungi are those in the *Botryosphaeria* complex, a putative *Microthia*, *Cryptodiaporthe* and *Cytospora* spp. respectively. All except *Cytospora* spp. have been isolated at a low level from healthy asymptomatic tissue suggesting that they have some degree of benign endophytic role and that the environment may moderate the host-pathogen relationship. Co-occurrence of several of the pathogens in single canker lesions also demonstrates a synergism in canker disease expression. Data loggers recording temperature and humidity have been installed at 20 of these sites covering the northern and southern rainfall extremities. Interpolated rainfall, temperature and humidity data for each site are being collected for comparison against canker impact scores in an attempt to develop predictive ability in climate change scenarios. The systemic fungicides fenarimol, prochloraz and tebuconazole are being investigated as control options in *B. verticillata* and *L. orbifolia* – initially *in vitro*, then *in vivo*, for the four main canker causing pathogens.

Managing feral olives and restoring endangered bushland – how can we maximise restoration success?

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African Olive (*Olea europaea* ssp. *cuspidata*) is a dense crowned evergreen small tree, and a closely related sub-species of the cultivated European Olive. Invasion by African Olive threatens highly fragmented native vegetation in the Cumberland Plain region (western Sydney), where it forms a dense mid canopy excluding the regeneration of native species. We established a three year ecological restoration experiment following removal and mechanical chipping of an established African Olive forest to test the effectiveness of burning and re-seeding to re-establish native plant diversity. Burned plots had some regeneration of native species, indicating that the native soil seedbank was still present after 15 years of olive invasion. Native grasses were found to be not persistent in the soil seedbank, however species such as *Microlaena stipoides*, *Elymus scaber* and *Themeda australis* were readily established by supplementary direct seeding. Germination and establishment of native shrubs from the direct seeding mix was poor, suggesting that these species may have to be planted in subsequent years. The use of burning and direct seeding to establish early successional stage Cumberland Plain Woodland provides the basis of an ecological restoration model, which could be implemented in areas of African olive removal to exclude subsequent establishment of African Olive and promote re-establishment of native plant diversity.



An adaptive management strategy helps recover endangered Western Australian flora

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For critically endangered flora, recovery actions must be implemented urgently. Knowledge gaps in species ecology and biology necessitate an adaptive management approach. This approach obtains information needed to improve future management.

Lambertia echinata subspecies *echinata* is a critically endangered WA endemic, highly threatened by the root pathogen *Phytophthora cinnamomi*. Most of the habitat within the species' known distribution is infested with the disease. The collection of seed and its use in translocating plants back into the wild are conventional flora recovery actions for plants at risk of extinction in Western Australia.

Unfortunately, early attempts at translocation for this taxon were foiled by drought and disease. These failed attempts, coupled with limited remaining seed resources, led to the establishment of conservation seed orchards outside the species' known range as a next step in an adaptive management strategy. Seed orchards provide secure sites, free from threatening processes where living plants can be maintained through intensive management.

In 2006, two orchard sites were established from wild sourced material and with careful nurturing, plants exhibited high rates of survival and growth. By 2008, all plants had flowered and many produced fruit. In 2009, sufficient seeds were harvested for the production of seedlings for new translocations. In June 2010, 100 plants were established at each of two disease-free sites east of Esperance. The success of the seed orchards has allowed us to generate seed and seedlings for conservation efforts without impacting on natural populations. This strategy is contributing to the improvement of this *Lambertia*'s long-term future.

