CRC for Australian Weed Management #13
Technical Series

Weeds of pastures and field crops in Tasmania: economic impacts and biological control

By J.E. Ireson, J.T. Davies, D.A. Friend, R.J. Holloway, W.S. Chatterton, E.I. Van Putten and R.E.C. McFadyen

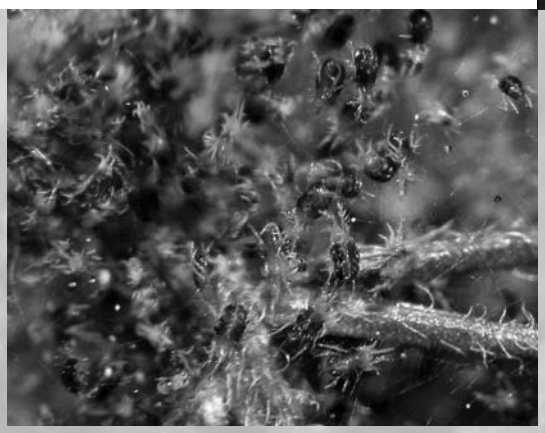
CRC Weed management

Technical series #13 • Weeds of pastures and field crops in Tasmania: economic impacts and biological control

CRC for Australian Weed Management #13

Technical Series

Weeds of pastures and field crops in Tasmania: economic impacts and biological control



By J.E. Ireson[1], J.T. Davies[2], D.A. Friend[3], R.J. Holloway[1], W.S. Chatterton[1], E.I. Van Putten[4] and R.E.C. McFadyen[5]

[1] Tasmanian Institute of Agricultural Research, 13 St John's Avenue, New Town, Tasmania 7008; john.ireson@dpiw.tas.gov.au

[2] Department of Primary Industries, Frankston, Victoria 3199

[3] Tasmanian Institute of Agricultural Research, Mt Pleasant Laboratories, Prospect, Tasmania 7250

[4] School of Economics, University of Tasmania, Private Bag 85a, Hobart, Tasmania 7001

[5] CRC for Australian Weed Management, 80 Meiers Road, Indooroopilly, Queensland 4068

CRC Weed management

Acknowledgments

We thank the CRC for Australian Weed Management and the Tasmanian Institute of Agricultural Research for their financial support for this project. We also thank all the landholders who took part in the weed survey and the Tasmanian Farmers and Graziers Association and DairyTas for supplying the information which enabled these landholders to be contacted. Information on assessing the cost of weed control in Tasmanian pastures and field crops was provided by Peter Ball, Andrew Bishop, Michelle Buntain, Hugh Griffiths and Mike Hart (Department of Primary Industries and Water, Tasmania), Adrian Geard (Tasmanian Alkaloids), Geoff Dean (Tasmanian Institute of Agricultural Research), Tim Groom (Botanical Resources) and David Sterling (Simplot Australia). We would also like to thank Jamie Cooper, Andrew Crane, Christian Goninon and Sandy Leighton (Department of Primary Industries and Water, Tasmania) for providing information to enable the completion of this project and for their comments and advice on the draft manuscript. The authors also wish to acknowledge Wal Ashby, Peter Crane, Alan Duncan, David Elliott, Kerry Graham, Graeme Greenwood, Sandy Leighton, Reece Luxton, Elaine Noble, Geoff Pedley and Wayne Watson for their assistance and support in the release of biological control agents for either ragwort, thistles and docks during their former association as weed officers with the State Government or with Landcare / weed strategy groups. We also thank Paul Dolan (Tasmanian Institute of Agricultural Research) for technical assistance. Thanks are also due to Scott Foster (Tasmanian Institute of Agricultural Research) for providing statistical advice.

CRC for Australian Weed Management Technical Series no. 13
January 2007

Enquiries and additional copies:
CRC for Australian Weed Management, Waite Campus, University of Adelaide, PMB 1, Glen Osmond, SA 5064 Australia
Telephone: (61) (08) 8303 6590
Fax: (61) (08) 8303 7311
Email: crcweeds@adelaide.edu.au
www.weeds.crc.org.au

ISBN: 1-920932-59-3
ISBN: 978-1-920932-59-6

Front cover: *Gorse spider mite*
Photo: W. Chatterton, TIAR

This report should be cited as: Ireson, J.E., Davies, J.T., Friend, D.A., Holloway, R.J., Chatterton, W.S., Van Putten E.I. and McFadyen, R.E.C. (2006). *Weeds of pastures and field crops in Tasmania: economic impacts and biological control.* Technical Series no. 13, CRC for Australian Weed Management, Adelaide.

Preface

It has been estimated that weeds cost Australian agriculture about $4 billion annually (Sinden et al 2004). In Tasmania, about 1.8 million ha is used for production agriculture (Australian Bureau of Statistics 2001).

In 1996, the cost of weeds to Tasmanian primary producers in terms of lost production and the cost of control was estimated at $33 million annually (Anon 1996).

The primary aim of this technical bulletin is to provide a revised assessment of the cost of weeds to Tasmanian pastures and field crops as well as identifying the weeds that are having the most significant impact on Tasmanian agriculture. It also reviews the current status of all weed biological control programs that have been conducted in Tasmania against some of the major weeds and provides a case study of the successful biological control program on ragwort.

The document should serve as a useful reference for those involved in weed control both within the state and nationally.

Table of contents

List of tables

List of figures

Section 1: The economic impact of weeds on Tasmanian pastures and field crops

In this study, the annual cost of weeds to Tasmanian pastures and field crops was estimated at about $58 million. The main component of this figure is estimated production losses due to a reduction in the quality and quantity of pastures and crops resulting from the presence of weeds.

About $8.8m of the total cost are so-called financial losses, largely the costs of herbicides used to control the weeds. This estimate is conservative, as labour costs used for chemical applications and other activities associated with weed control that may significantly increase financial losses have been excluded. For this reason it can be used as a minimum figure to indicate the cost of weeds to Tasmanian agricultural industries.

1.1 Introduction

It is well established in literature focused on the economic impact of weeds that farmer income decreases as a result of weed infestations. The cost imposed on farmers and consequently the reduction in income, is the result of a reduction in the quality and quantity of crops resulting from competition from weeds (Townsend and Sinden 1999). Profits are also affected by the weed control cost that is incurred.

These two components are relevant in both the cropping and grazing industry in Tasmania. Similar to the national situation, it is expected that productivity losses will greatly exceed the control cost of weeds (Vere et al 1997).

If weed problems were confined to a single property or agricultural enterprise, economic theory would suggest that a farmer would control weeds optimally to maximise profits. In this case there would seem to be no role for the government to intervene and spend public funds on a private problem. However, governments intervene because weeds spread across private land boundaries.

Weed control by one single landowner may be ineffective, and re-infestation is likely to occur if adjoining properties do not also initiate weed control. Similarly, the benefits of one farmer's weed control efforts will not be constrained to that property only. Others will benefit from the private weed control costs incurred – they can free-ride on the efforts of others (Pannell 1988). Additionally, weeds will spread to public land that is ultimately the Government's domain. These reasons justify government intervention to achieve a socially optimal outcome.

The main focus of weed research has been from the biological perspective, with an apparent lack of more general economic research (Townsend and Sinden 1999). Nationwide, there have been only two studies that investigated the economic implications of weeds (Combellack 1987 and Sinden et al 2004) and one Tasmania-based study referred to by Anon (1996) and Anon (2005).

The general lack of economic research may be due to the many difficulties associated with obtaining a reasonably accurate state or Australia wide estimate of the economic impact of weeds. Firstly, there are numerous weeds that can have different effects on the various agricultural enterprises. Secondly, some weeds may be beneficial at times if they act as a fodder buffer in dry seasons. In addition, the exact locations, extent and spread of weeds are largely unknown despite a significant effort to map them.

Furthermore, estimates of the impact of weeds on human and animal health, weed damage to water resources or of weeds as fire hazards, vermin shelter or hosts for pests and diseases are usually not included because such estimates are difficult to calculate (Anon 1996). This is because they frequently do not have an explicit monetary value. Although only a limited number of studies have investigated the economic impact of weeds on a state or Australia wide basis, there are many studies on the cost and benefits of controlling specific weeds on both public and private land.

For example, Vere and Campbell (1979) estimated the costs and benefits of controlling serrated tussock (*Nasella trichotoma*) in the Tablelands in New South Wales and Vere and Dellow (1984) the cost of controlling blackberry (*Rubus fruticosus* agg.) in central western New South Wales. Similarly, a number of publications deal with the opportunity cost of specific weeds; for example Adamson et al (2000) estimated the production foregone due to Siam weed (*Chromolaena odorata*) in coastal Queensland.

There are also a number of weed species-specific studies that have investigated optimal control efforts using different modelling and linear programming techniques. Optimisation studies take production losses and control costs over time into consideration (King 1991; Vere et al 1993) and can also model potential re-introduction scenarios. Similar optimisation studies have not been undertaken for scenarios where more than one weed

is present as this situation is very complex, requiring detailed information that is difficult and expensive to collect (Pannell 1988).

Despite the complexity of the issue, Combellack (1987) first estimated the cost of weeds specific to agriculture in Australia at $2,096 million for 1981–82. Sinden et al (2004) estimated the cost of weeds to Australian agriculture was around $4 billion, a conservative estimate considered to be at the lower end of the actual cost.

For Tasmania, which has about 1.7% of the total area used for crop and pasture production in Australia (Australian Bureau of Statistics 2001), an earlier estimate of the cost of weeds to the state's crop and livestock enterprises was $33 million per year (Anon 1996; 2005). This figure was also considered to be conservative as no labour costs were included (Bishop pers. comm.).

The present publication uses data currently available to provide a revised assessment of the estimated cost of weeds to Tasmania. As the weed problem is complex and affects different agricultural industries, full details of the assumptions and sources used in producing the figures are provided to enable a critical assessment of the assumptions in the analysis and the final result.

1.2 Methods

Sinden et al (2004) based the estimates of the economic impact of weeds in Australia on the sum of on-farm costs of control plus the opportunity costs from lost production in crops, livestock and horticulture. Financial cost included hired and contracted labour, however, the costs of owner / operator labour for chemical application and other control activities were not included.

The approach in this Tasmanian study is based on estimated production losses and the cost of herbicides but not labour.

1.2.1 Pasture

The economic impact of weeds in pastures was based on estimated losses in primary production to the dairy, beef and sheep industries and the cost of herbicides used to control them. Herbicide costs include direct costs associated with application and tractor fuel as well as the additional costs for a tractor and boom sprayer. Labour costs are not included as they vary widely depending on whether the control is carried out by the owner, a farm worker or contract labour.

It is acknowledged that the costs of controlling a weed can vary significantly, depending on the weed species being targeted and its location. For instance, gorse (*Ulex europaeus*) is one of the most serious pasture weeds in Tasmania and one of the most difficult and expensive to control. The cost of controlling a dense gorse infestation in pastures can range from $500 to $2,000/ha (National Gorse Taskforce 2006), particularly if follow-up treatments are necessary. In this study average costs were assumed.

Numbers of dairy and beef cattle and sheep in Tasmania were obtained from the Australian Bureau of Statistics (2005a) to estimate the area of agricultural land used by these industries. Calculations of production losses from the dairy, beef and sheep industries are based on gross margins sourced from the most recently published Livestock Enterprise Budgets for high and low rainfall areas (DPIWE Tasmania 2002; 2005).

An estimate of 10% production losses was used for these calculations. This assumption was based on % cover in pastures, which often range from 5–20% on individual properties (Harradine and Jones 1985; Ireson et al 2000b) and anecdotal evidence from farmers on losses in animal productivity. Sinden et al (2004) used a figure of 5% for grazing industries, but acknowledged that the estimate was conservative.

For the calculation of financial losses it was assumed that 5% of pastures are sprayed annually to control weeds (DPIWE Tasmania 2002; 2005). Herbicide costs were also based on figures obtained from the Livestock Enterprise Budgets (DPIWE Tasmania 2002; 2005).

1.2.2 Field crops

The impact of weeds in field crops was attributed to the cost of the herbicides used to control them. As for pastures, herbicide costs also include direct costs associated with application and tractor fuel as well as the additional overhead costs for a tractor and boom sprayer; again labour costs are not included. Herbicide costs were based on figures obtained from Cash Crop Enterprise Budgets for high rainfall (DPIWE Tasmania 2000) and low rainfall areas (DPIWE Tasmania 2003). Production losses that may occur in a crop as a result of the presence of weeds are not included due to the difficulties in making such an estimate.

1.3 Results

1.3.1 Pasture

The total estimated annual production loss to the dairy industry (self replacement and replacement herds) due to weeds is $19,359,050 and in the beef industry $15,392,122 (Tables 1.1 and 1.3). The total estimated production loss to the sheep industry in Tasmania is $14,118,143 (Tables 1.2 and 1.3). The combined productivity losses for the three pastoral enterprises in Tasmania are summarised in Table 1.3.

To determine the financial cost of weeds in Tasmania, the estimated herbicide costs to livestock industries (without labour) was calculated. The cost of herbicide per hectare was estimated at $44 (Table 1.4). If it is assumed (as per enterprise budgets) that productivity losses are expected to warrant annual spraying in 5% of pastures, then 5% of the area required by each pastoral enterprise (Tables 1.1 and 1.2) is 6,940 ha for dairy, 20,915 ha for beef and 19,126 ha for sheep. The estimated financial losses due to herbicide costs for each pastoral enterprise are summarised in Table 1.5.

Table 1.1 Details of dairy and beef enterprises in Tasmania and estimated production losses due to weeds[1]

	Dairy – self-replacing herd	Dairy – replace-ments are purchased	Beef trading – finishing store weaners	Beef breeding – vealers	Beef breeding – store weaners	Beef breeding – prime yearlings	Beef trading (store weaners reared to prime yearlings)
% of total industry	50	50	40	10	20	20	10
Rainfall area	high	high	high	high	low	low	low
Number of cattle in Tasmania	94,500	94,500	198,400	49,600	99,200	99,200	49,600
DSE[2]'s per animal	26.20	20.80	10.68	17.76	15.02	17.06	8.01
Stocking rate (DSE/ha)	32	32	25	25	12	12	12
Area required (ha)	77,372	61,425	84,757	35,236	124,165	141,029	33,108
Gross margin ($/ha)	1,316	1,494	454	582	280	344	352
Total gross margin	$101.82m	$91.77m	$38.50m	$20.51m	$34.77m	$48.51m	$11.65m
10% loss to weeds	**$10.18m**	**$9.18m**	**$3.85m**	**$2.05m**	**$3.48m**	**$4.85m**	**$1.17m**

[1] Numbers of dairy and beef cattle obtained from Australian Bureau of Statistics (2005a); calculations of production losses based on gross margins sourced from DPIWE Tasmania (2002; 2005).

[2] Dry sheep equivalent.

Table 1.2 Details of sheep enterprises in Tasmania and estimated production losses due to weeds[1]

	Medium merino wethers	Medium merino ewes	Superfine merino ewes	Medium merino ewes – prime lamb production	Prime lambs
% of total industry	25	15	15	35	10
Rainfall area	low	low	low	low	high
Number of sheep in Tasmania (DSE[2]/ha)	795,750	477,450	477,450	1,114,050	318,300
DSE's per animal	0.71	2.20	2.14	1.45	2.21
Stocking rate	12	12	12	12	25
Area required (ha)	47,082	87,533	85,145	134,614	28,138
Gross margin ($/ha)	314	200	192	533	739
Total gross margin	$14.78m	$17.51m	$16.35m	$71.75m	$20.79m
10% loss to weeds	**$1.48m**	**$1.75m**	**$1.64m**	**$7.18m**	**$2.08m**

1 Sheep numbers obtained from Australian Bureau of Statistics (2005a); calculations of production losses based on gross margins sourced from DPIWE Tasmania (2002; 2005).

2 Dry sheep equivalent.

Table 1.3 Combined estimated production losses due to weeds for Tasmanian dairy, beef and sheep industries

Industry	Estimated losses due to weeds ($)
Dairy	19,359,050
Beef	15,392,122
Sheep	14,118,143
Total losses	**48,869,315**

Table 1.4 Estimated herbicide costs (direct and overhead) for weed control in livestock industries

Cost items[1]	Cost ($/ha)
Herbicide[2] (2 l/ha 2,4D @ $8.00/l)	16.00
Application[3]	2.90
Tractor fuel[3] (1.2 ha/hr @ $6.55/hr)	11.10[4]
Tractor[3] (1.2 ha/hr @ $8.84/hr)	10.61
Boom spray[3] (1.2 ha/hr @ $2.83/hr)	3.40
Total	**44.01**

1 Excluding labour costs.

2 Retail price, June 2006.

3 Figures obtained from Livestock Enterprise Budgets (DPIWE Tasmania 2005).

4 Note: tractor fuel is 25% of total and therefore very sensitive to increasing fuel prices.

Table 1.5 Estimated financial losses for Tasmanian pastoral enterprises due to herbicide costs for weed control

Industry	Area required by each enterprise (ha)	Estimated herbicide costs ($)[1]
Dairy	138,797	305,353
Beef	418,295	920,249
Sheep	382,512	841,526
Total	**939,604**	**2,067,128**

1 Calculation based on 5% of area required by each enterprise being sprayed with herbicide on an annual basis to control weeds @ $44/ha.

1.3.2 Field crops

The estimated annual cost of weeds to Tasmanian field crops based on the cost of herbicides used to control them was $6.7 million (Table 1.6). Annual herbicide costs vary considerably due to the different control requirements and recommendations for each crop. Furthermore, the amount of herbicide used annually on any particular crop may also vary considerably each year depending on the area planted as determined by market demand.

The combined annual cost due to weeds incurred through production losses and herbicide costs in pastoral and crop enterprises is estimated at around $58 million (Table 1.7).

Table 1.6 Estimated herbicide costs (without labour) in Tasmanian cash crop enterprises based on cash crop enterprise budgets (DPIWE Tasmania 2003) unless otherwise indicated

Crop	Area of crop in state (ha)[1]	Herbicide costs[2]	Cost/ha ($)	Total annual cost ($)
Barley	9,000	$15/ha for herbicide, tractor / boom spray costs $7/ha plus fuel costs @ $2/ha	24	216,000
Beans	1,662	$52/ha for herbicide, tractor / boom spray costs $7/ha plus fuel costs @ $2/ha	61	101,382
Broccoli	783	Costs for broccoli vary[3] but can be around $63/ha. Tractor / boom spray costs are an additional $7/ha plus fuel costs @ $2/ha	72	56,376
Carrots	887	$362/ha for herbicide, tractor / boom spray costs are $21/ha plus fuel costs @ $2/ha	385	341,495
Fennel	51	$80/ha for herbicide (establishment year), tractor / boom spray costs are $35/ha plus fuel costs @ $11/ha	126	6,426
Lucerne	4,000	$36/ha for herbicide (establishment year), tractor / boom spray costs are $13/ha plus fuel costs @ $4/ha	53	212,000
Lupins	500[4]	$8/ha (establishment year) for herbicide, tractor / boom spray costs are $7/ha plus fuel costs @ $2/ha	17	8,500
Oats (Quamby spring sown)	2,500	$15/ha for herbicide, tractor / boom spray costs are $7/ha plus fuel costs @ $2/ha	24	60,000
Onions	1,263	$1,300/ha for herbicide, tractor / boom spray costs are $49/ha plus fuel costs @ $12/ha	1,361	1,718,943
Peas	5,112	$60/ha for herbicide, tractor / boom spray costs are $7/ha plus fuel costs @ $2/ha	69	352,728
Peppermint	30	$176/ha for herbicide (establishment year), tractor / boom spray costs are $11/ha plus fuel costs @ $4/ha	191	5,730
Poppies	10,000	Approximately $200/ha[5]. This includes the cost of herbicides (approx. $175) plus tractor / boom spray and fuel costs (approx. $15) which can range up to $25/ha for a contractor	200	2,000,000
Potatoes	6,762	$117/ha for herbicide, tractor / boom spray costs are $7/ha plus fuel costs @ $3/ha	127	858,774
Pyrethrum	1,000	Mean annual cost $313/ha[6] for herbicide, tractor / boom spray costs are $7/ha plus fuel costs @ $3/ha	323	323,000
Annual ryegrass (pasture seed)	3,000	$44/ha for herbicide, tractor / boom spray costs are $21/ha plus fuel costs @ $6/ha	71	213,000
Triticale	1,600	$15/ha for herbicide, tractor / boom spray costs are $7/ha plus fuel costs @ $2/ha	24	38,400
Wheat	8,000	$15/ha for herbicide, tractor / boom spray costs are $7/ha plus fuel costs @ $2/ha	24	192,000
Totals	**56,150**			**6,704,754**

1 Source: Australian Bureau of Statistics (2005a).

2 Fuel costs obtained from DPIWE Tasmania (2003) and therefore reflect 2002 prices. Prices vary because they are calculated on time taken to apply herbicide in each crop and number of sprays required.

3 Many broccoli crops rely on cultivation to remove weeds @ $90/ha. Herbicide costs can range from $26/ha to $63/ha up to $308/ha (information provided by David Sterling, Simplot Australia).

4 Figure provided by Geoff Dean, Cereal Agronomist (TIAR).

5 Figure provided by Adrian Geard, Tasmanian Alkaloids.

6 Figure provided by Tim Groom, Botanical Resources.

Table 1.7 Combined estimated annual costs (production losses and herbicide costs only) due to weeds in Tasmanian pastures and field crops

Industry	Production losses ($)	Herbicide (financial) costs ($)
Dairy	19,359,050	305,353
Beef	15,392,122	920,249
Sheep	14,118,143	841,526
Crops	not estimated	6,704,754
Total estimated annual costs	48,869,315	8,771,882

1.4 Discussion

The land area used for crop and pasture production in Australia is 47.5 million ha, with Tasmania having 1.7% (823,000ha) of this figure (Australian Bureau of Statistics 2001). If this percentage is used to calculate the cost of weeds to Tasmania from the mean $3.9 billion figure of Sinden et al (2004), the estimated cost of weeds to Tasmania would be around $66 million.

The cost of weeds to Tasmania, as calculated in this paper, is $48.9 million in production losses and $8.8 million in financial losses, a total of around $58 million. This is higher than the $33 million estimated 10 years ago by Anon (1996), which at the time was considered conservative. The current figure is also conservative, as it does not include any labour costs, lost production in field crops or the cost of weeds to horticultural enterprises. The estimate is about 7% of the gross annual value of agricultural production in Tasmania of around $857 million (Australian Bureau of Statistics 2005b).

Section 2: Weeds of major importance to Tasmanian pastures and field crops

A state-wide survey of rural landholders to determine the most important pasture and cropping weeds in Tasmania resulted in replies from 990 or 19.4% of those contacted. Weeds were 'regionalised' by dividing the state up into nine designated agricultural regions as well as into three predefined Natural Resource Management (NRM) regions.

The results are summarised in a series of reference tables that rank the 20 most important weeds listed for the state, for each of these regions. The perceived economic impact and problem status of the weed (ie whether the problem had increased, decreased or remained stable over the last 10 years) and the main agricultural enterprises affected are also summarised in these tables. The results should assist in developing weed management strategies and determining the success or otherwise of state-wide or regional control programs.

2.1 Introduction

Comprehensive information on Tasmanian agricultural weeds, including their status, general distribution and control, is available from the Tasmanian Department of Primary Industries and Water website (www.dpiw.tas.gov.au). Information on the biology, distribution and control of Tasmanian agricultural weeds can also be obtained from Ashby (1996) and Parsons and Cuthbertson (2001). In addition, Hyde-Wyatt and Morris (1989) give a guide to the identification of the most commonly found weeds of crops and pastures in Tasmania.

No major state-wide survey of Tasmanian farmers has previously been conducted to determine the identity and problem status of the weeds they regard as having the greatest impact on their production.

