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Biodiversity and Conservation Science

Nursery propagation and seed biology of threatened flora for translocation.

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Kings Park Science has utilised an integrated conservation approach for many threatened species including:

- *Grevillea scapigera* (Proteaceae)
- *Symonanthus bancroftii* (Solanaceae)
- *Eremophila resinosa* (Scrophulariaceae)
- *Darwinia masonii* (Myrtaceae)

- *Lepidosperma gibsonii* (Cyperaceae)
- *Androcalva perlaria* (Malvaceae)
- *Ricinocarpos brevis* (Euphorbiaceae)
- *Tetratheca erubescens* (Elaeocarpaceae)

Propagation & seed research integral components

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Plant production for translocation

Summary of main approaches

Propagation method	Cost	Time frame for field ready plants	Equipment & facility support needed	Advantages	Disadvantages	Example
Seeds	Low	Short (4 - 8 m)	Low (basic accredited nursery facilities)	Greenstock with strong root systems	Only practical when seed is available & seed biology understood i.e. seed quality, dormancy & germination requirements	*Acacia woodmaniorum*
Cuttings	Low-medium	Short (4 - 12 m)	Low to medium	Overcomes seed bottlenecks Produces semi mature plants	Plants may not perform as well due to weaker root systems, not all plants strike from cuttings, slower than seeds.	*Darwinia masonii*
Division	Medium	Short - medium (6 -24 m)	Low to medium	Can work well with rhizomatous plants, overcomes seed bottlenecks	Slow to establish, takes up a large amount of space, only applicable to a niche group of plants	*Lepidosperma gibsonii*
Tissue culture	High	Medium-long (>12 m)	High	Small amount of material required, overcomes seed & other bottlenecks, large rates of multiplication	Many potential bottlenecks i.e multiplication, root induction, deflasking	*Synaphea quartzitica*

Plant production cont.
(excluding tissue culture)

- Direct seeding *in situ* – potentially very cheap however emergence and persistence low
- Direct seeding into pots – useful when seeds are not limiting & germinate easily
- Prick out seedlings from Petri dishes – useful with fewer seeds & germination bottlenecks
- Cuttings – strike cuttings in punnets then remove & pot up (slower)
- Cuttings – strike cuttings directly into forestry pots (quicker)

However, seed derived plants commonly perform better than cutting derived plants

Androcalva perlaria in situ translocation – Wellstead region

Propagation method	% survival - 2 yrs
Seedlings (n = 80)	78.8 ± 10.0
Cuttings (n = 80)	53.8 ± 13.4

Where possible seed is preferable though clearly not always an option…

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Avenues for seed biology research

Seed-focused disciplines

Germination requirements
(Temperature, light conditions, moisture, stimulants)

Enhancement & *in situ* germination
(priming, coating, pelleting, field trials)

Dormancy
(type, embryo attributes, treatments)

Longevity
(rapid ageing, Probert analysis & ranking)

Seed attributes
(mass, shape, seed quality, appendages)

Storage
(temperature, duration, moisture content)

Dispersal
(cafeteria experiments, ant midden assessment)

Soil seedbank dynamics
(burial & retrieval, soil cores, persistence, dormancy cycling)

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Seed dormancy within WA DRF

- ~429 DRF from ~45 families
- Based mainly on the characteristics of related species we find:

  ~15 % likely to possess non-dormant seeds

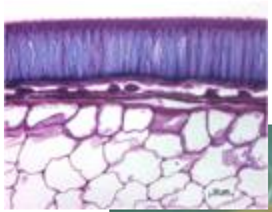
  ~19 % likely to have physical seed dormancy

  ~44 % likely to have physiological seed dormancy

  ~12 % likely to have underdeveloped embryos (MD or MPD)

- **UP TO 75% MAY HAVE SOME FORM OF SEED DORMANCY**
- May(?) confer seed persistence within the soil seed bank

Non dormant seed



Physical dormancy

Morphophysiological dormancy

Physiological dormancy

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Fire related cues for promoting germination in DRF