Investigation into the germination and propagation of *Persoonia pauciflora* P.H. Weston

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Persoonia pauciflora P.H. Weston is found in only one known population near North Rothbury in NSW. The extremely restricted distribution of this species and previously recognised problematic germination of *Persoonia* species makes conservation of this endangered species difficult. Collaboration between the NSW Seedbank and NSW National Parks and Wildlife investigated methods of germination and propagation to establish *ex situ* collections. Plant material and seeds were collected in December 2009 from 19 plants randomly within the population. Cuttings were treated with 1, 3 and 8 ppm concentrations of Indole Butyric Acid rooting gel. Five replicates per pot were placed in nursery grade seed raising mix and housed in glasshouses with two humidity regimes (mist or fog). Pots were inspected at 2.5, 5 and 7 months for the presence of roots. The highest strike rate was observed for cuttings treated with 3 ppm rooting gel (59%), which increased to 85% in the mist regime. Survival rate of stuck cuttings was approximately 50% after 7 months. Collected seeds were categorised into three age cohorts: 1) fleshy ripe seeds held on the plant, 2) dispersed fleshy seeds and 3) dispersed seeds with little flesh evident. Embryos were extracted, surface sterilised and treated with: 250 ppm of gibberellic acid (GA₃), smoke water or smoke water + GA₃, along with a control. The optimal temperature for germination was observed as 20°C with alternating 12 hours light/12 hours dark. High levels of contamination especially in the smoke water treatments hindered conclusive evaluation of optimal germination conditions and best germination was observed in the GA₃ alone treatment (~3%) with no apparent effect of cohorts.



Local Provenance: Is the traditional paradigm in restoration ecology still relevant under climate change and fragmentation?

Nola Hancock

Traditionally, seed for restoration projects have been sourced locally, to “preserve” the genetic integrity of the replanted site. However, the processes of climate change and fragmentation, with the subsequent development of novel environments, are forcing us to reconsider this basic tenet of restoration ecology. The question of where to source seed for restoration projects is complex and becoming increasingly urgent.

My research aims to test the “local provenance is best” paradigm by comparing the performance of local to non-local provenances within common garden experiments, under current local conditions and under manipulated climate. My focus is on species from the Cumberland Plain Woodland in western Sydney. This vegetation is classified as an Endangered Ecological Community under the *NSW Threatened Species Conservation Act* (1995) and as Endangered under the *Commonwealth Environment Protection and Biodiversity Conservation Act* (1999).

My research questions are:

1. Do plants grown from seeds sourced locally have superior establishment and performance than those of the same species collected from other sites across the geographic range of the species?
2. What is the degree of variability in survival and growth rates of plants grown from seeds from different provenances of the same species, when grown under elevated CO₂ compared to variability within provenances?
3. Do provenances of plants collected from warmer and drier locations within the geographic range have superior survival and performance when subject to pulses of extreme high temperatures at a particular site?

The ongoing recovery of *Acacia chapmanii* subsp. *australis* in Drummond Nature Reserve: A case study in adaptive management

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Prior to this research, the size class structure, levels of canopy deaths and an absence of juveniles indicated all known populations of *Acacia chapmanii* subsp. *australis* R.S.Cowan & Maslin, a Declared Rare Flora, were in decline. Utilising an adaptive management approach when required to make conservation decisions on rare species substantially reduces risk whilst increasing our understanding of managed ecosystems (Wilhere 2002).

A. chapmanii is killed by fire and therefore relies on seed for survival, with the hard seededness requiring fire related germination cues to break dormancy. After a 2004 experimental burn when both burnt and control plots were fenced, seedling establishment from soil seed bank and planted seed only occurred in burnt plots. Monthly monitoring over the first 12 months showed 43% of planted seed and 50% of soilbank seed that initially germinated, survived to seedling stage.

Following this success, to monitor herbivore effect a normal DEC fuel reduction burn was conducted, with seedling emergence in the same order as after the 2004 fire. Seedling survival in open burnt plots was much lower than in fenced plots with skat counts indicating kangaroos as the culprits. Only an occasional seedling in unfenced burnt plots survived into its second year. However, when these unfenced and well grazed plots were enclosed in 2007 which eliminated herbivory impacts, there was a significant increase in *A. chapmanii* seedlings establishing 2 and 3 years following the fire. This increase was not seen in the initial fenced plots, possibly due to the dense ground cover of a range of species that had germinated or resprouted following the fire.

