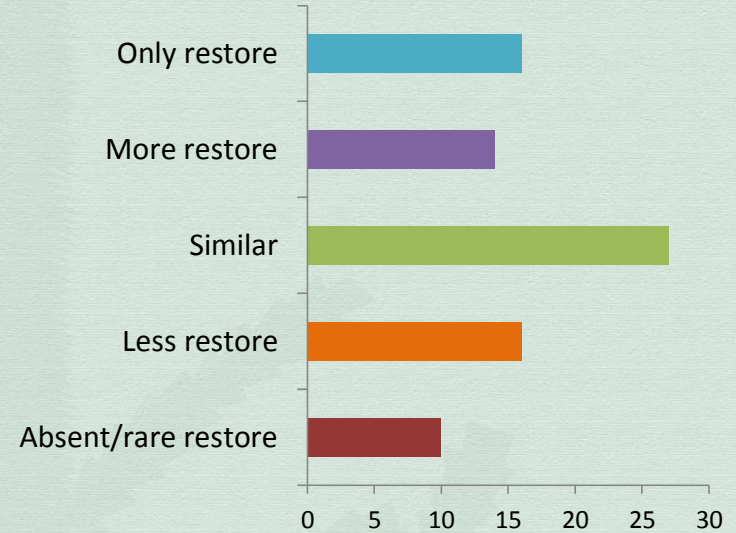
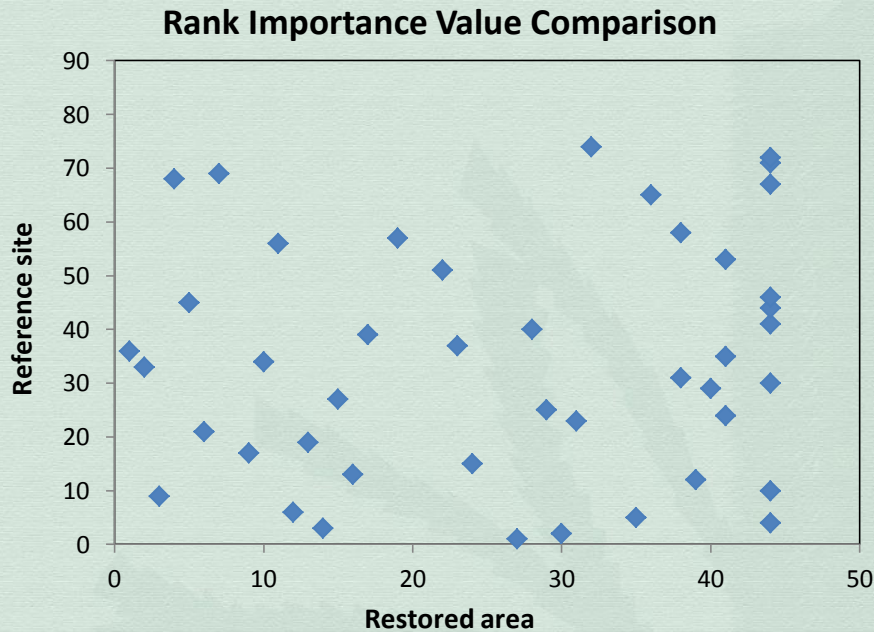


# Restoration Potentials of Species



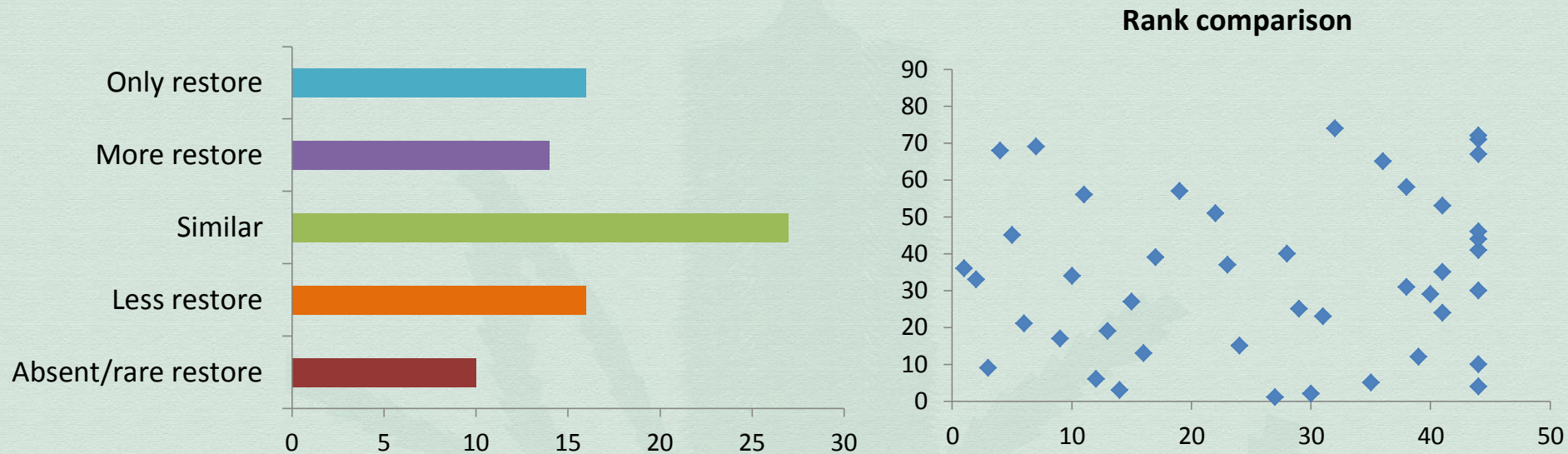


# Restoration Potential Summary



- Plant diversity is similar (in this case) but vegetation structure differs initially in young banksia woodland on restoration sites
- Long-term trends?