- ~44%(?) likely to respond to smoke (~20 families)
- ~20%(?) likely to be heat responsive (3 families)
- Need to identify triggers for better management of DRF *in situ* and for *ex situ* conservation collections
- Dormancy may interact with fire cues so what are the conditions for breaking dormancy & stimulating germination?

  i.e. afterripening, wet/dry cycling, & stratification



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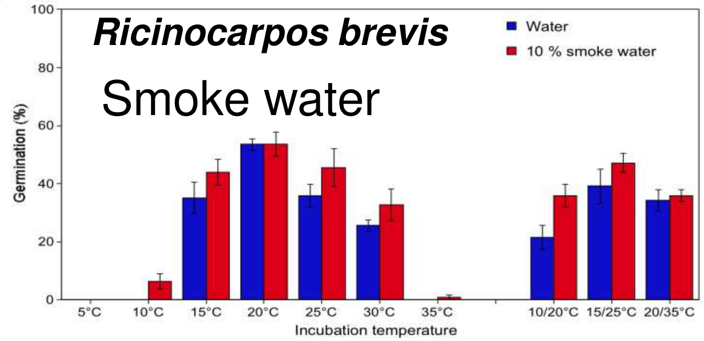
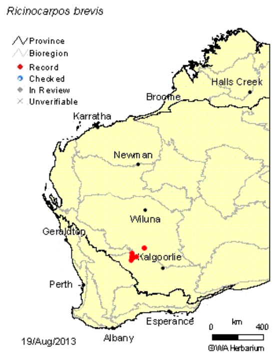
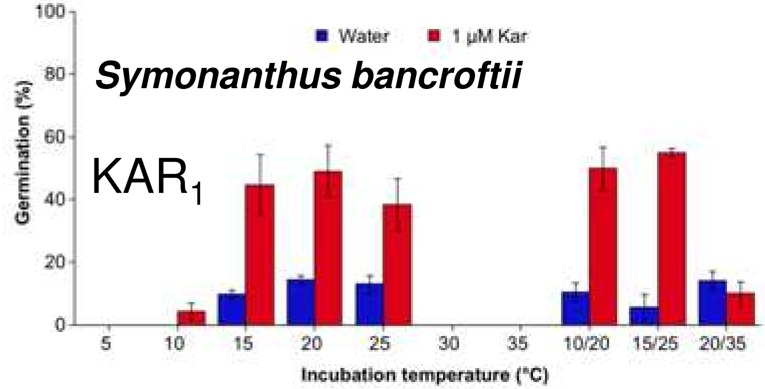
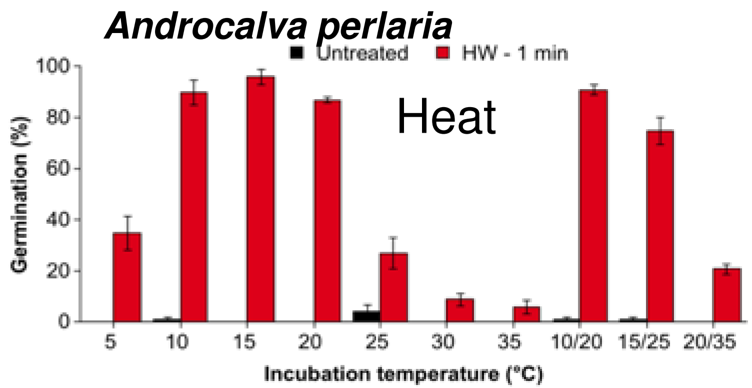
Germination responses to incubation temperature and fire related cues









