Restoring a Threatened Ecological Community following mining

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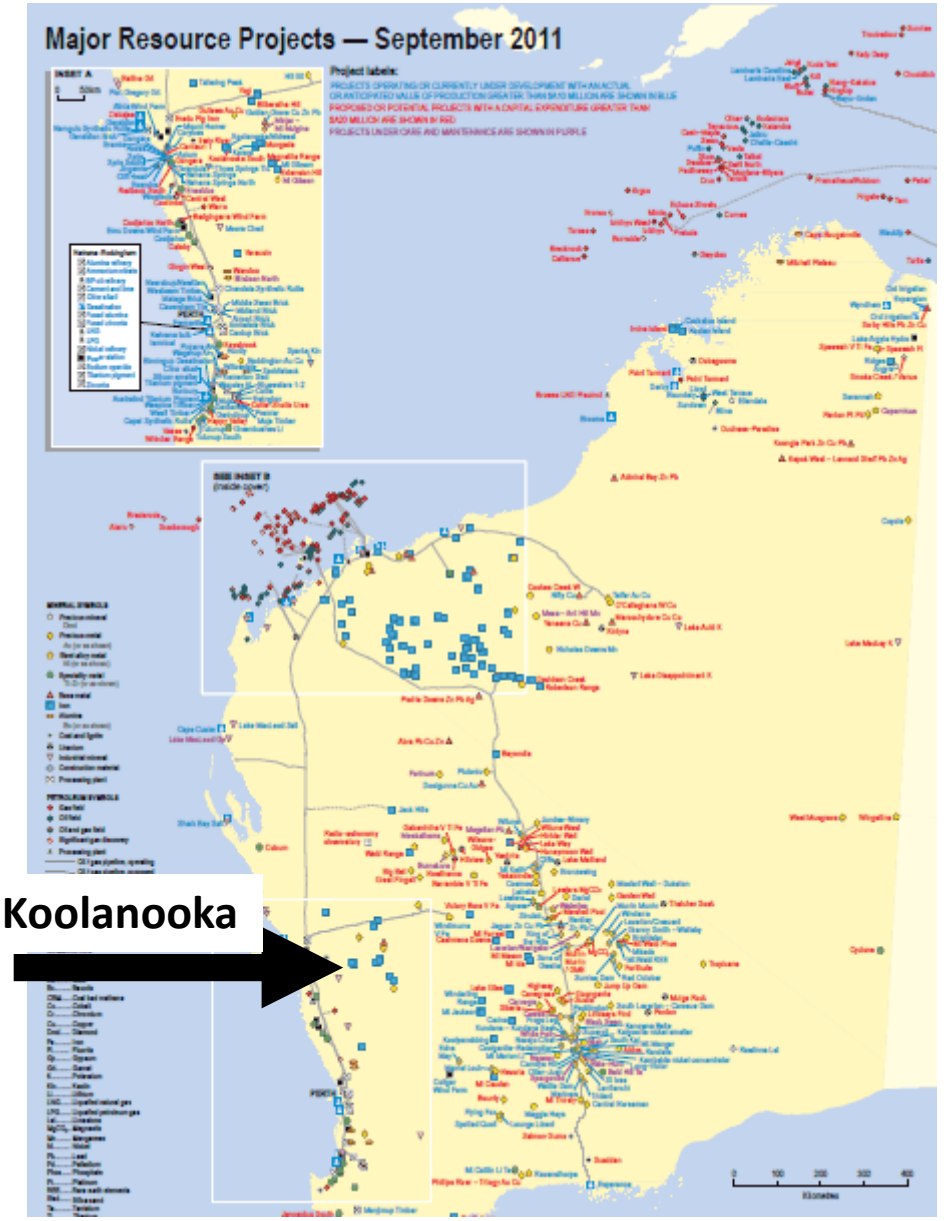
Mining in WA

