Estimating search and control costs required to achieve weed eradication

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Outline

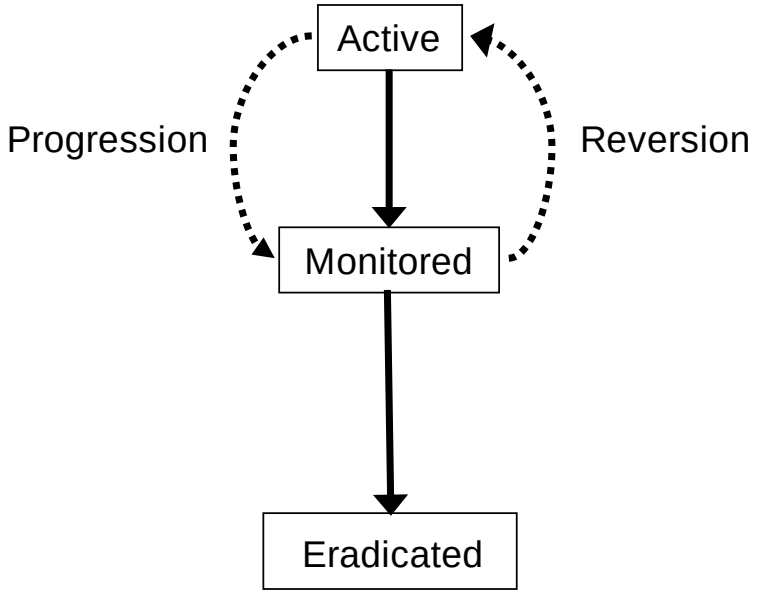
1. Eradication feasibility
2. The model of Panetta et al. (*in review*)
3. Model extension
4. Results
5. Future work

Eradication feasibility

- Eradication of pests and diseases can be a lengthy, difficult and costly process
- A goal that is often prescribed but seldom achieved
- Determine feasibility of eradication by estimating search and control effort required to eliminate all individuals from an area
  - For weeds, presence of persistent seed banks makes eradication even more difficult
- Decision makers need to consider both the amount of investment required and the period over which it needs to be maintained when deciding whether to commit to eradication
- A basis for estimating eradication programme duration based on simple data has been lacking

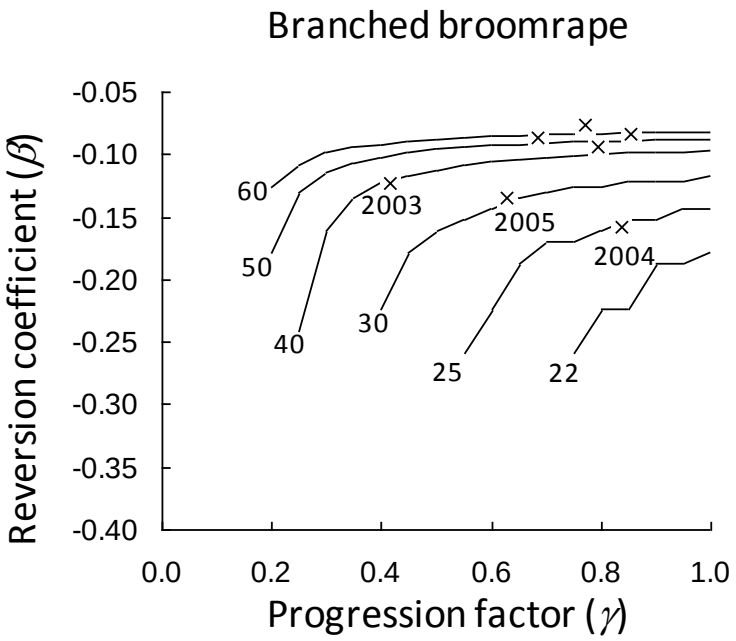
The model of Panetta et al. (*in review*)