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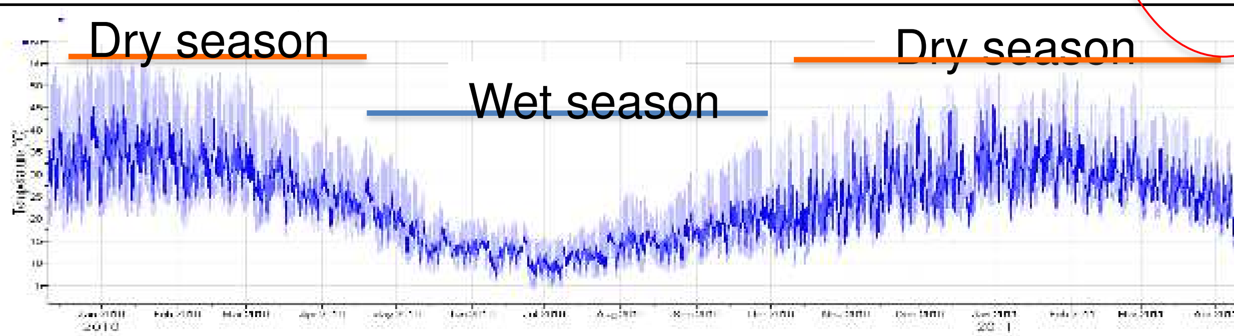
In situ seed persistence

Androcalva perlaria – Physical seed dormancy

	Months of *in situ* burial				
	0 months	12 months	24 months	36 months	62 months
% Seed Fill	98.5 ± 1.0%	94.1 ± 2.5%	94.5 ± 5.5%	94.0 ± 2.0%	88.5 ± 6.2%
Lab germination					
Untreated	8.0 ± 2.3%	0.0 ± 0.0%	0.0 ± 0.0%	0.0 ± 0.0%	0.0 ± 0.0%
HW - 1 min	91.0 ± 4.4%	96.9 ± 3.1%	99.0 ± 1.0%	97.8 ± 1.3%	100.0 ± 0.0%

Symonanthus bancroftii – Physiological seed dormancy

	0 months Spring	**5 months** Autumn	**12 months** Spring	**17 months** Autumn	**24 months** Spring	**28 months** Autumn	**36 months** Spring	**76 months** Autumn
% Seed fill	94.3 ± 2.5%	88.8 ± 2.1%	90.3 ± 1.4%	89.3 ± 2.8%	80.8 ± 3.0%	84.7 ± 2.2%	89.0 ± 2.0%	88.5 ± 3.3%
Lab germination								
Water	0.0 ± 0.0%	0.0 ± 0.0%	0.5 ± 0.5%	0.6 ± 0.6%	0.0 ± 0.0%	3.1 ± 1.7%	0.9 ± 0.9%	2.9 ± 1.6%
1 µm KAR_1	0.0 ± 0.0%	16.7 ± 7.6%	20.7 ± 11.3%	81.1 ± 14.4%	14.7 ± 2.7%	79.0 ± 7.7%	2.5 ± 0.8%	86.4 ± 5.1%



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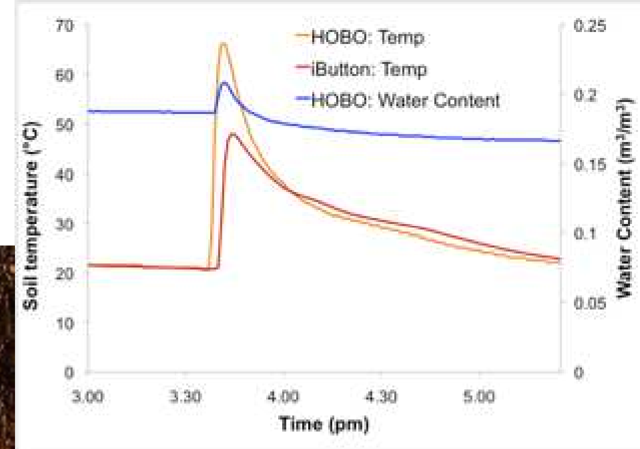
Fire driving seedling recruitment