A number of other species also established within the burnt area, with indications that some species may become more dominant than they were prior to the fire. Of most concern is the extensive establishment of *Eucalyptus wandoo* seedlings. The established populations of *A. chapmanii* were mostly in open kwongan or low shrubland areas. Further research needs to be undertaken to understand how *A. chapmanii* will cope in future years under the canopy of an over-storey of *E. wandoo*,



particularly as the fenced plot adjacent to the canopy of established *E. wandoo* had significantly fewer *A. chapmanii* seedlings establishing than in the other fenced burnt plots.

Tweed Shire Riparian Vine Weed Control Strategy

Sally Jacka

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In 2008, the New South Wales Environment Trust funded Tweed Shire Council to develop a strategy to commence control of two vine weed species, Cats Claw Creeper (*Macfadyena unguis-cati*) and Madeira Vine (*Anredera cordifolia*) that are posing a severe threat to the environmental quality of waterways and riparian habitat in the Tweed Shire in northern NSW.

Mature infestation locations were identified through aerial surveys. Mapping of the data collected was a useful tool in developing a strategy for effective long-term weed control. Key target sites were identified for vine weed control with priority given to upper-most stream infestations of streams not heavily infested. Using this strategy, it may be possible to eradicate these weeds from small sub-catchments. Consideration was also given to the protection of areas of high conservation value.

Council's pro-active approach to implementing weed control measures and training of landholders of key target sites has, thus far, proved to be successful with all of the landholders in the first stage of the program actively participating and keen to maintain the sites. Infestations found during follow-up surveys and reported by community members are recorded on a 'living spreadsheet' that provides an estimate of current condition and extent of the vines and helps to determine impact of control measures.

Through on-ground restoration work, land holder involvement and on-going monitoring and evaluation, this program has potential to achieve significant outcomes in riparian restoration.

Helicopter surveys as an efficient survey method for the Declared Rare Flora, *Conospermum toddii*, in the Great Victoria Desert

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The Great Victoria Desert of Western Australia is a relatively untouched and floristically diverse area, characterised by extensive longitudinal sand dune and sand plain systems. Energy and Minerals Australia's Mulga Rocks Deposit lies approximately 250 kilometres northeast of Kalgoorlie. The area surrounding the deposits has undergone extensive botanical surveying by Mattiske Consulting Pty Ltd. *Conospermum toddii*, a spreading shrub occurring on yellow sand dunes, is endemic to Western Australia and is listed as Declared Rare Flora under the State *Wildlife Conservation Act 1950* and as Endangered under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*. The current knowledge of *Conospermum toddii* (*Ct*) has been expanded through on-ground surveys and targeted searches of dune systems by helicopter. Woolard Consulting Pty Ltd developed a Terrain Predictive Model (TPM) to test the regional distribution of *Ct* habitats. This model relates the style, colour and morphology of individual dune complexes to the likelihood of suitable *Ct* habitats. The TPM was tested during two helicopter surveys in 2009 and 2010 on a range of potential sand dune systems within 150 kilometres of the Mulga Rocks Deposit. Populations of *Conospermum toddii* were found up to 70 kilometres east of the resource area and it is estimated that there are greater than 30,000 plants within these known populations. This species also regenerates after fire, with populations burnt 2-4 years supporting juvenile plants. The co-operation between the mining industry and environmental agencies has been beneficial for the conservation and understanding of this species and other Priority species.

New Recruits for the Loveable Triggerplant (*Stylidium amabile*)

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Stylidium amabile (Loveable Triggerplant) is a Critically Endangered species known from only two populations at Maya, 300 km south east of Geraldton in Western Australia's Midwest region. Monitoring at the two *Stylidium amabile* populations had recorded that the number of individuals had declined from 135 plants in 1993 to 27 plants in 2008. Recorded observations over this period indicated that occasional unplanned disturbance events (both fire and soil disturbance) had been followed by

recruitment of the species. It was considered that the absence of disturbance in recent years was contributing to the decline in population numbers, and if this state continued this would be likely to lead to extinction within a few years.

