# Guidelines for plant population offsetting

## GISERA Knowledge Transfer Session

**Francisco Encinas-Viso** | Research scientist

26 July 2018

**CANBR/NRCA**
www.csiro.au

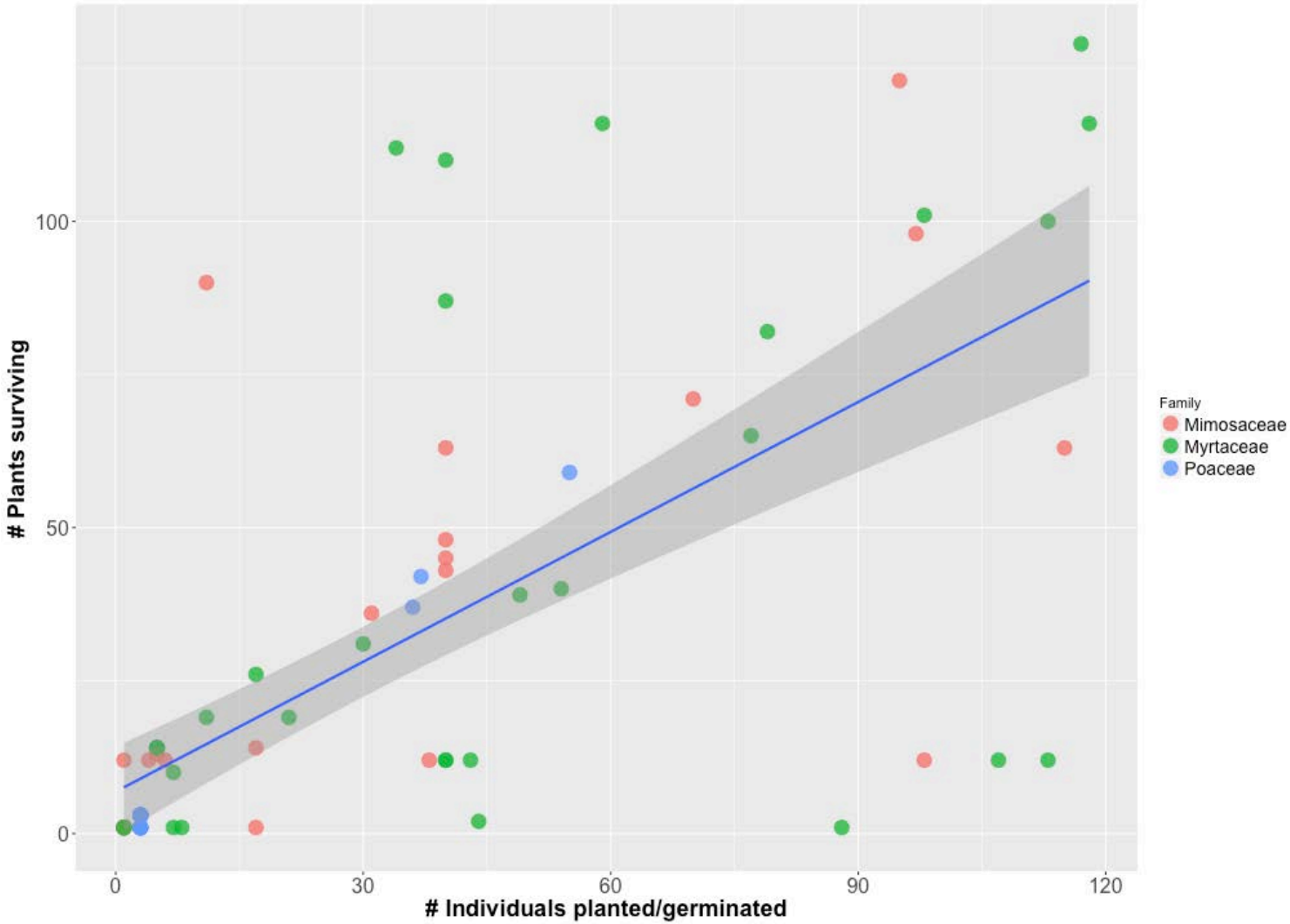
GISERA
Gas Industry Social and Environmental Research Alliance

# 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

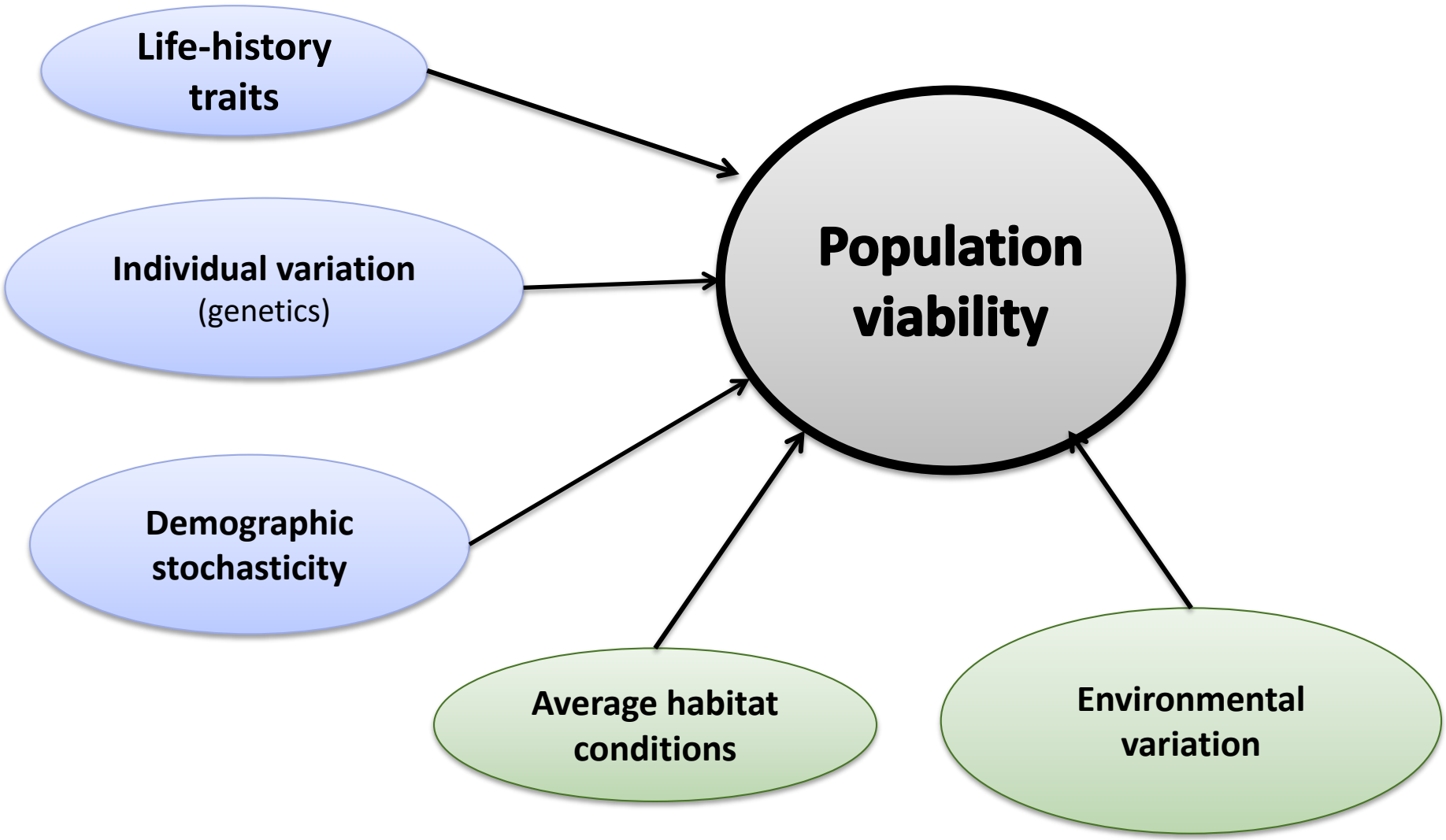
I will focus on **technical challenges:**