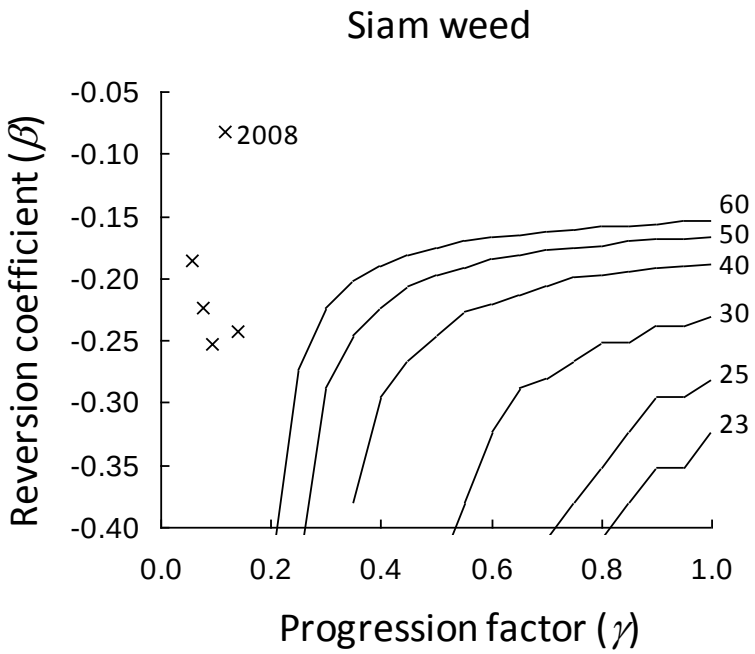
- Total infested area is in one of two states:
  - Active: weed is detectable above ground
  - Monitored: no recruits detected >=12 mths
- Model based on rates of (i) 'progression' and (ii) 'reversion'
- Progression: infested area changes from active to monitored status
- Reversion: infested area changes from monitored to active status upon germination
- Eradication occurs when no detections for time >max seed longevity



The model of Panetta et al. cont'd

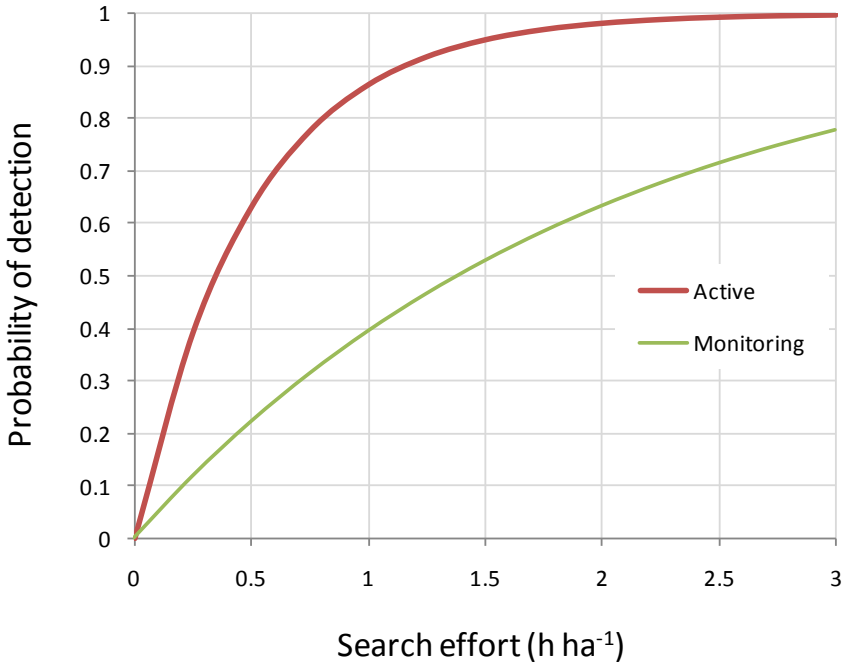
- Applied to eradication of branched broomrape in SA, Siam weed in Qld
- Results: branched broomrape : +62 years to eradication
  Siam weed: +248 years to eradication