Such a survey was undertaken in July 2005, with the aims being:

- to re-assess Tasmania's most important agricultural weeds and their regional location, thereby assisting the formulation of appropriate weed management strategies
- to indicate if a weed problem had increased, decreased or remained stable over the past 10 years, thereby providing supporting evidence for the outcome of any long-term regional integrated control programs, by comparing the data with current or future surveys
- to obtain supporting information to justify the funding and prioritising of weed control programs.

Tables and maps are used to present the results of the survey as they apply to the whole state and to regions within the state, providing a reference for groups associated with weed control activities in Tasmania.

2.2 Methods

2.2.1 Survey process

In June 2005, survey forms were sent to 5,093 rural landholders throughout Tasmania. The mail-out databases supplied by the Tasmanian Farmers and Graziers Association and DairyTas enabled the majority of rural landholders within the state to be contacted. Replies were received from 990 of these landholders (19.4%).

Each landholder was asked to list the weeds on their property in order of importance, to indicate the economic impact of each weed (major, moderate, minor) and whether the problem status of each weed had increased, decreased or remained stable during the last 10 years. They were also asked to list their agricultural enterprises in order of priority (dairy, beef, sheep, cropping, other) for which the property was mostly used.

Originally, the intention was to use the survey to assess pasture weeds, however, as many Tasmanian pastoralists have now diversified, the survey was also extended to include cropping weeds.

2.2.2 Sample regions

Due to a range of factors (eg climate, soil type, altitude, land use, management), the status of any weed can vary considerably between different locations. For this reason, weed status was defined on a state-wide and regional basis, using the weeds considered by landholders to be causing the greatest problem in these areas.

Weeds were 'regionalised' using two methods. First, the state was divided into nine different agricultural regions (Figure 2.1), defined using local government boundaries, respondent postcodes, the area of land used for agricultural development and the 800 mm annual isohyet. This isohyet was used to divide Tasmania up into high and low rainfall pasture ecotypes. The division broadly reflects the two main pastoral areas in Tasmania, with

dairying and beef production in the high rainfall areas and sheep and beef production in the low rainfall areas.

The nine regions (see Figure 2.1) were designated as:

1. north-western (NW)
2. northern (N)
3. north-eastern (NE)
4. northern midlands (NM)
5. east coast (EC)
6. central and southern midlands (CSM)
7. southern (S)
8. King Island (K)
9. Flinders Island (F).

It should be noted that the western sector (W) is not a major agricultural region in comparison to the rest of the state. The largest area of pasture (around 120 ha) occurs at Granville Harbour on the west coast and is used to graze beef cattle.

Secondly, the three NRM regions of Tasmania (north-western, northern and southern) (Figure 2.2), as defined under the Bilateral Agreement between the State and Federal Government (Natural Heritage Trust 2003), were utilised. This will enable the survey results to be utilised in the weed management strategies that have been developed for each of these regions (Cronin 2004; Greening Australia (Tasmania) and the Cradle Coast Regional Weed Management Steering Committee 2005; Schrammeyer 2005).

2.2.3 Weed ranking

To rank the regional economic impact of each weed, the three impact categories (major, moderate or minor) were added separately across all properties to give the total for each category. The total score for each category was then weighted (major x 3, moderate x 2, minor x 1) and added to give a total ranking for each weed.

The final ranking and economic impact of each weed was expressed as a percentage of the total number of respondents. However, some respondents did not categorise the problem status of some weeds and these were grouped as '% not specified'.

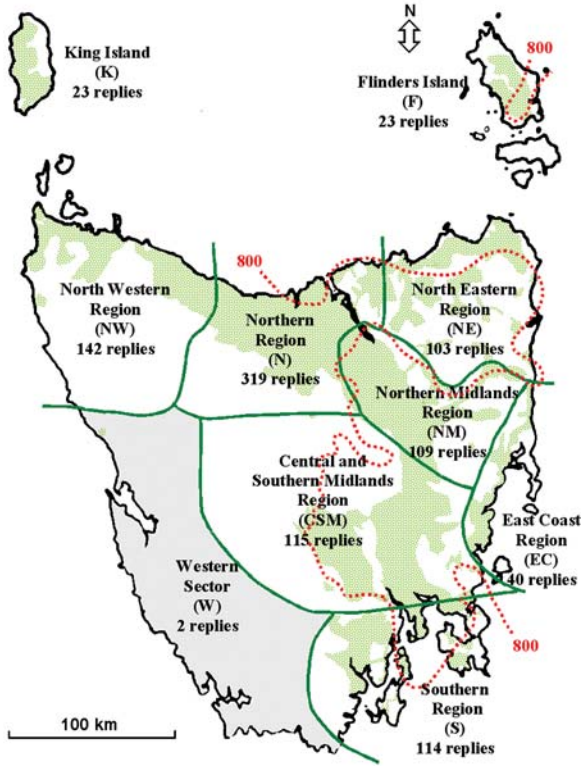


Figure 2.1 Location of the nine designated agricultural regions in Tasmania in relation to the main areas of agricultural development (green) and the 800 mm annual isohyet (low rainfall areas to the east of this isohyet)

Note: The western sector (grey) is not included as an agricultural region. Figures indicate the number of respondents replying to the survey from each region / sector.

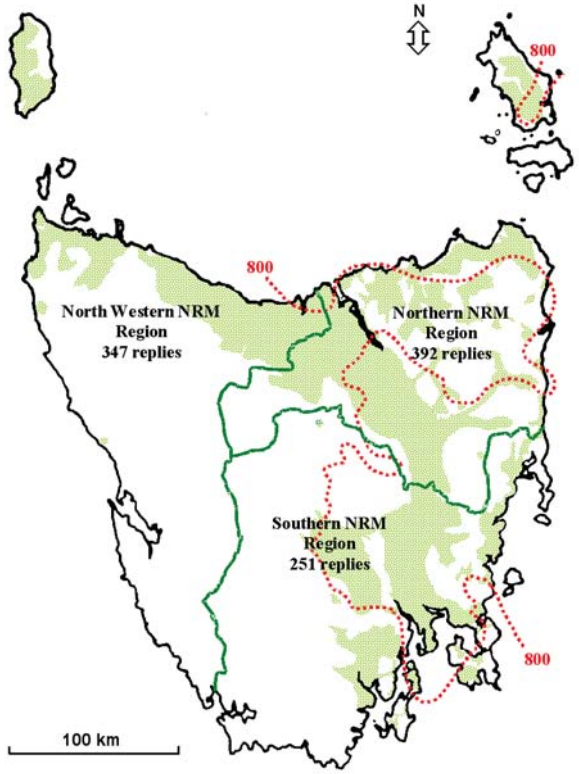


Figure 2.2 Location of the three Natural Resource Management (NRM) regions in Tasmania in relation to the main areas of agricultural development (green) and the 800 mm annual isohyet (low rainfall areas to the east of this isohyet)

Note: Figures indicate the number of respondents replying to the survey from each region.

Indications as to whether the problem status for each individual weed had increased, decreased or remained stable over the last 10 years are expressed as a percentage of the total number of respondents.

A weed was classified in the 'increase' category if the figure for '% increase' was approximately equal to or greater than the sum of the figures for '% decrease' and '% stable'. A weed was classified in the 'decrease' category if the figure for '% decrease' was approximately equal to or greater than the sum of the figures for '% increase' and '% stable'.

Similarly, a weed was classified in the 'stable' category if the figure for '% stable' was approximately equal to or greater than the sum of the figures for '% increase' and '% decrease'. A weed was also classified in the 'stable' category if the difference between the sum of the '% stable' and '% increase' categories and the sum of '% stable' and '% decrease' categories was equal to or less than 10%. If this difference was greater than 10%, the status of the weed was classified as being in a range designated either as 'increasing / stable' or 'decreasing / stable'.

The main enterprises conducted on the property on which each weed is a problem are expressed as a percentage of the total number of respondents.

In order to provide an indicator of the main problem weeds perceived by landholders in this survey, the results were used to present lists of the first 20 agricultural weeds ranked both for the state and within each designated region. A similar approach had previously been taken in ranking 20 Weeds of National Significance (WONS) (Thorp and Lynch 2000).

2.2.4 Identification

The common names submitted by farmers enabled a particular weed to be easily identified to species level in most cases. However, in instances when more than one species could have been involved either within a particular region or in another region, these are grouped unnamed under the one genus.

Species of amaranthus are therefore grouped under *Amaranthus* spp., barley grass under *Hordeum* spp., bent grass under *Agrostis* spp., bracken under *Pteridium* spp., briar under *Rosa* spp., docks under *Rumex* spp., nettle under *Urtica* spp., oil poppies under *Papaver* spp., rushes under *Juncus* spp., slender thistles under *Carduus* spp., storksbill under *Erodium* spp., tussock grass under *Poa* spp., wild oats under *Avena* spp. and willows under *Salix* spp. In Tasmania, European blackberry (*Rubus fruticosus* agg.) is an aggregate of eight different closely related species grouped under one name (Evans pers. comm.).

Tea tree is listed under *Leptospermum* spp. and *Melaleuca* spp. as species from both genera could have been involved. Respondents frequently used the name cat's ear which is the recognised common name of *Hypochaeris radicata* and is therefore the scientific name used in the Tables. However, it is also possible that respondents could have been referring to hawkbit (*Leontodon taraxacoides*), dandelion (*Taraxacum officinale*) and perhaps even other broadleaf weeds.

In addition, respondents did not always specify a particular thistle or brassica species, leaving a large number of unspecified thistles and brassicas. This would have resulted in spear thistle (*Cirsium vulgare*), slender thistles (*Carduus* spp.), Californian thistle (*Cirsium arvense*), variegated thistle (*Silybum marinum*), cotton thistle (*Onopordum acanthium*), star thistle (*Centaurea calcitrapa*) and the brassica species, wild radish (*Raphanus raphanistrum*) and wild turnip (*Brassica rapa* ssp. *silvestris*) having a lower ranking than justified, if no additional adjusting score was applied.

To get a more accurate ranking of these weeds, the status (major, moderate and minor) of the unspecified species in these two groups was added to each identified species in the proportions each identified species occurred. It should be noted that cotton and star thistle were not among the first 20 weeds ranked on the state-wide or regional lists.

2.3 Results

The 20 agricultural weeds most frequently listed for the state, their ranking, perceived economic impact, problem status and the percentage breakdown of the enterprises to which each weed is a problem are presented in Table 2.1.

The identity and problem status of all the agricultural weeds most frequently listed in each of the nine designated agricultural and three NRM regions (Figures 2.1 and 2.2) are summarised in Table 2.2.

Weeds are listed under 58 common names, 56 of these being identifiable as single species or to at least two other related weed species in the same genus, the exceptions being cat's ear and tea tree (see footnotes 6 and 7 in Table 2.2).

Table 2.1 List of the first 20 state-wide agricultural weeds ranked using survey responses from 990 landholders, together with their perceived economic impact, problem status and the main enterprises affected

Weeds in order of importance[1]		Percentage of respondents considering the weed to be having an economic impact on their farm[2]					Perceived problem status over previous 10 years[3]				Main enterprise of landholders listing the weed as a problem on their property[4]				
	Rank	% Total	% Minor	% Moderate	% Major	% Not specified	% Decrease	% Stable	% Increase	% Not specified	% Dairy	% Beef	% Sheep	% Cropping	% Other
Spear thistle[5]	1	36.3	32.0	56.5	10.9	0.6	40.0	20.9	32.6	6.5	**20.8**	**46.4**	20.8	9.4	2.6
Cirsium vulgare		(359)	(115)	(203)	(39)	(2)	(86)	(45)	(70)	(14)	(40)	(89)	(40)	(18)	(5)
Blackberry	2	36.2	45.8	42.5	10.9	0.8	55.9	9.8	25.7	8.6	**18.3**	**54.4**	13.5	8.9	**4.9**
Rubus fruticosus agg.		(358)	(164)	(152)	(39)	(3)	(200)	(35)	(92)	(31)	(60)	(178)	(44)	(29)	(16)
Capeweed	3	31.2	32.0	45.3	20.7	2.0	26.9	7.1	60.8	5.2	6.6	**45.2**	**33.6**	11.3	3.3
Arctotheca calendula		(309)	(99)	(140)	(64)	(6)	(83)	(22)	(188)	(16)	(18)	(124)	(92)	(31)	(9)
Gorse	4	29.6	41.3	32.8	24.9	1.0	42.3	6.5	45.1	6.1	11.9	34.2	**43.9**	9.2	0.8
Ulex europaeus		(293)	(121)	(96)	(73)	(3)	(124)	(19)	(132)	(18)	(31)	(89)	(114)	(24)	(2)
Ragwort	5	31.8	51.4	31.8	14.3	2.5	50.8	7.9	36.2	5.1	**22.9**	**56.9**	7.3	10.1	2.8
Senecio jacobaea		(315)	(162)	(100)	(45)	(8)	(160)	(25)	(114)	(16)	(66)	(164)	(21)	(29)	(8)
Slender thistles[5]	6	27.8	35.3	50.9	13.1	0.7	37.6	15.7	37.6	9.1	**17.6**	**52.0**	22.3	7.4	0.7
Carduus spp.		(275)	(97)	(140)	(36)	(2)	(62)	(26)	(62)	(15)	(26)	(77)	(33)	(11)	(1)
Wild radish[5]	7	13.7	15.5	45.6	38.2	0.7	28.5	16.3	47.1	8.1	4.7	14.2	15.1	**66.0**	0
Raphanus raphanistrum		(136)	(21)	(62)	(52)	(1)	(35)	(20)	(58)	(10)	(5)	(15)	(16)	(70)	
Californian thistle[5]	8	16.1	42.1	40.3	16.3	1.3	26.0	11.5	55.2	7.3	**21.9**	31.0	**23.0**	**19.5**	**4.6**
Cirsium arvense		(159)	(67)	(64)	(26)	(2)	(25)	(11)	(53)	(7)	(19)	(27)	(20)	(17)	(4)
Bracken	9	12.7	42.0	38.9	15.9	3.2	52.4	19.1	19.8	8.7	11.3	**58.3**	20.0	4.3	**6.1**
Pteridium spp.		(126)	(53)	(49)	(20)	(4)	(66)	(24)	(25)	(11)	(13)	(67)	(23)	(5)	(7)
Dock	10	9.4	45.2	47.3	6.4	1.1	32.3	20.4	36.5	10.8	**16.7**	**41.7**	13.1	**23.8**	4.7
Rumex spp.		(93)	(42)	(44)	(6)	(1)	(30)	(19)	(34)	(10)	(14)	(35)	(11)	(20)	(4)
Fat hen	11	8.0	26.6	58.2	13.9	1.3	24.0	24.1	44.3	7.6	5.8	14.5	**23.2**	**56.5**	0
Chenopodium album		(79)	(21)	(46)	(11)	(1)	(19)	(19)	(35)	(6)	(4)	(10)	(16)	(39)	
Rushes	12	7.2	25.4	56.3	14.1	4.2	45.0	12.7	31.0	11.3	7.0	**56.4**	9.9	9.9	2.8
Juncus spp.		(71)	(18)	(40)	(10)	(3)	(32)	(9)	(22)	(8)	(5)	(40)	(7)	(7)	(2)

Nightshade	13	6.4	17.5	57.1	22.2	3.2	11.1	15.9	68.2	4.8	0	17.3	5.8	**71.1**	5.8
Solanum nigrum		(63)	(11)	(36)	(14)	(2)	(7)	(10)	(43)	(3)		(9)	(3)	(37)	(3)
Wireweed	14	5.9	15.5	63.8	20.7	0	20.7	22.4	48.3	8.6	2.0	8.2	22.5	**65.3**	2.0
Polygonum aviculare		(58)	(9)	(37)	(12)		(12)	(13)	(28)	(5)	(1)	(4)	(11)	(32)	(1)
Wild turnip[5]	15	6.0	28.8	45.8	25.4	0	28.3	9.4	52.8	9.6	4.6	27.3	13.6	**50.0**	**4.5**
Brassica rapa ssp. *silvestris*		(59)	(17)	(27)	(15)		(15)	(5)	(28)	(5)	(2)	(12)	(6)	(22)	(2)
Barley grass	16	5.7	30.4	35.7	30.4	3.5	14.3	23.2	53.6	8.9	16.0	**48.0**	**32.0**	4.0	0
Hordeum spp.		(56)	(17)	(20)	(17)	(2)	(8)	(13)	(30)	(5)	(8)	(24)	(16)	(2)	
Horehound	17	6.2	52.4	27.9	19.7	0	16.4	16.4	63.9	3.3	0	1.9	**84.6**	13.5	0
Marrubium vulgare		(61)	(32)	(17)	(12)		(10)	(10)	(39)	(2)		(1)	(44)	(7)	
Fumitory	18	5.3	23.1	50.0	23.1	3.8	26.9	17.3	46.2	9.6	0	6.8	15.9	**77.3**	0
Fumaria muralis		(52)	(12)	(26)	(12)	(2)	(14)	(9)	(24)	(5)		(3)	(7)	(34)	
Cat's ear[6]	19	5.7	32.2	57.1	8.9	1.8	37.5	26.8	30.4	5.3	**14.0**	**52.0**	16.0	14.0	**4.0**
Hypochaeris radicata		(56)	(18)	(32)	(5)	(1)	(21)	(15)	(17)	(3)	(7)	(26)	(8)	(7)	(2)
Amaranthus	20	4.1	19.5	31.7	46.4	2.4	7.3	7.3	78.1	7.3	2.7	2.7	16.2	**75.7**	2.7
Amaranthus spp.		(41)	(8)	(13)	(19)	(1)	(3)	(3)	(32)	(3)	(1)	(1)	(6)	(28)	(1)

[1] To rank weeds, the three economic impact categories (major, moderate or minor) were added separately to give a score for each category. This was weighted (major x 3, moderate x 2, minor x 1) and added to give a total score for each weed.

[2] Percent total is % of total of 990 respondents who consider the weed to be having an economic impact on their property. The level of impact is then categorised as % minor, moderate and major. Percentages in these categories are based on figures in brackets, which indicate the number of respondents in each particular category.

[3] Problem status refers to the perceived change in the level of a weed infestation for the state over the last 10 years, based on the replies from 990 landholders indicating whether their weed problem had increased, decreased or was stable. Some landholders did not specify status, hence the 'not specified' category. Percentages are based on the number of respondents (in brackets) to this particular category. A weed was classified in the 'increase' category (figure underlined) if the figure in the '% increase' column for the weed was approximately equal to or greater than the sum of the figures for '% decrease' and '% stable'. A weed was classified in the 'decrease' category (figure underlined) if the figure in the '% decrease' column, was approximately equal to or greater than the sum of the figures for '% increase' and '% stable'. Similarly, a weed was classified in the 'stable' category (figure underlined) if the figure in the '% stable' column, was approximately equal to or greater than the sum of the figures for '% increase' and '% decrease.' A weed was also classified in the stable category if the difference between the sum of the '% stable' and '% increase' categories and the sum of '% stable' and '% decrease' categories was equal to or less than 10%. If this difference was greater than 10%, the weed was classified either as 'increasing / stable' or 'decreasing / stable' (range indicated by two figures underlined).

Note: these categories are for use as a general state-wide indicator only and should be treated with caution depending on the number of respondents. Obviously, the status of any weed can vary considerably between locations.

[4] Percentages based on the number of respondents (in brackets) to this particular category. Figures in bold indicate the weed is a particular problem in the enterprise(s), as a higher proportion of landholders listed the weed as a problem in the enterprise in comparison to the proportion of landholders involved in that enterprise for the state (Appendix Table A.13).

[5] Respondents did not always specify a particular thistle or brassica species, leaving a large number of unspecified thistles and brassicas. For a more accurate ranking of these weeds, the status (major, moderate and minor) of unspecified species in these two groups were added to each identified species in the proportions they occurred.

[6] Likely to be mainly cat's ear, but probably also contains hawkbit *(Leontodon taraxacoides)*, dandelion *(Taraxacum officinale)* and other broadleaf weeds.

Note: Numbers in brackets are total numbers. As there were always variable responses to the survey categories (economic impact, perceived change in weed status, main enterprise) and the status of some thistle and brassica species were estimated (see footnote 5), the total of the numbers across each subsection in this table will not be equal.

Table 2.2 Identity and problem status of agricultural weeds ranked amongst the first 20 in each of the nine designated agricultural and three NRM regions from survey responses from 990 Tasmanian landholders

Weed	Weed of National Significance[1]	Weed in Tasmanian first 20 state-wide list	Perceived problem status over previous 10 years for the state[2]	No. of agricultural[3] and NRM[4] regions in Tasmania in which the weed is listed in the first 20	Agricultural / NRM region where the weed is listed in the first 20 and the perceived problem status of the weed in each region in the last 10 years[5]
Capeweed *(Arctotheca calendula)*	No	Yes	Increase	9 (3)	*Agricultural region*: NW (stable), N (increase), NE (increase), NM (increase), EC (increase), CSM (increase), S (increase), KI (increase), FI (decrease) *NRM region*: NW (increase), N (increase), S (increase)
Slender thistle (*Carduus* spp.)	No	Yes	Stable	9 (3)	*Agricultural region*: NW (stable), N (stable), NE (decrease / stable), NM (stable), EC (decrease), CSM (decrease / stable), S (stable), KI (decrease), FI (increase) *NRM region*: NW (increase), N (stable), S (decrease / stable)
Spear thistle *(Cirsium vulgare)*	No	Yes	Stable	9 (3)	*Agricultural region*: NW (stable), N (stable), NE (increase), NM (decrease), EC (stable), CSM (increase / stable), S (increase / stable), KI (stable), FI (decrease) *NRM region*: NW (stable), N (decrease), S (increase / stable)
Blackberry (*Rubus fruticosus* agg.)	Yes	Yes	Decrease	8 (3)	*Agricultural region*: NW (decrease), N (decrease), NE (decrease), NM (decrease), EC (decrease), CSM (decrease), S (decrease), KI (increase) *NRM region*: NW (decrease), N (decrease), S (decrease)
Bracken (*Pteridium* spp.)	No	Yes	Decrease	8 (3)	*Agricultural region*: NW (decrease), N (decrease / stable), NE (decrease / stable), EC (decrease), CSM (stable), S (decrease), KI (decrease), FI (stable) *NRM region*: NW (decrease), N (decrease), S (decrease)
Gorse *(Ulex europaeus)*	Yes	Yes	Stable	8 (3)	*Agricultural region*: NW (stable), N (stable), NE (decrease), NM (stable), EC (increase), CSM (increase), S (increase), KI (decrease) *NRM region*: NW (decrease), N (stable), S (increase)

Ragwort *(Senecio jacobaea)*	No	Yes	Decrease	7 (3)	*Agricultural region*: NW (decrease), N (decrease), NE (increase), NM (decrease), EC (increase), S (decrease), KI (decrease) *NRM region*: NW (decrease), N (stable), S (decrease)
Rushes (*Juncus* spp.)	No	Yes	Decrease	7 (2)	*Agricultural region*: NW (decrease), NE (decrease), EC (stable), CSM (increase), S (increase), KI (decrease), FI (decrease) *NRM region*: NW (decrease), S (increase)
Californian thistle (*Cirsium* spp.)	No	Yes	Increase	7 (3)	*Agricultural region*: NW (stable), N (increase), NE (increase), EC (increase), CSM (increase), S (decrease), KI (increase) *NRM region*: NW (increase), N (increase), S (increase)
Barley grass (*Hordeum* spp.)	No	Yes	Increase	6 (3)	*Agricultural region*: N (increase), NE (increase), NM (increase / stable), EC (increase), CSM (stable), S (increase) *NRM region*: NW (increase), N (increase / stable), S (increase)
Dock (*Rumex* spp.)	No	Yes	Stable	6 (2)	*Agricultural region*: NW (increase), N (stable), NE (increase / stable), NM (decrease), EC (increase), FI (increase) *NRM region*: NW (increase), N (stable)
Wild radish *(Raphanus raphanistrum)*	No	Yes	Increase	6 (2)	*Agricultural region*: NW (increase / stable), N (increase), NE (increase), NM (increase), CSM (decrease), FI (decrease) *NRM region*: NW (increase), N (increase)
Cat's ear *(Hypochaeris radicata)*[6]	No	Yes	Stable	5 (2)	*Agricultural region*: NW (decrease), N (stable), NE (stable), CSM (increase), KI (stable) *NRM region*: NW (decrease), N (increase / stable)
Fat hen *(Chenopodium album)*	No	Yes	Increase / stable	5 (3)	*Agricultural region*: NW (increase), N, (increase / stable), NE (stable), NM (stable), CSM (increase) *NRM region*: NW (increase / stable), N (stable), S (increase)
Variegated thistle *(Silybum marianum)*	No	No	Stable	5 (2)	*Agricultural region*: NE (unknown), EC (increase), CSM (increase / stable), KI (decrease), FI (not specified) *NRM region*: N (decrease / stable), S (increase / stable)
Wireweed *(Polygonum aviculare)*	No	Yes	Increase	5 (3)	*Agricultural region*: NW (increase), N (increase), NM (increase), CSM (increase), S (decrease) *NRM region*: NW (increase), N (increase), S (increase / stable)