Androcalva perlaria

Site were no plants seen for > 6 yrs

September 2014

Controlled fire



Max heat pulse (>60° C) ~4 mins – 2-3 cm below ground

December 2014

>100 seedling appeared ~ 3 months after the fire

9 months later

>130 plants flowering & fruiting

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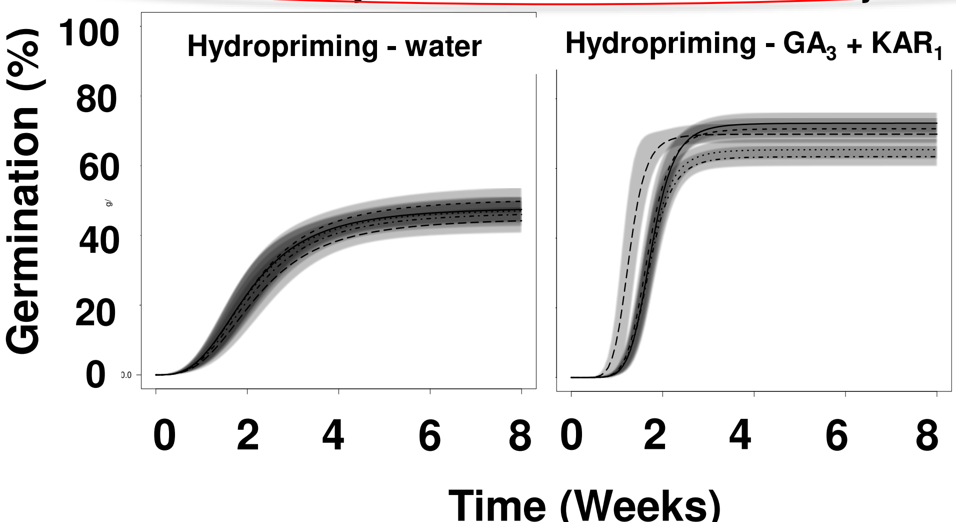
Seed priming

- Used to improve various germination parameters
- *R. brevis* seeds exposed to priming treatments: 0 - 5 days
- Seeds were dried back before incubation
- **Hydropriming enhanced total germination & rate**

Ricinocarpos brevis

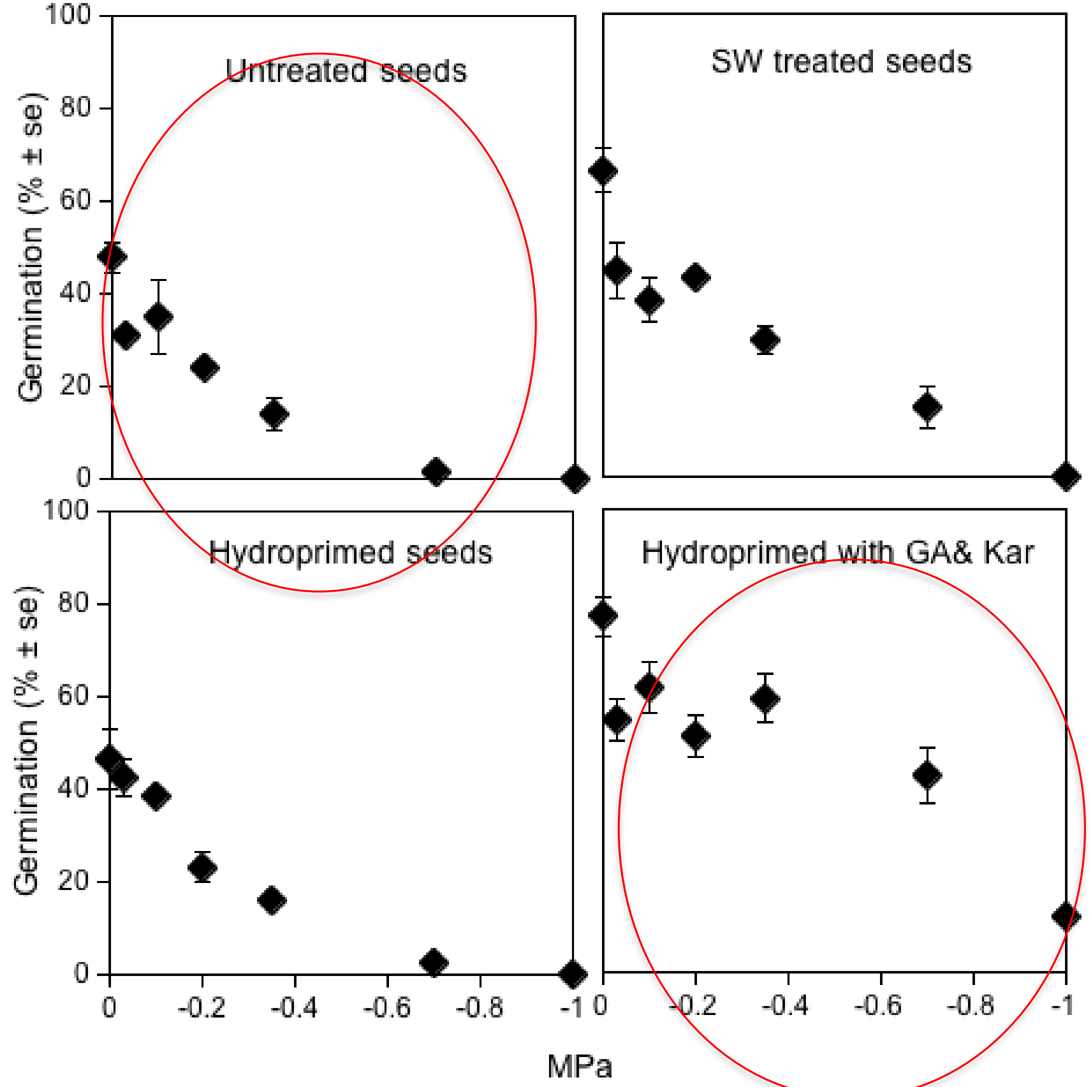
Priming time		$T_{initial\ germination}$	Priming time		$T_{initial\ germination}$
0 h	=	12 days	0 h	=	12 days
24 h	=	8 days	24 h	=	8 days
48 h	=	8 days	48 h	=	8 days
72 h	=	8 days	72 h	=	8 days
96 h	=	8 days	96 h	=	7 days
120 h	=	6 days	120 h	=	5 days