# Winners and Losers



Absent restore	Less restore	More restore	Only restore
<i>Austroanthonia occidentalis</i>	<i>Hibbertia hypericoides</i>	<i>Acacia pulchella</i>	<i>Acacia huegelii</i>
<i>Calectasia narragara</i>	<i>Amphipogon turbinatus</i>	<i>Eremaea asterocarpa</i>	<i>Acacia stenoptera</i>
<i>Calytrix flavescens</i>	<i>Banksia menziesii</i>	<i>Eucalyptus todiana</i>	<i>Anigozanthos manglesii</i>
<i>Daviesia triflora</i>	<i>Dampiera linearis</i>	<i>Adenanthos cygnorum</i>	<i>Aotus procumbens</i>
<i>Leucopogon</i> sp.	<i>Dasypogon bromeliifolius</i>	<i>Croninia kingiana</i>	<i>Boronia ramosa</i>
<i>Lomandra preissii</i>	<i>Desmocladius fasciculatus</i>	<i>Gompholobium tomentosum</i>	<i>Brachyloma preissii</i>
<i>Petrophile linearis</i>	<i>Desmocladius flexuosus</i>	<i>Hibbertia huegelii</i>	<i>Hypolaena exsulca</i>
<i>Pimelea sulphurea</i>	<i>Eremaea pauciflora</i>	<i>Hibbertia subvaginata</i>	<i>Laxmannia ramosa</i>
<i>Scaevola repens</i>	<i>Lepidosperma squamatum</i>	<i>Jacksonia furcellata</i>	<i>Macarthuria australis</i>
<i>Thysanotus triandrus</i>	<i>Lyginia barbata/imberbis</i>	<i>Laxmannia squarrosa</i>	<i>Anigozanthos humilis</i>
	<i>Nuytsia floribunda</i>	<i>Lechenaultia floribunda</i>	<i>Calytrix fraseri</i>
	<i>Patersonia occidentalis</i>	<i>Lomandra suaveolens</i>	<i>Cartonema philydroides</i>
	<i>Phlebocarya ciliata</i>	<i>Melaleuca thymoides</i>	<i>Gastrolobium capitatum</i>
	<i>Schoenus efoliatus</i>	<i>Scholtzia involucrata</i>	<i>Jacksonia gracillima</i>
	<i>Thysanotus thyrsoides</i>		<i>Kunzea glabrescens</i>
	<i>Xanthosia huegelii</i>		<i>Lomandra sericea</i>



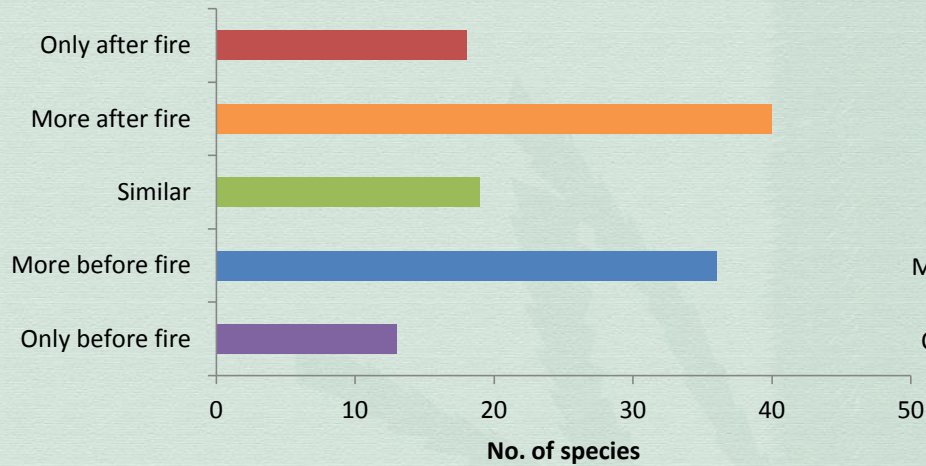
# Fire Impacts on Banksia Woodland Plants