Weed	Weed of National Significance[1]	Weed in Tasmanian first 20 state-wide list	Perceived problem status over previous 10 years for the state[2]	No. of agricultural[3] and NRM[4] regions in Tasmania in which the weed is listed in the first 20	Agricultural / NRM region where the weed is listed in the first 20 and the perceived problem status of the weed in each region in the last 10 years[5]
Horehound *(Marrubium vulgare)*	No	Yes	Increase	4 (1)	*Agricultural region*: NM (increase), EC (increase), CSM (increase), FI (increase) *NRM region*: S (increase)
Fumitory *(Fumaria muralis)*	No	Yes	Increase	4 (2)	*Agricultural region*: NW (increase), N (increase / stable), NE (increase), NM (increase / stable) *NRM region*: NW (increase), N (increase)
Wild turnip *(Brassica rapa* ssp. *silvestris)*	No	Yes	Increase	4 (3)	*Agricultural region*: NW (increase), N (increase), NE (stable) S (increase) *NRM region*: NW (increase), N (stable), S (increase)
Willows (*Salix* spp.)	Yes	No	Decrease	4 (2)	*Agricultural region*: NE (increase), NM (decrease / stable), EC (decrease), CSM (increase) *NRM region*: N (decrease), S (stable)
African boxthorn *(Lycium ferocissimum)*	No	No	Increase	3 (1)	*Agricultural region*: EC (decrease), S (increase), KI (decrease) *NRM region*: S (increase)
Hawthorn *(Crataegus monogyna)*	No	No	Increase	3	*Agricultural region*: NM (decrease), EC (increase), CSM (increase)
Nightshade *(Solanum nigrum)*	No	Yes	Increase	3 (2)	*Agricultural region*: N (increase), NE (increase), NM (increase) *NRM region*: NW (increase), N (increase)
Storksbill (*Erodium* spp.)	No	No	Increase	3	*Agricultural region*: NW (increase), NM (increase), S (increase)
Tussock grass (*Poa* spp.)	No	No	Increase	3 (1)	*Agricultural region*: EC (increase), S (increase), FI (increase / stable) *NRM region*: N (increase)
Bent grass (*Agrostis* spp.)	No	No	Increase	2	*Agricultural region*: EC (stable), FI (stable)
Hemlock *(Conium maculatum)*	No	No	Stable	2	*Agricultural region*: NW (increase), EC (increase / stable)

Saffron thistle *(Carthamus lanatus)*	No	No	Increase / stable	2	*Agricultural region*: NM (increase), CSM (increase)
Tea tree *(Leptospermum* spp., *Melaleuca* spp.)[7]	No	No	Increase	2	*Agricultural region*: EC (increase), KI (increase)
Wild onion, crow garlic *(Allium vineale)*	No	No	Increase	2	*Agricultural region*: KI (increase), FI (increase)
Twitch grass *(Agropyron repens)*	No	No	Decrease	2 (1)	*Agricultural region*: NW (decrease), N (decrease / stable) *NRM region*: NW (decrease / stable)
Amaranthus (*Amaranthus* spp.)	No	Yes	Increase	1 (1)	*Agricultural region*: N (increase) *NRM region*: NW (increase)
Briar (*Rosa* spp.)	No	No	Stable	1 (1)	*Agricultural region*: CSM (stable) *NRM region*: S (decrease)
Bridal creeper *(Asparagus asparagoides)*	Yes	No	Increase	1	*Agricultural region*: KI (increase)
Buzzies *(Acaena novae-zelandiae)*	No	No	Increase	1	*Agricultural region*: S (increase)
Charlock *(Sinapsis arvensis)*	No	No	Increase	1	*Agricultural region*: S (stable)
Cotton thistle *(Onopordium acanthium)*	No	No	Decrease / stable	1	*Agricultural region*: NM (decrease)
Espartillo grass *(Stipa caudata)*	No	No	Not specified	1	*Agricultural region*: FI (not specified)
Fog grass *(Holcus lanatus)*	No	No	Increase	1	*Agricultural region*: FI (decrease)
Glyceria *(Glyceria maxima)*	No	No	Increase	1	*Agricultural region*: NW (decrease)
Mirror bush *(Coprosma repens)*	No	No	Increase	1	*Agricultural region*: KI (increase)
Nettle (*Urtica* spp.)	No	No	Increase	1	*Agricultural region*: KI (not specified)

Weed	Weed of National Significance[1]	Weed in Tasmanian first 20 state-wide list	Perceived problem status over previous 10 years for the state[2]	No. of agricultural[3] and NRM[4] regions in Tasmania in which the weed is listed in the first 20	Agricultural / NRM region where the weed is listed in the first 20 and the perceived problem status of the weed in each region in the last 10 years[5]
Oil poppy (*Papaver* spp.)	No	No	Increase	1	*Agricultural region*: N (increase)
Onion grass *(Romulea rosea)*	No	No	Increase	1	*Agricultural region*: FI (increase)
Onion weed *(Asphodelus fistulosis)*	No	No	Increase	1	*Agricultural region*: FI (increase)
Parramatta rat's tail (*Sporobolus* spp.)	No	No	Increase	1	*Agricultural region*: FI (increase)
Paterson's curse *(Echium plantagineum)*	No	No	Increase	1	*Agricultural region*: FI (not specified)
Penny royal *(Mentha pulegium)*	No	No	Increase	1	*Agricultural region*: KI (increase)
Rat's tail fescue *(Vulpia bromoides)*	No	No	Increase	1	*Agricultural region*: FI (increase)
Sagg *(Lomandra longifolia)*	No	No	Decrease / stable	1	*Agricultural region*: NE (stable)
Serrated tussock *(Nasella trichotoma)*	Yes	No	Decrease	1	*Agricultural region*: S (decrease)
Sorrel *(Rumex acetosella)*	No	No	Stable	1 (1)	*Agricultural region*: CSM (stable) *NRM region*: S (stable)
Spanish heath *(Erica lusitanica)*	No	No	Increase	1	*Agricultural region*: S (increase)
Spurge (*Euphorbia* spp.)	No	No	Increase	1	*Agricultural region*: KI (increase)
Sweet vernal grass *(Anthoxanthum odoratum)*	No	No	Not specified	1	*Agricultural region*: FI (not specified)
Tall fescue *(Festuca arundinacea)*	No	No	Stable	1	*Agricultural region*: KI (stable)

Whiteweed *(Cardaria draba)*	No	No	Increase	1 (1)	*Agricultural region*: S (increase) *NRM region*: S (increase)
Wild oats (*Avena* spp.)	No	No	Increase	1	*Agricultural region*: NM (increase)

[1] 20 Weeds of National Significance (Thorp and Lynch 2000) based on their economic, environmental and social impacts. Seven of these weeds are present in Tasmania and five appear in this table. The absent weeds are boneseed, *Chrysanthemoides monilifera* spp. *monilifera* and Chilean needle grass, *Nassella neesiana*. Boneseed is an environmental weed that predominates in coastal areas and is rarely a problem for farmers. Chilean needle grass, an invasive pasture weed, was first identified in southern Tasmania near Hobart in 2001 (Crane pers. comm.) and attempts are being made to eradicate it.

[2] Problem status refers to the perceived change in the weed problem for the state over the last 10 years based on the replies from 990 landholders. For details see footnote 3, Table 2.1.

[3] Nine agricultural regions designated for this survey, omitting western sector (Figure 2.1) as it is not a main agricultural region.

[4] Three NRM Regions (Figure 2.2). Number of NRM regions in which each weed is listed is indicated in brackets.

[5] Status in this column refers to the perceived change in the level of a weed infestation over the last 10 years by landowners who responded to the survey from each of the agricultural or NRM regions of the state that were defined for this survey (Figures 2.1 and 2.2). Status classifications for each region as presented in Appendix (Tables A.1 to A.12).

Note: these categories are for use as a general indicator only and should be treated with caution depending on the number of respondents. Obviously, the status of any weed can vary considerably between regions and between locations within regions.

[6] Likely to be mainly cat's ear, but probably also contains hawkbit *(Leontodon taraxacoides)*, dandelion *(Taraxacum officinale)* and other broadleaf weeds.

[7] Likely to be *Melaleuca pustulata* (Cranbrook paperbark) in the east coast region and probably a mixture of *Leptospermum* and *Melaleuca* species on King Island. *M.pustulata* is endemic to Tasmania where it is restricted to the central east coast. Although it is listed as a threatened species, it does invade pasture and is regarded by some landholders as a weed.

2.3.1 Agricultural regions

The 20 agricultural weeds most frequently listed in each of the nine designated agricultural regions for the state (Figure 2.1) are presented in a similar format to the state-wide list (Table 2.1) in the Appendix (Tables A.1–A.9). As would be expected, the importance of a weed often varied between each of the designated agricultural regions (Table 2.2 and Appendix Tables A.1–A.9).

Capeweed *(Arctotheca calendula)*, slender thistle and spear thistle appeared on all nine lists and blackberry, bracken and gorse on eight (Table 2.2). Eight of the weeds listed for Flinders Island (Table 2.2 and Appendix Table A.9), six from King Island (Table 2.2 and Appendix Table A.8) and five from the southern region (Table 2.2 and Appendix Table A.7) appeared on no other list.

The first ranking, including the state-wide and the nine agricultural region lists, involved four weeds. Spear thistle was ranked first on the state-wide list (Table 2.1) as well as on the lists for the north-western region, King Island and Flinders Island (Appendix Tables A.1, A.8 and A.9). Gorse was ranked first on the lists for the northern midlands, east coast and central and southern midlands regions (Appendix Tables A.4–A.6), blackberry for the north-eastern and southern regions (Appendix Tables A.3 and A.7) and ragwort *(Senecio jacobaea)* for the northern region (Appendix Table A.2).

Respondents indicated variations in perceived problem status between the agricultural regions (Appendix Tables A.1–A.9). For the 58 weed species or weed genera listed (Table 2.2), respondents indicated that, on a state-wide basis, 35 had increased in status, 10 remained stable and four were placed either in the decrease / stable (2) or increase / stable range (2), with the status of two not being specified. Infestations of only seven weeds, blackberry, bracken, ragwort, rushes, serrated tussock, twitch grass *(Agropyron repens)* and willow, were indicated by respondents to have decreased in status over the last 10 years (Table 2.2). Of these, only blackberry, bracken, ragwort and rushes were amongst the 20 weeds most frequently listed for the state (Table 2.1).

Economic impact of the weeds varied between the regions (Appendix Tables A.1–A.9). Of the seven weeds for which respondents reported a state-wide decrease in problem status but were still ranked amongst the first 20 weeds on the regional lists, serrated tussock was regarded by 50% of respondents in the southern region (Appendix Table A.7) as having a major economic impact. A majority listed willows as having a major economic impact in the north-eastern region (Appendix Table A.3), a moderate to major impact in the east coast, central and southern midlands regions (Appendix Tables A.5 and A.6) and a minor impact in the northern midlands region (Appendix Table A.4).

Rushes were also indicated by the majority of respondents as having a moderate economic impact in all seven agricultural regions in which they are ranked amongst the first 20 weeds (Appendix Tables A.1, A.3 and A.5–A.9). Bracken was indicated as having an economic impact in the minor to moderate range in all of the eight regions in which it was listed (Appendix Tables A.1–A.3 and A.5–A.9). Twitch grass was indicated as having a moderate impact in the north-western region and a moderate to major impact in the northern region (Appendix Tables A.1 and A.2).

The most consistent results for the seven weeds for which a state-wide decrease in problem status was recorded in the last 10 years were obtained for blackberry and ragwort (Tables 2.1 and 2.2). The majority of respondents listed blackberry as having a minor or moderate economic impact in the eight agricultural regions in which it was ranked in the first 20 weeds (Table 2.2 and Appendix Tables A.1–A.8). On King Island where the only increase in problem status was recorded, the weed was considered as having a minor economic impact.

For ragwort, a decrease in status was recorded in five of the seven regions in which it was ranked in the first 20 weeds (Table 2.2 and Appendix Tables A.1–A.2, A.4 and A.7–A.8). In six of these seven regions, respondents indicated it was now having a minor economic impact (Appendix Tables A1, A.3–A.5, A.7–A.8). In the northern region, where ragwort has been a major problem for the beef and dairy industries, respondents indicated a variable economic impact ranging from minor to moderate in association with the perceived decrease in status (Appendix Table A.2). In the north-eastern and east coast regions where an increase in problem status was recorded, the economic impact was considered minor (Appendix Tables A.3 and A.5).

The enterprise on which a particular weed had its greatest impact also often varied between each of the designated agricultural regions. For example, the survey results clearly indicate that gorse and horehound *(Marrubium vulgare)* are major problems in pastures in the drier parts of the state on properties for which sheep are listed as the main enterprise (Table 2.2 and Appendix Tables A.4–A.6, A.13 and Figure 2.1).

On a state-wide basis about 73% listed dairy, beef or sheep as their main enterprises and about 13% listed cropping (Appendix Table A.13). Respondents that listed cropping as the main enterprise varied considerably from region to region. This ranged from a 19% listing in the northern region (where most of the state's cropping industry is based) to 7% or less in the less intensive

cropping areas of the southern and east coast regions and on King and Flinders Island. In all other regions, all respondents listed sheep, beef or dairy as their main enterprises (Appendix Table A.13).

Seven weeds that are predominantly a problem in field crops were amongst the 20 most frequently listed weeds for the state. These were amaranthus, fat hen *(Chenopodium album)*, fumitory *(Fumaria muralis)*, nightshade *(Solanum nigrum)*, wild radish, wild turnip and wireweed *(Polygonum aviculare)*. These seven weeds were also ranked on the list for the more crop intensive northern agricultural region (Appendix Table A.2). At least four or more of these weeds appeared on the lists from the north-western, north-eastern and northern midlands agricultural regions (Appendix Tables A.1 and A.3–A.4).

Although the west coast is not a major agricultural region, two landholders responded to the survey. This result included the beef cattle enterprises at Granville Harbour (120 ha) and near Strahan (9 ha). Of the two weeds listed at the Granville Harbour property, fireweed *(Senecio linearifolius)* was considered a major problem and thistles moderate, with the status of these weeds increasing over the last 10 years. At the Strahan property, blackberry, gorse and broom (*Cytisus scoparius*) were all considered as having a moderate impact, with the problem decreasing over 10 years with herbicide use.

2.3.2 NRM regions

Twenty-eight weeds are listed from the three NRM regions combined (Table 2.2), all being identifiable as single species or species groups.

The 20 agricultural weeds most frequently listed in each of the three NRM regions, together with their ranking, perceived economic impact, problem status and the percentage breakdown of the enterprises to which each weed is a problem are presented in the Appendix (Tables A.10–A.12).

Of the 28 weeds listed for the three NRM regions, 12 (blackberry, bracken, barley grass, Californian thistle, capeweed, fat hen, gorse, ragwort, slender thistle, spear thistle, wild turnip and wireweed) were ranked amongst the first 20 weeds in all three regions (Table 2.2 and Appendix Tables A.10–A.12).

Five weeds, African boxthorn *(Lycium ferocissimum)*, whiteweed *(Cardaria draba)*, briar, horehound and sorrel *(Rumex acetosella)*, that were listed for the southern NRM region, two (amaranthus and twitch grass) for the north-western NRM region and one (tussock grass) in the northern NRM region appeared on neither of the other two lists. Gorse was ranked first on the lists for the northern and southern NRM regions (Appendix Tables A.11–A.12) and blackberry in the north-western NRM region (Appendix Table A.10).

Only blackberry and bracken were indicated by the majority of respondents to be decreasing in problem status in all three NRM regions. Ragwort was indicated as decreasing in problem status in the north-western and southern NRM regions and as stable in the northern NRM region, but 49% of respondents listed the economic impact of ragwort in this latter region as minor and only 16% as major (Appendix Tables A.10–A.12).

Respondents ranked the economic impact of blackberry in approximately equal proportions in the minor–moderate range in all three NRM regions (Appendix Tables A.10–A.12). A similar result was obtained for bracken in the southern and northern NRM regions and a clear majority of respondents indicating a minor impact in the north-western NRM region (Appendix Table A.10).

When divided amongst the three NRM regions, the survey results broadly indicate the regional location of Tasmania's main pastoral enterprises. The majority of respondents listed sheep and beef as the major pastoral enterprises in the drier southern NRM region, with dairy and beef being the major pastoral enterprises in the wetter north-western NRM region. The northern NRM region encompasses locations involving all three pastoral enterprises (Appendix Table A.13 and Figure 2.2).

The results are also indicative of the north-western NRM region encompassing the greater proportion of the state's cropping enterprises. Eight of the 20 weeds listed for the north-western NRM region (amaranthus, fat hen, fumitory, nightshade, twitch grass, wild radish, wild turnip and wireweed) are predominantly cropping weeds. Six of these weeds; fat hen, fumitory, nightshade, wild radish, wild turnip and wireweed, are listed for the northern NRM region and four cropping weeds; fat hen, sorrel, wild turnip and wireweed, are listed for the southern NRM region (Appendix Tables A.10–A.12).

2.4 Discussion

The data have been presented in tabular reference formats, which may assist in developing target priorities for a weed or for determining the success or otherwise of a state-wide or regional control program. However, the data should be treated with caution, as it is dependent on the number of respondents in each region. Furthermore, the status of any weed problem can vary considerably between locations and over time and assessments can be subjective (Thorp and Lynch

2000). For this reason, those involved in control programs with any of the weeds listed (either regional or state-wide) may be far better placed to interpret the data and its authenticity than the authors.

It is, of course, not possible to use the information obtained from this survey to attempt an in depth analysis on the situation with every weed that has been listed, due to lack of supporting data. However, the survey results for blackberry and ragwort, for which respondents indicated a consistent decrease in the problem status of these weeds during the last 10 years, are particularly interesting.

These weeds have often been the focus of control programs involving state-wide weed management networks that have included state and local government, private enterprise, Landcare and community groups as well as individual landholders. A decrease in the problem status of these weeds might therefore be attributed solely to improved management strategies using traditional control methods. However, both weeds have also been the target of biological control programs (see Section 3).

There is anecdotal evidence that the blackberry rust *(Phragmidium violaceum)* has contributed to the control of blackberry by reducing its vigour. The rust was illegally released in Australia in 1984 and is now widespread in Tasmania. Although no studies have been done to determine the efficacy of the blackberry rust in Tasmania (Evans pers. comm.), the efficacy of the ragwort flea beetle *(Longitarsus flavicornis)*, released in 1979 for the biological control of ragwort, has been demonstrated (Ireson et al 1991). Since then, two additional agents, the ragwort stem and crown boring moth *(Cochlis atricapitana)* and the ragwort plume moth *(Platyptilia isodactyla)* have been established in the state and are also contributing to the control program (Ireson et al 1999b; 2003b). Furthermore, the decline in the economic impact of ragwort, as indicated by the results of this survey, is also supported by plant counts, seedbank data and photographic evidence collected from trial sites since 1979.

These data are used in a case study presenting evidence for the successful biological control of ragwort in Section 4.

Section 3: Weed biological control agents in Tasmania: their target weeds and current status

A tabulated summary providing details for all weed biological control agents deliberately released or approved for future release in Tasmania is presented in this section. Twenty-seven agents have been deliberately released for the biological control of 14 weed species in 11 programs. The blackberry rust *(Phragmidium violaceum)* and the willow sawfly *(Nematus oligospilus)* were not deliberately released in the state but details of their current status are also summarised. Of the 27 deliberately released agents, 25 are invertebrate species (24 insect species and one mite species) and two are fungal pathogens. Fourteen of these agents (52%) have established, seven (26%) have failed to establish and the status of the remaining six (22%) is still to be confirmed.

Only the ragwort biological control program has been completed, with a sufficient complement of established agents now resulting in effective control. The other weed biological control programs being conducted in Tasmania vary considerably in their stage of development and the amount of resources available for their continuation. The difficulties in completing long-term biological control programs and the importance of recording successes are discussed.

3.1 Introduction

Weed biological control involves the use of a living species (insect, mite or pathogen) to control an undesirable plant. Although there are several techniques that can be employed (Nordlund 1996; Eilenberg et al 2001), the most commonly used is classical biological control. This involves the introduction of an exotic, usually co-evolved, natural enemy from its native range into the range where its host plant has become a weed.

In Australia, strict protocols under legislative control ensure that classical biological control agents for weeds are selected very carefully to minimise the risk of introduced agents attacking desirable plants (Briese 2000). Initially, studies are carried out overseas to identify the organisms attacking the weed in its native range and to identify those that have a high level of host specificity. More stringent host specificity testing is then conducted on close relatives of the weed, native plants and economically important plants (Briese 2000; 2003). If the tests indicate that the potential agents are unlikely to cause serious damage to any beneficial plant species, permits to import and release the agent will be issued by agencies of the Australian Government.

There is no guarantee that an agent will establish after it is released or that it will control the target weed. Experience has shown that one or several control agents may be required to have a significant impact on a weed (McFadyen 2000). Biological control will not eradicate a weed, because the agents always need some surviving plants to complete their life cycle. Rather, a successful biological control program reduces the vigour, abundance and therefore the economic impact of the weed to low levels, often in conjunction with traditional control methods as part of an overall integrated weed management program.

Knowledge of the agent's biology, including its life cycle, as well as the impact of traditional control methods on the agent (eg herbicides, grazing animals, cutting) is important if biological control is to be successfully integrated into a management strategy.

Once an agent is well established, field collection and redistribution programs are often conducted to accelerate agent dispersal, particularly if it is initially slow to disperse. An evaluation of agent efficacy on the target weed is also essential to determine the economic benefits of the program (Briese et al 2003). To enable this, base line studies on the population density, growth characteristics and general biology of the weed should be conducted before the release of agents to enable changes over time to be quantified. Due to the amount of research required, biological control programs are initially expensive and slow to develop, often taking up to 20 years or more to achieve full success. However, once in place the ongoing costs are negligible and there have been many programs in Australia and worldwide that demonstrate classical biological control to be a successful, cost effective and safe method of weed control (McFadyen 1998; Page and Lacey 2006).

A world catalogue of classical biological control agents and their target weeds has been compiled by Julien and Griffiths (1998) and contains a list of all agents released in Australia up to 1996. This section presents a list of the classical biological control agents that have been released in Tasmania and the current status of each program up to 2006. Agents whose releases have been approved by the Australian Government but are still to be released are also listed. Details of the blackberry rust *(Phragmidium*

violaceum) and the willow sawfly *(Nematus oligospilus)* that did not establish in Tasmania from deliberate releases are also provided.

3.2 Sources of agents released in Tasmania

Many of Tasmania's most important weeds are also problems in parts of south-east mainland Australia, particularly Victoria. Therefore, in most cases, Tasmania has been the recipient of biological control agents from programs initiated either by CSIRO or jointly by CSIRO and state governments in other states, with funding support from industry corporations.