Priming improves water stress tolerance

- Germination in response to water stress assessed
- Different priming treatments
- **Priming improved overall germination and water stress tolerance**

Ricinocarpos brevis



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Field emergence

-Seed based translocation-

Southern Cross rainfall figures

Ricinocarpos brevis

				Assessment date			
				21 August 2014	9 October 2014	23 October 2014	15 February 2015
				9 weeks	**16 weeks**	**18 weeks**	**34 weeks**
Shadecloth guard	Weekly irrigation	Seed Location	Seed pre-treatment	Average emergence (% ± SE)	Average emergence (% ± SE)	Average emergence (% ± SE)	Average emergence (% ± SE)
		Surface	None	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0
		Surface	10% smoke water	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0
		Buried	None	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0
		Buried	10% smoke water	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0
Yes		Buried	10% smoke water	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0
		Buried	Hydropriming with GA_3 and Kar_1	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0
Yes							
	Yes	Buried	10% smoke water	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0
Yes	Yes	Buried	10% smoke water	0.0 ± 0.0	**2.5 ± 1.3**	**4.0 ± 2.5**	**1.0 ± 1.0**
	Yes	Buried	Hydropriming with GA_3 and Kar_1	0.0 ± 0.0	**3.5 ± 3.5**	**5.0 ± 4.5**	**3.5 ± 3.5**
Yes	Yes	Buried	Hydropriming with GA_3 and Kar_1	0.0 ± 0.0	**7.5 ± 4.9**	**9.0 ± 4.7**	**4.5 ± 2.7**

Encouraging improvement however more work to do!

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Summary

- Kings Park Science has been involved in many different plant conservation projects
- An integrated conservation model is useful for good outcomes
- Most DRF are likely to possess seed dormancy
- Seed dormancy may enhance soil persistence
- Many DRF are likely to respond to fire related cues
- Understanding seed ecology improves germination under *ex situ* and *in situ* conditions
- Seed enhancement techniques can aid *in situ* conservation efforts

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