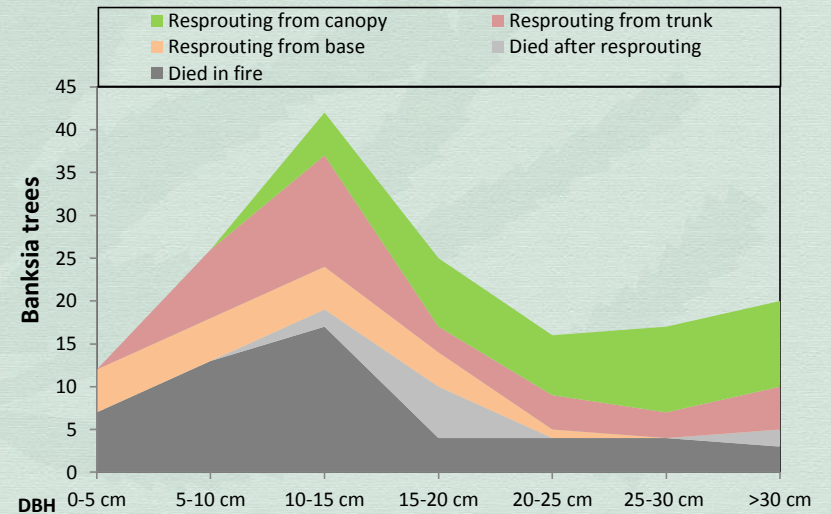
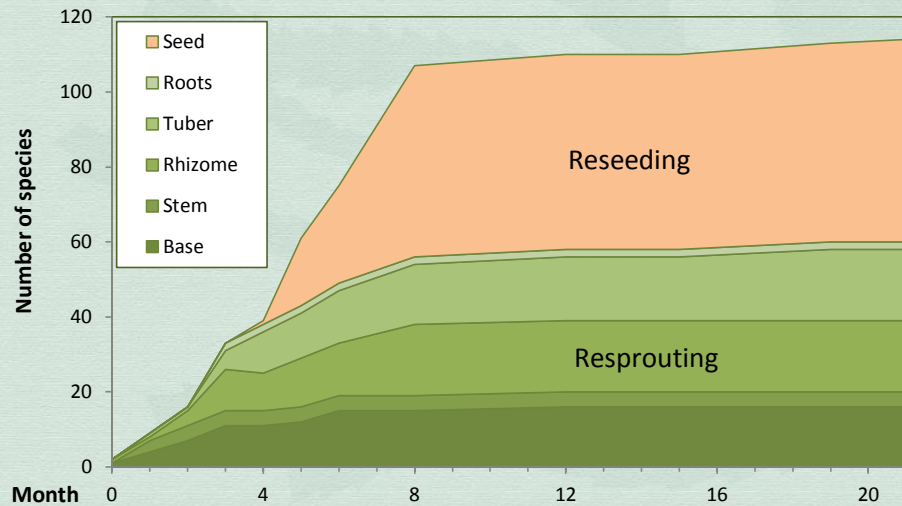
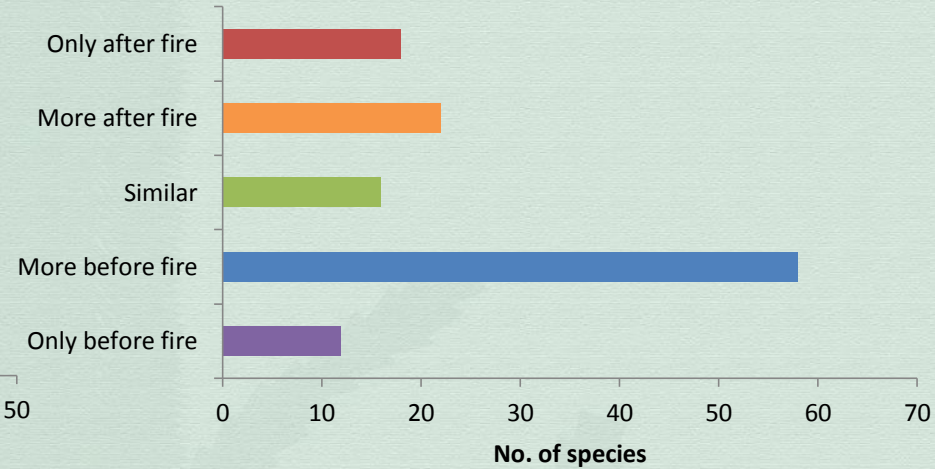


# Fire Responses by Plants

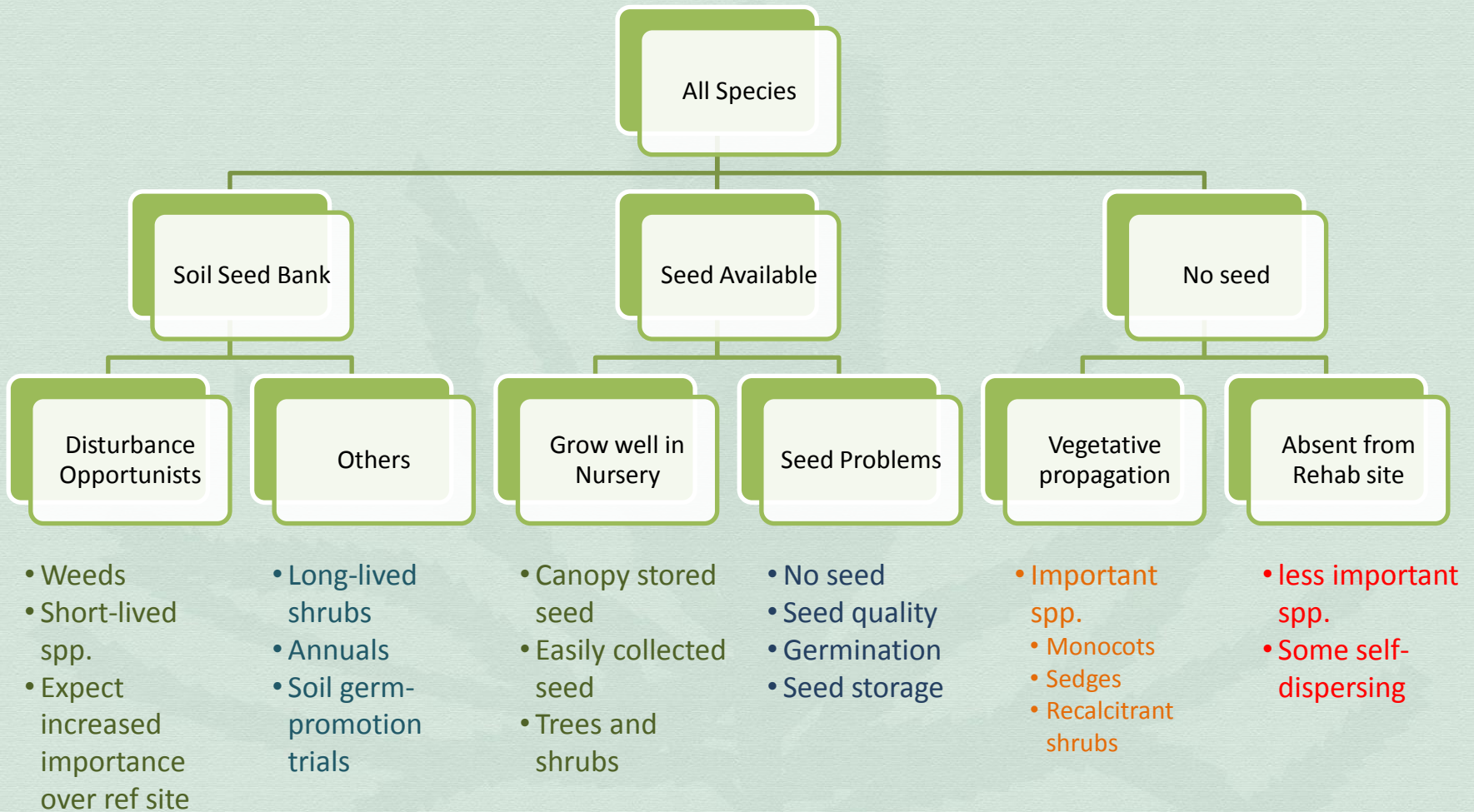
## Abundance (natives)