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

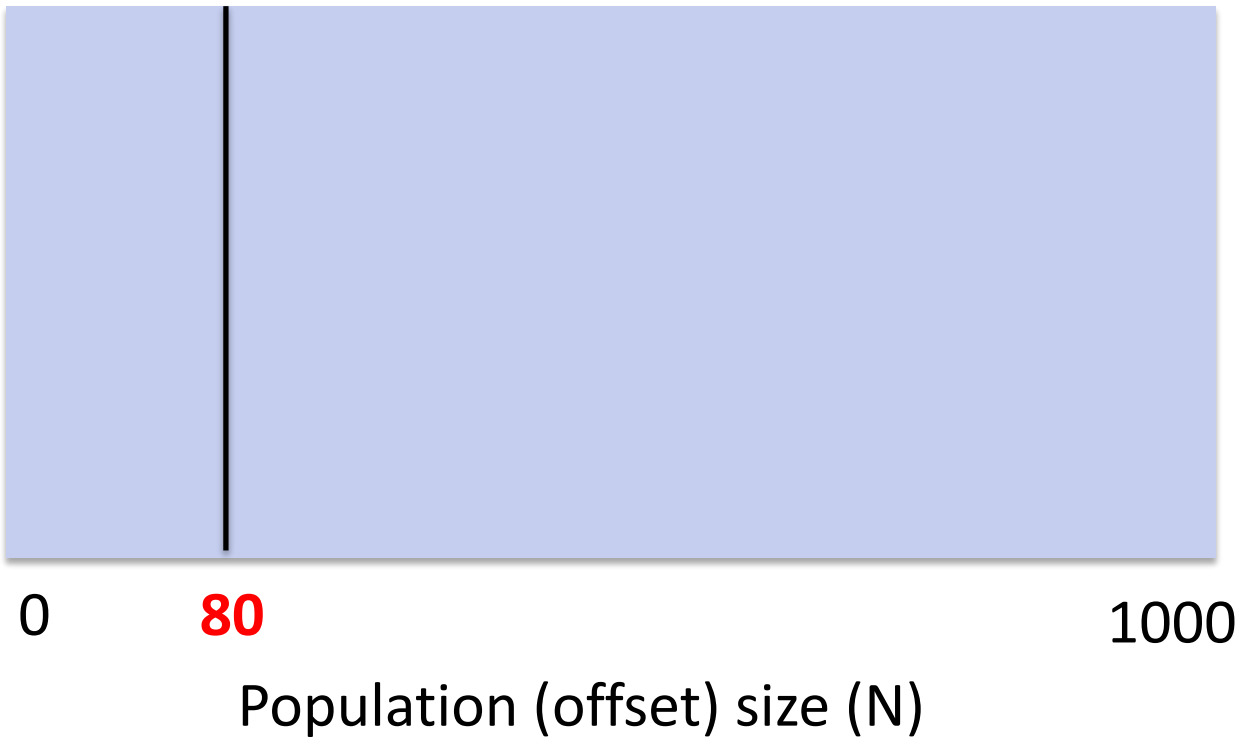
# Plant population biology

- 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



# A naïve model for population offsetting



# A naïve model for population offsetting

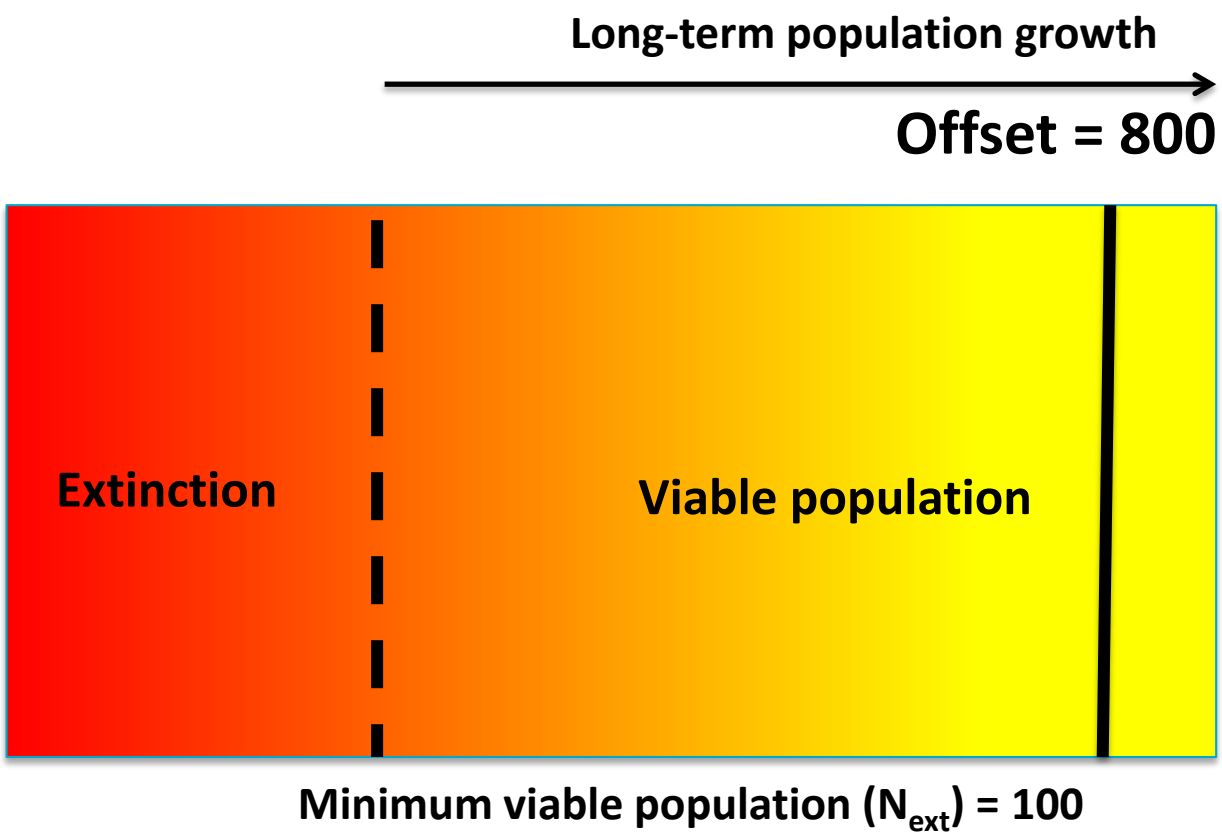
**Offset = 800**

0 **80 -> Impacted** 1000

Population (offset) size (N)

No science-based planning, is this offset size good?

# A science-based model for population offsetting




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.

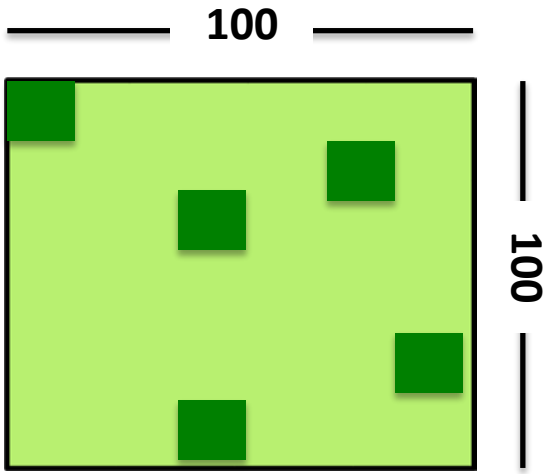
2. Provide estimates of viability under different scenarios (based on biology of the groups and parameterise using available data).

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

