

MoniTool

An eradication-monitoring tool

Software Manual

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Hester S. And Herbert K. *MoniTool: an eradication-monitoring tool, Software Manual*, Australian Centre of Excellence for Risk Analysis Project 1004A, December 2011.

ACKNOWLEDGEMENTS

This report is a product of the Australian Centre of Excellence for Risk Analysis (ACERA). In preparing this report, the authors acknowledge the financial and other support provided by the Department of Agriculture, Fisheries and Forestry (DAFF), the University of Melbourne, Australian Mathematical Sciences Institute (AMSI) and Australian Research Centre for Urban Ecology (ARCUE).

The authors are grateful to the following people for advice and support throughout the construction of this manual: Cindy Hauser, Fran Hausmann, Paul Pheloung, and Victorian State Prohibited Weed Officers and Victoria DPI colleagues (Neil Smith, Karen Herbert, Sarah Partington, Erin Cox, Michael Hansford, Sarah Brunel and Emily Hart) who attended a meeting on 27th October at Attwood, Melbourne to discuss the eradication-monitoring tool.

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1 Background

Eradicating pests and diseases can be a lengthy process. Eradication programmes need to be regularly reassessed to check progress towards the eradication objective and whether an alternative management action may be preferable. Panetta and Lawes (2005) outline three criteria that can be used to evaluate weed eradication programmes: delimitation, containment and extirpation. *Delimitation* - establishing the full spatial extent of a pest or disease incursion - is described by Panetta and Lawes (2005) as the fundamental criterion by which to evaluate an eradication programme. If an incursion is not delimited properly then its expansion may continue regardless of control that might be applied to known areas of incursion. *Containment* refers to preventing further spread of the incursion, and *extirpation* refers to the elimination of individual infestations within the delimitation area. Because containment can be difficult to prove, Panetta and Lawes (2005) suggest that checking conformity to the delimitation and extirpation criteria will be sufficient to assess progress toward the eradication objective.

Ideally, delimitation would be achieved as quickly as possible following detection of an incursion, because the invasive species continues to spread as searching takes place, increasing the probability of escape, the extent of the invasion and the ultimate effort required to manage the invasion (Leung *et al.* 2010). In reality though, delimitation for most invasive pests and diseases does not occur rapidly, but is a gradual process.

To assist biosecurity managers to monitor and illustrate the progress of extirpation/eradication attempts, *MoniTool* has been developed from a concept that combines delimitation and extirpation, as initially suggested by Panetta and Lawes (2007) and recently revised by Burgman *et al.* (submitted). The tool produces a graphical illustration of progress over time against both these measures.

1.1 The eradication-monitoring concept

To assess progress towards eradication, Panetta and Lawes (2007) developed the 'eradograph' concept, which is based on combining measures of the progress towards delimitation (*D*) and extirpation (*E*). The original eradograph concept has recently been revised by Burgman *et al.* (submitted) in order to correct incompatibilities in the units that were used to measure *D* and *E*. Whilst the revision retains the original intention of Panetta and Lawes (2007), it modifies the construction of the eradograph so that the axes of the graph are interpretable and biologically meaningful. The following discussion draws heavily on the recent revision.

An example of an eradication monitoring graph produced by the revised method is given in Figure 1. The variable D is the ratio of new infested area discovered in a given time period and the area searched in that time period. Progress towards delimitation would be expressed as a decrease in D , caused by a stable (or reducing) amount of new infested area as area searched increases. The measure of extirpation, E , is derived from the 'monitoring profile' of infestations – the frequency distribution of time since the most recent detection of the weed at infested sites. More specifically, E in a given year is calculated as the difference between the mean of the frequency distribution of the time since the most recent detection for all populations, including those where eradication has been declared, and the time it takes to conclude that a population has been extirpated (Burgman et al. (in press)).