An exception was the biological control program for gorse. Gorse was declared a target for biological control in 1995, by the Standing Committee of Agriculture and Resource Management, after nomination by the then Tasmanian Department of Primary Industry and Fisheries (Ireson et al 1999a). The Tasmanian Institute of Agricultural Research, with funding support from the Australian Government's Natural Heritage Trust, contracted Landcare Research New Zealand Ltd to conduct host specificity tests on gorse agents already established in New Zealand. Following approval for release, agents were introduced to Australia through the Department of Primary Industries, Victoria, using their quarantine facility at Frankston.

3.3 Results

Twenty-seven agents have been released in Tasmania for the biological control of 14 weed species in the 11 programs for which releases have been conducted (Table 3.1). The releases of three additional agents, the boneseed leaf buckle mite (*Aceria* sp.), the gorse soft shoot moth (*Agonopterix ulicetella*) and the broom gall mite *(Aceria genistae)* have been approved and are imminent, pending importation and release from quarantine (Table 3.1).

Of the 27 deliberately released agents, 25 are invertebrate species (including 24 insect species and one mite species) and two are fungal pathogens (Table 3.1). Fourteen of these agents (52%) have established, seven (26%) have failed to establish with the establishment of the remaining six (22%) still to be confirmed (Table 3.1). Five of the seven agents that have failed to establish are foliage feeders with evidence suggesting that predation was a key factor in preventing their establishment (Table 3.1).

Of the programs conducted in Tasmania, only the ragwort biological control program is considered complete with a sufficient complement of agents to enable the effective control that continues to be recorded at sites around the state (Table 3.1).

Although blackberry is a major Tasmanian weed (see Section 2) the blackberry rust did not establish from deliberate releases. The release of the rust was initially opposed by the Tasmanian Government due to concerns raised about the potential impact on the state's apiary industry. However, the rust was eventually recorded in Tasmania in 1985 (Table 3.2) having probably dispersed on wind currents from the mainland after its illegal release in Victoria in 1984, although it is possible it was also released illegally in Tasmania.

At this stage, it is not known if any of the additional European strains of blackberry rust that have been released in New South Wales, Western Australia and Victoria to improve the biological control of blackberry (Morin et al 2006) will be deliberately released in Tasmania. Although no efficacy studies have been conducted on the established rust strain, anecdotal evidence suggests that it is contributing to the control of at least some of the eight species of European blackberry that have been identified in the state (Evans pers.comm.) (Table 3.2).

Table 3.1 Weed biological control agents deliberately released or approved for release in Tasmania

Target weed	Agent	Part of plant affected	Year[1] of release in Tasmania	Origin[2], status and effect on target plant
Asparagus asparagoides (L.) Druce (Bridal creeper)	*Zygina* sp. (Hemiptera: Cicadellidae) (Bridal creeper leafhopper)	Foliage and stem	1999	Ex South Africa (Bachelor and Woodburn 2002). Established. Dispersal and impact not assessed at the only release site in northern Tasmania. As bridal creeper infestations in Tasmania are relatively small and localised, attempts have been made to eradicate infestations using herbicides. The impact of these measures on the insect is unknown. Additional releases on Flinders Island in 2000 also resulted in establishment, but infestations have since been treated with herbicide in an eradication program (Cooper pers. comm.).
	Puccinia myrsiphylli G. Winter (Uredinales: Phragmidiaceae) (Bridal creeper rust)	Foliage	2000	Ex South Africa (Morin et al 2002). Established after releases on Flinders Island, however, survival of rust could be affected by the eradication program.
Chrysanthemoides monilifera ssp. *monilifera* (L.) T. Norl. (Boneseed)	*Chrysolina scotti* Daccordi (Coleoptera: Chrysomelidae) (Black boneseed beetle)	Foliage	1991	Ex South Africa. None of the four agents released have established after multiple releases. Biotic resistance by invertebrate predators is suspected as a key factor preventing establishment of all four agents (Meggs 1995; Ireson et al 2002).
	Comostolopsis germana Prout (Lepidoptera: Geometridae) (Bitou tip moth)	Foliage	1993	
	Chrysolina sp. B (Coleoptera: Chrysomelidae) (Painted boneseed beetle)	Foliage	1995	
	Tortrix sp. (Lepidoptera: Tortricidae) (Boneseed leaf roller moth)	Foliage	2000	
	Aceria sp. (Acari: Eriophyidae) (Boneseed leaf buckle mite)	Foliage	Release pending	Ex South Africa. Release approved in 2005 (Morley pers. comm.). Awaiting successful breeding through one generation in quarantine, as per regulations.

Target weed	Agent	Part of plant affected	Year[1] of release in Tasmania	Origin[2], status and effect on target plant
Carduus spp. (Slender thistle, nodding thistle) *Carduus pycnocephalus* L. (Slender thistle), *Carduus tenuiflorus* Curtis (Winged slender thistle), *Carduus nutans* L. (Nodding thistle)	*Puccinia cardui-pycnocephali* Sydow (Uredinales: Phragmidiaceae) (Slender thistle rust fungus)	Foliage	1993 1994 1997	Ex France and Italy. Established and widespread. Repeat releases of two aggressive Mediterranean isolates IT2 and FR3 conducted in Tasmania in 1993, 1994 and 1997 on slender thistle *(Carduus pycnocephalus)*. Winged slender thistle *(Carduus tenuiflorus)* also present at some release sites (Burdon et al 2000). Studies in Tasmania on *C. pycnocephalus* showed that the rust could reduce plant size and flower production (Burdon et al 2000). Concluded the pathogen would be useful in controlling *C. pycnocephalus* and *C. tenuiflorus* when integrated with other methods, by further reducing competitive ability of the thistles. Impact of the pathogen alone is insufficient to reduce thistle densities. No further impact assessments.
	Trichosirocalus mortadelo Alonso-Zarazaga and Sánches-Ruiz (Coleoptera: Curculionidae) (Rosette weevil) (Figure 3.1)	Crown	1998	Ex Germany via Canada via New Zealand (Woodburn 1997). Established at one site at Westbury in northern Tasmania. The site has been used as a nursery to collect and transfer adults to other sites. Agent feeds on several *Carduus* species (Alonso-Zarazaga and Sánches-Ruiz 2002) and will be used against slender thistle *(C. tenuiflorus)* and nodding thistle *(C. nutans)* in Tasmania. Agent also uses spear thistle *(Cirsium vulgare)*, present at Westbury site, as marginal host (Woodburn and Swirepick 2002) (see below). Dispersal and impact not assessed in Tasmania. Field studies in NSW (Woodburn 1997) showed weevil significantly reduced rosette growth and seed production in *C. nutans*. Recent studies indicate the weed is now being controlled at mainland sites (Swirepick and Smyth 2002).
Cirsium vulgare (Savi) Tenore (Spear thistle)	*Urophora stylata* (Fabricius) (Diptera: Tephrididae) (Spear thistle gall fly)	Seed head	1997	Ex France. Not established. Survey at both release sites in northern Tasmania in December 2004 failed to recover the agent (Ireson unpubl. data).
	Trichosirocalus mortadelo Alonso-Zarazaga and Sánches-Ruiz (Coleoptera: Curculionidae) (Rosette weevil) (Figure 3.1)	Crown	1998	As for *T. mortadelo* on slender thistles (above).

Cytisus scoparius (L.) Link (English broom)	*Leucoptera spartifoliella* (Hübner) (Lepidoptera: Lyonetiidae) (Broom twig mining moth) (Figures 3.2 to 3.3)	Branches	1996 1998 2004	Ex Europe via New Zealand. Failed to establish from releases of material imported from the mainland in 1996 and 1998 at seven locations around the state. Recovered at a site near Oatlands in Tasmanian midlands in 2005, but establishment not certain. Rearing and releases are continuing.
	Aceria genistae (Nalepa) (Acarina: Eriophyidae) (broom gall mite)	Buds	Release pending	Ex Europe. Release approved in 2002 (Hosking and Sheppard 2002); awaiting importation and successful breeding through one generation in quarantine, as per regulations.
Echium plantagineum (L.) (Paterson's curse)	*Dialectica scalariella* (Zeller) (Lepidoptera: Gracillariidae) (Paterson's curse leaf miner)	Foliage	1990	Ex France and Portugal. Current status unknown. Reared then released at 14 sites between July 1990 and April 1992 (Ireson unpubl. data). Initially recovered and dispersed rapidly from release sites but population subsequently declined possibly due to its inability to survive cold winters. Impact on the plant minimal (CSIRO 1998) and no further work in Tasmania since 1992.
	Mogulones geographicus (Goeze) (Coleoptera: Curculionidae) (Paterson's curse root weevil)	Taproot, petioles and foliage	2004	Ex France. Recovered after release at one site in southern Tasmania, but establishment not confirmed.
	Longitarsus echii (Koch) (Coleoptera: Chrysomelidae) (Paterson's curse tap root flea beetle)	Taproot, crown and foliage	2004	Ex France and Spain. As for *M. geographicus* (above).
	Mogulones larvatus (Schultz)	Crown, petioles and foliage	2006	Ex France. Released at one site, but establishment not confirmed.
Onopordum acanthium L. (Cotton thistle)	*Lixus cardui* Olivier (Coleoptera: Curculionidae) (Onopordum stem-boring weevil)	Stem and foliage	1997	Ex France. Established after release at one site near Campbell Town in northern Tasmania. Dispersal and impact not assessed.
	Larinus latus Herbst (Coleoptera: Curculionidae) (Onopordum seedhead weevil)	Seeds	1999	Ex Greece. Current status unknown. Released at the same site as *L. cardui* (above) but establishment not confirmed.
Rumex spp. (Dock) Common Tasmanian pasture species are: *Rumex crispus* (L.) (Curled dock) and *Rumex obtusifolius* (L.) (Broadleaf dock)	*Pyropteron doryliformis* (Ochsenheimer) (Lepidoptera: Sesiidae) (Dock moth) (Figure 3.4)	Roots and crown	1997	Ex Morocco (Scott and Sagliocco 1991). Established. Released at three sites in northern Tasmania and recovered during surveys in 2006. Anecdotal and visual evidence indicates *P. doryliformis* has had a significant impact on *Rumex* spp. near the release sites. No surveys yet conducted to determine dispersal or obtain quantitative data on its impact in Tasmania.

Target weed	Agent	Part of plant affected	Year[1] of release in Tasmania	Origin[2], status and effect on target plant
Senecio jacobaea L. (Ragwort)	*Botanophila jacobaeae* Waterhouse [formerly *Pegohylemia jacobaeae* (Hardy), also referred to as *Hylemia jacobaeae* Meade and incorrectly as *Hylemia seneciella* (Meade)] [3] (Diptera: Anthomyiidae) (Ragwort seed fly)	Seeds	1963	Ex England via New Zealand. Not established. Only one release in Tasmania from insects sent by CSIRO in 1963. Release not recorded in Julien and Griffiths (1998), but is in records of Tasmanian Department of Agriculture.
	Longitarsus flavicornis (Stephens) (Coleoptera: Chrysomelidae) (Ragwort flea beetle) (Figures 3.5 to 3.7)	Roots, crown and foliage	1979	Ex France. Established and widespread. High levels of control in many areas with reductions in plant densities in excess of 90% (Ireson et al 1991; 2000b).
			1986	Ex Spain. Established at six sites but dispersal unknown due to difficulties in distinguishing field populations from the dominant French biotype (Ireson et al 1999b). Efficacy probably similar.
	Longitarsus jacobaeae (Waterhouse) (Coleoptera: Chrysomelidae) (Ragwort flea beetle)	Roots, crown and foliage	1988	Ex Italy via Oregon USA via New Zealand. Established at five sites but dispersal unknown due to difficulties in distinguishing field populations from *L. flavicornis* (Ireson et al 1999b).
	Tyria jacobaeae (L.) (Lepdoptera: Arctiidae) (Cinnabar moth)	Foliage and flowers	1993	Ex England via New Zealand (Miller 1929; Ireson et al 1999b). Not established probably because of high levels of predation and lack of suitable pupation sites (Ireson et al 1999b).
	Cochylis atricapitana (Stephens) (Lepidoptera: Cochylidae) (Ragwort stem and crown boring moth) (Figures 3.8 to 3.9)	Stem and crown	1995	Ex Spain (McLaren 1992). Established and becoming widespread. Surveys indicate larval feeding stunts growth of flowering plants and contributes to decline in rosette density as in Victoria (McLaren et al 2000). No detailed efficacy studies conducted.
	Platyptilia isodactyla (Zeller) (Lepidoptera: Pterophoridae) (Ragwort plume moth) (Figures 3.10 to 3.11)	Stem and crown	2000	Ex Spain (McLaren 1997). Established. Maximum dispersal of 1.5 km 2 years post-release but no recent surveys. Significant larval damage to plants observed in field, but no detailed efficacy studies conducted.

Ulex europaeus L. (Gorse)	*Exapion ulicis* (Forster) (Coleoptera: Brentidae) (Gorse seed weevil) (Figures 3.12 to 3.13)	Seeds	1939	Ex England via New Zealand (Evans 1942). Established and widespread (Ireson et al 2006). Destruction to mature seed ranges from 12.4–55.4% annually but is below that required to impact gorse populations (Davies 2006).
	Tetranychus lintearius Dufour (Acari: Tetranychidae) (Gorse spider mite) (Figures 3.14 to 3.15)	Foliage	1998	Ex England, Portugal and Spain via New Zealand (Ireson et al 1999a). Established and widespread (Ireson et al 2003a). Reductions in foliage dry weight of *ca*. 36% over 2.5 years from the time of release measured (Davies 2006). Surveys indicate predation by Chilean predatory mite *(Phytoseiulus persimilis)* and predatory ladybird beetles (*Stethorus* spp.) restrict impact (Ireson et al 2003a).
	Sericothrips staphylinus Haliday (Thysanoptera: Thripidae) (Gorse thrips) (Figure 3.16)	Foliage	2001	Ex England via New Zealand (Ireson et al 2004). Established but populations slow to increase. Measured at *ca*. 1 thrips/cm on gorse tips at maximum density in mid summer 5 years after initial release, with no noticeable damage at any site. Dispersal appears slow at a mean of around 6 m (range 0–26 m) after 3–5 years (Ireson unpubl. data), but could be an underestimate due to low population densities (Ireson et al 2006).
	Agonopterix ulicetella (Stainton) (Lepidoptera: Oecophoridae) (Gorse soft shoot moth)	Foliage	Release pending	Native to Europe. Release approved 2004 (Ireson unpubl. data); awaiting importation and breeding through one generation in quarantine, as per regulations.
Marrubium vulgare L. (Horehound)	*Wheeleria spilodactylus* (Curtis) (Lepidoptera: Pterophoridae) (Horehound plume moth) (Figures 3.17 to 3.18)	Foliage	1997	Ex France (Sagliocco 2000). Established (Ireson et al 2000a) and now widespread (Ireson unpubl. data). No field studies conducted to determine impact in Tasmania or elsewhere. Severe defoliation by larvae in spring probably reducing plant vigour and seed output. Studies by Ainsworth (1999) suggest agent has potential in integrated control program with 2,4 D or other similar acting herbicides.

[1] Year(s) of first release in Tasmania. Mass rearing programs and multiple field releases have been conducted for many agents in Tasmania. For some agents, difficult to establish or slow to disperse, rearing and field release programs continued over several years. For instance, in unsuccessful attempts to establish the black boneseed beetle *(Chrysolina scotti),* releases were conducted from October 1991 to December 1993 and from November 1995 to November 1996 (Ireson et al 2002).

[2] Agent origin from Julien and Griffiths (1998) unless otherwise indicated.

[3] Information from Julien and Griffiths (1998).

Table 3.2 Weed biological control agents present but not deliberately released in Tasmania

Target weed	Agent	Part of plant affected	Year first identified in Tasmania	Origin, status and effect on target plant
Rubus fruticosus L., aggregate (Blackberry)	*Phragmidium violaceum* (Schultz) Winter (Uredinales: Phragmidiaceae) (Blackberry rust)	Foliage, buds, fruit and canes	1985	Ex Europe via Victoria. Illegally introduced and first identified in Victoria in 1984 (Mahr and Bruzzese 1998). Spread naturally to Tasmania where first identified in 1985 (Herbarium DAR 43852a)[1]. F15 strain released in Victoria in 1991 but presence in Tasmania has not been determined (Evans pers. comm.). Significant reduction in daughter plant production and total biomass reported in south-eastern Victoria on *R. polyanthemus* and *R. ulmifolius*[2] (Mahr and Bruzzese 1998). Anecdotal and visual evidence that *P. violaceum* is impacting on species of blackberry in Tasmania (Metcalf pers. comm.; Evans pers. comm.). No study carried out to obtain quantitative impact data or species affected in Tasmania.
Salix spp. (Willow)	*Nematus oligospilus* Forster (Leaf-feeding willow sawfly)	Foliage	2005	Native to the northern hemisphere, it is not known how *N. oligospilus* reached Australia but may have come from New Zealand where it was recorded in 1997. First recorded in Australia in 2003 (Bruzzese and McFadyen 2006) and probably spread naturally from Victoria to Tasmania. First recorded in northern Tasmania in February 2006 (Adair pers. comm.). Impacts still unknown.

1 Refers to specimen number held at DPI Victoria at Rydalmere from which *P. violaceum* was first identified on Tasmanian blackberry specimens.

2 *R. polyanthus* and *R. ulmifolius* do not occur in Tasmania.

3.4 Discussion

McFadyen (2000), in reviewing the many worldwide successes in the biological control of weeds, makes the point that "success is the successful control of the weed, not the success of individual agents against the weed". A program should therefore be viewed as a failure not when an individual agent or guild of agents has failed, but only when the overall program has failed.

Hoffmann (1995) defined success in weed biological control under three categories: complete, substantial and negligible. Complete control is when no other method is used or required, at least in the areas where the agent(s) is/are established; substantial, where other methods are needed but the effort required is reduced (eg reduced herbicide applications); negligible, where despite agent damage, control still depends on other measures. It should also be noted that substantial control includes cases where control of the weed may be complete in some seasons or over part of its range, or where the control achieved is widespread and economically significant but the weed is still a major problem (McFadyen 2000).

There is now enough evidence to show that the biological control of ragwort can be classified as ranging from substantial to complete in many parts of Tasmania where the weed has been a major problem (see Section 4).

The control achieved by the ragwort flea beetle *(Longitarsus flavicornis)* alone is now resulting in significant economic benefits (Page and Lacey 2006) (see Section 4). Furthermore, there is anecdotal and visual evidence to indicate that control is still improving in many areas as two additional agents, the ragwort stem and crown boring moth *(Cochylis atricapitana)* and the ragwort plume moth *(Platyptilia isodactyla)*, continue to spread. However, although it is evident from surveys (Ireson unpubl. data) that these agents are damaging ragwort, their impact either alone or in combination with *L. flavicornis* still needs to be measured quantitatively.

In Tasmania, only the ragwort biological control program has reached the stage where the release of additional agents or the redistribution of established agents is no longer required. All of the remaining programs will not be completed for many years. The other weed biological control programs being conducted in Tasmania vary in their stage of development, and the resources available for their continuation.

The Tasmanian Institute of Agricultural Research has played a leading role in the introduction of gorse biological control agents into Australia. However, the introduction of agents for other Tasmanian weeds continues to be dependent on agents from control programs on the same weed in other states. Even so, the decision to introduce an agent should not be based just on its availability. Other factors need to be considered, such as the likelihood of the agent establishing (based on factors such as climate compatibility), the resources available to work on the project and whether biological control (as opposed to other control measures) is appropriate for the particular target weed.

For instance, the horehound clearwing moth *(Chamaesphecia mysiniformis)*, which feeds on the roots and lower stems of horehound, has been established in the more arid and warmer sites on the mainland such as Wyperfeld in north-western Victoria (Sagliocco and Weiss 2004). It has not been considered for release in Tasmania because the optimum temperature required for adults to mate is around 30°C (Sagliocco and Coupland 1995). Although this temperature is recorded in Tasmania during summer, such conditions may not occur consistently over sufficient periods during summer to enable survival of the agent. However, as horehound is a serious weed in the drier sheep-grazed pastures of Tasmania (mean annual rainfall < 800 mm (see Section 2)), its climatic limits in Tasmania should be investigated as its feeding would complement that of the foliage feeding horehound plume moth *(Wheeleria spilodactyla)*.

Although agents for the biological control of Paterson's curse and cotton thistle have been released in Tasmania, both species are minor agricultural weeds compared to ragwort, gorse, slender thistle, spear thistle and horehound (see Section 2). Resources for the biological control of agricultural weeds in Tasmania will therefore continue to be directed to these latter species.

Boneseed and broom remain the focus of biological control programs for environmental weeds in Tasmania. Bridal creeper infestations are relatively small and localised in Tasmania and are now being targeted for eradication (Table 3.1) so biological control is probably no longer relevant. In general, biological control is inappropriate if a weed species can be eradicated using other methods.

Additional agents may be required for some weeds (eg gorse, boneseed) where post-release studies indicate either the failure of the agent to establish or that the impact on the target weed is less than the level required. However, some established agents such as the hore-hound plume moth and the slender thistle rust *(Puccinia cardui-pycnocephali)* may already have sufficient impact to provide adequate control of these species when integrated with other methods (Ainsworth 1999; Burdon et al 2000).

Redistribution programs may be required to accelerate the distribution of other agents, such as the thistle crown weevil *(Trichosirocalus mortadelo)* and the gorse thrips *(Sericothrips staphylinus)* released at only one site in Tasmania, whose populations are slow to increase (Ireson et al 2006). In addition, further studies are needed to investigate agent efficacy and the best methods of incorporating biocontrol into integrated management strategies. These programs, therefore, need to continue but will be dependent on funding availability.

Although the enormous economic benefits from successful Australian biological control programs have been demonstrated (Page and Lacey 2006), political and financial time frames are much shorter than those required to achieve successful outcomes from such a program. Some programs take over 20 years, such as the one for ragwort and it is difficult to maintain continued funding over such a long period. Consequently, many biological control programs are often poorly resourced and not fully evaluated once the agents are released. Furthermore, the full extent of weed infestations prior to the initiation of a successful biological control program may be forgotten because of the long time lag (McFadyen 2000).

The full benefits of biological control programs may not be appreciated, particularly if no records are kept and no evaluation is undertaken. It is therefore important to record data from those long-term successes that are achieved, eg ragwort in Tasmania (see Section 4), in order to justify further investment in weed biological control (McFadyen 2000; Briese et al 2003; Page and Lacey 2006).