A disturbance trial was carried out which tested the use of prescribed burning and smoke water application to induce recruitment. Disturbance mechanisms were applied in four sets of plots located in areas where adult *Stylidium amabile* plants had been previously recorded but where plants no longer survived. Seed burial sub-plots were also put in place within the trial area to test whether soil temperature and the effect of shading influenced recruitment.

The disturbance trial was implemented in May 2009. A moderately hot burn was achieved, which was followed by significant rainfall. Monitoring in December 2009 recorded 425 new recruits in total. The largest number of recruits was recorded in burnt plots and in areas where a greater concentration of adult plants are known to have historically been present. Some recruitment also occurred in unburnt areas which were affected by smoke from the burn, and a smaller number of recruits were recorded in smoke water treatment areas. There was no significant difference in the number of recruits recorded between seed burial plots located in sun and those located in shade. No recruits were recorded in control plots.

Monitoring in March 2010 recorded a mortality rate of 50-60% for the first summer. There was no difference in survival rates for recruits within seed burial sub-plots located in sun and shade areas.

Monitoring in July 2010 recorded a larger number of plants than had been recorded in March 2010, which indicates an additional wave of recruitment took place during the second winter.

The initial success of the recruitment trial indicates that the use of fire as a management tool is likely to be critical in the maintenance of this species. However the trial is currently in the early stages of data collection and it is expected that other factors will also play a role in the long term outcome. The observation of recruitment and survival over several years is intended, together with monitoring of other relevant information including rainfall records, the presence of herbivores, soil temperature and the effect of shading and the response of associated vegetation.

Prioritisation of *Lambertia* taxa for conservation according to the threat posed by *Phytophthora cinnamomi*

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Lambertia are keystone species within the communities in which they occur. Five of the Western Australian *Lambertia* taxa are Declared Rare Flora and two taxa have a P (priority) conservation code. Ranking of taxa according to *Phytophthora cinnamomi* susceptibility is fundamental to conservation options within integrated strategies conserving threatened flora of the South-West Botanical Province of Western Australia. Variation in *P. cinnamomi* susceptibility to infection within the genus *Lambertia* was evaluated by soil and stem inoculation. Mortality score following soil inoculation was significantly positively correlated with lesion score determined by stem inoculation. The resulting scores positioned the *Lambertia* taxa in relation to *P. cinnamomi* susceptibility on the resistance-susceptibility continuum and prioritised taxa in relation to the threat posed by the pathogen. The highest mortality and lesion scores for the rare and endangered taxa *L. orbifolia* subsp. *orbifolia*, *L. fairallii*, and *L. rariflora* subsp. *lutea* suggest high risk of extinction to *P. cinnamomi* infestation. Furthermore rare and endangered taxa *L. orbifolia* subsp. Scott River Plains, *L. echinata* subsp. *occidentalis* and *L. echinata* subsp. *echinata* with high mortality and moderate lesions scores are also likely at high risk of extinction to *P. cinnamomi* infestation. For common taxa with restricted geographic distribution, the high mortality and lesion scores for *L. ericifolia* suggest high risk of localised extinction in *P. cinnamomi* disease centres. Positioning taxa on the *P. cinnamomi* resistance-susceptibility continuum needs to be incorporated into extinction-risk methodology in order to prioritise flora for conservation actions according to hazard from the pathogen.