Mining leases in WA cover 22,000 km^2

- roughly 1/3 the size of Tasmania

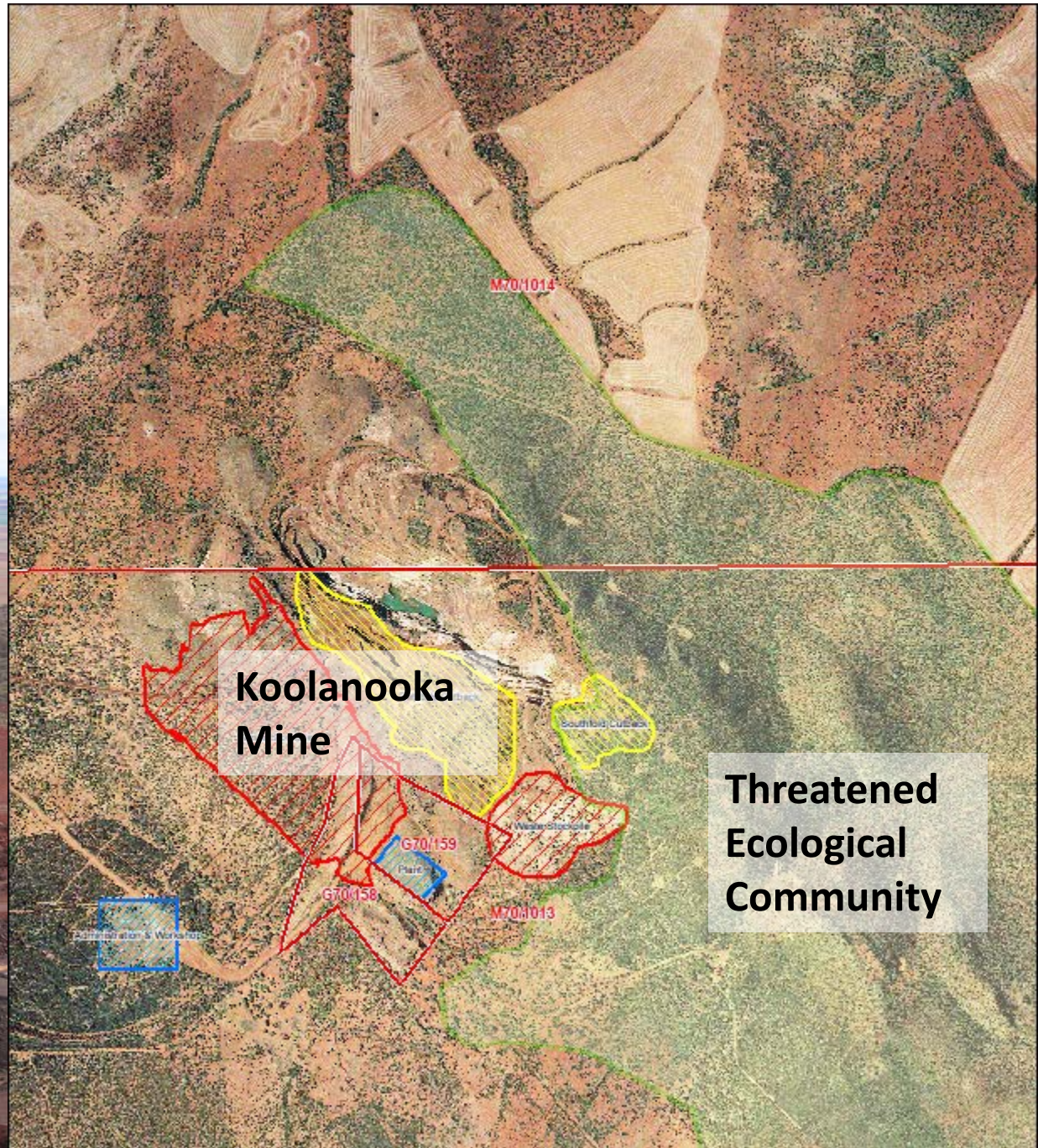
"Rehabilitation is looming as one of the
major environmental policy issues
of coming years as older mines begin to close"
- WA EPA Annual Report 2014-15

"Without confidence that rehabilitation can
successfully restore comparable ecological function
post-disturbance at a large scale,
rehabilitation alone has limited value as a mitigation option
for reducing proposal impact."
- WA EPA Annual Report 2012-13



Koolanooka Mine

- Sinosteel Midwest Corporation
- Iron Ore
- Banded Ironstone Formation
- Koolanooka Threatened Ecological Community
- Legacy site



Ministerial Statement 811

Condition 13-3

The proponent shall progressively rehabilitate all areas disturbed in the implementation of the proposal, with the exception of the mine pits as described in Schedule 1 in accordance with the following:

1. Re-establishment of vegetation such that the following criteria are met within five years following the cessation of productive mining:

(a) flora and vegetation are re-established with not less than 70 percent composition (not including weed species) of the known original species diversity*; and

(b) weed coverage no more than that in undisturbed bushland in the area or less than 10%, whichever is the lesser.

*refer to ATA, 2004, Vegetation and Flora Assessment, Koolanooka, Midwest Corporation Limited, March 2004 and Ecologica, 2008a, Koolanooka Hills/Blue Hills Flora and Vegetation Survey, Midwest Corporation Limited September 2008

Research Partnership

- Research to underpin restoration practices in order to achieve ministerial conditions
- Project: 2012-2017
- Our approach:
  1. Define targets
  2. Methods of species return
  3. Optimising methods