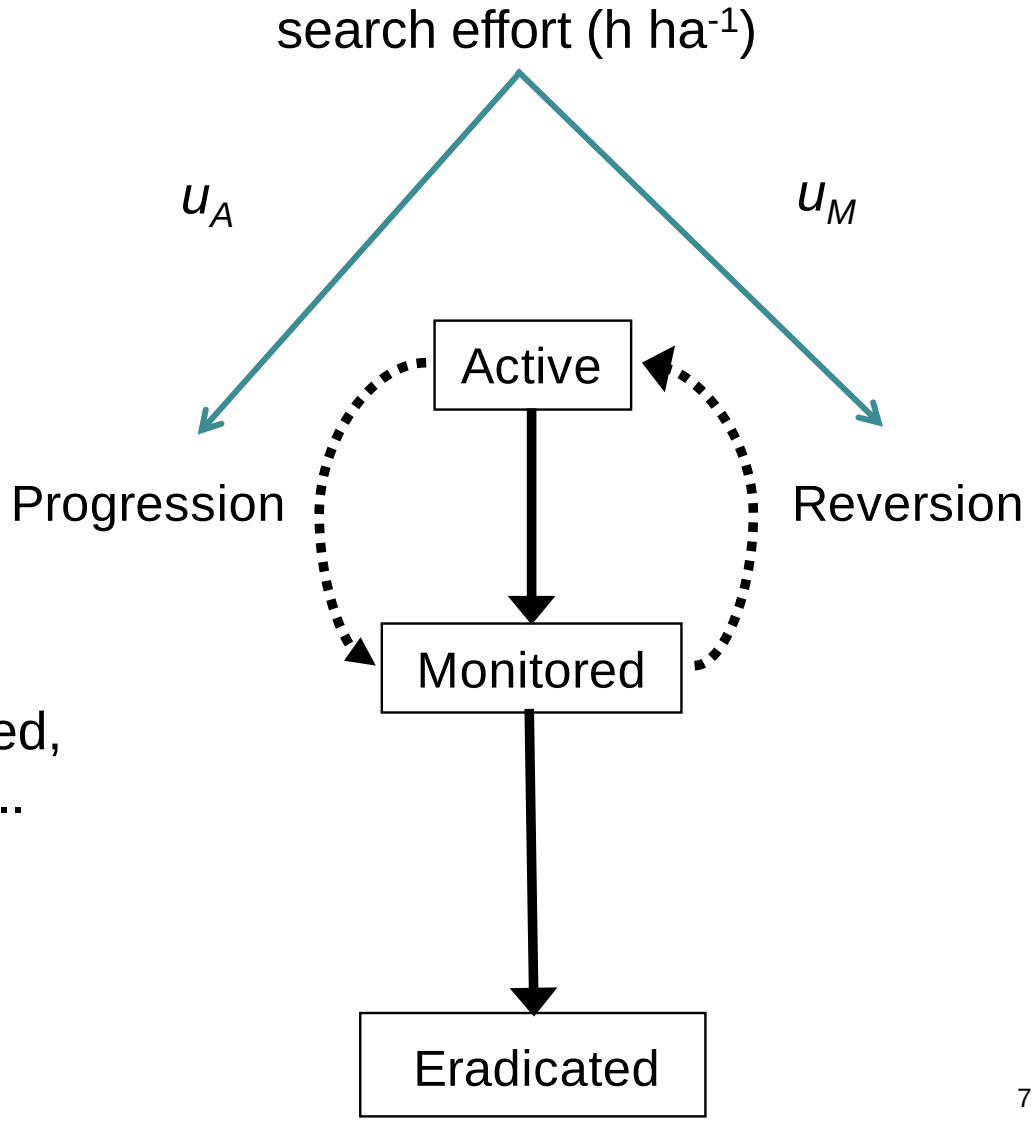


Model extension

- Explores cost of achieving particular levels of progression and reversion by relating them to search and control effort
- Search theory allows the probability of detection to be related to search effort u_i ($i = A, M$):



Model extension



Subject to: detectability, speed, control effectiveness.....