In the initial stages of an eradication programme we might expect large values of D as surveillance activities are initiated and many new infestations are detected. Ideally, as the programme progresses, and given appropriate levels of searching, the value of D would reduce and eventually reach zero at some infested area, indicating successful delimitation. If treatment of the weeds that are detected is effective and seed production is not allowed to occur, eventually no plants will be detected at infested sites although seeds or other propagules may still be present in the soil. When this is the case, these sites enter the 'monitoring' phase. The larger the number of sites in this phase and the longer the amount of time spent in this phase, the smaller the value of E . Extirpation can be declared at individual sites when $E = 0$ at some infested area.

In contrast to the eradograph of Panetta and Lawes where the measure of delimitation was plotted against extirpation, in the revision both measures are plotted against total area ever infested (Figure 1). The arrow in Figure 1 thus demonstrates the ideal trajectory of both lines. It should be noted that being 'infested' is treated as a permanent state, meaning that data points for successive years cannot have lower x-axis values because the total area ever infested can never decrease (Burgman et al. in press).

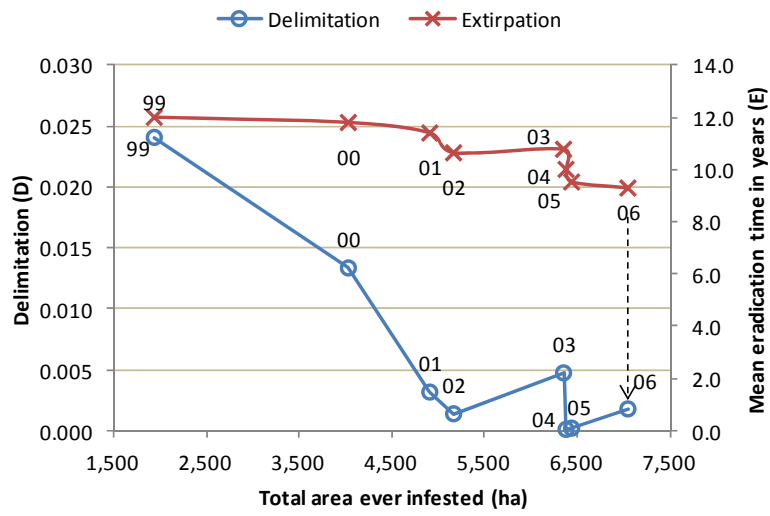


Figure 1 An example of an eradication-monitoring graph

2 The eradication-monitoring tool

2.1 Getting started

A test (beta) version of the revised eradograph tool has been developed in Microsoft Excel using the Visual Basic programming language and is available upon request from ACERA at <http://www.acera.unimelb.edu.au/>. To use the tool, users must ensure that macros are enabled in Excel. Data from the branched broomrape eradication programme in South Australia, as given in Panetta and Lawes (2005, 2007), are used to illustrate use of the tool in this manual and are supplied with the tool.

2.2 Users input information into a series of worksheets in Excel. Steps 2.3 to 2.6 guide users through this process.

2.3 Initial assumptions

As the initial step to using this tool, the user must enter the following information under the *Assumptions* heading on the worksheet titled *eradograph* (A in Figure 2):

- the year in which the eradication programme commenced (e.g., 1999);
- the latest year for which data is available (e.g., 2006); and
- Maximum seed longevity - the average time (in years) since the final detection after which it may safely be concluded that the population has been extirpated (e.g, 12). This is often, but not always, equivalent to the seed longevity.