GOVERNMENT OF WESTERN AUSTRALIA

BOTANIC GARDENS & PARKS AUTHORITY

SINOSTEEL SMC

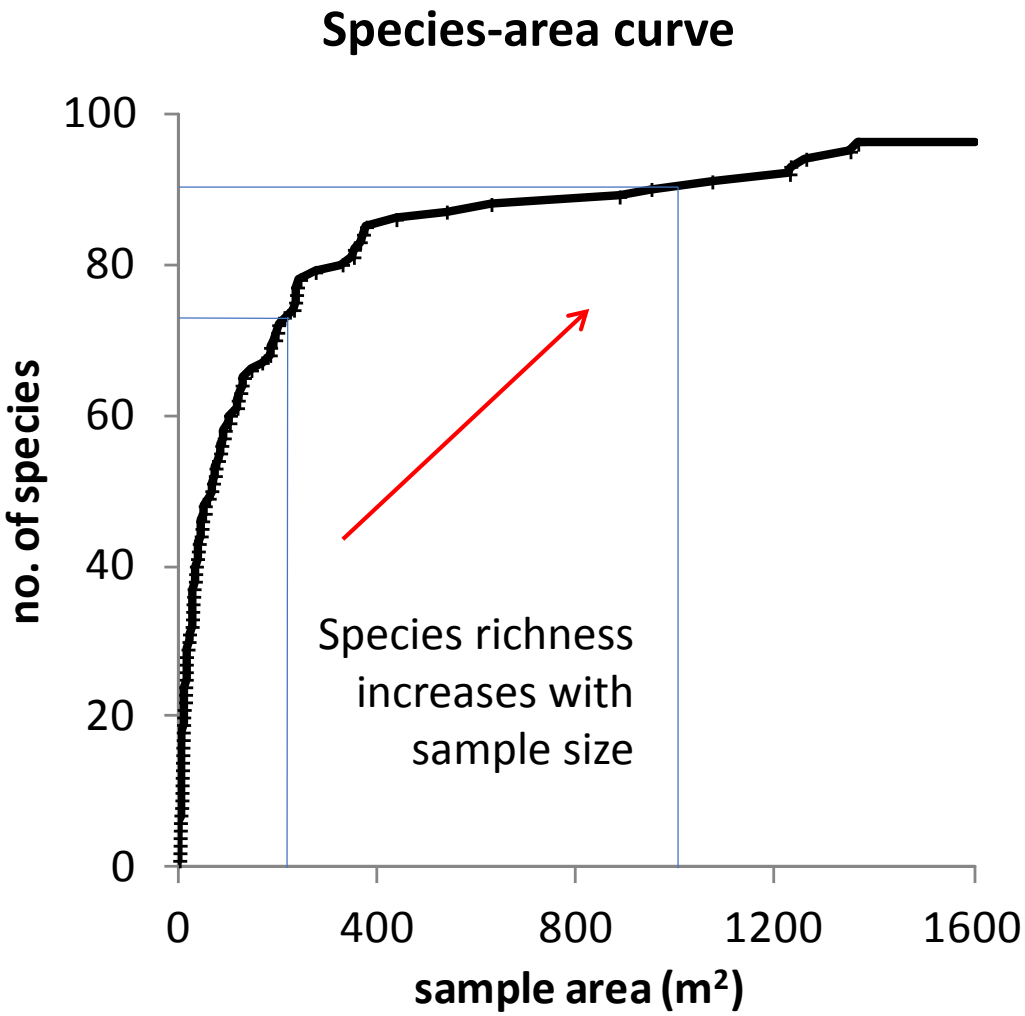
1. Define targets

70% of what? Surveys to date

Survey	Year	Field method	Communities	Richness no. of species	Target: 70% richness
1: DEC TEC IRP survey	2003	11, 10x10m plots	5 associations	67	47
2: consultant 1	2004	>30, 50m transects	31 communities	207	145
3: DEC BIF survey	2006/08	50, 20x20m plots	6 communities	217	152
4: consultant 2	2008	2 relevés	2 communities	47	33
5: consultant 3	2010	10, 20x20m plots	3 communities	96	67

1. Define targets

- Which species and how many?
- Target should be scale dependent
  - i.e. depend on the area to be restored
  - so, if the area is e.g. 200 m^2 you should return fewer species than 1000 m^2

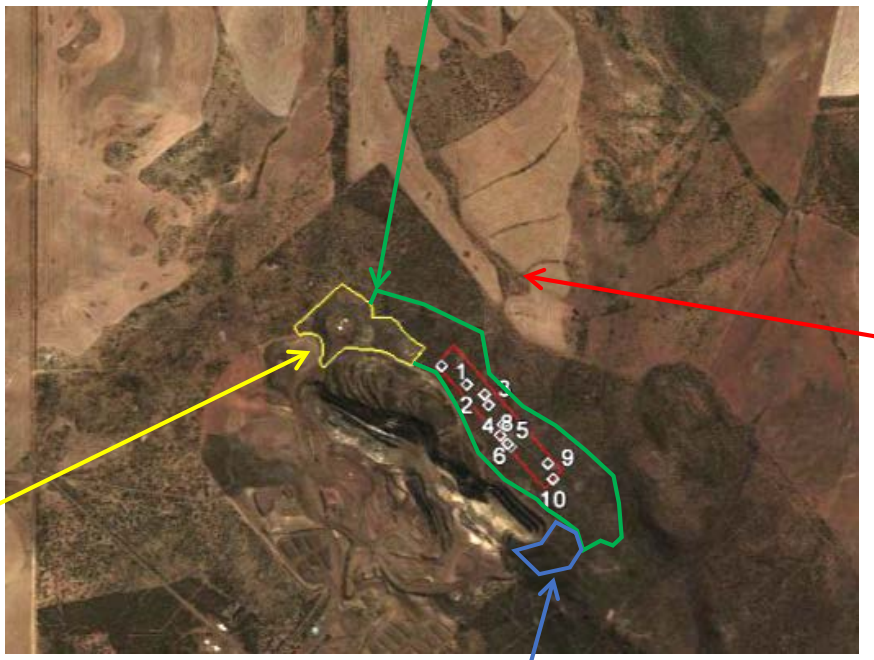


Data from 40x40m plots Eneabba shrublands, WA: Miller, Enright, Perry, Lamont

1. Define targets

- An approach to richness target definition
- Outcome
  - Target community identified
  - Richness target clarified
  - Species for target community listed and prioritised

Reference community
- Contiguous
- “Undisturbed”
- TEC
- Same aspect, geomorphology and slope
- Mapped as 1 community



7 ha target / reference
10 random 20x20 m **Quadrats** (5.7% of 7 ha)
- Species list
- Cover scores
- Perennial stem density