# Modelling work

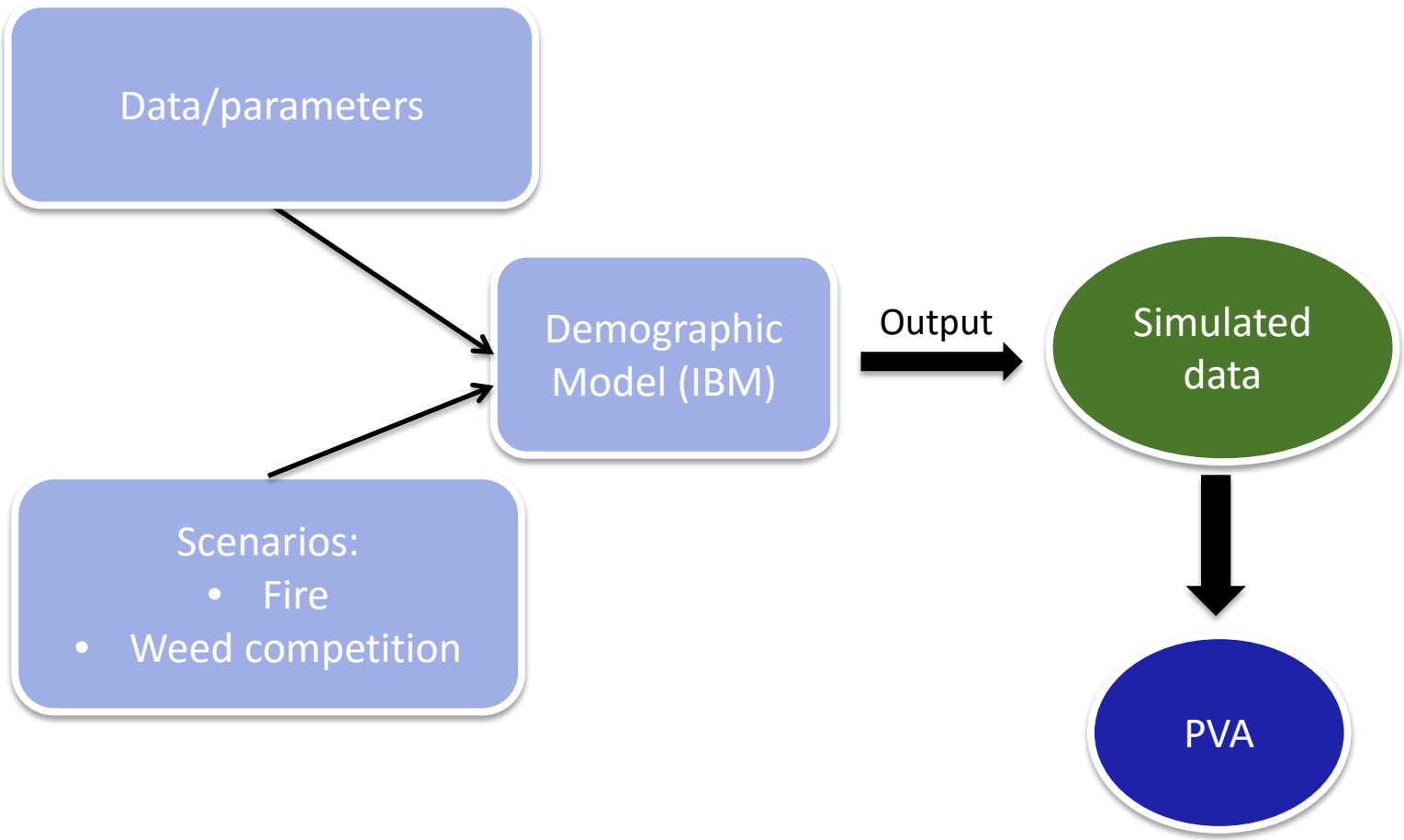
Plant demographic model which is *spatially and genetically-explicit*

Spatial grid 100 x 100 cells




Suitable sites

# Modelling workflow



# Main outcomes and recommendations

# General outcomes

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

# General outcomes

1. Specific recommendations and associated management actions for each plant.

| Plant group | Key vital rates | Main threats | Offset ratios |
|---|---|---|---|
| Eucalypts | Mortality of early age classes | Fire, grazing, inbreeding if Fragmentation is severe | ≥ 10:1 |
| Acacia | Adult and seed mortality | High intensity fire | ≥ 4:1 |
| Forbs | Adult mortality | Habitat fragmentation, fire, weeds | ≥ 7:1 |
| Grasses | Seed germination rates and adult mortality | Weeds, fire | ≥ 10:1 |