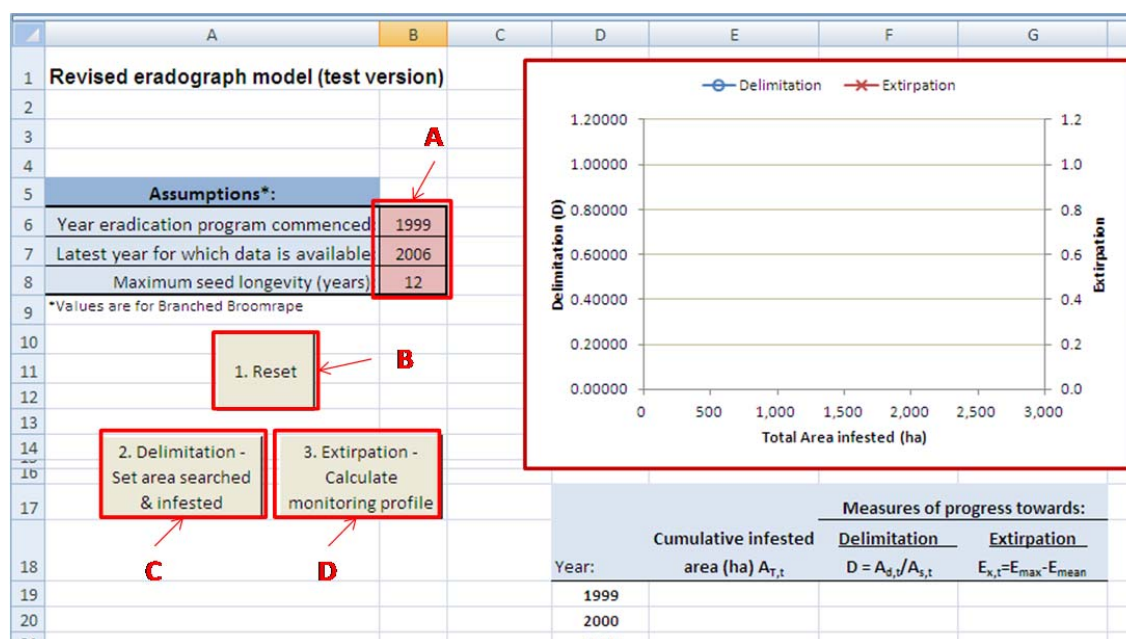


Figure 2. A screen view of the *eradograph* sheet

2.4 Removing previous runs

Information from previous runs of the tool can be cleared by pressing the button called

1. Reset (B in Figure 2).

2.5 Set area searched and infested

In order to calculate progress towards delimitation, the user must enter values for $A_{s,t}$ (area searched in a given year, t , of the programme) and $A_{d,t}$ (area of infestation newly detected in year t). To do this, these steps should be followed:

1. Press the button called **2. Delimitation - Set area searched & infested** (C in Figure 2). This takes the user to a new sheet called *Area*, containing preset row and column headings, as well as columns containing the calendar year and which year in the eradication programme this particular year relates to.
2. Insert values for $A_{s,t}$ and $A_{d,t}$ for particular years under the relevant column headings (A in Figure 2). Information provided in these cells is used by a formula in column F to automatically calculate $A_{T,t}$ (cumulative infested area in year t) as shown in B, Figure 3.
3. Press the button **Calculate D** to calculate the delimitation measure D . The user will be returned to the *eradograph* sheet. Values of D and $A_{T,t}$ for each year now appear in columns E and F of this sheet, beginning at row 19 (see Figure 2).

Year (t) ^a	Year in programme (n)	$A_{s,t}$ (ha)	$A_{d,t}$ (ha)	$A_{T,t}$ (ha)
1999	0	80,400	1,935	1935
2000	1	157,000	2,095	4030
2001	2	279,000	879	4909
2002	3	188,000	257	5166
2003	4	251,000	1,187	6353
2004	5	310,000	27	6380
2005	6	319,000	60	6440
2006	7	344,000	608	7048

Figure 3. Screen view of the *Area* sheet where data on area searched and newly detected area is entered.

2.6 Uploading the monitoring profile

The monitoring profile provides information on the length of time since a given infestation has been actively monitored, and is used in the calculation of the extirpation measure. To enter this information, follow these steps:

1. Press the button called **3. Extirpation - Calculate monitoring profile** found in the *eradograph* sheet (D in Figure 2). This opens a new sheet called *mf*, enters appropriate row and column headings, and clears any existing information (Figure 4).

Column headings are the calendar years of the eradication programme, and row headings are 'years since active' and will extend from 0 to the number of years that the programme has been running.

2. Enter values in each cell that represent, for the particular calendar year, the number of infestations that have been in the monitoring stage for the corresponding years since active.

For example, the value of 205 (A in Figure 4) indicates that in the year 2000 there were a total of 205 sites that were being actively managed (so in the monitoring stage for 0 years). The value of 51 (B in Figure 4), indicates that in the year 2000 there were a total of 51 sites where active treatment had not been applied for one year – ie. these sites had been in the monitoring stage for 1 year.