Exhaustive search
of remainder for new species
- 8, 12.5m x 700m transects
- 4 people, 2.5 hrs

7 ha TEC offset

4.5 ha TEC impact

2. Methods of species return depends on reproductive biology

Topsoil

Applied seed

Seedlings / cuttings

Dispersal

3. Optimising plant return

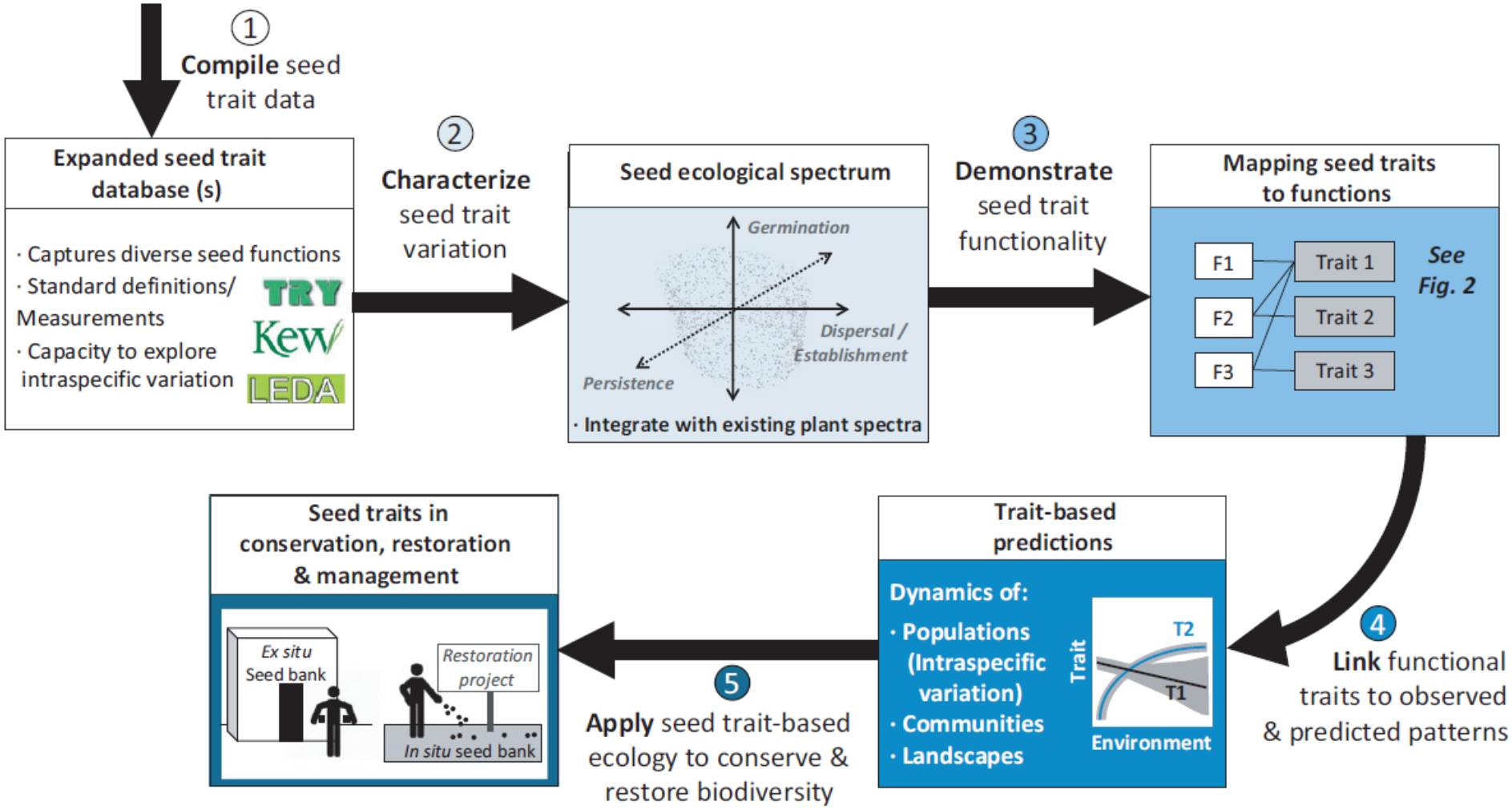
- Transitions from seed to seedling
- Rock supplementation to overcome topsoil deficits
- How do soil properties and rainfall influence seedling emergence?