## Cover (natives)



# Restoration Potential





# Propagation Potential of Plants



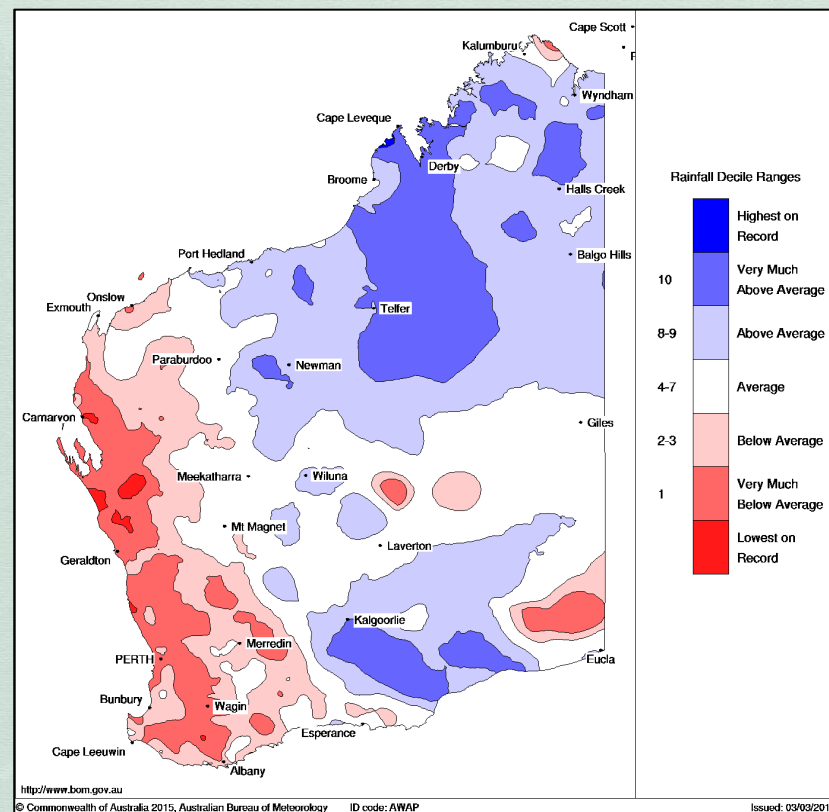
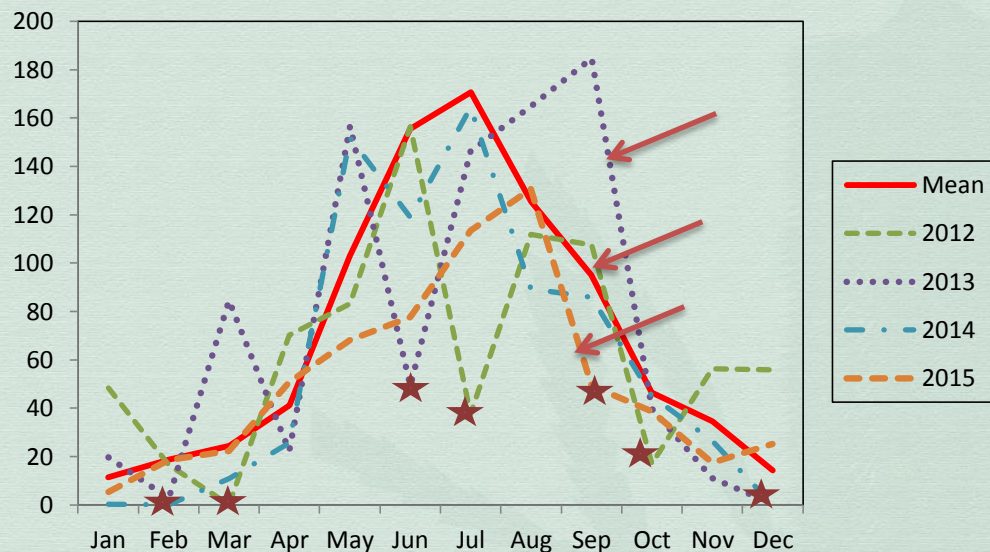
Seed quality and germinability  
determine nursery outcomes



