Modelling Plant Detectability using Failure Time Analysis

G.E. Garrard¹, B.A. Wintle², S.A. Bekessy¹, M.A. McCarthy³

¹School of Social Science & Planning, RMIT University
²School of Botany, University of Melbourne
³Australian Research Centre for Urban Ecology
Biodiversity Planning in Urban Fringe Landscapes

Re-imagining the Australian Suburb

www.re-imagining.org
Outline

• Introduction
  - Plant & animal detectability studies

• Failure Time Analysis

• Model & Simulation

• Discussion
  - Implications for threatened species
  - Future research
Detectability & Threatened Species

• Imperfect detection may lead to:
  - Inadequate survey effort
  - Poor/inappropriate management
  - Increased extinction risk

• This is true for plants & animals
Quantifying Detection Rates

• Why?
  - Determine minimum survey effort
  - Incorporate as a standard into threatened species legislation

• How?
Detectability Curves

Pr(detection| present) = 1 - (1 - d)^v

where:
  d = single visit detection probability
  v = number of visits

Source: Wintle *et al.*, 2005
Failure Time Analysis

• Survival, time-to-event analysis
• Time to event is important
• Applications include:
  – Industrial: time to failure
  – Medical: survival post-transplant
  – Insurance: survival to certain age
  – Ecology: arrival of insects to flowers
Failure Time Analysis

• Censored observations
  – An important feature
  – Allow the use of partial information
  – Occur when:

Failure time > Duration of study
Failure Time Analysis

• Exponential distribution
  – Constant hazard rate \( h(t) = \lambda \)
  – Mean detection time \( \bar{t} = 1/\lambda \)

• Likelihood \( l_i = \lambda^{\delta_i} \exp(-\lambda t_i) \)
  – Where \( \delta_i \) is detection status (0, 1) of species \( i \) at time \( t \).
Modelling

• Data simulation in R
  - Single species
  - $N = 10, 20, 30, \ldots, 100$

$$\overline{t} = \exp^{a + \beta x}$$

Where $x \sim \text{dnorm}(0,1)$, $a = 2.5$, $\beta = 1.25$
Modelling

- Modelled in WinBUGS
  - 1000 for each N
  - Test estimates of $\alpha$ and $\beta$

- Censored & uncensored
  - $\delta_i = 0$ when $t > 100$
Results

Dots are average estimates from 1000 runs, error bars are 95% CIs
Results

Censoring when $t \geq 100$

Dots are average estimates from 1000 runs, error bars are 95% CIs
Implications

- Failure time a useful way to determine flora survey effort
- Scientifically-based survey standards
- Greater transparency in EIAs
- Improved threatened species management
Future Research

• Further model testing

• Field studies
  - Grassland surveys, Melbourne
  - Plant & environmental variables
  - Seasonal variation
Acknowledgements

• Brendan Wintle
• Sarah Bekessy
• Michael McCarthy

Contact Details
Georgia Garrard
School of Global Studies, Social Science & Planning
RMIT University, Melbourne, Australia
georgia.garrard@mit.edu.au