Optimising plant return: Transitions from seed to seedling

Seed traits are important in restoration

New Phytologist

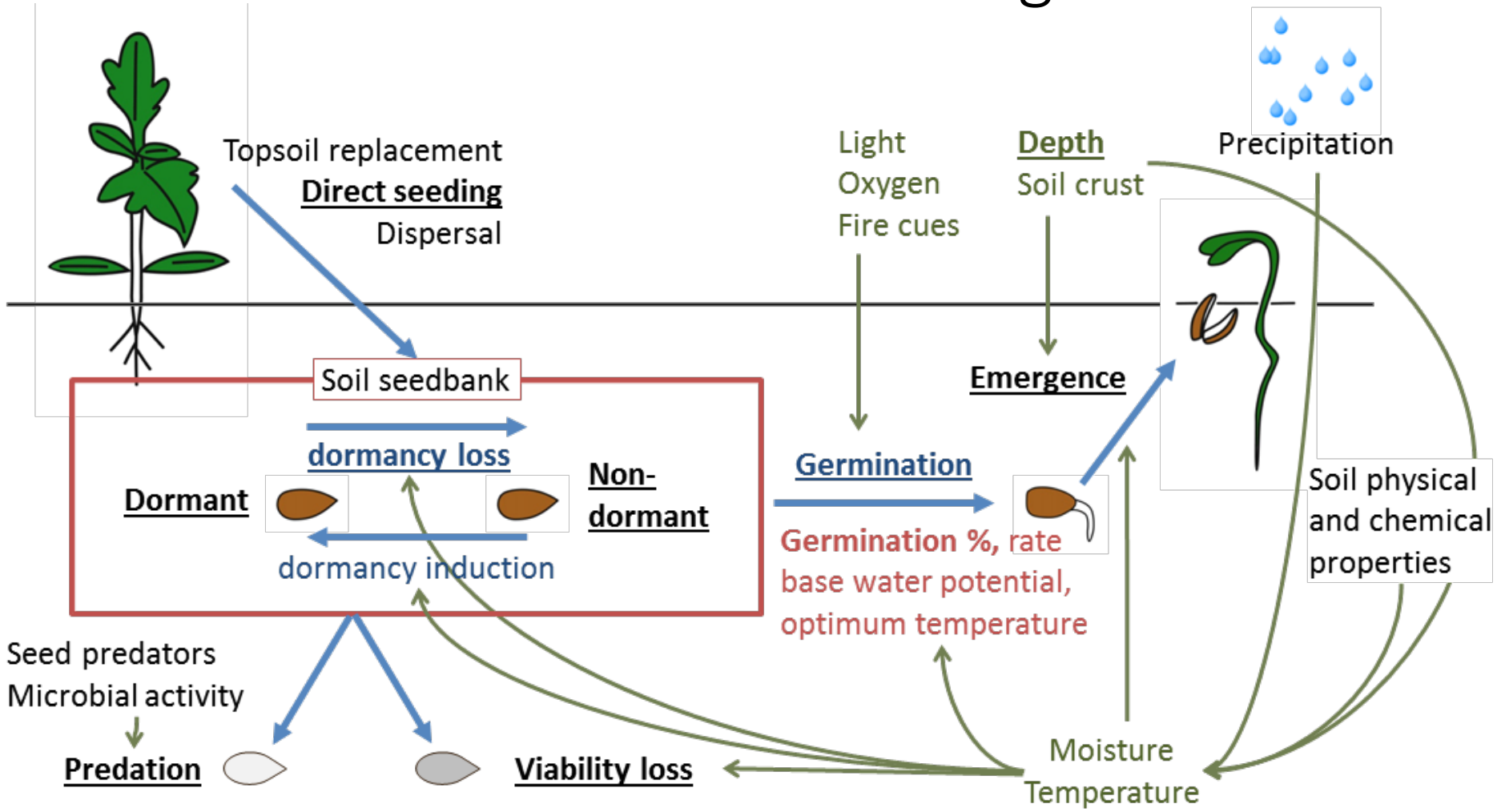
Research review **Review 3**



Saatkamp A, Cochrane A, Commander L, et al. 2018, A research agenda for seed-trait functional ecology. *New Phytologist*

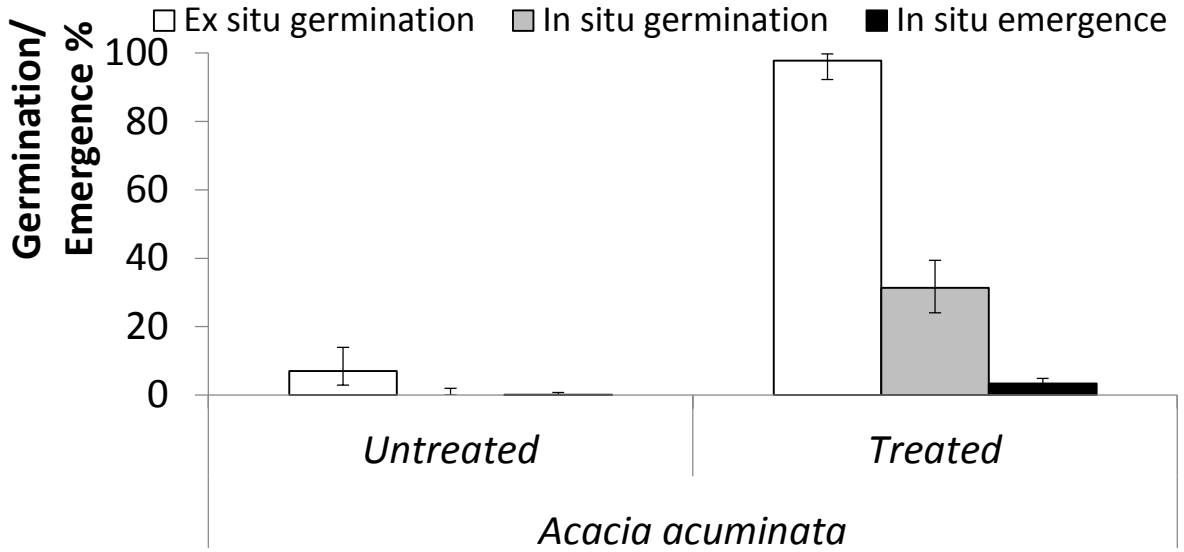
Optimising plant return:

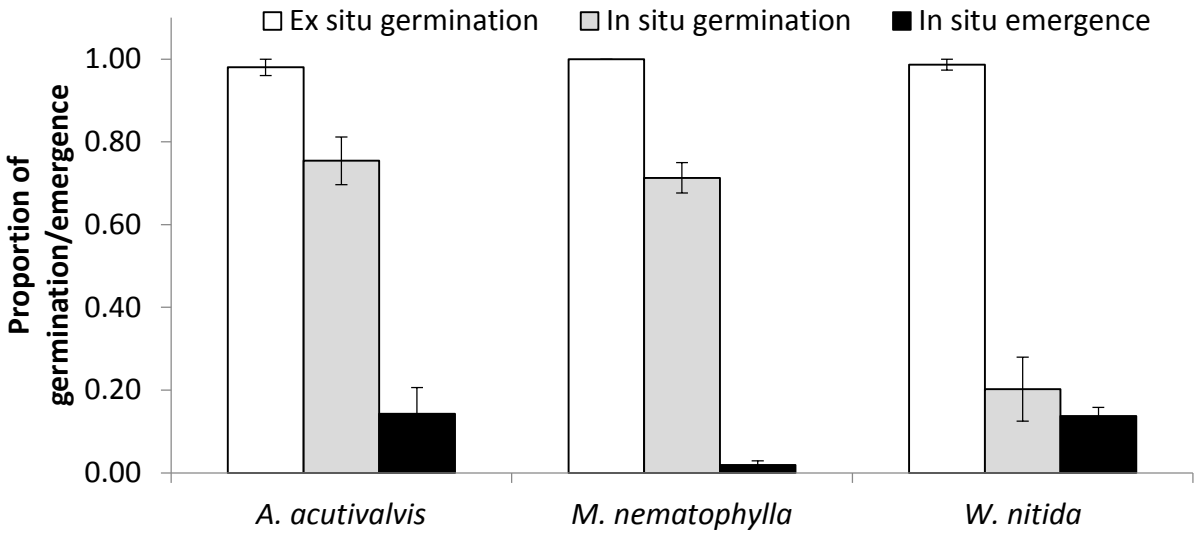
Transitions from seed to seedling

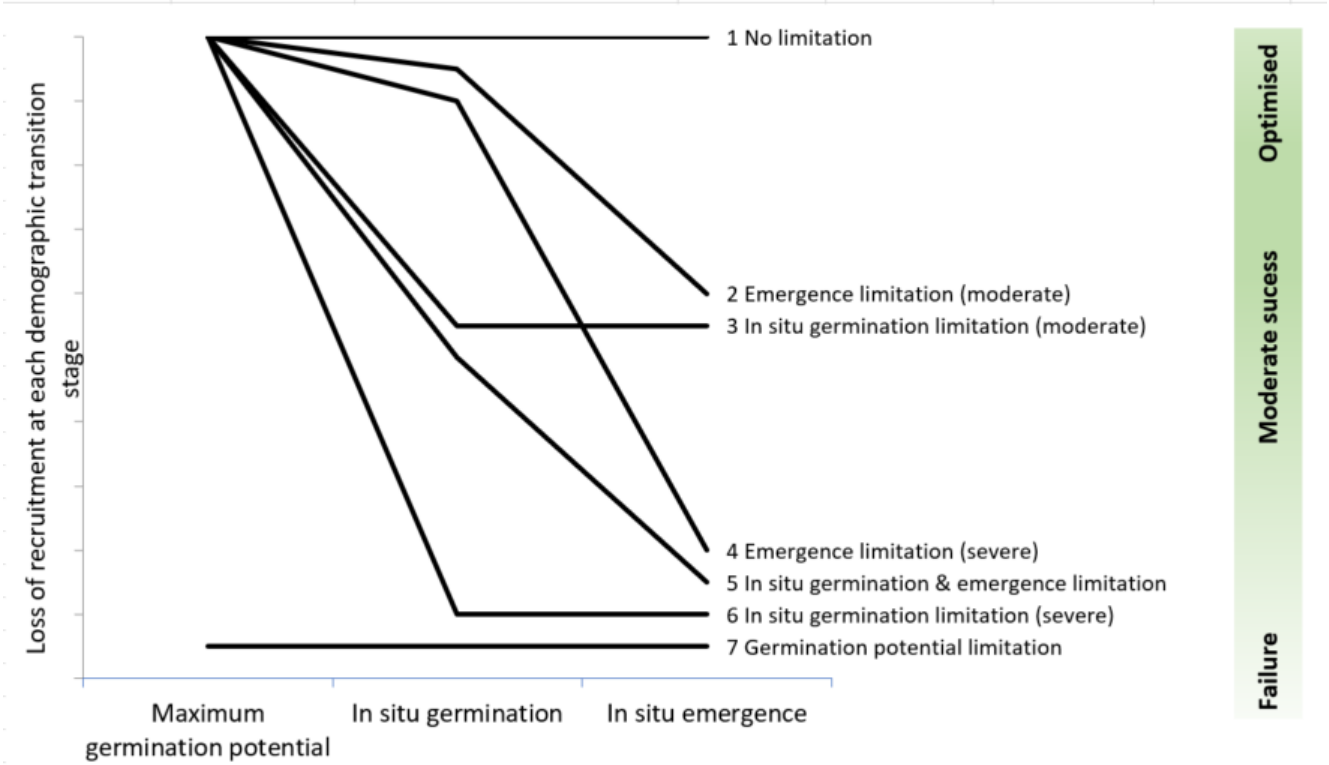


Commander et al. Plant and Soil, submitted

Dormancy, in situ germination or in situ emergence limited several species





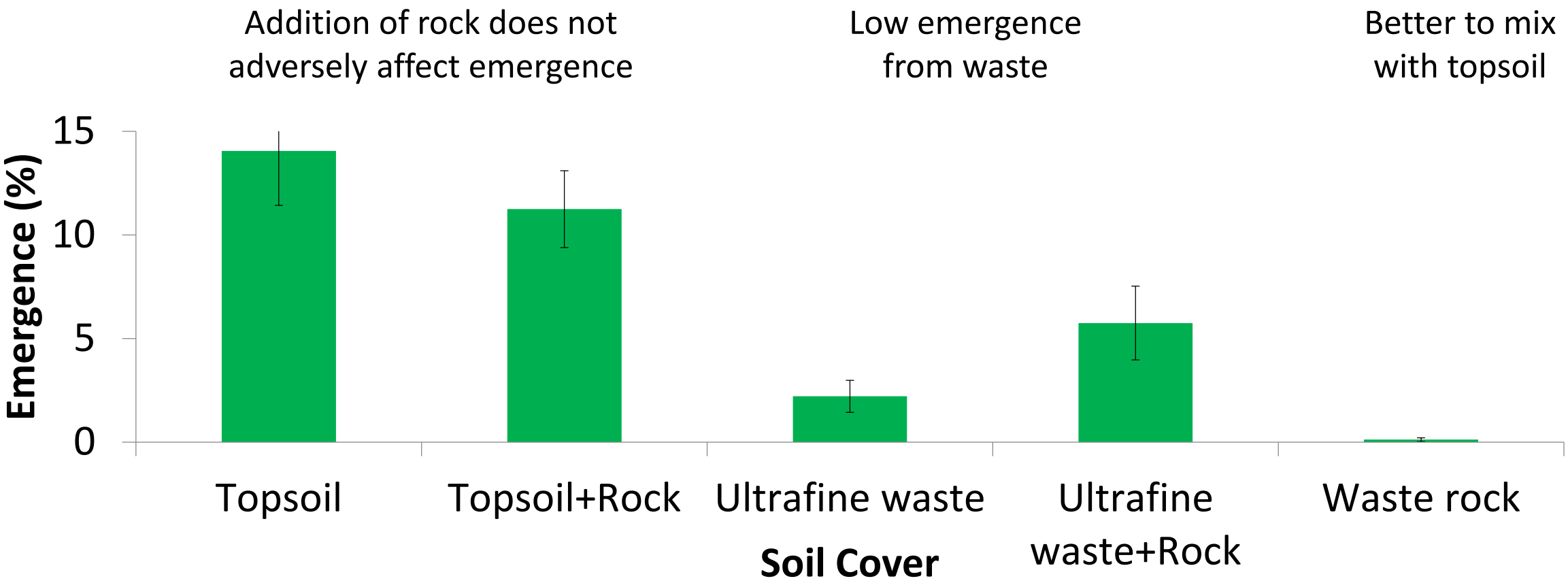


Commander et al. Plant and Soil, submitted

Optimising plant return:
Rock supplementation to overcome topsoil deficits

- **The problems:**
  - Insufficient topsoil
  - Seedling emergence from waste unknown
- **The innovative approach:**
  - Mix topsoil with waste material (25%) to cover larger area
  - How soil traits influence emergence

Optimising plant return: Rock supplementation to overcome topsoil deficits



Merino-Martín et al. 2017, Overcoming topsoil deficits in restoration of semiarid lands: Designing hydrologically favourable soil covers for seedling emergence, Ecological Engineering 105, 102–117