Successful clonal propagation  
of sedges



# Responses to Climate



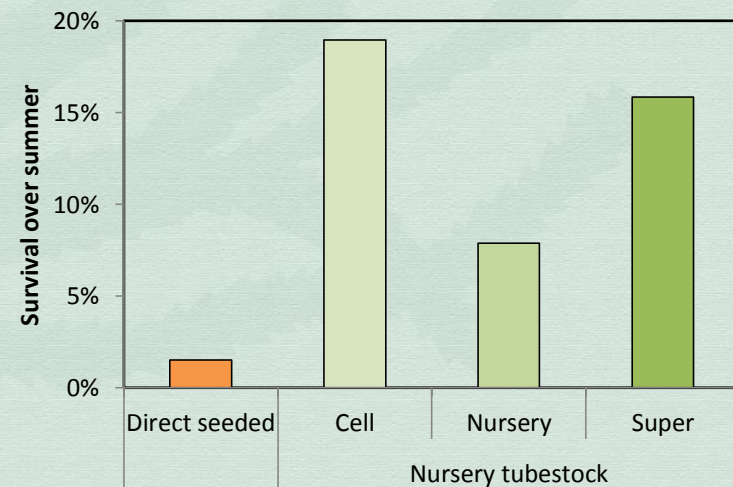
- Severe drought impacts some species more than others



# Seed Germination and Survival

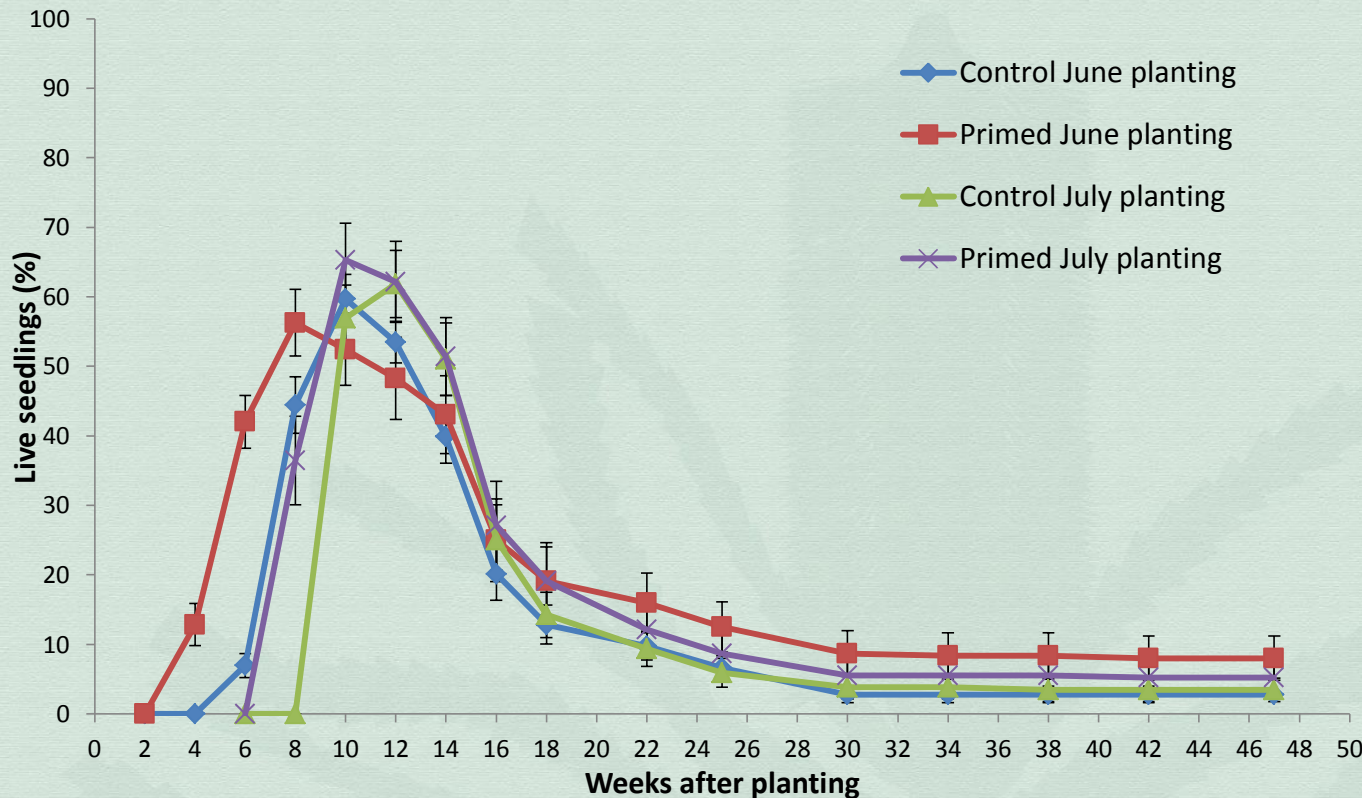


- Banksia seedling mortality is often high due to invertebrate grazing in winter and severe drought in summer
- Seedlings of most other plants are more resilient than banksias





# Banksia Seed Germination Trials



Indicate grazing losses

- Significant losses to grazing, but drought impacts severe (very hot dry summer in 2015/16)
- Experiment repeated in May & June 2016