Figure 3.1 Rosette weevil, *Trichosirocalus mortadelo*
Photo: W. Chatterton, TIAR

Figure 3.2 Broom twig mining moth, *Leucoptera spartifoliella*
Photo: W. Chatterton, TIAR

Figure 3.3 Broom twig damage created by mining larvae of the broom twig mining moth
Photo: W. Chatterton, TIAR

Figure 3.4 Dock root damage by larvae of the dock moth, *Pyropteron doryliformis*
Photo: R. Holloway, TIAR

Figure 3.5 Ragwort flea beetle, *Longitarsus flavicornis*
Photo: R. Holloway, TIAR

Figure 3.6 Root feeding larva of the ragwort flea beetle
Photo: R. Holloway, TIAR

Figure 3.7 Ragwort crown damage by ragwort flea beetle larvae
Photo: R. Holloway, TIAR

Figure 3.8 Ragwort stem and crown boring moth, *Cochylis atricapitana*
Photo: R. Holloway, TIAR

Figure 3.9 Damage by ragwort stem and crown boring moth larvae
Photo: R. Holloway, TIAR

Figure 3.10 Ragwort plume moth, *Platyptilia isodactyla*
Photo: W. Chatterton, TIAR

Figure 3.11 Ragwort crown damage by larvae of ragwort plume moth
Photo: R. Holloway, TIAR

Figure 3.12 Gorse seed weevil, *Exapion ulicis*
Photo: W. Chatterton, TIAR

Figure 3.13 Gorse seed damage by gorse seed weevil larvae
Photo: R. Holloway, TIAR

Figure 3.14 Gorse spider mite, *Tetranychus lintearius*
Photo: W. Chatterton, TIAR

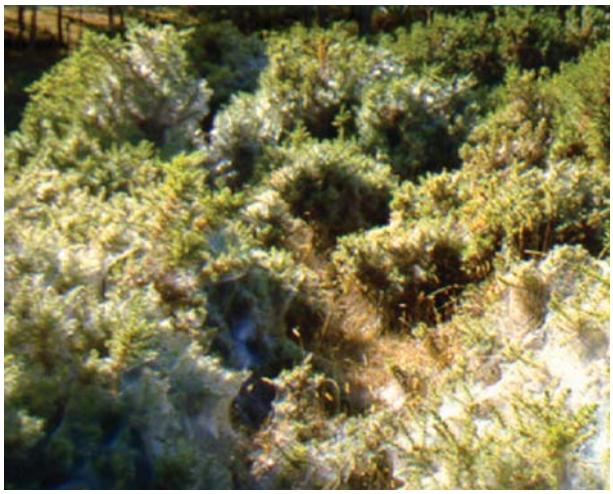


Figure 3.15 Gorse spider mite webbing
Photo: R. Holloway, TIAR

Figure 3.16 Gorse thrips, *Sericothrips staphylinus*
Photo: W. Chatterton, TIAR

Figure 3.17 Horehound plume moth, *Wheeleria spilodactylus*
Photo: R. Holloway, TIAR

Figure 3.18 Larvae of horehound plume moth feeding on horehound
Photo: R. Holloway, TIAR

Section 4: Success in the biological control of ragwort, *Senecio jacobaea* L., in Tasmania

Tasmanian studies on the biology and efficacy of the ragwort flea beetle *(Longitarsus flavicornis)* are reviewed. These studies demonstrated the ability of *L. flavicornis* to reduce ragwort infestations by around 95% and showed that this biological control agent could be suitably used in an integrated control strategy with wick wiped or spot sprayed herbicides, sheep grazing or cutting. This strategy has now been recommended to landholders for over 20 years.

The widespread establishment of *L. flavicornis* throughout Tasmania's ragwort infestations has been associated with a general decline in the problem status of this weed as indicated by the results of recent surveys of landholders. Large reductions in ragwort densities and seedbanks were recorded at monitored sites. The potential impact of more recently established biological control agents, the ragwort stem and crown boring moth *(Cochylis atricapitana)* and the ragwort plume moth *(Platyptilia isodactyla)*, is discussed.

The ongoing decline of ragwort as a major Tasmanian pasture weed is providing significant economic benefits for Tasmanian farmers, particularly those involved in the dairy and beef industries.

4.1 Introduction

Ragwort *(Senecio jacobaea)* is a native of Europe and Western Asia, which has become a weed of major economic significance on the north-west coast of the United States, in the maritime provinces of Canada and in New Zealand, Argentina and Australia (Harper and Wood 1957). The history of its establishment in Australia is not well recorded but it became widely established in the high rainfall regions of Victoria and Tasmania from the beginning of the 20th century (Parsons and Cuthbertson 2001).

Ragwort is a facultative biennial, the biennial life cycle usually occurring in plants growing on wasteland where plants flower after two years growth and then die. In pasture situations ragwort normally behaves as a perennial, with individual plants living for several years and sometimes flowering several times before dying. This perennial life cycle is promoted by damage to the plant from stock hooves, grazing and cutting.

Ragwort is a weed of major economic significance in Australia due to its detrimental effects on agricultural production and invasion of natural ecosystems. It is poisonous to all livestock due to the presence of pyrrolizidine alkaloids. In Tasmania, ragwort has commonly comprised 5–20% of ground cover on *ca*. 16,000 ha of cattle grazed pasture with the heaviest infestations occurring in the higher rainfall areas (>800 mm) (Figure 4.1). At least 270,000 ha of pasture are considered vulnerable to invasion (Friend unpubl. data). In 1995 and 1996 annual production losses from ragwort in the Tasmanian dairy and beef industries were estimated at $2.5 million (Ireson 2000).

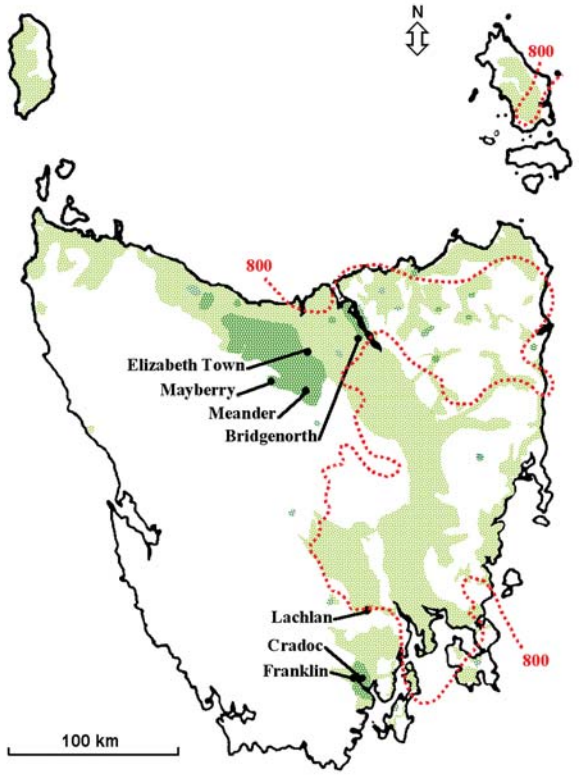


Figure 4.1 Location of the main ragwort infestations (dark green) and study sites in relation to the main agricultural areas (light and dark green) of Tasmania. The 800 mm isohyet is used to divide Tasmania into high rainfall (west) and low rainfall zones (east)

Note: This division broadly reflects the two main pastoral enterprises in Tasmania: dairying and beef production in the high rainfall zone and sheep and beef production in the drier areas.

Direct approaches to control include herbicides, pulling or grubbing and grazing by sheep. Although ragwort is toxic to livestock, sheep have a high tolerance of the toxic alkaloids it contains. Indirect approaches to control include pasture improvement, grazing management, cropping or establishing tree cover. Control by these direct and indirect methods is expensive and needs to be sustained over a long period (> 10 years) to be successful.

This is primarily due to the large seedbank that develops in ragwort infestations of up to 2,000 germinable seeds/m^2 (Friend unpubl. data), with seed production ranging from 5,000 to 250,000 per plant depending on plant size (McLaren and Mickan 1997; Parsons and Cuthbertson 2001). Burial of the seed deeper than 2 cm can induce dormancy ranging from 10–16 years (McLaren and Mickan 1997).

Biological control programs have been undertaken against ragwort in New Zealand, North America, Canada and Australia, with investigations beginning in Australia in the late 1920s (McLaren et al 2000). The ragwort biological control program in Australia, including the history of agent releases and progress to 1999, was reviewed by McLaren et al (2000). Ireson et al (1999b) reviewed the establishment, distribution and efficacy of agents released for the Tasmanian ragwort biological control program to 1999 (see also Section 3, Table 3.1).

The results of the 2005 weed survey (Section 2) indicated a general decrease in the problem status of ragwort in Tasmania during the last 10 years. This section presents evidence for the role of biological control in this decline. Previous work on the efficacy of the ragwort flea beetle *(Longitarsus flavicornis)* is reviewed together with the current status of two additional biological control agents recently established in Tasmania; the ragwort stem and crown boring moth *(Cochylis atricapitana)* and the ragwort plume moth *(Platyptilia isodactyla)*. Additional data is presented on the reduction of ragwort plant densities and seedbanks associated with *L. flavicornis*.

4.2 Review of previous work on ragwort biological control in Tasmania

A French biotype of *L. flavicornis* was first released in Tasmania in 1979 and successfully established following multiple releases of glasshouse-reared adults. Field collection and transfer of around two million adults from established sites accelerated the spread, and field surveys to the end of February 1999 showed it had become established in most of the state's ragwort infestations (Ireson et al 2000b).

Two of the earliest release sites where establishment of *L. flavicornis* was recorded were at Lachlan in southern Tasmania (42° 50' S, 147° 03' E) and Mayberry in the north (41° 34' S, 146° 19' E) (Figure 4.1). At both sites, releases were made in the summer and autumn of 1979/80 and studies on the efficacy of *L. flavicornis* conducted. The Lachlan site was also used for investigations on the biology and life cycle of *L. flavicornis*.

Full details of these investigations were presented by Ireson et al (1991) and used to formulate an integrated control strategy to determine which on-farm management techniques would promote the establishment and build-up of *L. flavicornis* populations. Results on the establishment of *L. flavicornis* in other parts of the state were detailed by Ireson et al (2000b). The main aspects of these studies are summarised below.

4.2.1 Efficacy of *Longitarsus flavicornis*

Studies on the demography of ragwort populations at Lachlan and Mayberry were based on observations in 12 fixed quadrats located at random in a 20 x 30 m sample plot within 10 m of the *L. flavicornis* release point (Ireson et al 1991). Observations were made four times a year in autumn (May), winter (August), spring (November) and summer (February) from May 1982 to May 1989. Seasonal fluctuations in ragwort density over the 7-year study period (Figure 4.2) reflect the balance between recruitment of new plants through germination and losses through mortality.

Slashing at the flowering stage limited seed production and recruitment of seedlings at both sites up to February 1985. However, slashing at Mayberry in February 1985 and at both sites in February 1986 was less effective in limiting seed production, and considerable recruitment of seedlings occurred in these years (Figure 4.2). Despite this recruitment, few seedlings survived beyond one year and population densities at both sites decreased markedly in 1987 and 1988.

When first observed in May 1982 the density of ragwort was 14.6 plants/m^2 at Lachlan and 55.2/m^2 at Mayberry (Figure 4.2) and the full range of crown and shoot classes were present in the populations. In the period to May 1989 the density declined to 0.5/m^2 at Lachlan and 6.4/m^2 at Mayberry (a fall of *ca*. 97% and 88% respectively) and populations became dominated by plants with single crowns and small rosettes (Ireson et al 1991).

No herbicides were used at either Lachlan or Mayberry during the 7-year study period. Sheep grazed both sites, but there was no evidence that grazing had a major influence in bringing about the observed changes, as

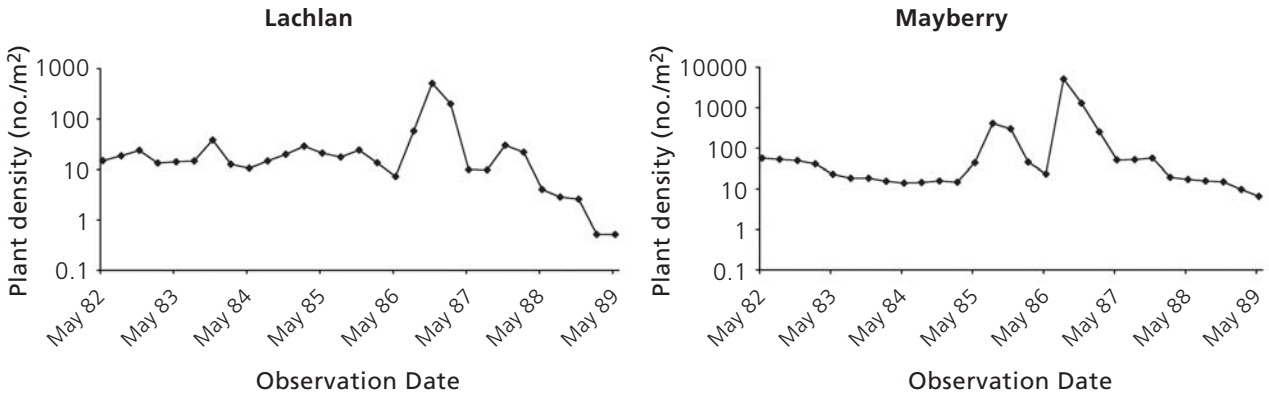


Figure 4.2 Density of ragwort plants at Lachlan and Mayberry between May 1982 and May 1989 (after Ireson et al 1991)

the grazing was infrequent and not intensive. Amor et al (1983) showed that heavy sheep grazing can cause a decrease in the density of ragwort plants, but also causes a shift to a plant population dominated by multi-crowned plants (Friend unpubl. data), which was not observed at Lachlan or Mayberry.

Cutting of flowering plants may limit seed production and hence the number of seedlings available to maintain the population. However, the effect is similar to sheep grazing as it promotes the production of new vegetative shoots from the crowns and the development of a population dominated by multi-crown plants (Poole and Cairns 1940).

The changes in the density and structure of the ragwort populations observed at both Lachlan and Mayberry coincided with the spread and increase in the *L. flavicornis* populations at these sites (Ireson et al 1991). These changes are considered to have resulted from the effects of feeding by *L. flavicornis*.

By 1985, *L. flavicornis* had spread across the study plot at Lachlan. Here, the population of *L. flavicornis* larvae (mean number per sample core 5 cm diameter, 5 cm deep) from April to September 1985 was estimated at *ca*. 40 larvae per core in plants with a mean crown diameter of *ca*. 8 mm. Changes in the density and structure of the ragwort population seen at Lachlan and Mayberry were not observed in studies conducted on the demography of ragwort at four other sites in Tasmania where *L. flavicornis* was not present during the period of observation (Friend unpubl. data).

4.2.2 Life cycle of *Longitarsus flavicornis*

L. flavicornis is univoltine with no diapause in its life cycle. Adults emerge from pupae in the soil from late spring and maximum adult populations are recorded in mid-summer (January), when they can be seen mating and feeding on ragwort foliage. Egg laying commences in summer, the majority of eggs being laid in the soil around the root crown although some are laid on the abaxial surface of leaves. Eggs hatch in late summer and larvae develop through three instars during autumn, winter and spring, feeding predominantly on the roots and crown of ragwort. Although larvae are found tunnelling internally in roots, crowns and petioles, most larvae occur in the surrounding soil, feeding externally on the roots and crowns. Pupation occurs in the soil in late spring.

4.2.3 Development of an integrated control strategy using *Longitarsus flavicornis*

The studies at Lachlan and Mayberry indicated that up to eight years may be required for populations to reach levels high enough to effectively control ragwort. By the late 1980s and early 1990s declines in ragwort populations were apparent at sites around the state (Ireson 1993). However, surveys at some sites suggested that the impact of established *L. flavicornis* populations was being adversely affected by site conditions (Ireson et al 2000b).

Factors thought to be responsible for reduced efficacy of *L. flavicornis* were frequent pasture flooding and poor drainage causing high larval mortality through drowning. Potter (2003) showed that winter flooding could significantly increase larval mortality.

Some pasture management practices were also thought to keep *L. flavicornis* populations at low levels. Boom spraying with herbicides to control rosette stage plants was one such practice. Potter (2003) showed that although boom sprayed herbicides could achieve a high plant kill, this could significantly reduce populations of *L. flavicornis*. In addition, Potter et al (2004) showed that *L. flavicornis* adults prefer rosettes to flowering plants for food, shelter and as an oviposition site.

Similarly, heavy grazing by sheep in summer and autumn reduces the food and shelter available to *L. flavicornis* adults, and may remove newly hatched larvae present

in leaf petioles and this is detrimental to survival and dispersal of the beetle (Ireson et al 1991). Used strategically to graze flowering stems only, sheep can be valuable in suppressing the spread of ragwort and enhance the effectiveness of *L. flavicornis* (Ireson 1993).

Heavy stocking with cattle is also thought to have an adverse effect on *L. flavicornis* by trampling larvae feeding externally on the roots and root crowns of ragwort plants, particularly in wet areas subject to pugging. However, this has not yet been tested experimentally.

Based on this information on the life cycle of *L. flavicornis* and factors affecting population increase, an integrated control strategy for ragwort was developed to use *L. flavicornis* together with other control methods, whilst minimising the impact of possible adverse factors. The principal aim was to minimise ragwort seed production and seed dispersal by removing flowering stems, leaving vegetative rosettes to provide food, shelter and oviposition sites for adult beetles.

This integrated control strategy still being promoted to landholders, involves the following key elements:

- Wick wiping or spot spraying herbicides in late spring and summer to kill flowering (seed producing) plants leaving the non-flowering rosettes intact to provide food, shelter and oviposition sites.
- Avoiding boom spraying of herbicides, which can reduce the build-up of *L. flavicornis* by reducing its food supply.
- Cutting in summer and autumn to a height of 10–15 cm above the ground to remove flowering stems and keep rosettes intact. This strategy does not prevent seeding past the green bud stage as seeds can still mature on these cut stems, but is effective in reducing wind dispersal of seed. However, cutting may need repeating several times to prevent flowering.
- Using sheep to selectively graze flowering ragwort during summer and early autumn, but avoiding heavy grazing that would damage rosettes. By late autumn, the activity of *L. flavicornis* adults has started to decline and normal grazing practices can be resumed.
- Avoiding heavy stocking of cattle in paddocks prone to waterlogging to reduce trampling on larvae feeding externally on the roots and crown of ragwort plants.

4.2.4 Establishment of *Cochylis atricapitana* and *Platyptilia isodactyla*

C. atricapitana and *P. isodactyla*, which were originally collected in Spain, were released in Tasmania in 1995 and 2000 respectively to further increase the control already being achieved by *L. flavicornis* (Ireson et al 1999b; McLaren et al 2000).

The larvae of both species bore into the stem and crown of ragwort and are therefore complementary to the root feeding activities of *L. flavicornis* larvae. *P. isodactyla* is adapted to survive in wet or waterlogged pasture as its most common host plant in Europe is marsh ragwort *(Senecio aquaticus)*, which occurs in such wet situations (McLaren 1997). It should therefore be a useful agent in pastures susceptible to winter flooding where the establishment of *L. flavicornis* has been restricted, due to the susceptibility of larvae to drowning (Potter 2003).

C. atricapitana is spreading from 22 release sites in Tasmania (Ireson 2000) and *P. isodactyla* has been recovered from 13 sites since its release (Ireson et al 2003b; Ireson unpubl. data). Surveys two to three years after the initial release of *P. isodactyla* showed that it was dispersing at an average rate of *ca*. 400 m/year, about six times the spread rate of *C. atricapitana* during the same period after its initial release (Ireson et al 2003b).

At release sites where these agents have been recovered, substantial damage to the stem and crown of flowering plants and rosettes has been observed. A reduced ragwort density is apparent where the agents have established, but no quantitative efficacy studies on these agents, either alone or in combination with *L. flavicornis*, has been carried out in Tasmania. Nor is there any information on the effect of farm management practices (grazing, cutting and herbicides) on the two species. In Victoria, where *C. atricapitana* has been established following its release in 1987 (McLaren 1992), preliminary efficacy studies showed that this agent was stunting growth, killing rosettes and reducing the diameter of rosettes (McLaren et al 2000).

4.3 Evidence for the decline of ragwort in Tasmania

4.3.1 Survey results

Evidence for the general decline in the problem status of ragwort was presented in the survey results in Section 2. The results for ragwort (Tables 2.1 and 2.2; Appendix Tables A.1–A.12) are summarised in Table 4.1.

The main outcomes were:

- State-wide, only 32% of the 990 landholders who responded to the survey considered ragwort to have an economic impact on their property. Of these, 51% rated ragwort as having a minor impact, 32% moderate impact, 14% major impact and 3% did not specify.
- When respondents listing ragwort as a problem were asked if its problem status had changed over the last 10 years, 51% said it had decreased, 36% said it had increased and 8% reported no change. An additional 5% of respondents did not specify.

- State-wide results are also reflected across the three Natural Resource Management (NRM) regions. Ragwort ranked amongst the top 20 weeds in all three regions (Section 2, Figure 2.2 and Appendix Tables A.10–A.12). However, the majority of respondents in the north-western and southern NRM regions reported the ragwort problem had decreased in the last 10 years and that it was stable in the northern NRM region. In all three NRM regions the majority of respondents rated the economic impact of the weed as minor.
- In the agricultural regions (Section 2, Figure 2.1 and Appendix Tables A.1–A.9), ragwort was ranked amongst the first 20 weeds in all but two (central and southern midlands and Flinders Island). The largest numbers of respondents (56%) who considered ragwort to have an economic impact on their property were from the northern region.
- In six of eight agricultural regions the majority of respondents reported the ragwort problem had decreased in the last 10 years. Respondents reported an increase in the east coast and north-eastern agricultural regions.
- A clear majority of respondents reported that ragwort was a minor economic problem on their property in all agricultural regions except the northern region where respondents reported impact in the minor to moderate range.
- The biggest decline in the problem status of ragwort was in the southern region, where 64% of respondents reported a decrease in the last 10 years and 77% of respondents indicated economic impact as minor.
- Respondents clearly indicated that the biggest economic impact of ragwort was on the beef and dairy industries.

4.3.2 Photographic evidence

Visual demonstration of the impact of *L. flavicornis* is provided by 'before' and 'after' photographs taken at two sites in southern Tasmania at Cradoc (43° 06' S, 147° 02' E) and Franklin (43° 10' S, 147° 00' E) (Figures 4.3a and 4.3b). At both sites, *L. flavicornis* established from the release of *ca*. 1000 adults in late summer 1988. The site at Cradoc was grazed periodically by sheep and the site at Franklin by sheep and occasionally horses. No herbicides or other control measures were applied at either site.

The 'before' photograph at Cradoc (Figure 4.3a) was taken in February 1987, one year prior to the release of *L. flavicornis*. The 'after' photograph was taken in February 1995, seven years after the release of *L. flavicornis*.

The 'before' photograph at Franklin (Figure 4.3b) was taken in January 1991, three years after the release of *L. flavicornis*. However, the beetle may have been present at the site one to two years prior to the release through adults dispersing from sites 3–5 km away, where establishment had been recorded several years earlier. The 'after' photograph was taken in February 1994, six years after the release of *L. flavicornis* (or eight years after establishment, if populations dispersed naturally into the site two years before the release).

At both sites, vacuum collections of *L. flavicornis* adults taken during summer surveys in the two years prior to the second photographs exceeded 100 adults per minute at some sample points. The *L. flavicornis* populations had therefore reached high densities (Ireson 1998).

4.3.3 Measurements of plant density and seedbank size

Methods

At four study sites in Northern Tasmania, data on the soil seedbank and ragwort plant density was obtained in 2005 for comparison with data from 1979–1985. The earlier studies included measurements of seedbank and rosette densities taken in June or July each year in fixed $1m^2$ quadrats along permanent transects in a sample area located from marked posts on fencelines (Friend unpubl. data).

The sites were located at Bridgenorth (41° 23' S, 146° 59' E), Elizabeth Town (41° 26' S, 146° 33' E), Meander (41° 39' S, 146° 34' E) (Figure 4.1) and Meander ('Cheshunt') (41° 37' S, 146° 36' E) (hereafter referred to as Cheshunt). At the time of the earlier studies the sites were grazed but no cutting was conducted or herbicides used. Sheep were the predominant grazing animals at Bridgenorth, whereas cattle alone were grazed at Elizabeth Town and Cheshunt and a mixture of cattle and sheep at Meander.

Interviews with the landholders in 2005 indicated that ownership of the Bridgenorth, Meander and Elizabeth Town sites had remained the same since the original trials. At Cheshunt, there had been a change in ownership during the last two years. The same grazing strategies were still being used at all sites in 2005 as in the earlier period. No herbicides were ever used to control ragwort at Bridgenorth and Meander since the original trials, but they were used regularly at Elizabeth Town and Cheshunt.

The original sample areas were identified in June 2005 and the same fixed quadrats used by Friend (unpubl. data) located at each site. Plant density counts of small, medium and large rosettes (as defined by Ireson et al

Figure 4.3a Visual evidence of the impact of the ragwort flea beetle *(Longitarsus flavicornis)* at Cradoc, southern Tasmania

Note: *L. flavicornis* was released in February 1988 one year after the first photograph was taken. The second photograph was taken seven years later in 1995. High densities of *L. flavicornis* were recorded during the two previous summers. No herbicides were applied since the release.