Australian Seed Bank Partnership

Lucy Sutherland

Australian National Botanic Gardens, GPO Box 1777, Canberra ACT 2601

The Australian Seed Bank Partnership is working to achieve a vision for seed banking in the next ten years to ensure that no Australian native plant becomes extinct. This alliance between eighteen



institutions is collaborating in efforts for collecting and storing seed as a long term insurance against loss of biodiversity and aiming to improve Australia's capacity to undertake restoration for biodiverse and resilient ecosystems. Science underpins much of the work of the Partnership and makes a major contribution to improving both conservation and restoration outcomes from seed banking. The Partnership builds on the successes of the AuSCaR network which established a group of seed scientists, seed researchers, collectors and technicians capable of ensuring positive impacts on a wide range of conservation activities and developing practical responses to climate change. This poster highlights some of the successes of the Partners' work and outlines some of the future plans to further integrate seed banking into conservation efforts.

Market driven micropropagation of WA plants for landscaping, revegetation and horticulture industries

Linda Thomson, Reta Carleton, Chris Newell and George Lullfitz

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Commercialisation of the WA flora using micropropagation contributes to the *ex situ* conservation of plants and can reduce harvesting of source plant populations. Micropropagation produces large volumes of plants and is particularly effective for revegetation when:-

- supplies of good quality, viable seed are low
- seed dormancy problems cannot be easily resolved
- source plant populations are small
- alternative propagation methods fail or cannot meet industry demand eg. monocot plants

Lullfitz Nursery exclusively micropropagates WA plants for the horticulture, wholesale landscape and revegetation industries, and has acquired intellectual property over a 20 year period. The nursery works with revegetation and landscaping companies, landscape architects, local government, and regional revegetation and conservation nurseries, to target endemic species around the state for selection and development. Source material for micropropagation can be any part of a plant, including seeds. Successful propagation outcomes are correlated with good quality seed and explants. Species genetic variation can be captured by sampling different plants or seeds. Provenance information is recorded for each collection and genotypes are assigned a unique code. Initiated cultures must be aseptic and research is required to determine the protocols for plant multiplication. Each species has weed risk assessment and each genotype has pathogen testing. *In vitro* cultures are exported overseas to laboratories for multiplication, and then imported to the Lullfitz Nursery for acclimatisation and deflasking. Strict quarantine inspections are required. The R&D process can take 2-3 years, depending on the species; so long term planning is critical to achieve good outcomes.

Friday workshops

Seeds: From collection to germination

Katherine Downes

Curtin University, Kent St, Bentley, WA

Seeds are packaged living plants for dispersal that come in a range of sizes and forms. Workshop participants will be shown a diverse array of seeds and some of these seeds will be examined under the microscope. Seeds will be dissected to view different embryo types, and the features of endospermic versus non-endospermic seeds. This will be followed by a brief discussion of seed collection. Topics to be covered include licensing requirements (for WA), useful equipment, and when to collect seeds of different species. Workshop participants will be encouraged to share their collecting tips for different genera. In addition, methods of seed cleaning will be discussed.

The second part of the workshop will be a chance to consider seed dormancy and germination. Seed dormancy ensures that plants germinate when environmental conditions are most conducive to seedling establishment. Whether seeds are serotinous or stored in the soil also has implications for dormancy. The main types of dormancy and methods to alleviate dormancy and stimulate germination, both *in situ* and *ex situ*, will be examined.

NatureMap workshop

Paul Gioia

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NatureMap is an online window into Western Australia's biodiversity. Users can query "where is what?" and "what is where?" about WA's flora and fauna in a single, easy-to-use, portal. NatureMap targets a wide range of users, including researchers, conservation planners, community groups, industry, environmental consultants and the general public. Anyone can easily produce maps, species lists, reports and data downloads of WA's biodiversity, all at no charge, and without requiring a degree in GIS or a bank balance to match.

Funded primarily by DEC, NatureMap is a collaborative project between the Department of Environment and Conservation and the Western Australian Museum. NatureMap presents the most comprehensive and authoritative source of information currently available on the distribution of Western Australia's flora and fauna by utilising data warehoused from a host of key corporate biodiversity databases.