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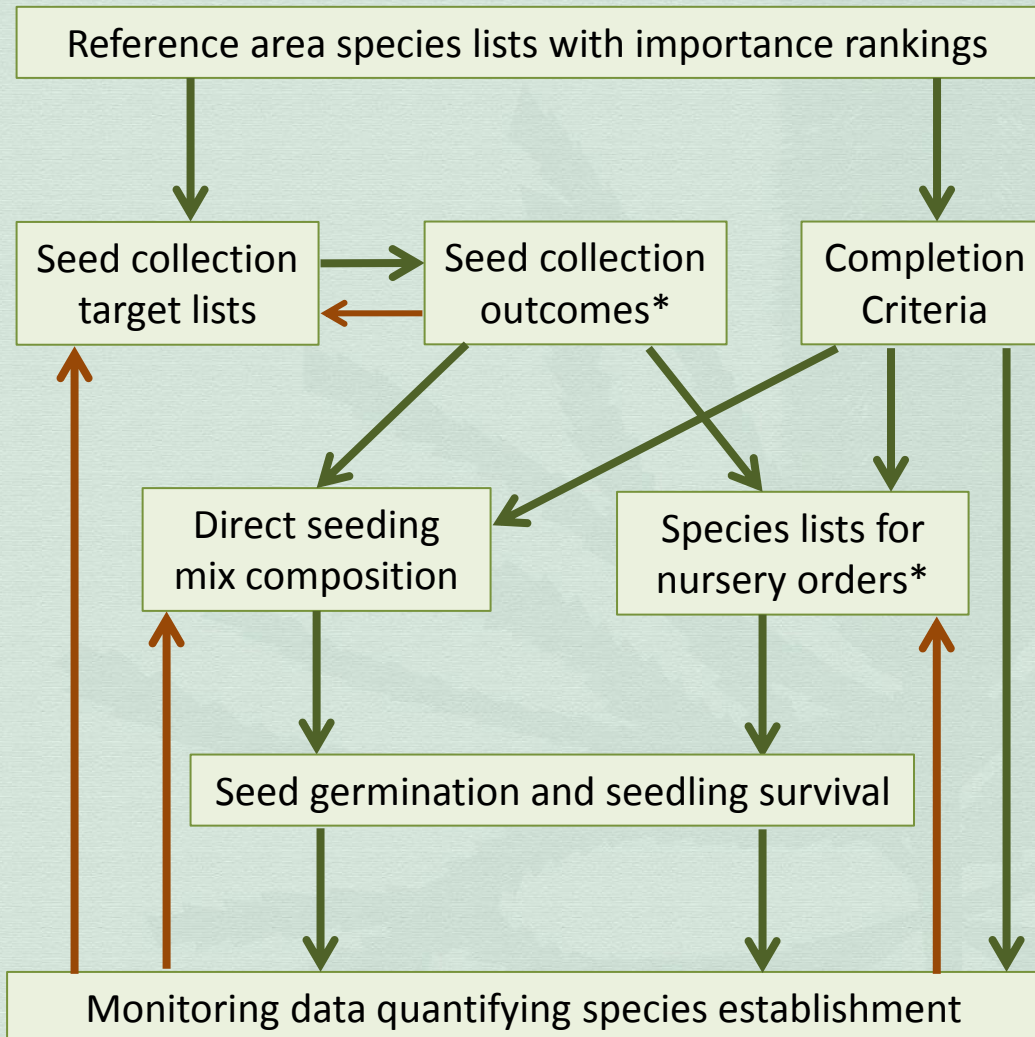
# Restoration Realities

Species related (1, 2) and site specific (3) factors ranked in according to expected importance in banksia woodland

1. Seed collection	2. Propagation	3. Survival
1. Canopy stored seed	1. Germination easy	1. Weed competition
2. Seed easy to collect	2. Seed treatments	2. Poor soil quality
3. Seed collectible in sufficient numbers	3. Germination slow and/or erratic	3. Grazing by invertebrates
4. Seed quality poor	4. Seed viability low	4. Diseases and pests
5. Seed very hard to get	5. Clonal division only	5. Grazing by large animals
6. Viable seed almost impossible to get	6. Almost impossible to propagate	6. Severe drought



# Adaptive Management using Monitoring Data in Restoration



\*Includes clonal division for plants without seed



# Turnover of Species



- Some disturbance opportunists declining by year 4
- More susceptible to severe summer drought