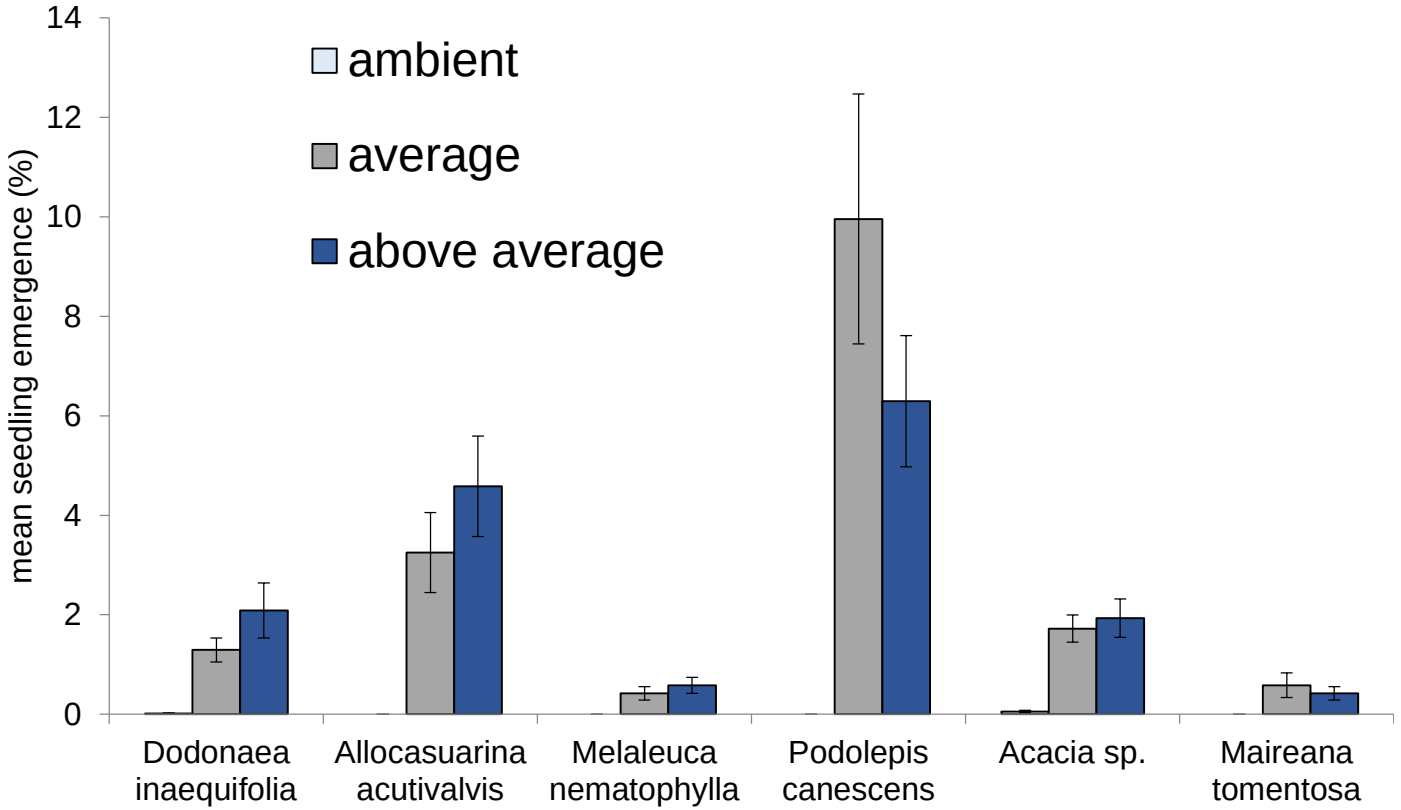
Optimising plant return: How do soil properties and rainfall influence seedling emergence?

- Is emergence:
  - every year,
  - only when the rainfall is at least average or
  - only in high rainfall years?
- The innovative approach:
  - Constructed a ‘rain-out’ shelter, the first of its kind
  - 20x30 m, allowing 6, 10x10 m plots
  - Two irrigation regimes: average, above average

How do soil properties and rainfall influence seedling emergence?

The findings:

- Under natural (ambient) rainfall, (a low rainfall year) emergence was very low
- Seedlings emerged in a simulated average and above average year
- Irrigation has the potential to stimulate recruitment



Commander et al. unpublished

Restoring the TEC

- 3 sources of plants
  - Topsoil spread
  - Broadcast seed mix with 32 species
  - Planted seedlings/cuttings of 5 species
- Various planting treatments
  - e.g. deep planted, treated with Salicylic acid
- 3 irrigation regimes
  - Unirrigated, single irrigation, continuous irrigation
- 2 landscape positions
  - Flat, slope

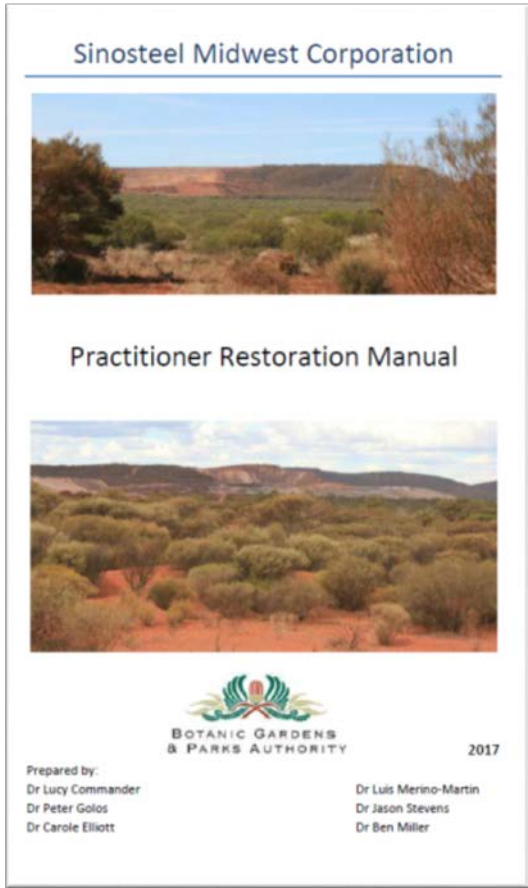
Commander et al. unpublished

Project Outcomes

- Demonstrated that restoration of at least 70% species diversity of flora is achievable.
- Published a Restoration Guide.
- Extensive knowledge on BIF restoration for the benefit of the State
- AMEC Environmental Award
- 4 Honours students
- 3 popular articles
- 4 community tours and presentations
- Peer reviewed papers and conference presentations.

Merino-Martín L, Courtauld C, Commander L, et al. (2017) Interactions between seed functional traits and burial depth regulate germination and seedling emergence under water stress in species from semiarid environments. *Journal of Arid Environments* **147,** 25-33.

ASSOCIATION OF MINING AND EXPLORATION COMPANIES



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