Figure 4.3b Visual evidence of the impact of the ragwort flea beetle *(Longitarsus flavicornis)* at Franklin, southern Tasmania

Note: *L. flavicornis* was released in January 1988, three years before the first photograph was taken. The second photograph was taken six years after release in 1994. As for Cradoc, high densities of *L. flavicornis* were recorded during the two previous summers and no herbicides were applied since the release.

1991) were made in 25 quadrats at each site. To obtain estimates of the size of the seedbank, soil cores were then taken from 25 adjacent quadrats. Ten cores (2.2 cm diameter; 8 cm deep) were taken from each quadrat using the same corer as used in the earlier period.

The soil cores were returned to the laboratory in plastic bags and held at 4–6° C until processed. The method used to germinate seeds was similar to that used by Friend (unpubl. data) in his earlier study. The 10 cores from each quadrat were broken up, mixed and distributed between three plastic containers (16 cm x 10 cm x 5cm) so that the soil was less than 1 cm deep in each container. Each container was labelled and placed in a misting bed in a heated glasshouse (*ca*. 20° C) to ensure that the soil remained damp. Initially, samples were examined after two weeks and then weekly for two weeks to count ragwort seedlings that had germinated.

The containers were then removed from the misting bed and the soil allowed to dry. After drying, the soil in each container was again broken up and the containers returned to the misting bed for a further four weeks to allow germination of any remaining seeds. The number of seeds germinating from each quadrat was expressed as the mean number of germinable seeds/m^2.

Surveys of *L. flavicornis* activity were also conducted at all four sites in July 2005 and again at Elizabeth Town in June 2006. Searches were conducted for the presence of 10 medium-to-large rosette plants at, or in the vicinity of, the study sites (stem diameter below oldest leaf 2–5 mm for old rosettes, > 5mm for large rosettes). Rosettes were collected by taking a 5 cm diameter soil core of the plant to a depth of 5 cm. Samples were returned to the laboratory and the larvae extracted using the method described by Ireson et al (1991).

Statistical analysis of the seed germination and plant count data was performed using GENSTAT (GENSTAT 2006). The data were logarithmically transformed and a one-way Analysis of Variance (ANOVA) used to compare rosette and seedbank densities measured in 2005 with

the densities measured in 1979–1985. As the data were collected along defined transects at fixed points they were analysed as a randomised complete block. However, rosette densities were zero at Bridgenorth, Meander and Cheshunt, and seedbanks zero at Bridgenorth and Meander in 2005, so the 2005 data in these instances were not included in the ANOVA. Where data for 2005 was zero, the null hypothesis was that the means for each year from 1979–1985 were not significantly different from zero and this hypothesis was tested based on the *t* distribution.

Results

The winter seedbank and rosette populations fluctuated from year to year at each site, with these annual variations being statistically significant (Figs. 4.4a–4.4d). The ragwort seedbank had decreased at all of the four sites sampled in 2005 in comparison to the samples taken 20–26 years previously. At Meander and Bridgenorth, the mean number of germinable seeds/m^2 for each year from 1979 to 1983 was significantly different from the zero counts recorded in 2005 (Figure 4.4a).

At Cheshunt, seedlings were germinated in the 2005 samples but numbers were lower than those in all of the samples collected from 1979–1983 (Figure 4.4b). The 2005 germination count differed significantly from counts in 1983 but there was no significant difference between the 2005 count and those from 1979–1982 (Figure 4.4b). At Elizabeth Town the numbers of seedlings germinated in the 2005 samples were significantly lower than in samples from 1979–1981 (Figure 4.4b).

Rosette densities recorded at Meander and Bridgenorth each year from1979 to1984 were significantly different from the zero densities recorded at the two sites in 2005 (Figure 4.4c).

At Cheshunt, rosette densities recorded over the 5-year period from 1981–1985 differed significantly from the zero count in 2005. However, the low rosette numbers recorded at the site in 1979 and 1980 were not significantly different from the zero count in 2005 (Figure 4.4d). At Elizabeth Town, rosette densities recorded in 2005 were significantly lower than those recorded in 1979 and 1980, but had increased slightly, but not significantly, compared to those recorded in 1981 (Figure 4.4d).

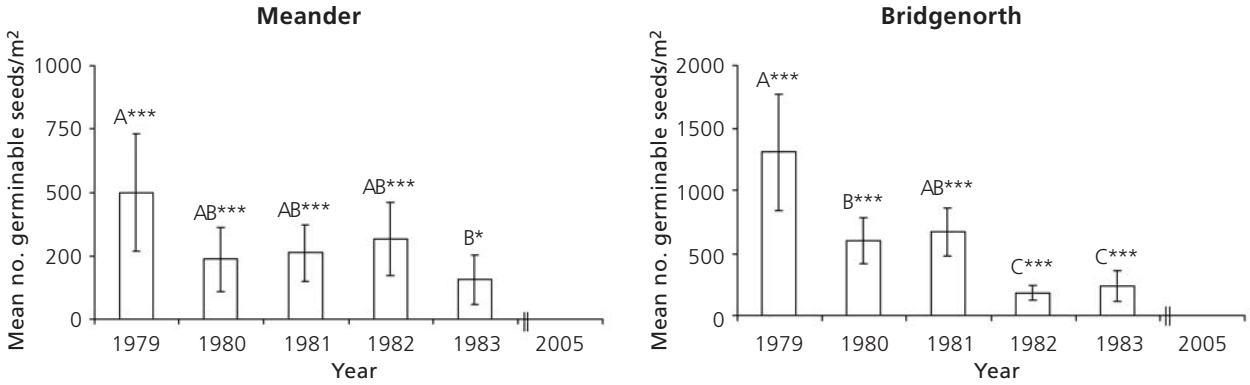


Figure 4.4a Mean number (±SE) of germinable ragwort seeds/m^2 at Meander and Bridgenorth

Note: Data plotted using untransformed means but LSD's calculated from an ANOVA on logarithmically transformed data. Means with the same letter are not significantly different. Asterisks indicate level of significance between the mean for the particular year and the zero recorded in 2005 (***P<0.001; *P<0.05).

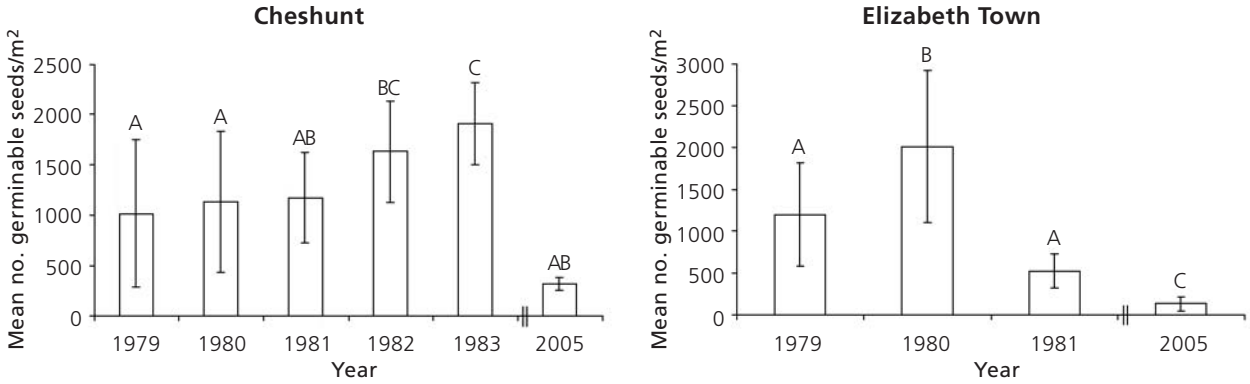


Figure 4.4b Mean number (±SE) of germinable ragwort seeds/m^2 at Cheshunt and Elizabeth Town

Note: Data plotted using untransformed means but LSD's calculated from an ANOVA on the logarithmically transformed data. Means with the same letter are not significantly different at the 0.05 level.

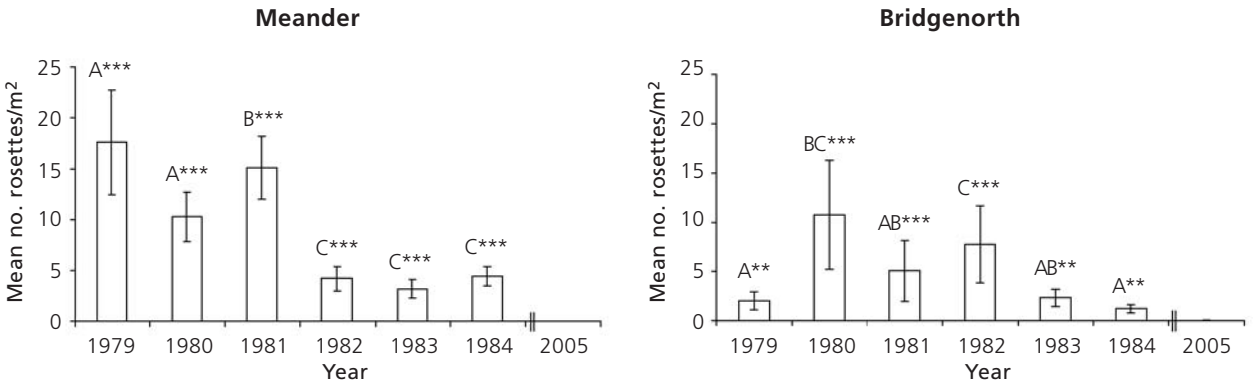


Figure 4.4c Mean number (±SE) of ragwort rosettes/m^2 at Meander and Bridgenorth

Note: Data plotted using untransformed means but LSD's calculated using logarithmically transformed data. Means with the same letter are not significantly different. Asterisks indicate level of significance between mean for the particular year and the zero recorded in 2005 (***P<0.001; **P<0.01). The mean for Meander 1979 is not significantly different from the 1980 mean but significantly different from the 1981 mean due to anomaly in non-linear mean transformation.

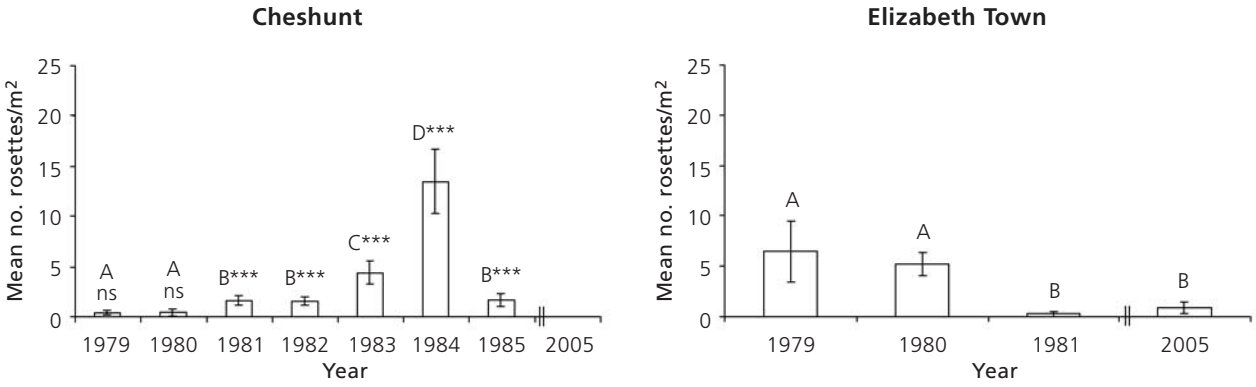


Figure 4.4d Mean number (±SE) of ragwort rosettes/m^2 at Cheshunt and Elizabeth Town

Note: Data plotted using untransformed means but LSD's calculated using logarithmically transformed data. Means with the same letter are not significantly different. For Cheshunt, asterisks indicate level of significance between the mean for the particular year and the zero in 2005 (***P<0.001; ns = not significant). For Elizabeth Town, means followed by the same letter are not significantly different at the 0.05 level.

At Bridgenorth in July 2005, surveys to detect the presence of *L. flavicornis* larvae failed to locate any medium to large rosettes in the site vicinity. Large rosettes were sampled in the vicinity of the other three sites, up to 200 m from the sample sites. At Meander, Cheshunt and Elizabeth Town the mean number of larvae per sample core (5 cm diameter: 5 cm deep) was 10.9 (SE ±3.9), 104.5 (SE ±18.5) and 39.8 (SE ±7.1) respectively. The rosettes sampled had mean crown diameters of 9.5 mm, 18.5 mm and 13.1 mm respectively.

4.4 Discussion

The evidence that *L. flavicornis* has been a key factor in the decrease in the problem status of ragwort comes from long term efficacy studies, the widespread establishment of *L. flavicornis* populations and photographic records. The landholder perception of a decrease in the status of ragwort in Tasmania, indicated by the survey (Section 2), is supported by the significant decline in ragwort seedbank and rosette populations at the four study sites in northern Tasmania.

Seasonal variations and pasture management strategies do cause general fluctuations in the seedbank and rosette populations such as observed at Meander, Bridgenorth, Cheshunt and Elizabeth Town. However, the general long-term decline of ragwort coincides with the establishment and increase in *L. flavicornis* populations around the state. The rosette core samples taken at Meander, Cheshunt and Elizabeth Town sites show that larval populations of *L. flavicornis* are still actively feeding on the medium to large rosettes found near the trial sites.

The population on ragwort near the Cheshunt site was proportionally higher than the mean number of larvae per core previously recorded at Lachlan (*ca*. 40 larvae per core, mean root crown diameter 8.3 mm) where control was achieved (Ireson et al 1991). Although no medium to large rosette plants could be found in the vicinity of Bridgenorth, previous surveys have shown *L. flavicornis* to be widely established throughout the area of the study site (Ireson et al 2000b).

The low seedbank levels at Meander and Bridgenorth (zero germination at both sites) compared to Elizabeth Town and Cheshunt may reflect differences in long-term herbicide use. Interviews with landholders revealed that no herbicides were used at Meander and Bridgenorth, with sheep being grazed predominantly at Bridgenorth and a mixture of cattle and sheep at Meander. At the Elizabeth Town and Cheshunt sites, herbicides have been used as a long-term control method for over 20 years. It is therefore possible that boom spraying of herbicides, which is known to be incompatible with integrated control strategies recommended for *L. flavicornis* (Ireson et al 2000b; Potter 2003; Potter et al 2004), may have reduced the effectiveness of *L. flavicornis* on these properties.

Earlier studies demonstrated that the use of boom sprayed herbicides to kill rosettes has a negative impact on *L. flavicornis* as the adult stage prefers to reside and oviposit on rosettes rather than flowering plants. Adoption of the recommended method using wick-wipe herbicides on flowering plants to reduce seed production, while leaving rosettes undamaged to provide a habitat for *L. flavicornis* (Potter et al 2004), would help to reduce the ragwort problem on these properties where boom spraying has been used. Alternatively, cutting flowering stems could be used to reduce seed production and spread of ragwort.

Using the Hoffman (1995) categories of success (see Section 3), biological control of ragwort already ranges from substantial to complete in many parts of Tasmania. This has achieved significant economic benefits to the dairy and beef industries in the state as well as additional environmental and social benefits (Page and Lacey 2006). Page and Lacey (2006) estimated the benefit-cost ratio of the ragwort biological control program in Australia at 32:1 and the increased production benefits to Tasmanian dairy and beef industries between 1985 and 2005 was estimated to be $19.2 million per annum.

At sites where the efficacy of *L. flavicornis* is limited by other factors such as waterlogging in winter, the additional biological control agents, *C. atricapitana* and *P. isodactyla*, are expected to contribute to further decline in the status of ragwort as a weed of significance in Tasmania.

Table 4.1 Perception of the ragwort problem in defined agricultural and natural resource management (NRM) regions using survey responses from 990 landholders across the state

		Percentage of respondents considering ragwort to be having an economic impact on their farm					Perceived problem status of ragwort over previous 10 years[2]				Main enterprise of landholders listing ragwort as a problem on their property[3]				
Agricultural and NRM regions[1]	**No. of respondents in each region**	**% With ragwort problem[4]**	**% Minor[4]**	**% Moderate[4]**	**% Major[4]**	**% Not specified[4]**	**% Decrease[4]**	**% Stable[4]**	**% Increase[4]**	**% Not specified[4]**	**% Dairy[4]**	**% Beef[4]**	**% Sheep[4]**	**% Cropping[4]**	**% Other[4]**
State-wide	990	31.8 (315)	51.4 (162)	31.8 (100)	14.3 (45)	2.5 (8)	50.8 (160)	7.9 (25)	36.2 (114)	5.1 (16)	**22.9** (66)	**56.9** (164)	7.3 (21)	10.1 (29)	2.8 (8)
North-western	142	25.4 (36)	69.4 (25)	16.7 (6)	8.3 (3)	5.6 (2)	50.0 (18)	5.6 (2)	38.8 (14)	5.6 (2)	31.4 (11)	**45.7** (16)	0	**20.0** (7)	2.9 (1)
Northern	319	55.5 (177)	40.1 (71)	40.7 (72)	16.4 (29)	2.8 (5)	55.4 (98)	7.3 (13)	32.2 (57)	5.1 (9)	**22.8** (37)	**56.2** (91)	7.4 (12)	10.5 (17)	3.1 (5)
North-eastern	103	39.8 (41)	63.4 (26)	24.4 (10)	12.2 (5)	0	29.3 (12)	9.8 (4)	51.2 (21)	9.7 (4)	**40.5** (15)	51.4 (19)	0	8.1 (3)	0
Northern Midlands	109	18.3 (20)	60.0 (12)	30.0 (6)	10.0 (2)	0	50.0 (10)	15.0 (3)	35.0 (7)	0	0	**52.9** (9)	35.3 (6)	5.9 (1)	**5.9** (1)
East Coast	40	22.5 (9)	55.6 (5)	22.2 (2)	22.2 (2)	0	33.3 (3)	0	66.7 (6)	0	**37.5** (3)	**62.5** (5)	0	0	0
Central and Southern Midlands	115	0.9 (1)	100.0	0	0	0	100 (1)	0	0	0	–[5]	–[5]	–[5]	–[5]	–[5]
Southern	114	19.1 (22)	77.3 (17)	13.6 (3)	9.1 (2)	0	63.6 (14)	9.1 (2)	27.3 (6)	0	0	**75.0** (15)	15.0 (3)	5.0 (1)	5.0 (1)
King Island	23	39.1 (9)	55.6 (5)	11.1 (1)	22.2 (2)	11.1 (1)	44.5 (4)	11.1 (1)	33.3 (3)	11.1 (1)	0	**100** (9)	0	0	0
Flinders Island	23	0	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
NRM North-western	347	39.8 (138)	50.0 (69)	33.3 (46)	13.0 (18)	3.7 (5)	57.3 (79)	6.5 (9)	32.6 (45)	3.6 (5)	16.3 (21)	**62.0** (80)	3.1 (4)	15.5 (20)	3.1 (4)

NRM Northern	392	39.0 (153)	49.0 (75)	33.3 (51)	15.7 (24)	2.0 (3)	43.1 (66)	9.2 (14)	40.5 (62)	7.2 (11)	**32.4** (45)	**49.6** (69)	10.1 (14)	5.8 (8)	2.1 (3)
NRM Southern	251	9.6 (24)	75.0 (18)	12.5 (3)	12.5 (3)	0	62.5 (15)	8.3 (2)	29.2 (7)	0	0	**75.0** (15)	15.0 (3)	5.0 (1)	5.0 (1)

[1] Agricultural and NRM regions are as defined in Section 2 (methods) and illustrated in Figures 2.1 and 2.2.

[2] Problem status refers to the perceived change in the ragwort problem for the particular region over the last 10 years, based on replies from landholders in each specified region indicating whether their ragwort problem had increased, decreased or was stable. Some landholders did not specify status, hence the 'not specified' category. Percentages based on the number of respondents (in brackets) to this particular category. Ragwort was classified in the 'increase' category (figure underlined) if the figure in the '% increase' column was approximately equal to or greater than the sum of the figures for '% decrease' and '% stable'. Ragwort was classified in the 'decrease' category (figure underlined) if the figure in the '% decrease' column, was approximately equal to or greater than the sum of the figures for '% increase' and '% stable'. Similarly, ragwort was classified in the 'stable' category (figure underlined) if the figure in the '% stable' column, was approximately equal to or greater than the sum of the figures for '% increase' and '% decrease.' Ragwort was also classified in the stable category if the difference between the sum of the '% stable' and '% increase' categories and the sum of '% stable' and '% decrease' categories was equal to or less than 10%. If this difference was greater than 10%, ragwort was classified either as 'increasing / stable' or 'decreasing / stable' (range indicated by two figures underlined).

Note: these categories are for use as a general regional indicator only and should be treated with caution depending on the number of respondents. Obviously, the status of any weed can vary considerably between locations.

[3] Percentages based on the number of respondents (in brackets) to this particular category. Figures in bold indicate ragwort is a particular problem in the enterprise(s), as a higher proportion of landholders listed ragwort as a problem in the enterprise in comparison to the proportion of landholders involved in that enterprise for the region (Appendix Table A.13).

[4] Numbers in brackets refer to the total number of respondents in each category.

[5] Information not provided by respondent.

References

Adamson, D., Bilston, L. and Lynch, K. (2000). The potential economic benefits of the Siam weed *(Chromolaena odorata)* eradication campaign. RDE Connections, NRSM, University of Queensland.

Ainsworth, N. (1999). Potential for integrated control of horehound *Marrubium vulgare* L. by the plume moth *Wheeleria spilodactylus* (Curtis) and 2,4–D. *Biocontrol Science and Technology* **9**: 355–364.

Alonso-Zarazaga, M.A. and Sánchez-Ruiz, M. (2002). Revision of the *Trichosirocalus horridus* (Panzer) species complex with description of two new species infesting thistles (Coleoptera: Curculionidae, Ceutorhynchinae). *Australian Journal of Entomology* **41**: 199–208.

Amor, R.L., Lane, D.W. and Jackson, K.W. (1983). Observations on the influence of grazing by sheep or cattle on the density and cover of ragwort. *Australian Weeds* **2**: 94–95.

Anon. (1996). Weedplan: A Tasmanian weed management strategy. Ministerial Working Group for the Development of the Tasmanian Weed Management Strategy, Department of Primary Industry and Fisheries, Hobart.

Anon. (2005). Weedplan: Tasmania's weed management strategy (second edition). The Tasmanian Weed Management Committee, Department of Primary Industries, Water and Environment, Hobart.

Ashby, W. (1996). Tasmanian Weed Manual. Department of Primary Industry and Fisheries, Tasmania, September 1996.

Australian Bureau of Statistics (2001). Agriculture Australia, 1999–2000. ABS Catalogue Number 7113.0.

Australian Bureau of Statistics (2005a). Agricultural commodities, Australia 2003–04. ABS Catalogue Number 7121.0.

Australian Bureau of Statistics (2005b). Agricultural commodities, Australia 2003–04. ABS Catalogue Number 7503.0.

Bachelor, K.L. and Woodburn, T.L. (2002). Population development and impact of the bridal creeper leafhopper *Zygina* spp. in Western Australia. In *Proceedings of the 13th Australian Weeds Conference* (eds. H. Spafford Jacob, J. Dodd and J.H. Moore) Plant Protection Society of Western Australia, Perth, pp. 381–384.

Briese, D.T. (2000). Classical biological control. In *Australian weed management systems*, B.M. Sindel (ed.), R.G and F.G. Richardson, Meredith, Victoria, Australia, pp.161–192.

Briese, D.T. (2003). The centrifugal phylogenetic method used to select plants for host-specificity testing of weed biological control agents: Can and should it be modernised? In *Improving the selection, testing and evaluation of weed biological control agents* (eds. H. Spafford Jacob and D.T. Briese). University of Western Australia, Perth, pp. 23–33.