# Ecological Interactions





# Harmful Ecological Interactions



Pigface is often spread by rabbits and kangaroos



Galls were common on acacias by year 4

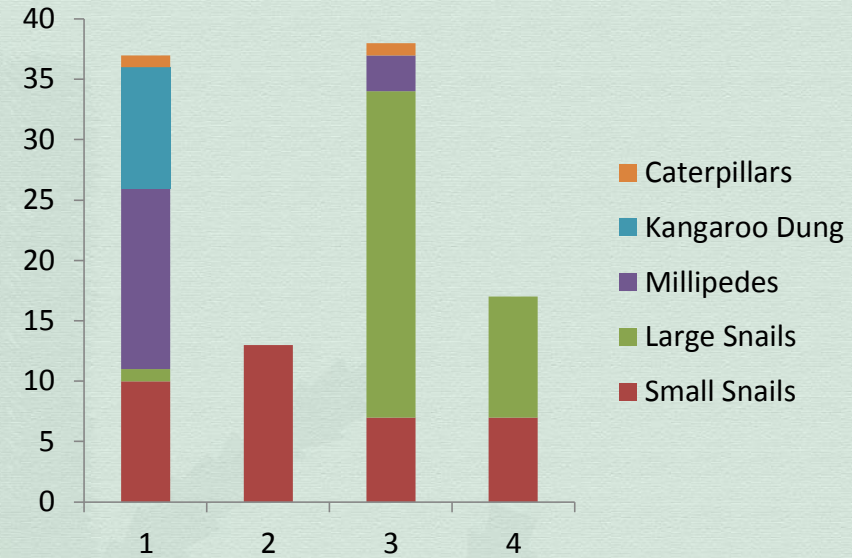


Kangaroo grazing was severe in unfenced areas

- Decomposition, Grazing, Dispersal Parasites, Predators



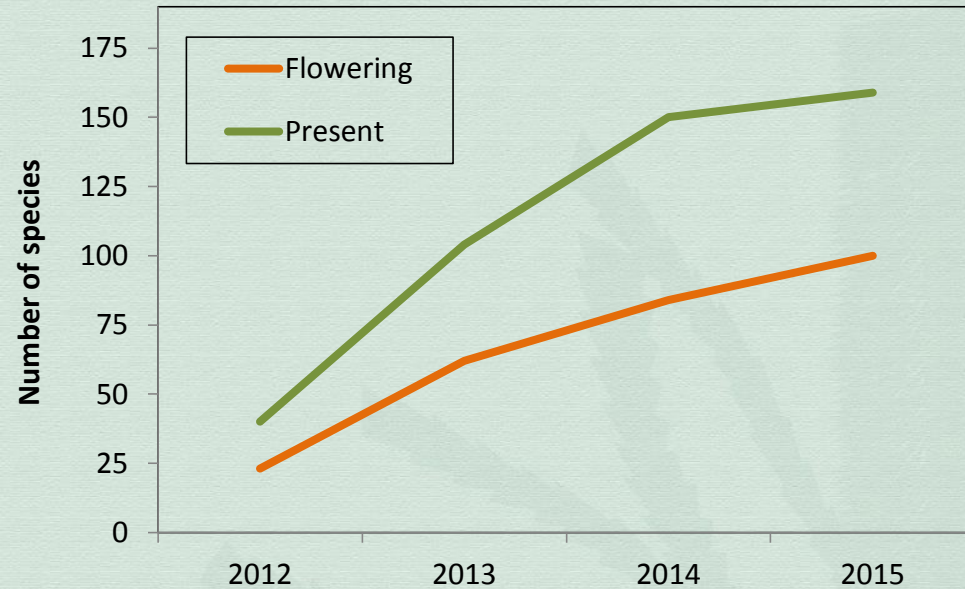
# Who is Eating My Seedlings?



- Visible threats to seedlings



# Time to Flowering and Seed





# Pollination in Revegetation Sites



**Row 1** - native  
bees

**Row 2** – wasps

**Row 3** - flies  
and butterflies

**Row 4** -  
beetles



# Managing Information





# Banksia Woodland Community Grant Workshop



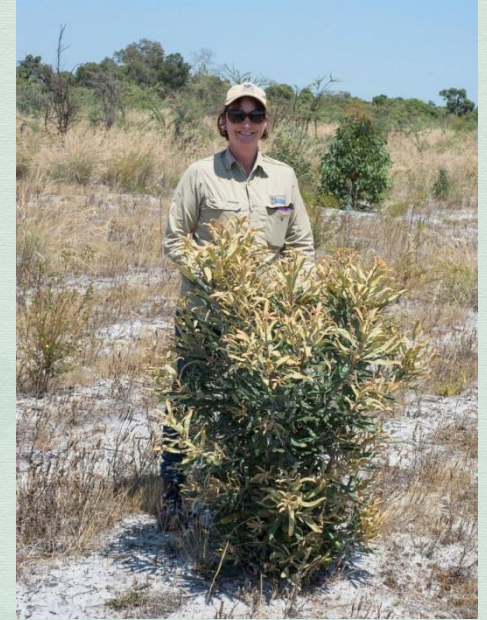
Most common request from community groups (Feb 2016):

- Share results and data to help manage native plants in restoration sites.



# Data Required by Community Groups & Land Managers

- Species lists for restoration sites:
  - ✧ Sorted by habitat type (e.g. upland only)
  - ✧ With soil/hydrology preferences
  - ✧ With relative importance/frequency
  - ✧ With seed collection/germination issues
  - ✧ Flowering and seed dispersal times
  - ✧ With restoration potential and issues
  - ✧ Animal associations (e.g. Carnaby's cockatoo food plants)
- Species data for land management:
  - ✧ Fire recovery type and frequency
  - ✧ Resilience to weeds and other disturbances





# Key Data Required for Restoration Ecology

1. Importance in reference sites
2. Age and month for flowering & seed set
3. Seed collection & storage issues
4. Germination or division in nursery
5. Direct seeding potential
6. Topsoil germination potential
7. Survival after out-planting
8. Expected climate impacts (especially drought impacts on seedlings)
9. Growth rate and lifespan
10. Expected problems:
  - a. weeds,
  - b. grazing,
  - c. disease

## Data sources:

1. Monitoring data on mortality of species
2. Restoration trials
3. Reference site comparisons
4. Photographs of seed and seedlings
5. Growth measurements
6. Pollination and seed set data
7. Species lists
8. Importance values
9. Weed cover
10. Groundwater information
11. Climate data - rainfall
12. Fencing trials