# General outcomes

1. Specific recommendations and associated management actions for each plant.

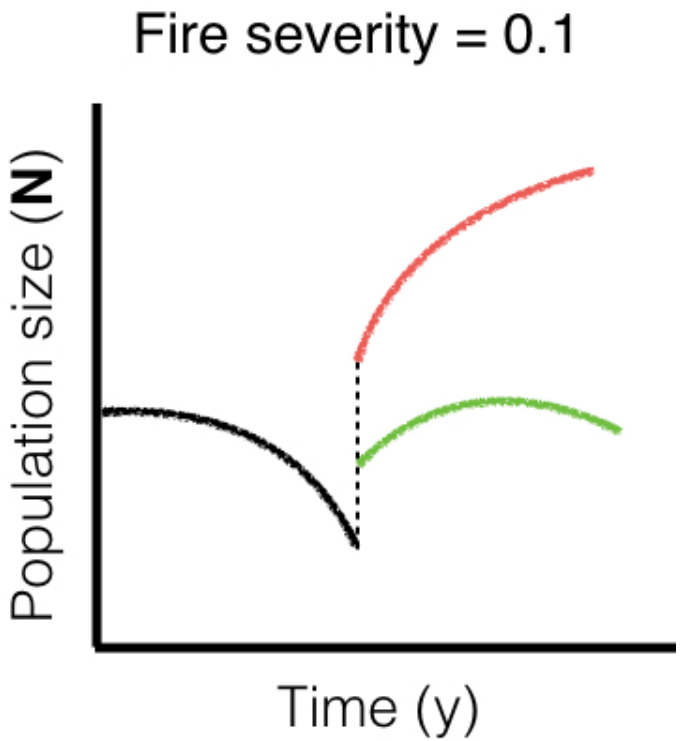
| Plant group | Key vital rates | Main threats | Offset ratios |
|---|---|---|---|
| Eucalypts | Mortality of early age classes | Fire, grazing, inbreed<br>Fragmentation is sev | |
| Acacia | Adult and seed mortality | High intensity fire | |
| Forbs | Adult mortality | Habitat fragmentation, fire, weeds | ≥ 7 |
| Grasses | Seed germination rates and adult mortality | Weeds, fire | ≥ 10:1 |

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

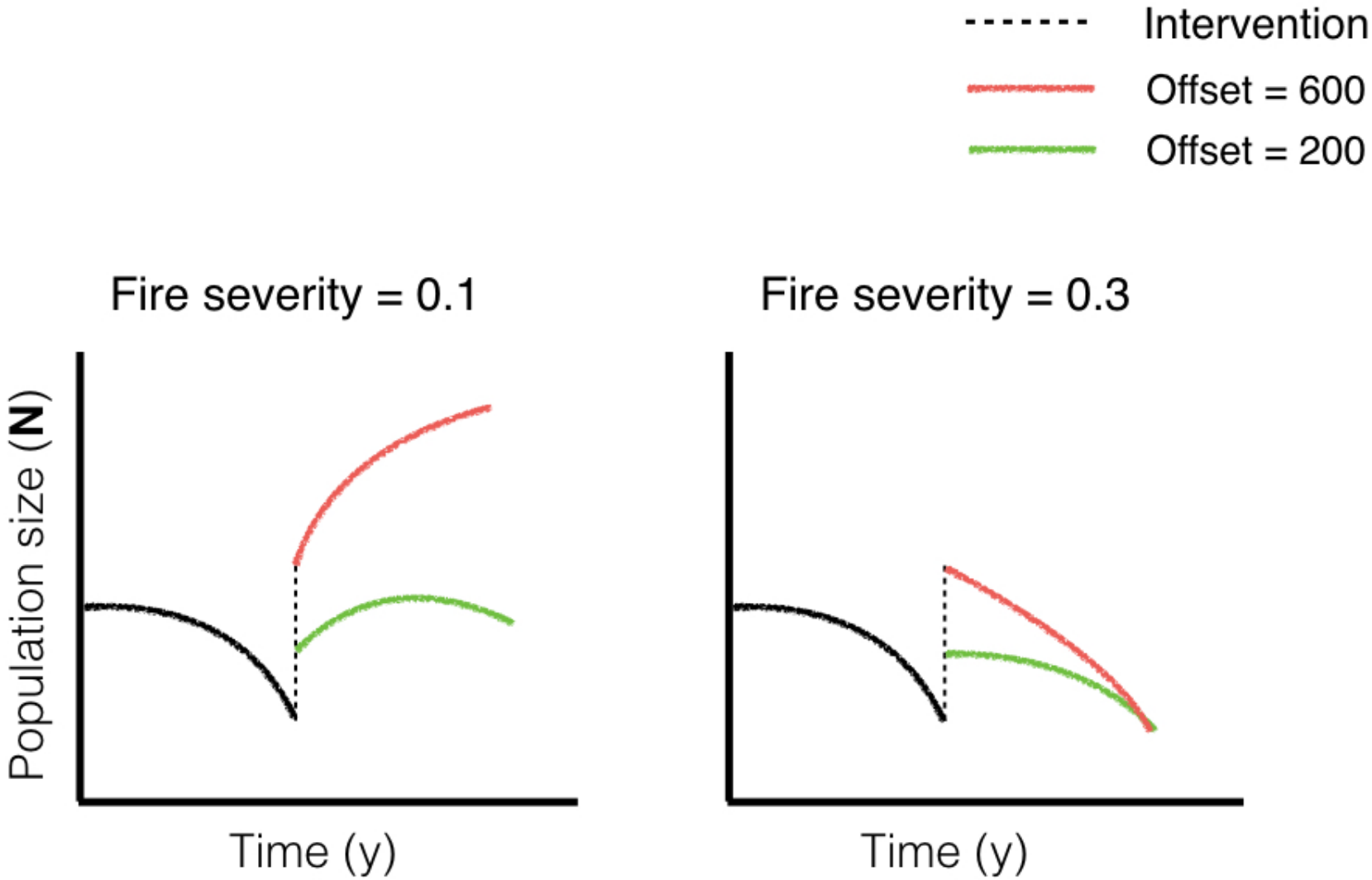
# General outcomes

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



# General outcomes



# 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

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.