Briese, D.T., Heard, T.A., McFadyen, R.E.C., Sheppard, A.W. and Spafford Jacob, H. (2003). The selection, testing and evaluation of weed biological control agents: Is there still room for improvement? In *Improving the selection, testing and evaluation of weed biological control agents* (eds. H. Spafford Jacob and D.T. Briese). University of Western Australia, Perth, pp. 1–3.

Bruzzese, E. and McFadyen, R.E.C. (2006). Arrival of leaf-feeding willow sawfly *Nematus oligospilus* Förster. *Plant Protection Quarterly* **21**: 43–44.

Burdon, J.J., Thrall, P.H., Groves, R.H. and Chaboudez, P. (2000). Biological control of *Carduus pycnocephalus* and *C. tenuiflorus* using the rust fungus *Puccinia cardui-pycnocephali. Plant Protection Quarterly* **15**: 14–17.

Combellack, H. (1987). Weed control pursuits in Australia. *Chemistry and Industry*, 20th April, pp. 273–280.

Cronin, S.J. (2004). Weed Management Strategy – Northern Natural Resource Management Region. Northen Region Weed Strategy Group.

CSIRO (1998). MRC Project CS209 Biological control of Paterson's curse, *Echium plantagineum*, Phase 3. Unpublished final report, 55 pp.

Davies, J.T. (2006). The efficacy of biological control agents of gorse, *Ulex europaeus* L., in Tasmania. PhD Dissertation, School of Agricultural Science and Tasmanian Institute of Agricultural Research, University of Tasmania, Hobart.

Department of Primary Industries, Water and Environment, Tasmania (2000). Cash crop enterprise budgets, high rainfall districts – Tasmania 1999–2000. DPIWE Food, Agriculture and Fisheries Division, January 2000.

Department of Primary Industries, Water and Environment, Tasmania (2002). Livestock enterprise budgets, low rainfall districts – Tasmania 2002–2003. DPIWE Food, Agriculture and Fisheries Division, December 2002.

Department of Primary Industries, Water and Environment, Tasmania (2003). Cash crop enterprise budgets, low rainfall districts – Tasmania 2003–2004. DPIWE Food, Agriculture and Fisheries Division, September 2003.

Department of Primary Industries, Water and Environment, Tasmania (2005). Livestock enterprise budgets, high rainfall districts – Tasmania 2005–2006. DPIWE Food, Agriculture and Fisheries Division. www.dpiw.tas.gov.au/inter.nsf/Attachments/EGIL-5426HP/$File/Histock.xls

Eilenberg, J., Hajek, A. and Lomer, C. (2001). Suggestions for unifying terminology in biological control. BioControl **46**: 387–400.

Evans, J.W. (1942). The gorse weevil. *Tasmanian Journal of Agriculture* **13**: 15–18.

GENSTAT (2006). Eighth edition, VSN International Ltd., Hemstead, Herts, United Kingdom.

Greening Australia (Tasmania) and the Cradle Coast Regional Weed Management Steering Committee (2005). Cradle Coast Regional Weed Management Strategy, Greening Australia (Tasmania) and the Cradle Coast Regional Weed Management Steering Committee, (Burnie).

Harper, J.L. and Wood, W.A. (1957). Biological flora of the British Isles, *Senecio jacobaea* L. *Journal of Ecology* **45**: 617–637.

Harradine, A.R. and Jones, A.L. (1985). Control of gorse regrowth by Angora goats in the Tasmanian midlands. *Australian Journal of Agricultural Research* **25**: 550–556.

Hoffmann, J.H. (1995). Biological control of weeds: the way forward, a South African perspective. In *Proceedings of the BCBP Symposium 1995*, Brighton, BCPC, pp. 77–89.

Hosking, J.R. and Sheppard, A.W. (2002). Application to seek approval for the release of the broom gall mite, *Aceria genistae*, a biocontrol agent against Scotch broom, *Cytisus scoparius*. Application No. 985 to Biosecurity Australia, unpublished report, 15pp.

Hyde-Wyatt, B.S. and Morris, D.I. (1989). Tasmanian Weed Handbook. Department of Agriculture Tasmania (2nd edition).

Ireson J.E. (1993). Biological control of weeds in Tasmania with particular reference to ragwort. In *Proceedings of the TCT-TFGA Nature Conservation Conference*, (eds. R. Donaghey and K. McKay). pp. 48–55. Tasmanian Conservation Trust Inc. / Tasmanian Farmers and Graziers Association.

Ireson, J.E. (1998). Biological control of ragwort. Final report to the Dairy Research and Development Corporation (project DCN 001). Tasmanian Institute of Agricultural Research. University of Tasmania.

Ireson, J.E. (2000). Biological control of ragwort in Tasmania. Unpublished final report to Dairy Research and Development Corporation, Project UT 011. Tasmanian Institute of Agricultural Research, University of Tasmania.

Ireson, J.E., Friend, D.A., Holloway, R.J. and Paterson, S. (1991). Biology of *Longitarsus flavicornis* (Stephens) (Coleoptera: Chrysomelidae) and its effectiveness in controlling ragwort (*Senecio jacobaea* L.) in Tasmania. *Journal of the Australian Entomological Society* **30**: 129–141.

Ireson, J.E., Gourlay, A.H., Kwong, R.M., Holloway, R.J. and Chatterton, W.S. (1999a). Progress on the rearing, release and establishment of the gorse spider mite, *Tetranychus lintearius* Dufour, for the biological control of gorse in Australia. In *Proceedings* of the *12th Australian Weeds Conference* (eds. A.C. Bishop, M. Boersma and C.D. Barnes). Tasmanian Weed Society, Devonport, pp. 320–324

Ireson, J.E., Holloway, R.J., Chatterton, W.S. and Leighton, S.M. (1999b). An overview of the establishment, distribution and efficacy of biological control agents for ragwort, *Senecio jacobaea* L., in Tasmania. In *Proceedings* of the *12th Australian Weeds Conference* (eds. A.C. Bishop, M. Boersma and C.D. Barnes). Tasmanian Weed Society, Devonport, pp. 425–430.

Ireson, J.E., Holloway, R.J. and Chatterton, W.S. (2000a). Progress on the rearing, release and establishment of the horehound plume moth, *Wheeleria spilodactylus* (Curtis), for the biological control of horehound in Tasmania. *Plant Protection Quarterly* **15**: 33–35.

Ireson, J.E., Leighton, S.M., Holloway, R.J. and Chatterton, W.S. (2000b). Establishment and redistribution of *Longitarsus flavicornis* (Stephens) (Coleoptera: Chrysomelidae) for the biological control of ragwort (*Senecio jacobaea* L.) in Tasmania. *Australian Journal of Entomology* **39**: 42–46.

Ireson, J.E., Davies, J. T., Holloway, R.J. and Chatterton, W.S. (2002). Attempts to establish biological control agents for boneseed in Tasmania. In *Proceedings of the 13th Australian Weeds Conference* (eds. H. Spafford Jacob, J. Dodd and J.H. Moore). Plant Protection Society of Western Australia, Perth. pp. 407–411.

Ireson, J.E., Gourlay, A.H., Kwong, R.M., Holloway, R.J. and Chatterton, W.S. (2003a). Host specificity, release and establishment of the gorse spider mite, *Tetranychus lintearius* Dufour (Acarina: Tetranychidae), for the biological control of gorse, *Ulex europaeus* L. (Fabaceae), in Australia. *Biological Control* **26**: 117–127.

Ireson, J.E., Holloway, R.J. and Chatterton, W.S. (2003b). Establishment and dispersal of the ragwort plume moth, *Platyptilia isodactyla* (Zeller), for the biological control of ragwort in Tasmania. Final report to the Dairy Research and Development Corporation, Project No. UT 11062.

Ireson, J.E., Kwong, R.M., Gourlay, H., Davies, J.T., Holloway, R.J. and Chatterton, W.S. (2004). Progress on the biological control of gorse *(Ulex europaeus)* in Australia. In *Proceedings of the XI International Symposium on Biological Control of Weeds* (eds. J.M. Cullen, D.T. Briese, D.J. Kriticos, W.M. Lonsdale, L. Morin and J.K. Scott). CSIRO Entomology, Canberra, Australia, pp. 415–418.

Ireson, J.E., Davies, J.T., Kwong, R.M., Holloway, R.J. and Chatterton, W.S. (2006). Biological control of gorse, *Ulex europaeus* L. in Australia: Where to next? In *Proceedings of the First Tasmanian Weeds Conference* (eds. C. Hanson and K. Stewart). Tasmanian Weed Society Incorporated, Devonport, pp. 15–19.

Julien, M.H. and Griffiths, M.W. (1998). Biological control of weeds: a world catalogue of agents and their target weeds. Wallingford, Oxford: CAB International 4th edition, 223 pp.

King, A. (1991). The control of saffron thistle in the Upper Hunter Region of New South Wales. 4th year dissertation, Dept. of Agricultural and Resource Economics, University of New England, Armidale.

McFadyen, R.E.C. (1998). Biological control of weeds. *Annual Review of Entomology* **43**: 369–393.

McFadyen, R.E.C. (2000). Successes in the biological control of weeds. In *Proceedings of the X International Symposium on Biological Control of Weeds* (ed. Neal R. Spencer). Montana State University, pp. 3–14.

McLaren, D.A. (1992). Observations on the life cycle and establishment of *Cochylis atricapitana* (Lep: Cochylidae), a moth for biological control of *Senecio jacobaea* in Australia. *Entomophaga* **37**: 641–648.

McLaren, D.A. (1997). Application for approval to release the ragwort plume moth, *Platyptilia isodactyla* (Zeller) in Australia. Unpublished report, Department of Natural Resources and Environment, Keith Turnbull Research Institute, Victoria.

McLaren, D.A. and Mickan, F. (1997). The Ragwort Management Handbook. Department of Natural Resources and Environment, East Melbourne.

McLaren, D.A., Ireson, J.E. and Kwong, R.M. (2000). Biological control of ragwort in Australia. In *Proceedings of the X International Symposium on Biological Control of Weeds* (ed. Neal R. Spencer). Montana State University, pp. 67–79.

Mahr, F.A. and Bruzzese, E. (1998). The effect of *Phragmidium violaceum* (Schultz) Winter (Uredinales) on *Rubus fruticosus* L. agg. in south-eastern Victoria. *Plant Protection Quarterly* **13**: 182–185.

Meggs, J. (1995). Biotic resistance to a chrysomelid beetle (*Chrysolina* sp.) introduced to Australia for the biological control of boneseed *(Chrysanthemoides monilifera* spp. *monilifera)*. B. Sc. (Hons) Thesis, Monash University, Melbourne.

Miller, D. (1929). Control of ragwort through insects. Experimental work with cinnabar moth. *New Zealand Journal of Agriculture* **39**: 9–17.

Morin, L., Willis, A.J., Armstrong, J. and Kriticos, D. (2002). Spread, epidemic development and impact of the bridal creeper rust in Australia: summary of results. In *Proceedings of the 13th Australian Weeds Conference* (eds. H. Spafford Jacob, J. Dodd and J.H. Moore). Plant Protection Society of Western Australia, Perth, pp. 385–388.

Morin, L., Aveyard, R., Bachelor, K.L., Evans K.J., Hartley, D. and Jourdan, M. (2006). Addditional strains of *Phragmidium violaceum* released for the biological control of blackberry. In *Proceedings of the 15th Australian Weeds Conference* (eds. C. Preston, J.H. Watts and N.D. Crossman). Weed Management Society of South Australia, Adelaide, pp. 565–568.

National Gorse Taskforce (2006). Gorse national best practice manual. Department of Primary Industries and Water, Hobart.

Natural Heritage Trust (2003). Bilateral Agreement between the Commonwealth of Australia and the State of Tasmania to deliver the Natural Heritage Trust. www.nht.gov.au/bilaterals

Nordlund, D.A. (1996). Biological control, integrated pest management and conceptual models. *Biocontrol News & Information* **17**: 35–44.

Page, A.R and Lacey, K.L. (2006). Economic assessment of Australian weed biological control. CRC for Australian Weed Management Technical Series 10, 151 pp.

Pannell, D. (1988). Weed management: A review of applied research in Australia. *Review of Marketing and Agricultural Economics* **56**: 255–264.

Parsons, W.T. and Cuthbertson, E.G. (2001). Noxious weeds of Australia, 2nd ed., CSIRO Publishing, Victoria, Australia.

Poole, A.L. and Cairns, D. (1940). Botanical aspects of ragwort (*Senecio jacobaea* L.) control. DSIR, New Zealand, Bulletin No. 82.

Potter, K.J.B. (2003). Factors affecting establishment and efficacy of the ragwort flea beetle, *Longitarsus flavicornis* (Stephens), in the biological control of ragwort, *Senecio jacobaea* L. in Tasmania. PhD Dissertation, University of Tasmania, Hobart.

Potter, K.J.B., Ireson, J.E. and Allen, G.R. (2004). Oviposition of the ragwort flea beetle, *Longitarsus flavicornis* (Stephens) (Coleoptera:Chrysomelidae), in relation to the phenology of ragwort, *Senecio jacobaea* L. (Asteraceae). *Biological Control* **30**: 404–409.

Sagliocco, J-L. (2000). The insect fauna associated with horehound (*Marrubium vulgare* L.) in western Mediterranean Europe and Morocco: potential for biological control in Australia. *Plant Protection Quarterly* **15**: 21–25.

Sagliocco, J-L. and Coupland, J.B. (1995). Biology and host specificity of *Chamaesphecia mysiniformis* (Lepidoptera: Sessiidae), a potential biological control agent of *Marrubium vulgare* (Lamiaceae) in Australia. *Biocontrol Science and Technology* **5**: 509–515.

Sagliocco, J-L. and Weiss, J. (2004). Importation, establishment and preliminary impact assessment of *Chamaesphecia mysiniformis* (Lepidoptera: Sesiidae) for the biological control of horehound in Australia. In *Proceedings of the 14th Australian Weeds Conference* (eds. B.M. Sindel and S.B. Johnson). Weed Society of New South Wales, Wagga Wagga, pp. 388–390.

Schrammeyer, E. (2005). Southern Tasmanian Weed Strategy, NRM South, Hobart.

Scott, J.K and Sagliocco, J-L. (1991). *Chamaesphecia doryliformis* (Lep.: Sesiidae), a potential agent for the control of *Rumex* spp. (Polygonaceae) in Australia. *Entomophaga* **36**: 245–51.

Sinden, J., Jones, R., Hester, S., Odom, D., Kalisch, C., James, R. and Cacho, O. (2004). The economic impact of weeds in Australia. CRC for Australian Weed Management Technical Series No. 8.

Swirepick, A. and Smyth, M. (2002). Biological control of broad-leafed pasture weeds (Paterson's curse, *Onopordum* and nodding thistles). What have we achieved and where to from here? In *Proceedings of the 13th Australian Weeds Conference* (eds. H. Spafford Jacob, J. Dodd and J.H. Moore). Plant Protection Society of Western Australia, Perth, pp. 373–376

Thorp, J.R. and Lynch, R. (2000). The determination of Weeds of National Significance. National Weeds Strategy Executive Committee, Launceston, 234 pp.

Townsend, J. and Sinden, J.A. (1999). Economic impacts of noxious weeds, other weeds, and tree growth, on agricultural production in the New England Tablelands, New South Wales. University of New England, Working Paper Series in Agricultural and Resource Economics No 99–5.

Vere, D. T. and Campbell, M. H. (1979). Estimating the economic impact of serrated tussock *(Nassella trichotoma)* in New South Wales. *Journal of the Australian Institute of Agricultural Science* **45**: 35–43.

Vere, D. T. and Dellow, J. J. (1984). Estimating the cost of blackberry in Central Western New South Wales. In *Proceedings of the 7th Australian Weeds Conference*, (ed. R.W. Madin). Council of Australian Weed Science Societies, Perth, pp. 6–13.

Vere, D. T., Auld, B. and Campbell, M. (1993). Economic assessment of Serrated Tussock *(Nassella trichotoma)* as a pasture weed. *Weed Technology* **7**: 776–782.

Vere, D.T., Jones, R.E. and Griffith, G.R. (1997). An integrated economic methodology for evaluating the impacts of weeds. *Agricultural production systems and the farm and industry benefits of improved weed management*, Technical Series No 2, CRC for Weed Management Systems, Australia.

Woodburn, T.L. (1997). Establishment in Australia of *Trichosirocalus horridus* a biological control agent for *Carduus nutans* and preliminary assessment of its impact on plant growth and reproductive potential. *Biocontrol Science and Technology* **7**: 645–656.

Woodburn, T. and Swirepick, A. (2002). Establishment of the crown weevil *Trichosirocalus horridus* on a novel host, *Cirsium vulgare* in Western Australia. In *Proceedings of the 13th Australian Weeds Conference* (eds. H. Spafford Jacob, J. Dodd and J.H. Moore). Plant Protection Society of Western Australia, Perth, p. 430.

Appendix

Tables A1–A9. Lists of the first 20 agricultural weeds in nine designated agricultural regions of Tasmania, together with their perceived economic impact, problem status and the main enterprises affected

Tables A10–A12. Lists of the first 20 agricultural weeds in the three designated Natural Resource Management (NRM) regions of Tasmania, together with their perceived economic impact, problem status and the main enterprises affected

Table A13. Regional and state-wide agricultural enterprise listings in Tasmania

Table A.1 List of the first 20 agricultural weeds in the north-western region ranked using survey responses from 142 landholders, together with their perceived economic impact, problem status and the main enterprises affected

Weeds in order of importance[1]		Percentage of respondents considering the weed to be having an economic impact on their farm[2]					Perceived problem status over previous 10 years[3]				Main enterprise of landholders listing the weed as a problem on their property[4]				
	Rank	% Total	% Minor	% Moderate	% Major	% Not specified	% Decrease	% Stable	% Increase	% Not specified	% Dairy	% Beef	% Sheep	% Cropping	% Other
Spear thistle[5]	1	45.1	32.8	54.7	12.5	0	32.6	25.6	30.2	11.6	**47.5**	42.5	0	7.5	2.5
Cirsium vulgare		(64)	(21)	(35)	(8)		(14)	(11)	(13)	(5)	(19)	(17)		(3)	(1)
Blackberry	2	46.5	48.5	39.4	10.6	1.5	53.0	7.6	25.8	13.6	**36.0**	**49.2**	**3.3**	8.2	3.3
Rubus fruticosus agg.		(66)	(32)	(26)	(7)	(1)	(35)	(5)	(17)	(9)	(22)	(30)	(2)	(5)	(2)
Californian thistle[5]	3	35.2	50.0	36.0	14.0	0	44.1	8.8	41.2	5.9	**40.6**	40.6	0	**12.5**	**6.3**
Cirsium arvense		(50)	(25)	(18)	(7)		(15)	(3)	(14)	(2)	(13)	(13)		(4)	(2)
Capeweed	4	26.1	37.9	40.5	13.5	8.1	37.8	10.8	43.3	8.1	23.5	**53.0**	0	**20.6**	2.9
Arctotheca calendula		(37)	(14)	(15)	(5)	(3)	(14)	(4)	(16)	(3)	(8)	(18)		(7)	(1)
Ragwort	5	25.4	69.4	16.7	8.3	5.6	50.0	5.6	38.8	5.6	31.4	**45.7**	0	**20.0**	2.9
Senecio jacobaea		(36)	(25)	(6)	(3)	(2)	(18)	(2)	(14)	(2)	(11)	(16)		(7)	(1)
Slender thistle[5]	6	15.5	27.3	59.1	13.6	0	40.0	13.3	33.4	13.3	30.8	**61.5**	0	7.7	0
Carduus spp.		(22)	(6)	(13)	(3)		(6)	(2)	(5)	(2)	(4)	(8)		(1)	
Gorse	7	17.6	56.0	24.0	16.0	4.0	44.0	4.0	40.0	12.0	**43.5**	43.5	0	**13.0**	0
Ulex europaeus		(25)	(14)	(6)	(4)	(1)	(11)	(1)	(10)	(3)	(10)	(10)		(3)	
Wild radish[5]	8	12.0	23.5	47.1	29.4	0	20.0	33.3	40.0	6.7	15.4	23.1	0	**61.5**	0
Raphanus raphanistrum		(17)	(4)	(8)	(5)		(3)	(5)	(6)	(1)	(2)	(3)		(8)	
Dock	9	12.0	35.3	47.1	17.6	0	23.5	17.7	41.2	17.6	**56.2**	31.2	0	6.3	**6.3**
Rumex spp.		(17)	(6)	(8)	(3)		(4)	(3)	(7)	(3)	(9)	(5)		(1)	(1)
Cat's ear[6]	10	10.6	40.0	60.0	0	0	73.3	6.7	20.0	0	23.1	**61.5**	0	**15.4**	0
Hypochaeris radicata		(15)	(6)	(9)			(11)	(1)	(3)		(3)	(8)		(2)	
Bracken	11	12.7	61.1	22.2	5.6	11.1	61.1	11.1	11.1	16.7	27.8	**55.5**	0	11.1	**5.6**
Pteridium spp.		(18)	(11)	(4)	(1)	(2)	(11)	(2)	(2)	(3)	(5)	(10)		(2)	(1)

Fumitory	12	6.3	11.1	66.7	22.2	0	0	22.2	66.7	11.1	0	16.7	0	**83.3**	0
Fumaria muralis		(9)	(1)	(6)	(2)			(2)	(6)	(1)		(1)		(5)	
Twitch grass	13	5.6	12.5	50.0	37.5	0	50.0	0	37.5	12.5	25.0	37.5	0	**37.5**	0
Agropyron repens		(8)	(1)	(4)	(3)		(4)		(3)	(1)	(2)	(3)		(3)	
Rushes	14	8.5	25.0	58.3	0	16.7	83.3	0	0	16.7	30.0	**70.0**	0	0	0
Juncus spp.		(12)	(3)	(7)		(2)	(10)			(2)	(3)	(7)			
Wild turnip[5]	15	4.9	0	85.7	14.3	0	16.6	16.7	50.0	16.7	16.7	33.3	0	**50.0**	0
Brassica rapa ssp. *silvestris*		(7)		(6)	(1)		(1)	(1)	(3)	(1)	(1)	(2)		(3)	
Storksbill	16	7.7	36.3	36.4	9.1	18.2	36.4	9.1	45.4	9.1	**33.3**	33.3	0	**33.3**	0
Erodium spp.		(11)	(4)	(4)	(1)	(2)	(4)	(1)	(5)	(1)	(3)	(3)		(3)	
Fat hen	17	6.3	22.2	55.6	11.1	11.1	0	33.3	66.7	0	0	12.5	0	**87.5**	0
Chenopodium album		(9)	(2)	(5)	(1)	(1)		(3)	(6)			(1)		(7)	
Wireweed	18	3.5	0	60.0	40.0	0	0	0	80.0	20.0	25.0	0	0	**75.0**	0
Polygonum aviculare		(5)		(3)	(2)				(4)	(1)	(1)			(3)	
Hemlock	19	4.9	71.4	14.3	14.3	0	28.6	14.3	57.1	0	**42.9**	42.8	0	**14.3**	0
Conium maculatum		(7)	(5)	(1)	(1)		(2)	(1)	(4)		(3)	(3)		(1)	
Glyceria	20	3.5	20.0	60.0	20.0	0	80.0	0	20.0	0	**40.0**	40.0	0	**20.0**	0
Glyceria maxima		(5)	(1)	(3)	(1)		(4)		(1)		(2)	(2)		(1)	

[1] To rank weeds, the three status categories (major, moderate or minor) were added separately to give a score for each category. This was weighted (major x 3, moderate x 2, minor x 1) and added to give a total score for each weed.

[2] Percent total is % of total of 142 respondents who consider the weed to be having an economic impact on their property. The level of impact is then categorised as % minor, moderate and major. Percentages in these categories are based on figures in brackets, which indicate the number of respondents in each particular category.

