Guidelines for plant population offsetting

GISERA Knowledge Transfer Session

Francisco Encinas-Viso | Research scientist
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The success of biodiversity offsetting

Recent studies show that biodiversity offsetting (BO) can often fail (low success rate).
Translocation data analysis

Jen Silcock’s data (UQ)
The success of biodiversity offsetting

Recent studies (e.g. Gibbons et al, 2016) show that biodiversity offsetting (BO) can often fail (low success rate), as it happens in restoration ecology projects.

Why are we failing?

Are best restoration practices being applied?
Biodiversity offsetting

I will focus on **technical challenges:**

*How can we augment or improve long-term plant population viability?*
Plant population biology

• Biological differences matter.
• Acknowledging and understanding differences between plant species, or generally life forms, help us to improve estimates of population viability and offsetting practices.
Factors affecting population viability

- Life-history traits
- Individual variation (genetics)
- Demographic stochasticity
- Average habitat conditions
- Environmental variation
A naïve model for population offsetting

Population (offset) size (N)
A naïve model for population offsetting

Offset = 800

No science-based planning, is this offset size good?
A science-based model for population offsetting

Long-term population growth

Offset = 800

Minimum viable population ($N_{ext}$) = 100

Population (offset) size ($N$)

Based on a model and data now get a better estimate of offset sizes
Management actions are important

However, we cannot rely **only** on offset size to maximise viability.

Why?

- If we do not apply appropriate management actions based on their biology and modeling analysis, it does not matter how many individuals you offset, the population will eventually go extinct.
- Management actions are the result of previous biological/ecological knowledge and modeling analysis.
Objectives

1. Effective management actions for selected plant groups of the Brigalow area.

2. Provide estimates of viability under different scenarios (based on biology of the groups and parameterise using available data).

3. Identify key life-history traits for each plant group with a sensitivity analysis.
Modelling work

Plant demographic model which is *spatially and genetically-explicit*

Spatial grid 100 x 100 cells

- Suitable sites
Modelling workflow

Data/parameters

Demographic Model (IBM)

Scenarios:
- Fire
- Weed competition

Simulated data

Output

PVA
Main outcomes and recommendations
General outcomes

1. Specific recommendations and associated management actions for each plant group.
General outcomes

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<th>Plant group</th>
<th>Key vital rates</th>
<th>Main threats</th>
<th>Offset ratios</th>
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# General outcomes

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Offset ratios suggested here can change depending on each case/species.
General outcomes

1. Estimated offset ratios, specific recommendations and associated management actions for each plant.

2. Mitigating mortality factors (e.g. fire, inbreeding depression, weed competition) is as important as choosing appropriate offset sizes.
General outcomes

Fire severity = 0.1

Population size (N) vs. Time (y)

---

Intervention
Offset = 600
Offset = 200
General outcomes

Fire severity = 0.1

- Intervention
- Offset = 600
- Offset = 200

Fire severity = 0.3
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3. For all plant groups, maintaining population connectivity and gene flow is essential to decrease extinction risk.
General outcomes

1. Estimated offset ratios, specific recommendations and associated management actions for each plant.

2. Mitigating mortality factors (e.g. fire, inbreeding depression, weed competition) is as important as choosing appropriate offset sizes.

3. For all plant groups, maintaining population connectivity and gene flow is essential to decrease extinction risk.

4. Combined management actions to increase spatial availability and genetic diversity increases up to 50% population viability and population persistence. This is particularly important in short-lived species with self-incompatibility mating systems.
Offsetting a perennial forb

The Button wrinklewort (*Rutidosis leptorrhynchodoides*) example:

- Perennial herb
- Insect-pollinated
- Self-incompatible mating system

Ecology:

- Endemic of grassland environments SE Australia
Population size ≠ population viability

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Population size ≠ population viability

![Graph showing cumulative probability of extinction over time with different population growth rates and time to extinction for different sites.]

- $r_p = 0.96$
- $r_p = 0.53$
- $r_p = 0.33$
- $r_p = 0.32$

More viable population
## Offsetting a perennial forb

Assuming that the targeted population is declining

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Forbs – Spatial availability and genetic diversity

Improving habitat conditions (e.g. removing Buffel grass) and genetic diversity increases $\sim 50\%$ population viability and persistence

![Graph showing the effect of spatial availability and genetic diversity on population size over time.](image)
General recommendations

• Apply management actions tailored to each plant group as guidance to do population-offsetting planning.
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• Use modelling and population viability analysis as complementary tools to predict extinction risk.
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• Report demographic data and success rate from offset monitoring to inform future plant population offset planning.
General recommendations

• Apply management actions tailored to each plant group as guidance to do population-offsetting planning.
• Use modelling and population viability analysis as complementary tools to predict extinction risk.
• Report demographic data and success rate from offset monitoring to inform future plant population offset planning.
• Implement research project offsets when levels of uncertainty (i.e. lack of biological knowledge of the targeted species) are high to maximise the success of the offset plan.
General recommendations

**Ooline** (*Cadellia pentastylis*)

**Belson’s panic** (*Homophilis bensonii*)
Thank you

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Appendix
Eucalypts- Fire effects

Increased population extinction:
If fire severity is > 10-25% and the frequency of fire events are > 15 % per year
Eucalypts - Offset simulations

- Offset of juveniles of > 7:1 increased viability > 50%.
- Viability depends on size of pre-existing population.
Forbes

Life-history traits:
• Short-lived perennial (3-5 years)
• Insect-pollinated.
• Self-incompatible mating system (obligate outcrossers).
• Fecundity depending on mate availability (gene flow).
Forbs – Offset and genetic rescue

> 50% increase of viability when introduced genetic diversity > 10%
Forbes – Offset and genetic rescue

![Graphs showing genetic diversity](image)

**Genetic diversity = 0.25**

- 100
- 300
- 500
- 700

**Genetic diversity = 0.5**

**Average seeds/plant before dispersal**

**Years after intervention**
Forbes – Connectivity is important

- Increasing population size (offset) 10:1 in an isolated population can secure long-term viability if mortality rate is < 5 % per year.
- Simulations offsetting more than one population improved viability.
General recommendations

• Better results always on pre-existing reproductive population (especially longevous species).
• Offset sites should be closely connected to other populations allowing gene flow between them.
• Mixing provenance not always good (e.g. *Solanum johnsonianum*) (*Shapcott et al 2017*).
• Reporting demographic data and success rate from offset monitoring. A large database available across all Australia to inform proposed offsets actions.
• Implementing research project offsets (WA offset guidelines) when levels of uncertainty are high (e.g. Ooline).
General recommendations

• Uncertainty is our main problem (what is an (un)acceptable risk?)
• Demographic and PVAs can help estimating effectiveness and viability (counterfactual scenarios) if a minimum knowledge is provided - predictions will be as good/bad as the data/information provided.