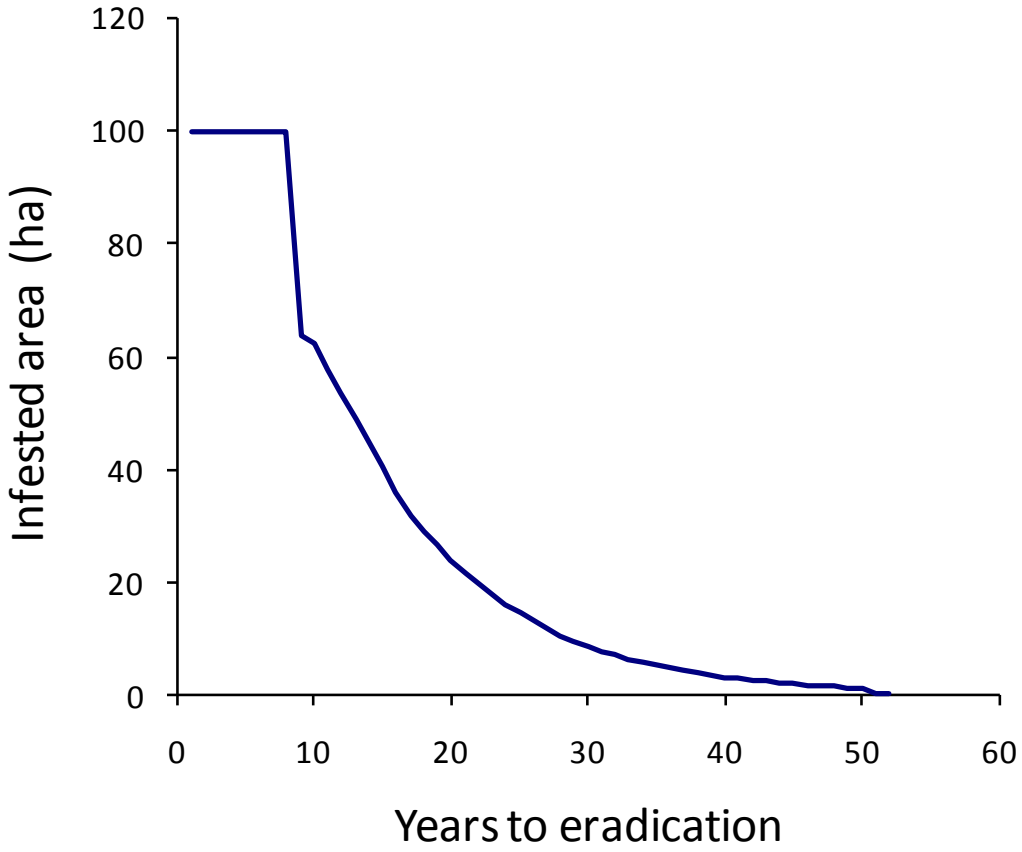
Outputs: time to eradication, total cost

Parameter values

Economic parameters		
u_A, u_M	0.25 – 12	Search effort (h ha^{-1}) in the active and monitoring stages
L	25	labour costs for searching ($ h^{-1})
A	100	Initial area of infesation (ha)
w_A, w_M	272.40	Control costs ($ ha^{-1}) in the active and monitoring stages
C_A	143,231	Annual administration costs ($)
C_R	37,715	Annual Research & Communication costs ($)
δ	0.06	Discount rate
Search parameters		
p_{KA}	0.98	Probability of kill in the active stage
p_{KM}	0.99	Probability of kill in monitored stage
S	1000	Search speed (m h^{-1})
R_A	20	Detectability in the active stage (m)
R_M	5	Detectability in the monitoring stage (m)
Demographic parameters		
HL	2	Seed half life (y)
Calculated parameters:		
C_S		Search costs ($ ha^{-1})
p_{FA}		Probability of find in the active stage
p_{FM}		probability of find in the monitoring stage
G		Germination rate