3. Press the button called **Calculate $E_{x,t}$** . Values for E will be calculated and entered next to the values for D on the *eradograph* sheet, and the user will be returned to this sheet.

	A	B	C	D	E	F	G	H	I	J
1	Calculating $A_{e,t}$ from monitoring profiles									
2										
3										
4										
5										
6										
7										
8										
9										
10										
11										
12										
13										
14										
15										

Number of sites per year in each 'years since active' category:								
Years since active:	1999	2000	2001	2002	2003	2004	2005	2006
0								
1								
2								
3								
4								
5								
6								
7								

Number of sites per year in each 'years since active' category:								
Years since active:	1999	2000	2001	2002	2003	2004	2005	2006
0		A 205	194	52	273	66	122	145
1		B 51	155	180	24	243	46	95
2			39	140	107	14	191	32
3				28	107	105	12	177
4					24	105	93	6
5						19	93	76
6							23	88
7								13

Figure 4. Screen view of the *mf* sheet

2.7 The eradication-monitoring graph

Following completion of step 2.6, an eradograph is automatically generated (Figure 5).

If the eradograph fails to plot check that the axis labelling is set to automatic (to do this, right click on each axis, select **Format axis**, then under **Axis options**, set each of the 4 options to **Auto**).

Data labels showing years must be manually inserted into the graph each time a new eradograph is developed (to do this, right click on data points in graph so that they are all highlighted, then select **Add data labels**, and finally click on each label that appears and change it to the appropriate year). It may also be necessary to change the axis settings to improve the readability of the graph.

The original data from Panetta and Lawes were plotted in Figure 5 using the revised equations. The graph shows that both delimitation and extirpation are progressing, albeit slowly, towards the ideal of $D=0$ and $E=0$.

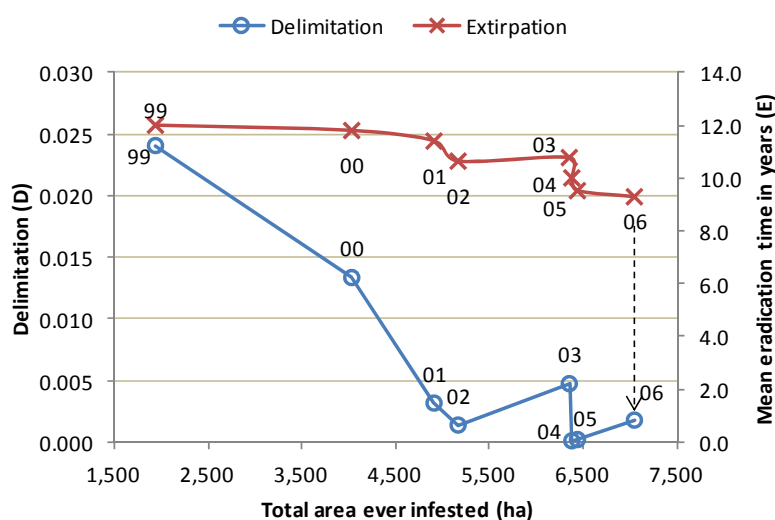


Figure 5. The branched broomrape data of Panetta and Pawes (2007) applied to the revised eradograph-monitoring tool. Data labels are years and the arrow represents the ideal trajectory of each line.

2.8 Implications for future management of a weed

The eradication-monitoring graph can be used to inform future management as follows:

- Curves for both extirpation and delimitation that are heading towards the bottom right of Figure 5 indicate that management is effective.
- A delimitation curve that is heading towards the upper right quadrant suggests that increased search effort should be considered.
- An extirpation curve that is heading towards the upper right quadrant suggests that increased control effort should be considered.

3 References

Burgman, M.A., McCarthy, M.A., Robinson, A., Hester, S.M., McBride, M.F., Elith, J. and Panetta, F.D. (accepted) Improving decisions for invasive species management: reformulation and extensions of the Panetta-Lawes eradication graph. *Diversity and Distributions*.

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