# Revegetation Report Card *Banksia attenuata*

Factor	Data
Seed Collection	0-101 seeds per tree (average 15), Jan-Feb
Seed preparation	Difficult (heat required to open cones)
Seed storage	Requires low humidity and temperature
Seed germination	High (30-95%), Inhibited by high temperature
Topsoil seed bank	No
Direct seeding results	Moderate (0-400 seedlings/ha)
Seedling survival (severe summer drought)	Low in first year (3-20%)
Tubestock survival (severe drought)	Low in first year (10-20%)
Grazing susceptibility	High (kangaroos, rabbits, invertebrates)
Growth rates	Fast (0.3-1 m/year height)
First flowering	> 5 years
Other impacts on seedlings	Grazing, parasitic galls, weeds





# New Banksia Woodland Datasets

- Data available for in NatureMap
  - ✧ Species lists with cover and abundance from 31 plots
  - ✧ Species occurrence data from 51 Plots
- Identification resources online
  - ✧ Banksia woodland plants photo resource
  - ✧ Banksia woodland pollinators and other invertebrates
  - ✧ Reference herbarium
- Ecological datasets
  - ✧ Fire recovery strategies and frequencies
  - ✧ Fire recovery trend data for species
  - ✧ Weed management impacts on species
  - ✧ Restoration potential for species
  - ✧ Seed viability and response to treatments (Threatened Flora Seed Centre)



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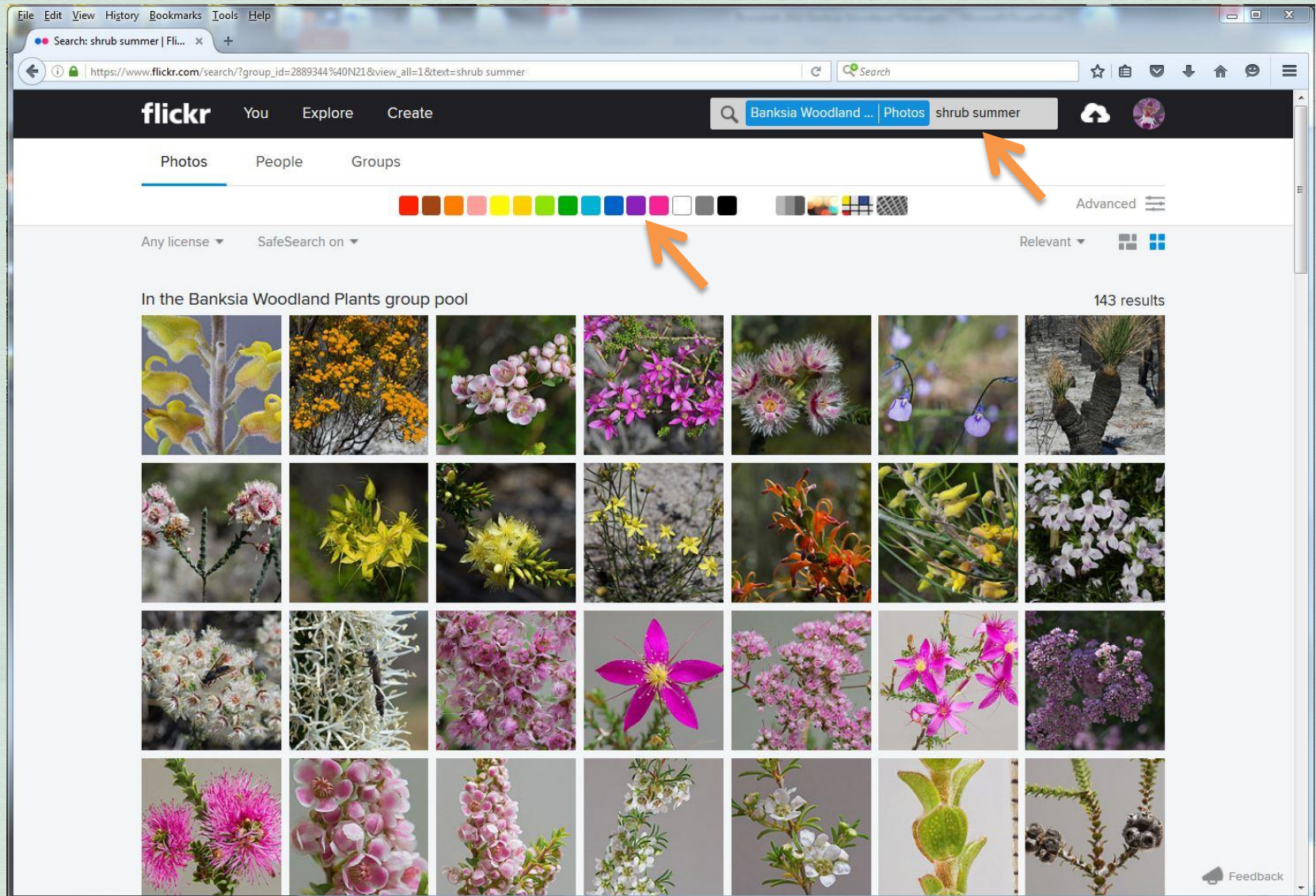


# Acknowledgements

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- **Threatened Flora Seed Centre:** Simone Dudley, Andrew Crawford, Anne Cochrane, Anne Monaghan.
- **Project management:** Stefan de Haan, Barbara Wilson, Steve Raper, Geoff Barrett, Craig Olejnik, Shawn Debono and Mark Brundrett.



# Banksia Woodland Plant Identification Tool



- Flickr Group: [www.flickr.com/groups/banksia\\_plants/](https://www.flickr.com/groups/banksia_plants/)



# Purple Summer Shrubs

