Restoring a Threatened Ecological Community following mining

Dr Lucy Commander
Luis Merino Martin, Peter Golos, Carole Elliott, Jason Stevens, Ben Miller

@lucy_commander
Mining in WA

Mining leases in WA cover 22,000 km²
- 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
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.

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
1. Define targets

70% of what? Surveys to date

<table>
<thead>
<tr>
<th>Survey</th>
<th>Year</th>
<th>Field method</th>
<th>Communities</th>
<th>Richness no. of species</th>
<th>Target: 70% richness</th>
</tr>
</thead>
<tbody>
<tr>
<td>1: DEC TEC IRP survey</td>
<td>2003</td>
<td>11, 10x10m plots</td>
<td>5 associations</td>
<td>67</td>
<td>47</td>
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<tr>
<td>2: consultant 1</td>
<td>2004</td>
<td>&gt;30, 50m transects</td>
<td>31 communities</td>
<td>207</td>
<td>145</td>
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<tr>
<td>3: DEC BIF survey</td>
<td>2006/08</td>
<td>50, 20x20m plots</td>
<td>6 communities</td>
<td>217</td>
<td>152</td>
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<tr>
<td>4: consultant 2</td>
<td>2008</td>
<td>2 relevés</td>
<td>2 communities</td>
<td>47</td>
<td>33</td>
</tr>
<tr>
<td>5: consultant 3</td>
<td>2010</td>
<td>10, 20x20m plots</td>
<td>3 communities</td>
<td>96</td>
<td>67</td>
</tr>
</tbody>
</table>
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 m² you should return fewer species than 1000 m²

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
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

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

![Germination/Emergence %](image)

**Germination/Emergence %**

- **Untreated**
- **Treated**

**Acacia acuminata**

- Ex situ germination
- In situ germination
- In situ emergence

**Proportion of germination/emergence**

- A. acutivalvis
- M. nematophylla
- W. nitida

![Loss of recruitment at each demographic transition](image)

1. No limitation
2. Emergence limitation (moderate)
3. In situ germination limitation (moderate)
4. Emergence limitation (severe)
5. In situ germination & emergence limitation
6. In situ germination limitation (severe)
7. Germination potential limitation

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

Addition of rock does not adversely affect emergence

Low emergence from waste

Better to mix with topsoil

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
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.

Acknowledgements

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