Evaluating Progress in Weed Eradication Programs

Dane Panetta\textsuperscript{1,2}, Simon Brooks\textsuperscript{1,2} and Roger Lawes\textsuperscript{1,3}

\textsuperscript{1}CRC for Australian Weed Management
\textsuperscript{2}Biosecurity Queensland, Department of Primary Industries and Fisheries
\textsuperscript{3}CSIRO Sustainable Ecosystems
Eradication: definition

The elimination of every single individual of a species from an area in which recolonisation is unlikely to occur
There is a need to evaluate progress towards the eradication objective in order to distinguish programs that are ‘on track’ from those that are destined to fail to meet this objective.
Evaluating progress: Criteria

- Delimitation
- Containment
- Extirpation
The extirpation criterion

Two phases:

- *Active control* (must prevent reproductive escape)
- *Monitoring* (begins when weed has not been detected for 12 months)
- Infestations revert from monitoring to active upon further detection
Reproductive escape: Effects of further input into seed banks

_Crupina vulgaris_: persistence v. seed input

![Graph showing the relationship between seed bank longevity and seeds per m².](image)

*Figure 2.* Years required to deplete viable common crupina achenes from the soil with 99.9% (--), 97% (---), and 95% (----) annual control.

_Zamora et al. 2000_
**Helenium amarum** reproductive escape (*)

![Graph showing the number of visits from 1953 to 1988.](image)

- **Number of visits**
- **Year**


- Enters monitoring phase

Biosecurity Queensland
Evaluating progress towards eradication

Because containment failure difficult to prove, model focuses on conformity with delimitation and extirpation criteria
Delimitation measure for year $n$ ($D_n$)

$$D_n = \frac{A_d}{P_n + \log(A_s + 1)}$$

Newly detected area
Delimitation measure for year $n$ ($D_n$)

$$D_n = \frac{A_d}{P_n + \log(A_s + 1)}$$

- $A_d$: Newly detected area
- $P_n$: Proportional change in infested area between year $n-1$ and year $n$
Delimitation measure for year $n$ ($D_n$)

$$D_n = \frac{A_d}{P_n + \log(A_s + 1)}$$

- **$A_d$**: Newly detected area
- **$P_n$**: Proportional change in infested area between year $n-1$ and year $n$
- **$A_s$**: Area searched
Extirpation measure for year $n\ (E_n)$

$E_n = \text{mean of frequency distribution of time since last detection (monitoring profile)}$

$E_n$ should be interpreted in terms of maximum seed longevity

$E_n = 0.2$

$E_n = 2.35$

$E_n = 8.35$
Eradograph (ideal situation)

Panetta and Lawes, in press
Deviations from the ideal: appropriate responses

- Increase search & control effort
- Increase search effort
- Increase control effort
- Maintain status quo

Biosecurity Queensland
Application: Branched broomrape (*Orobanche ramosa*) in South Australia

- Serious root parasite that threatens export markets
- Detected in 1992; a 70 x 70 km quarantine zone declared in 1999
- Seeds persist 10-15 yrs
- Dispersal by wind, machinery and stock
- Program expenditure to date $23 M
Total infested area

Cumulative infested area (ha $\times 10^3$)

Year

1999 2000 2001 2002 2003 2004 2005 2006

Rainfall May-Oct (mm)

0 50 100 150 200 250 300
Monitoring profiles

Years since last detection

Frequency

2000
n = 256

2001
n = 387

2002
n = 399

2003
n = 535

2004
n = 552

2005
n = 579

2006
n = 632
Eradograph

23% increase in infested area
9.4% increase in infested area

Max. seed persistence ~12 y
Eradication progress – *Mikania micrantha*

![Mikania micrantha plant](image)

![Graph showing eradication progress](image)
Eradication progress – *Limnocharis flava*

![Image of Limnocharis flava plant]

**Graph:**
- **Y-axis:** Area (ha)
- **X-axis:** June-December 2001 to June-December 2007
- **Legend:**
  - Infested area
  - E

**Progress Chart:**
- The area affected by the infestation shows a steady increase from 2001 to 2007, with a significant rise in the first year and a gradual increase in subsequent years.
# Source of detection of infestations of mikania and limnocharis

<table>
<thead>
<tr>
<th>Source of detection</th>
<th>Tracing information</th>
<th>Targeted search</th>
<th>Non-targeted search</th>
<th>Extension</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mikania</td>
<td>3</td>
<td>6</td>
<td>4</td>
<td>1</td>
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<tr>
<td>%</td>
<td>21.4</td>
<td>42.8</td>
<td>28.6</td>
<td>7.1</td>
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<td>Limnocharis</td>
<td>4</td>
<td>0</td>
<td>8</td>
<td>6</td>
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<tr>
<td>%</td>
<td>22.2</td>
<td>0</td>
<td>44.4</td>
<td>33.3</td>
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<tr>
<td>Total</td>
<td>7</td>
<td>6</td>
<td>12</td>
<td>7</td>
</tr>
<tr>
<td>%</td>
<td>21.9</td>
<td>18.8</td>
<td>37.5</td>
<td>21.9</td>
</tr>
</tbody>
</table>
When to stop looking?

• If stop too early, run risk that target will escape and cause damage
• If continue for too long, incur unnecessary expense
• Minimise net expected cost (NEC)
Optimal number of consecutive zero surveys \((n^*)\)

\[
n^* = \frac{\ln \left( \frac{-C_s}{C_e \times \ln(r)} \right)}{\ln(r)}
\]

- \(n^*\): Optimal number of surveys
- \(C_s\): Cost of survey
- \(C_e\): Cost of escape
- \(\ln(r)\): Probability not detected but present

Regan et al. 2006
NEC as a function of the number of consecutive absent annual surveys for $Cs/Ce = 1/1000$

undiscounted

5% discount rate
Conclusions

• Data needs fairly simple to evaluate progress towards eradication objective

• **Timely delimitation important - not possible if inadequate investment in detection (active and passive)**

• Must prevent seed production consistently if extirpation criterion is to be met
Thanks

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