# 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 leptorrhynchoides)* **example**:

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

**Ecology**:

- Endemic of grassland environments SE Australia

# Population size ≠ population viability

| | Stirling Ridge | Capital Circle | Captains Flat | Jerrabomberra | West Block |
|---|---|---|---|---|---|
| # Flowering plants | **70000** | **220** | **161** | **9** | **5** |
| Growth rate | **0.99** | **0.97** | **1.03** | - | - |
| $f_{SR}$ | **1.29** (0.23) | **1.94** (0.82) | **2.86** (0.78) | 0 | 0 |

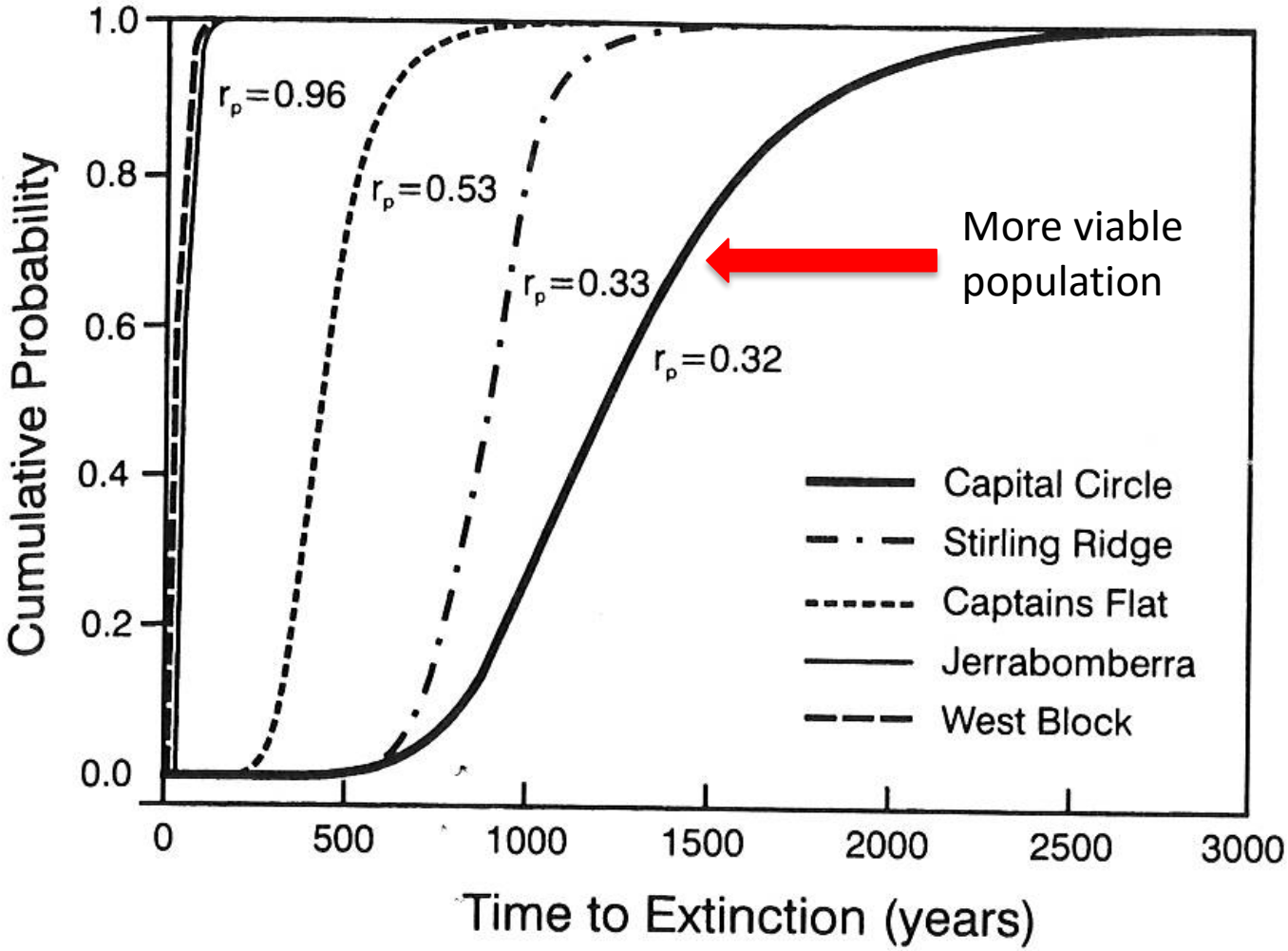
# Population size ≠ population viability

| | Stirling Ridge | Capital Circle | Captains Flat | Jerrabomberra | West Block |
|---|---|---|---|---|---|
| # Flowering plants | **70000** | **220** | **161** | **9** | **5** |
| Growth rate | **0.99** | **0.97** | **1.03** | - | - |
| $f_{SR}$ | **1.29** (0.23) | **1.94** (0.82) | **2.86** (0.78) | 0 | 0 |

# Population size ≠ population viability

| | Stirling Ridge | Capital Circle | Captains Flat | Jerrabomberra | West Block |
|---|---|---|---|---|---|
| # Flowering plants | **70000** | **220** | **161** | **9** | **5** |
| Growth rate | **0.99** | **0.97** | **1.03** | - | - |
| $f_{SR}$ | **1.29** (0.23) | **1.94** (0.82) | **2.86** (0.78) | 0 | 0 |