With a highly sophisticated query environment and fine-grained security model, NatureMap assists in conservation planning, environmental impact assessment, biodiversity research and general enquiry, and provides information on threatened species - in many cases without requiring registration or special access.

In the workshop attendees will learn:

- How to use NatureMap in conservation planning
- How to find out what species have been recorded in or restricted to a given area
- How to produce maps and reports and download data about species distributions

"What price quality restoration plant stock?"

David Hancock

Natural Area Holdings 99C Lord St Whiteman WA 6068

The issue of standards and quality control, industry shortcomings, regulation and free market, planning and supply / demand are all central to the subject question and to the focus of the conference. Sure to get the participants thinking, talking and hopefully acting to bring about positive outcomes.

The workshop aims to discuss a blueprint for the future of the revegetation industry. Including:

1. How to balance standards, regulations, outcomes and commercial imperatives and costs and still achieve our aims to preserve our floristic heritage
2. What are the essentials of a sound restoration project.
3. What are the risks to our flora from poor practices.



4. What role should the regulators adopt and how can they be supported.
5. Who is responsible for the outcome and how are they to be accountable.
6. What level of compromise is acceptable.
7. What guarantees / warranties should be put in place to ensure outcome compliance.
8. Who are the key stakeholders and how can they work together on these issues.

Plant Translocation workshop

Bob Makinson, Tricia Hogbin, Leonie Monks

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 Department of Environment Climate Change and Water, PO Box 488G Newcastle, NSW 2298.
 Department of Environment and Conservation, Locked Bag 104, Bentley Delivery Centre, WA 6983

This workshop is for people with an active interest or involvement in translocation at the policy and technical levels.

There is a good deal of knowledge about plant translocation activity which is never published. It appears that most of the public documentation is in the form of species-specific pre-event Translocation Proposals, abbreviated pre-event proposals in Recovery Plans, occasional media stories, and a smattering of scientific papers in peer-reviewed journals. Apart from the last, there is very little public documentation evaluating experiences.

The workshop will be a discussion on how best to consolidate and share the growing national experiences of both conservation and amelioration translocations, including how to:

- Improve documentation, including possible establishment of a national register of expertise and case studies;
- Improve evaluation and adaptive learning techniques;
- Improve targeting and content of future ANPC Translocation training workshops;
- Improve links with other centres of translocation expertise (domestic and international);
- Improve knowledge in the main conservation agencies, across State boundaries, of good practice and the potential for translocation as a conservation technique;
- Scan possibilities for more consistent collaborative approaches (e.g. with the Australian Seed Bank Partners);
- Scan overlap areas with the revegetation sectors (research and industry);
- Identify what useful role an ANPC Translocation Working Group can play beyond training events.

This workshop will be a discussion canvassing these issues and specifically the dot points above. It is envisaged that workshop outcomes will help take national translocation linkage and practice to a better level.

Using Interactive Identification Keys

Kevin Thiele

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Identification of specimens is an important aspect of conservation. Traditionally, this is done using literature - floras and published revisions - or by asking skilled experts. Increasingly, computer-based identification keys are being built and used for identification. In Australia and Western Australia a growing number of electronic identification keys are being developed and released, including for iconic groups such as *Eucalyptus*, *Acacia* and Proteaceae. This workshop will begin with an introduction to current and future developments in interactive identification, followed by a hands-on session using keys to the Proteaceae of Western Australia developed at the Western Australian Herbarium.

Participants should, if possible, bring a notebook computer to the workshop. The computer should have a recent version of the Java Virtual Machine (version v1.4.2 or greater) –

See:

- <http://www.lucidcentral.com/Support/Forums/tabid/240/forumid/4/postid/77/scope/posts/language/en-US/Default.aspx> for instructions on how to check your computer's Java version, and
- <http://www.lucidcentral.org/Software/Lucid3/SystemRequirements/tabid/187/language/en-US/Default.aspx> to download the JVM.