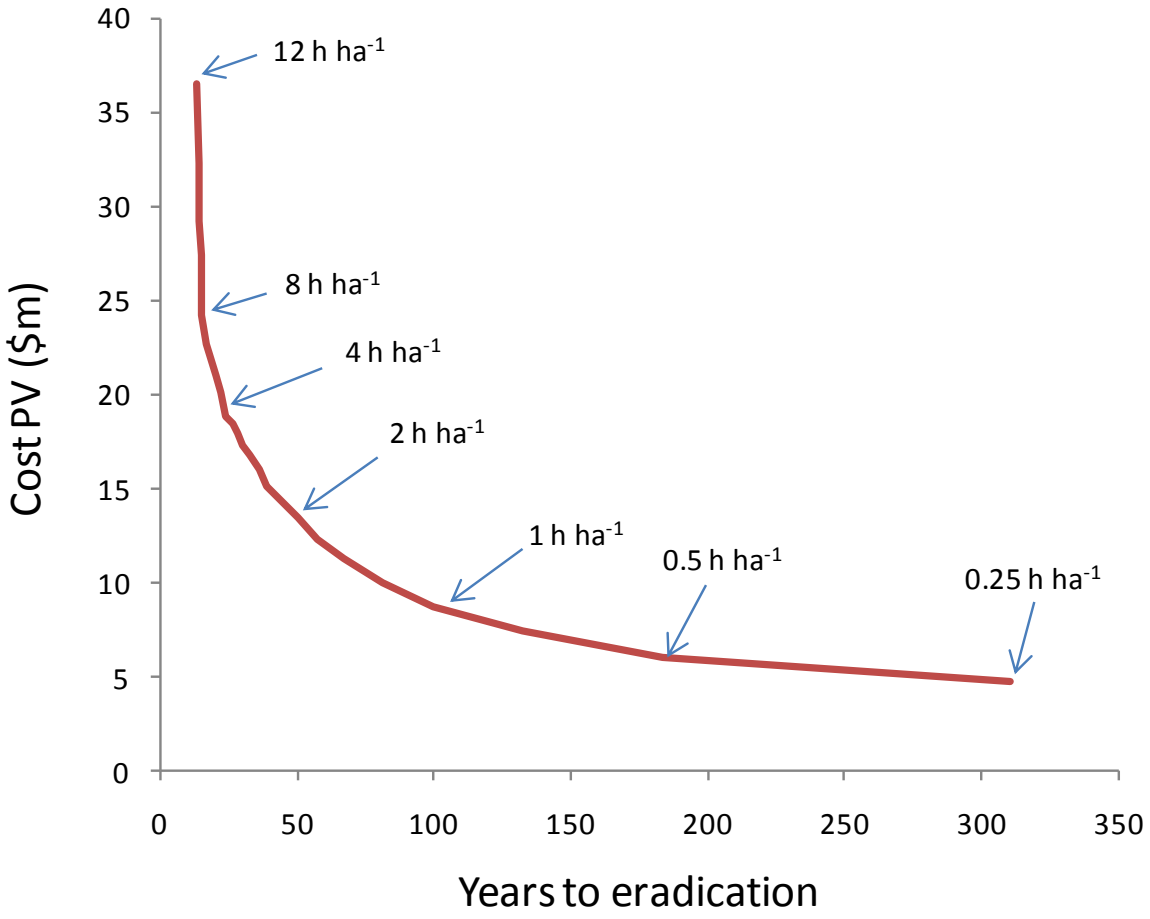
Results: achieving eradication

- Eradication occurs when total number of hectares < 1 at the site



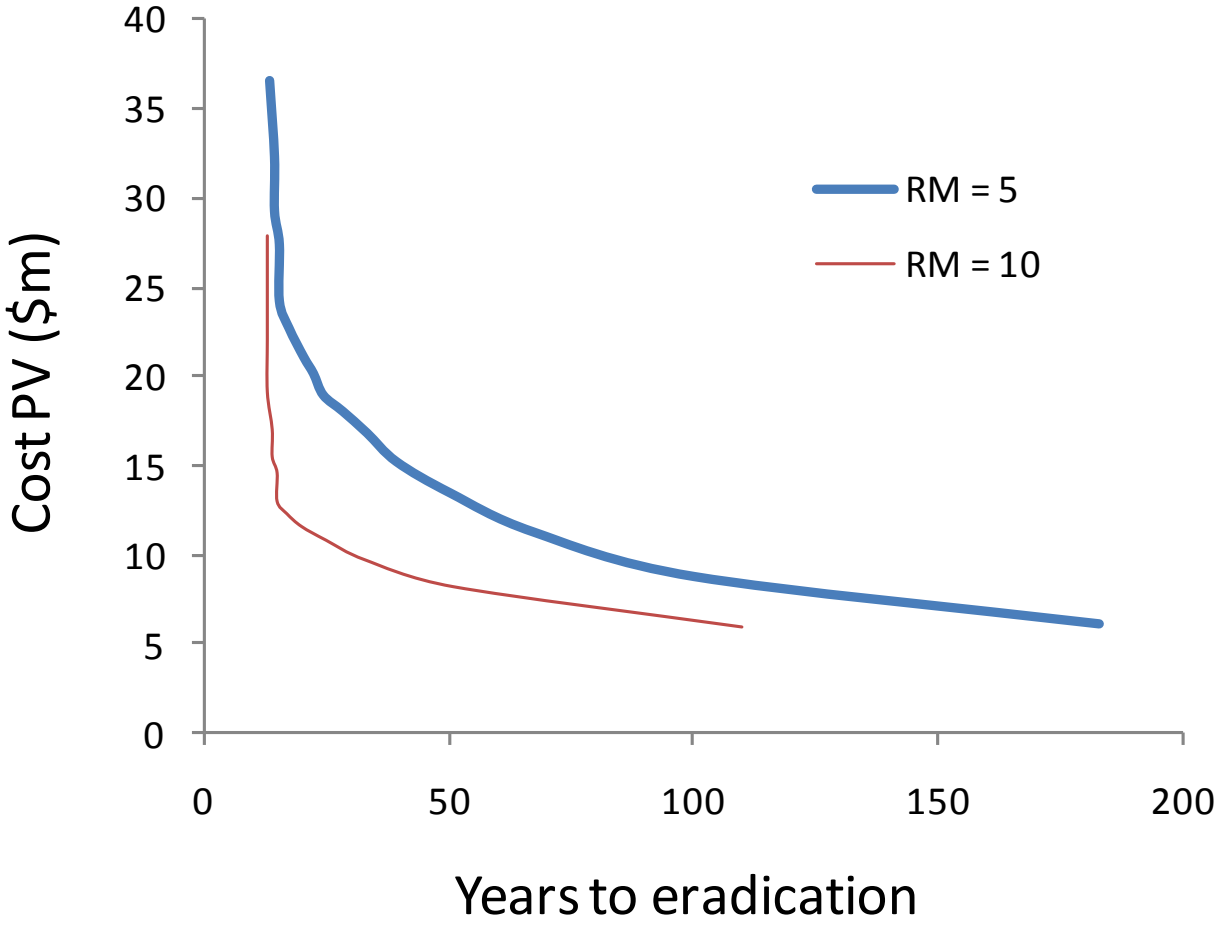
$u_A = u_M = 2\text{h ha}^{-1}$

Results: achieving eradication



- Minimum possible eradication time: 13 years for a search effort of 12 h ha^{-1}

Results: achieving eradication



Future work

- Incorporate natural attrition of seed bank
- Consider heterogeneous infestations that make up the total infested area
- Consider including new infested area
- Include uncertainty in parameter values
- Apply to an actual eradication case study – Siam weed, branched broomrape, orange hawkweed

Panetta, F.D., Cacho, O.J., Hester, S. and Sims-Chilton, N. (*in review*) Estimating and influencing the duration of weed eradication programmes. *Journal of Applied Ecology*.