# Population size ≠ population viability



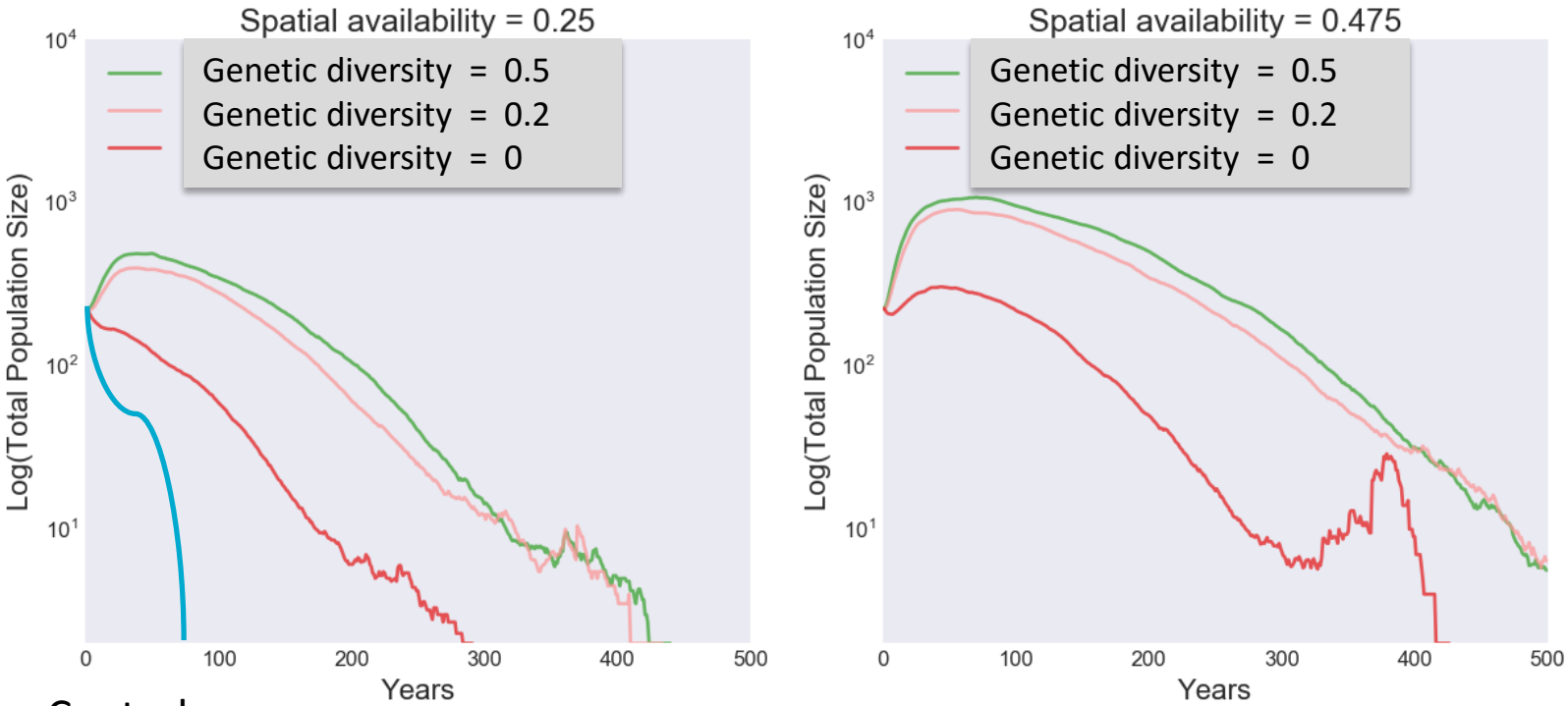

# Offsetting a perennial forb

| | Stirling Ridge | Capital Circle | Captains Flat | Jerrabomberra | West Block |
|---|---|---|---|---|---|
| # Flowering plants | **70000** | **220** | **161** | **9** | **5** |
| Growth rate | **0.99** | **0.97** | **1.03** | - | - |
| $f_{SR}$ | **1.29** (0.23) | **1.94** (0.82) | **2.86** (0.78) | 0 | 0 |

Assuming that the targeted population is declining

# Forbs – Spatial availability and genetic diversity

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




Control

# General recommendations

- Apply management actions tailored to each plant group as guidance to do population-offsetting 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.

# 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.

# 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

**Centre for Australian National Biodiversity Research/ National Research Collections of Australia**
Francisco Encinas-Viso

Research scientist

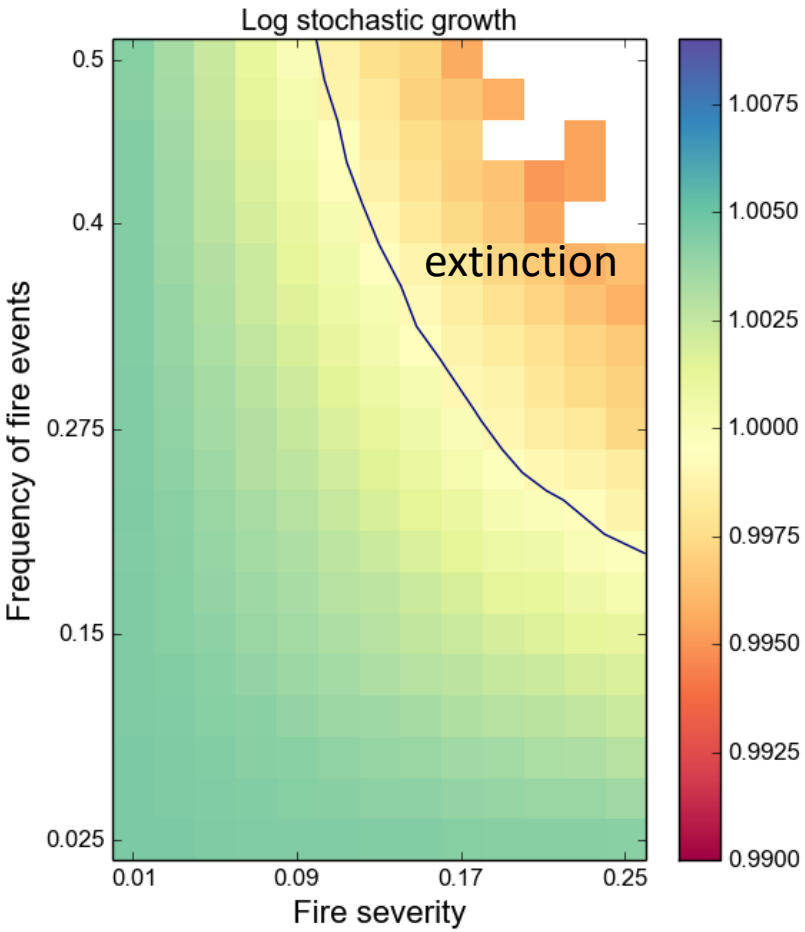
**t** +61 2 9123 4567
**e** francisco.encinas-viso@csiro.au

# Appendix

# Eucalypts- Fire effects

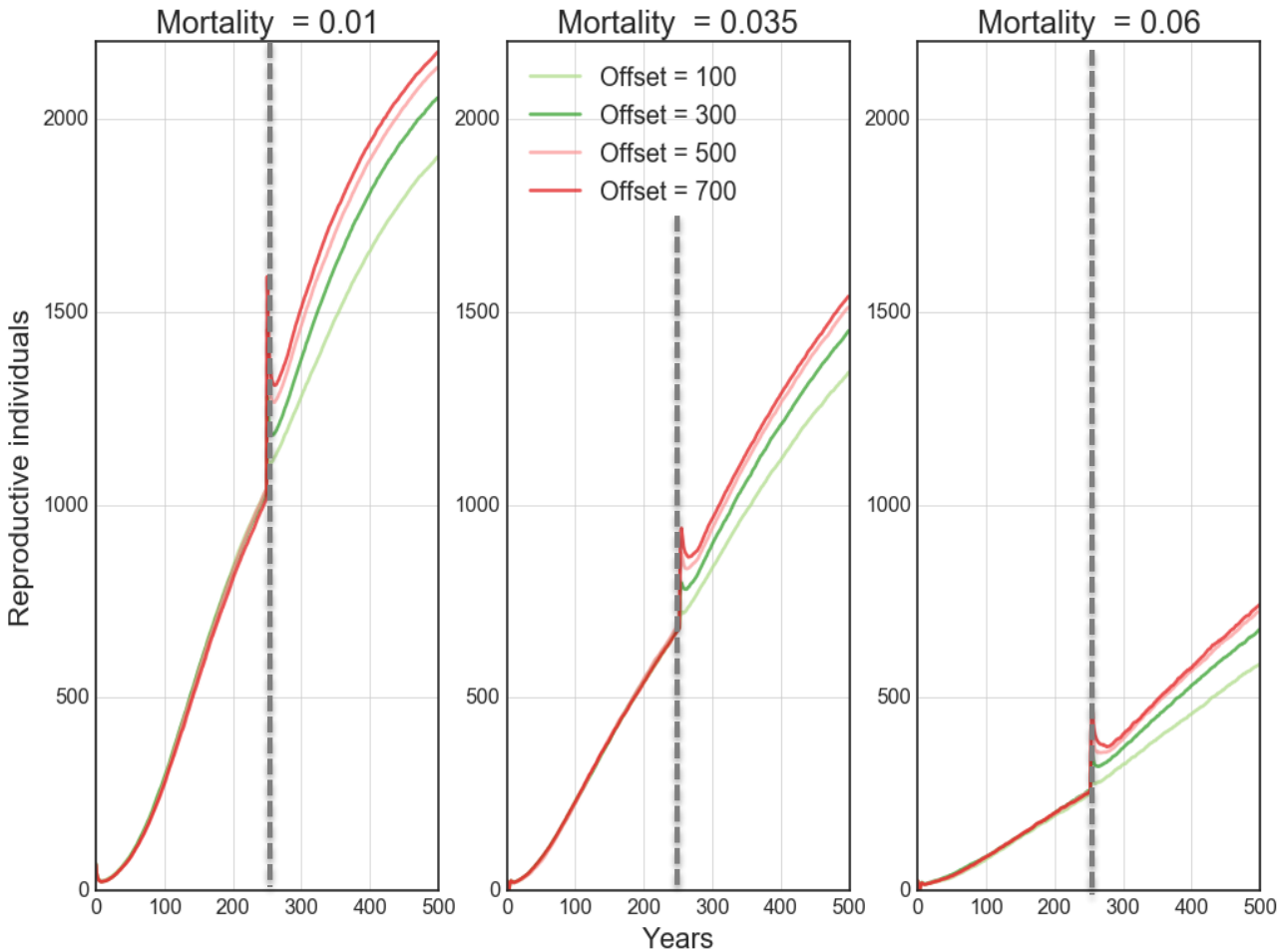
Increased population extinction:

If fire **severity is > 10-25%** and it 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.



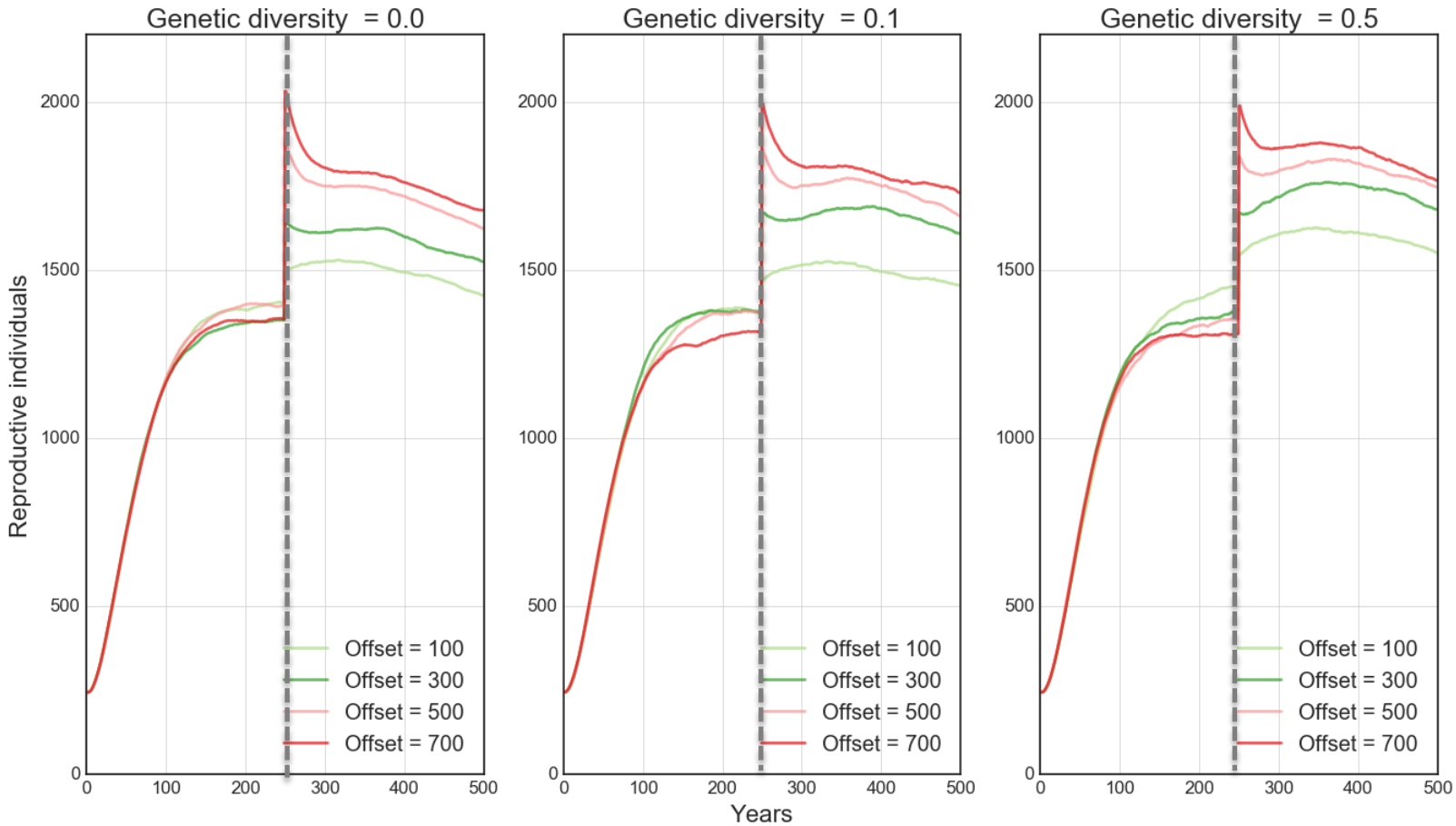
# Forbes

**Life-history traits:**

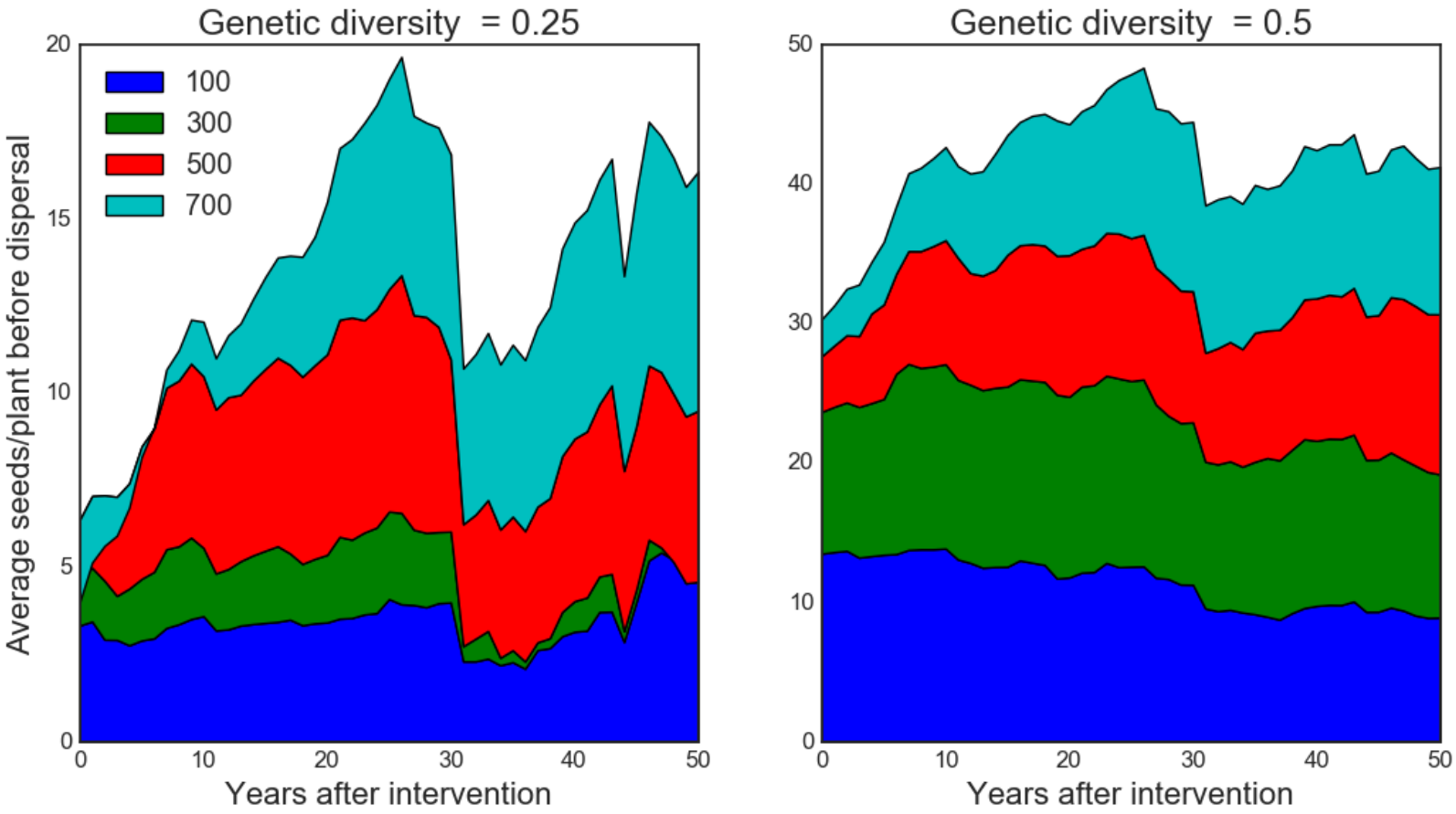
- Short-lived perennial (3-5 years)
- Insect-pollinated.
- Self-incompatible mating system (obligate outcrossers).
- Fecundity depending on mate availability (gene flow).

# Forbs – Offset and genetic rescue

**> 50 %** increase of viability when introduced genetic diversity **> 10 %**

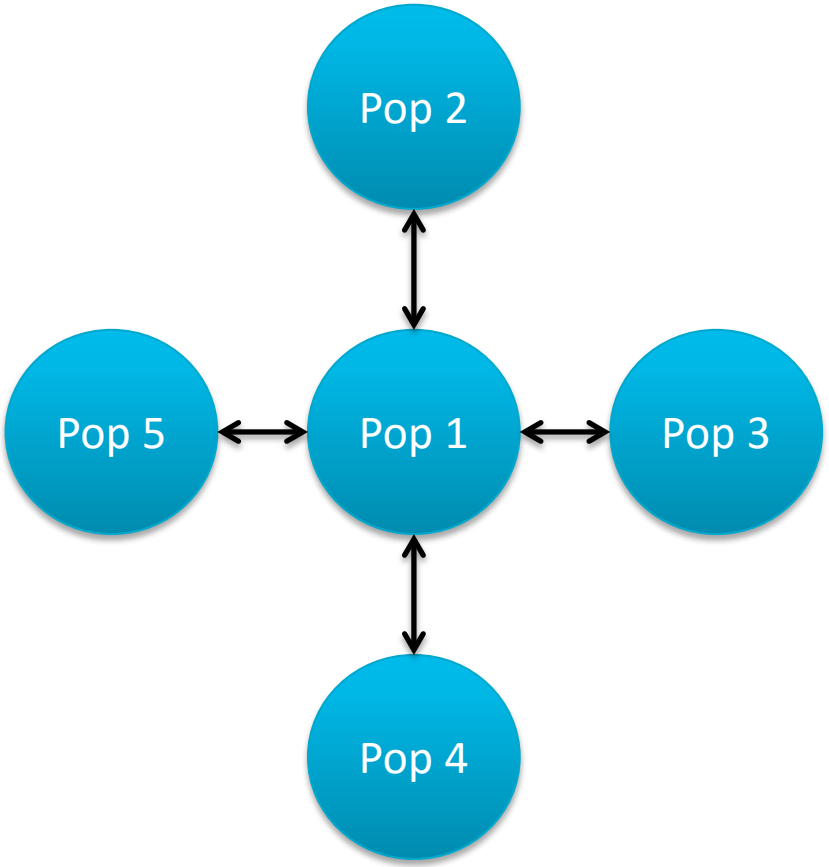


# Forbes – Offset and genetic rescue



# 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.