[3] Problem status refers to the perceived change in the level of a weed infestation for the north-western region over the last 10 years, based on the replies from 142 landholders indicating whether their weed problem had increased, decreased or was stable. Some landholders did not specify status, hence the 'not specified' category. Percentages are based on the number of respondents (in brackets) to this particular category. A weed was classified in the 'increase' category (figure underlined) if the figure in the '% increase' column for the weed was approximately equal to or greater than the sum of the figures for '% decrease' and '% stable'. A weed was classified in the 'decrease' category (figure underlined) if the figure in the '% decrease' column, was approximately equal to or greater than the sum of the figures for '% increase' and '% stable'. Similarly, a weed was classified in the 'stable' category (figure underlined) if the figure in the '% stable' column, was approximately equal to or greater than the sum of the figures for '% increase' and '% decrease'. A weed was also classified in the stable category if the difference between the sum of the '% stable' and '% increase' categories and the sum of '% stable' and '% decrease' categories was equal to or less than 10%. If this difference was greater than 10%, the weed was classified either as 'increasing / stable' or 'decreasing / stable' (range indicated by two figures underlined).

Note: these categories are for use as a general indicator only and should be treated with caution depending on the number of respondents. Obviously, the status of any weed can vary considerably between locations.

[4] Percentages based on the number of respondents (in brackets) to this particular category. Figures in bold indicate the weed is a particular problem in the enterprise(s), as a higher proportion of landholders listed the weed as a problem in the enterprise in comparison to the proportion of landholders involved in that enterprise for the region (Table A.13).

[5] Respondents did not always specify a particular thistle or brassica species, leaving a large number of unspecified thistles and brassicas. For a more accurate ranking of these weeds, the status (major, moderate and minor) of unspecified species in these two groups were added to each identified species in the proportions they occurred.

[6] Likely to be mainly cat's ear, but probably also contains hawkbit *(Leontodon taraxacoides)*, dandelion *(Taraxacum officinale)* and other broadleaf weeds.

Note: Numbers in brackets are total numbers. As there were always variable responses to the survey categories (economic impact, perceived change in weed status, main enterprise) and the status of some thistle and brassica species were estimated (see footnote 5), the total of the numbers across each subsection in this table will not be equal.

Table A.2 List of the first 20 agricultural weeds in the northern region ranked using survey responses from 319 landholders, together with their perceived economic impact, problem status and the main enterprises affected

Weeds in order of importance[1]		Percentage of respondents considering the weed to be having an economic impact on their farm[2]					Perceived problem status over previous 10 years[3]				Main enterprise of landholders listing the weed as a problem on their property[4]				
	Rank	% Total	% Minor	% Moderate	% Major	% Not specified	% Decrease	% Stable	% Increase	% Not specified	% Dairy	% Beef	% Sheep	% Cropping	% Other
Ragwort	1	55.5	40.1	40.7	16.4	2.8	55.4	7.3	32.2	5.1	**22.8**	**56.2**	7.4	10.5	3.1
Senecio jacobaea		(177)	(71)	(72)	(29)	(5)	(98)	(13)	(57)	(9)	(37)	(91)	(12)	(17)	(5)
Slender thistle[5]	2	40.1	34.4	49.2	16.4	0	36.6	11.3	46.5	5.6	**21.5**	**52.3**	**13.9**	10.8	1.5
Carduus spp.		(128)	(44)	(63)	(21)		(26)	(8)	(33)	(4)	(14)	(34)	(9)	(7)	(1)
Blackberry	3	37.6	42.5	41.7	15.0	0.8	59.2	9.2	25.8	5.8	**17.1**	**54.1**	**12.6**	9.9	**6.3**
Rubus fruticosus agg.		(120)	(51)	(50)	(18)	(1)	(71)	(11)	(31)	(7)	(19)	(60)	(14)	(11)	(7)
Spear thistle[5]	4	30.1	33.3	60.4	6.3	0	38.9	20.4	38.9	1.8	**25.0**	**47.9**	**16.7**	10.4	0
Cirsium vulgare		(96)	(32)	(58)	(6)		(21)	(11)	(21)	(1)	(12)	(23)	(8)	(5)	
Wild radish[5]	5	20.7	13.6	45.5	39.4	1.5	27.4	14.5	53.2	4.9	3.8	11.3	5.7	**79.2**	0
Raphanus raphanistrum		(66)	(9)	(30)	(26)	(1)	(17)	(9)	(33)	(3)	(2)	(6)	(3)	(42)	
Capeweed	6	23.5	34.7	45.3	17.3	2.7	32.0	8.0	58.7	1.3	10.9	**50.0**	**20.3**	12.5	**6.3**
Arctotheca calendula		(75)	(26)	(34)	(13)	(2)	(24)	(6)	(44)	(1)	(7)	(32)	(13)	(8)	(4)
Gorse	7	23.5	48.0	29.3	21.3	1.4	45.3	4.0	44.0	6.7	**24.2**	**48.5**	**18.2**	9.1	0
Ulex europaeus		(75)	(36)	(22)	(16)	(1)	(34)	(3)	(33)	(5)	(16)	(32)	(12)	(6)	
Nightshade	8	11.3	16.7	66.7	13.9	2.7	13.9	13.9	69.4	2.8	0	16.7	3.3	**73.3**	**6.7**
Solanum nigrum		(36)	(6)	(24)	(5)	(1)	(5)	(5)	(25)	(1)		(5)	(1)	(22)	(2)
Amaranthus	9	8.8	14.3	25.0	57.1	3.6	10.7	7.1	75.0	7.2	4.2	4.2	8.3	**79.2**	**4.1**
Amaranthus spp.		(28)	(4)	(7)	(16)	(1)	(3)	(2)	(21)	(2)	(1)	(1)	(2)	(19)	(1)
Wild turnip[5]	10	9.7	29.0	38.7	32.3	0	25.9	7.4	59.3	7.4	4.6	22.7	9.1	**59.1**	**4.5**
Brassica rapa ssp. *silvestris*		(31)	(9)	(12)	(10)		(7)	(2)	(16)	(2)	(1)	(5)	(2)	(13)	(1)
Fat hen	11	8.8	14.3	64.3	21.4	0	25.0	32.1	39.3	3.6	13.0	17.4	**17.4**	**52.2**	0
Chenopodium album		(28)	(4)	(18)	(6)		(7)	(9)	(11)	(1)	(3)	(4)	(4)	(12)	

Dock	12	11.3	38.9	52.8	5.5	2.8	30.6	25.0	36.1	8.3	6.7	**46.7**	**13.3**	**33.3**	0
Rumex spp.		(36)	(14)	(19)	(2)	(1)	(11)	(9)	(13)	(3)	(2)	(14)	(4)	(10)	
Fumitory	13	8.5	18.5	48.2	29.6	3.7	29.6	18.5	44.5	7.4	0	9.1	9.1	**81.8**	0
Fumaria muralis		(27)	(5)	(13)	(8)	(1)	(8)	(5)	(12)	(2)		(2)	(2)	(18)	
Bracken	14	10.0	43.7	34.4	18.8	3.1	43.7	28.1	18.8	9.4	10.3	**62.1**	**17.2**	0	**10.4**
Pteridium spp.		(32)	(14)	(11)	(6)	(1)	(14)	(9)	(6)	(3)	(3)	(18)	(5)		(3)
Wireweed	15	7.8	16.0	60.0	24.0	0	24.0	24.0	48.0	4.0	0	0	10.5	**89.5**	0
Polygonum aviculare		(25)	(4)	(15)	(6)		(6)	(6)	(12)	(1)			(2)	(17)	
Barley grass	16	6.9	18.2	36.3	36.4	9.1	18.2	13.6	59.1	9.1	**20.0**	**55.0**	**20.0**	5.0	0
Hordeum spp.		(22)	(4)	(8)	(8)	(2)	(4)	(3)	(13)	(2)	(4)	(11)	(4)	(1)	
Cat's ear[6]	17	7.2	30.4	60.9	8.7	0	34.8	17.4	39.1	8.7	9.1	**59.1**	**13.6**	13.6	**4.6**
Hypochaeris radicata		(23)	(7)	(14)	(2)		(8)	(4)	(9)	(2)	(2)	(13)	(3)	(3)	(1)
Twitch grass	18	5.3	23.5	47.1	29.4	0	35.3	29.4	23.5	11.8	7.1	0	7.1	**78.6**	**7.2**
Agropyron repens		(17)	(4)	(8)	(5)		(6)	(5)	(4)	(2)	(1)		(1)	(11)	(1)
Californian thistle[5]	19	5.0	31.2	31.2	37.6	0	0	22.2	66.7	11.1	**37.5**	37.5	0	**25.0**	0
Cirsium arvense		(16)	(5)	(5)	(6)			(2)	(6)	(1)	(3)	(3)		(2)	
Oil poppy	20	4.4	21.4	35.7	42.9	0	7.1	7.1	85.8	0	0	0	7.7	**92.3**	0
Papaver spp.		(14)	(3)	(5)	(6)		(1)	(1)	(12)				(1)	(12)	

[1] To rank weeds, the three status categories (major, moderate or minor) were added separately to give a score for each category. This was weighted (major x 3, moderate x 2, minor x 1) and added to give a total score for each weed.

[2] Percent total is % of total of 319 respondents who consider the weed to be having an economic impact on their property. The level of impact is then categorised as % minor, moderate and major. Percentages in these categories are based on figures in brackets, which indicate the number of respondents in each particular category.

[3] Problem status refers to the perceived change in the level of a weed infestation for the northern region over the last 10 years, based on the replies from 319 landholders indicating whether their weed problem had increased, decreased or was stable. Some landholders did not specify status, hence the 'not specified' category. Percentages are based on the number of respondents (in brackets) to this particular category. A weed was classified in the 'increase' category (figure underlined) if the figure in the '% increase' column for the weed was approximately equal to or greater than the sum of the figures for '% decrease' and '% stable'. A weed was classified in the 'decrease' category (figure underlined) if the figure in the '% decrease' column, was approximately equal to or greater than the sum of the figures for '% increase' and '% stable'. Similarly, a weed was classified in the 'stable' category (figure underlined) if the figure in the '% stable' column, was approximately equal to or greater than the sum of the figures for '% increase' and '% decrease'. A weed was also classified in the stable category if the difference between the sum of the '% stable' and '% increase' categories and the sum of '% stable' and '% decrease' categories was equal to or less than 10%. If this difference was greater than 10%, the weed was classified either as 'increasing / stable' or 'decreasing / stable' (range indicated by two figures underlined).

Note: these categories are for use as a general indicator only and should be treated with caution depending on the number of respondents. Obviously, the status of any weed can vary considerably between locations.

[4] Percentages based on the number of respondents (in brackets) to this particular category. Figures in bold indicate the weed is a particular problem in the enterprise(s), as a higher proportion of landholders listed the weed as a problem in the enterprise in comparison to the proportion of landholders involved in that enterprise for the region (Table A.13).

[5] Respondents did not always specify a particular thistle or brassica species, leaving a large number of unspecified thistles and brassicas. For a more accurate ranking of these weeds, the status (major, moderate and minor) of unspecified species in these two groups were added to each identified species in the proportions they occurred.

[6] Likely to be mainly cat's ear, but probably also contains hawkbit *(Leontodon taraxacoides)*, dandelion *(Taraxacum officinale)* and other broadleaf weeds.

Note: Numbers in brackets are total numbers. As there were always variable responses to the survey categories (economic impact, perceived change in weed status, main enterprise) and the status of some thistle and brassica species were estimated (see footnote 5), the total of the numbers across each subsection in this table will not be equal.

Table A.3 List of the first 20 agricultural weeds in the north-eastern region ranked using survey responses from 103 landholders, together with their perceived economic impact, problem status and the main enterprises affected

Weeds in order of importance[1]		Percentage of respondents considering the weed to be having an economic impact on their farm[2]					Perceived problem status over previous 10 years[3]				Main enterprise of landholders listing the weed as a problem on their property[4]				
	Rank	% Total	% Minor	% Moderate	% Major	% Not specified	% Decrease	% Stable	% Increase	% Not specified	% Dairy	% Beef	% Sheep	% Cropping	% Other
Blackberry	1	51.5	37.7	58.5	3.8	0	56.6	9.4	20.8	13.2	**34.1**	52.3	0	9.1	**4.5**
Rubus fruticosus agg.		(53)	(20)	(31)	(2)		(30)	(5)	(11)	(7)	(15)	(23)		(4)	(2)
Spear thistle[5]	2	49.5	47.1	45.1	7.8	0	60.6	9.1	21.2	9.1	**22.2**	**59.3**	3.7	11.1	**3.7**
Cirsium vulgare		(51)	(24)	(23)	(4)		(20)	(3)	(7)	(3)	(6)	(16)	(1)	(3)	(1)
Slender thistle[5]	3	38.8	52.5	42.5	5.0	0	44.0	16.0	28.0	12.0	**28.6**	**61.9**	0	9.5	0
Carduus spp.		(40)	(21)	(17)	(2)		(11)	(4)	(7)	(3)	(6)	(13)		(2)	
Capeweed	4	30.1	25.8	48.4	25.8	0	29.0	6.5	61.3	3.2	3.8	**80.8**	**7.7**	7.7	0
Arctotheca calendula		(31)	(8)	(15)	(8)		(9)	(2)	(19)	(1)	(1)	(21)	(2)	(2)	
Ragwort	5	39.8	63.4	24.4	12.2	0	29.3	9.8	51.2	9.7	**40.5**	51.4	0	8.1	0
Senecio jacobaea		(41)	(26)	(10)	(5)		(12)	(4)	(21)	(4)	(15)	(19)		(3)	
Bracken	6	13.6	35.7	35.7	28.6	0	42.9	28.6	21.4	7.1	16.7	**66.7**	**8.3**	8.3	0
Pteridium spp.		(14)	(5)	(5)	(4)		(6)	(4)	(3)	(1)	(2)	(8)	(1)	(1)	
Wild turnip[5]	7	13.6	35.7	42.9	21.4	0	30.8	15.4	38.4	15.4	0	**55.6**	0	**44.4**	0
Brassica rapa ssp. *silvestris*		(14)	(5)	(6)	(3)		(4)	(2)	(5)	(2)		(5)		(4)	
Fat hen	8	12.6	23.1	69.2	7.7	0	30.8	15.4	30.7	23.1	0	30.0	0	**70.0**	0
Chenopodium album		(13)	(3)	(9)	(1)		(4)	(2)	(4)	(3)		(3)		(7)	
Nightshade	9	9.7	10.0	50.0	40.0	0	10.0	30.0	50.0	10.0	0	25.0	0	**62.5**	**12.5**
Solanum nigrum		(10)	(1)	(5)	(4)		(1)	(3)	(5)	(1)		(2)		(5)	(1)
Wild radish[5]	10	10.7	27.3	45.4	27.3	0	20.0	0	40.0	40.0	14.3	28.6	0	**57.1**	0
Raphanus raphanistrum		(11)	(3)	(5)	(3)		(2)		(4)	(4)	(1)	(2)		(4)	
Gorse	11	13.6	78.6	14.3	7.1	0	50.0	7.1	35.7	7.2	8.3	**75.0**	**16.7**	0	0
Ulex europaeus		(14)	(11)	(2)	(1)		(7)	(1)	(5)	(1)	(1)	(9)	(2)		

Dock	12	12.6	69.2	23.1	7.7	0	30.8	15.4	46.1	7.7	16.7	**58.3**	0	**16.7**	**8.3**
Rumex spp.		(13)	(9)	(3)	(1)		(4)	(2)	(6)	(1)	(2)	(7)		(2)	(1)
Barley grass	13	8.7	66.7	11.1	22.2	0	11.1	22.2	44.5	22.2	**33.3**	**66.7**	0	0	0
Hordeum spp.		(9)	(6)	(1)	(2)		(1)	(2)	(4)	(2)	(2)	(4)			
Rushes	14	6.8	14.3	57.1	14.3	14.3	42.9	0	28.6	28.5	0	**66.6**	**16.7**	**16.7**	0
Juncus spp.		(7)	(1)	(4)	(1)	(1)	(3)		(2)	(2)		(4)	(1)	(1)	
Cat's ear[6]	15	3.9	25.0	50.0	25.0	0	0	75.0	25.0	0	0	**75.0**	**25.0**	0	0
Hypochaeris radicata		(4)	(1)	(2)	(1)			(3)	(1)			(3)	(1)		
Sagg	16	3.9	25.0	50.0	25.0	0	25.0	50.0	0	25.0	0	**100**	0	0	0
Lomandra longifolia		(4)	(1)	(2)	(1)		(1)	(2)		(1)		(4)			
Californian thistle[5]	17	4.9	40.0	60.0	0	0	0	0	66.7	33.3	**50.0**	0	0	**50.0**	0
Cirsium arvense		(5)	(2)	(3)					(2)	(1)	(1)			(1)	
Variegated thistle	18	4.9	40.0	60.0	0	0	33.3	0	0	66.7	**66.7**	33.3	0	0	0
Silybum marianum		(5)	(2)	(3)			(1)			(2)	(2)	(1)			
Willows	19	2.9	33.3	0	66.7	0	33.3	0	66.7	0	0	50.0	0	0	50.0
Salix spp.		(3)	(1)		(2)		(1)		(2)			(1)			(1)
Fumitory	20	2.9	33.3	33.4	33.3	0	0	0	66.7	33.3	0	0	0	**100**	0
Fumaria muralis		(3)	(1)	(1)	(1)				(2)	(1)				(3)	

[1] To rank weeds, the three status categories (major, moderate or minor) were added separately to give a score for each category. This was weighted (major x 3, moderate x 2, minor x 1) and added to give a total score for each weed.

[2] Percent total is % of total of 103 respondents who consider the weed to be having an economic impact on their property. The level of impact is then categorised as % minor, moderate and major. Percentages in these categories are based on figures in brackets, which indicate the number of respondents in each particular category.

[3] Problem status refers to the perceived change in the level of a weed infestation for the north-eastern region over the last 10 years, based on the replies from 103 landholders indicating whether their weed problem had increased, decreased or was stable. Some landholders did not specify status, hence the 'not specified' category. Percentages are based on the number of respondents (in brackets) to this particular category. A weed was classified in the 'increase' category (figure underlined) if the figure in the '% increase' column for the weed was approximately equal to or greater than the sum of the figures for '% decrease' and '% stable'. A weed was classified in the 'decrease' category (figure underlined) if the figure in the '% decrease' column, was approximately equal to or greater than the sum of the figures for '% increase' and '% stable'. Similarly, a weed was classified in the 'stable' category (figure underlined) if the figure in the '% stable' column, was approximately equal to or greater than the sum of the figures for '% increase' and '% decrease'. A weed was also classified in the stable category if the difference between the sum of the '% stable' and '% increase' categories and the sum of '% stable' and '% decrease' categories was equal to or less than 10%. If this difference was greater than 10%, the weed was classified either as 'increasing / stable' or 'decreasing / stable' (range indicated by two figures underlined).

Note: these categories are for use as a general indicator only and should be treated with caution depending on the number of respondents. Obviously, the status of any weed can vary considerably between locations.

[4] Percentages based on the number of respondents (in brackets) to this particular category. Figures in bold indicate the weed is a particular problem in the enterprise(s), as a higher proportion of landholders listed the weed as a problem in the enterprise in comparison to the proportion of landholders involved in that enterprise for the region (Table A.13).

[5] Respondents did not always specify a particular thistle or brassica species, leaving a large number of unspecified thistles and brassicas. For a more accurate ranking of these weeds, the status (major, moderate and minor) of unspecified species in these two groups were added to each identified species in the proportions they occurred.

[6] Likely to be mainly cat's ear, but probably also contains hawkbit *(Leontodon taraxacoides)*, dandelion *(Taraxacum officinale)* and other broadleaf weeds.

Note: Numbers in brackets are total numbers. As there were always variable responses to the survey categories (economic impact, perceived change in weed status, main enterprise) and the status of some thistle and brassica species were estimated (see footnote 5), the total of the numbers across each subsection in this table will not be equal.

Table A.4 List of the first 20 agricultural weeds in the northern midlands region ranked using survey responses from 109 landholders, together with their perceived economic impact, problem status and the main enterprises affected

Weeds in order of importance[1]		Percentage of respondents considering the weed to be having an economic impact on their farm[2]					Perceived problem status over previous 10 years[3]				Main enterprise of landholders listing the weed as a problem on their property[4]				
	Rank	% Total	% Minor	% Moderate	% Major	% Not specified	% Decrease	% Stable	% Increase	% Not specified	% Dairy	% Beef	% Sheep	% Cropping	% Other
Gorse	1	67.0	32.9	31.5	34.2	1.4	45.2	9.6	35.6	9.6	3.0	**28.8**	**57.6**	9.1	1.5
Ulex europaeus		(73)	(24)	(23)	(25)	(1)	(33)	(7)	(26)	(7)	(2)	(19)	(38)	(6)	(1)
Capeweed	2	44.0	20.8	50.0	29.2	0	18.8	2.1	70.8	8.3	0	**24.5**	**60.0**	13.3	2.2
Arctotheca calendula		(48)	(10)	(24)	(14)		(9)	(1)	(34)	(4)		(11)	(27)	(6)	(1)
Wild radish[5]	3	27.5	13.3	36.7	50.0	0	31.0	13.8	51.7	3.5	0	7.7	38.5	**53.8**	0
Raphanus raphanistrum		(30)	(4)	(11)	(15)		(9)	(4)	(15)	(1)		(2)	(10)	(14)	
Spear thistle[5]	4	33.9	24.3	62.2	10.8	2.7	45.4	18.2	27.3	9.1	**4.8**	**28.6**	47.6	14.3	**4.7**
Cirsium vulgare		(37)	(9)	(23)	(4)	(1)	(10)	(4)	(6)	(2)	(1)	(6)	(10)	(3)	(1)
Slender thistle[5]	5	27.5	36.7	60.0	0	3.3	31.6	15.8	31.6	21.0	**5.6**	**38.9**	**55.5**	0	0
Carduus spp.		(30)	(11)	(18)		(1)	(6)	(3)	(6)	(4)	(1)	(7)	(10)		
Blackberry	6	21.1	69.6	21.7	8.7	0	52.2	4.4	30.4	13.0	0	**50.0**	35.0	15.0	0
Rubus fruticosus agg.		(23)	(16)	(5)	(2)		(12)	(1)	(7)	(3)		(10)	(7)	(3)	
Ragwort	7	18.3	60.0	30.0	10.0	0	50.0	15.0	35.0	0	0	**52.9**	35.3	5.9	**5.9**
Senecio jacobaea		(20)	(12)	(6)	(2)		(10)	(3)	(7)			(9)	(6)	(1)	(1)
Nightshade	8	11.9	23.1	38.5	38.4	0	7.7	15.4	76.9	0	0	15.4	15.4	**69.2**	0
Solanum nigrum		(13)	(3)	(5)	(5)		(1)	(2)	(10)			(2)	(2)	(9)	
Fat hen	9	12.8	42.9	50.0	7.1	0	35.7	21.4	35.7	7.2	0	7.7	23.1	**69.2**	0
Chenopodium album		(14)	(6)	(7)	(1)		(5)	(3)	(5)	(1)		(1)	(3)	(9)	
Wireweed	10	10.1	27.3	54.5	18.2	0	27.3	18.2	45.4	9.1	0	22.2	11.1	**66.7**	0
Polygonum aviculare		(11)	(3)	(6)	(2)		(3)	(2)	(5)	(1)		(2)	(1)	(6)	
Hawthorn	11	14.7	68.7	18.8	6.2	6.3	50.0	18.7	18.8	12.5	0	**28.6**	**64.3**	0	**7.1**
Crataegus monogyna		(16)	(11)	(3)	(1)	(1)	(8)	(3)	(3)	(2)		(4)	(9)		(1)

Saffron thistle *Carthamus lanatus*	12	8.3 (9)	33.3 (3)	22.2 (2)	44.5 (4)	0	25.0 (1)	25.0 (1)	50.0 (2)	0	0	**25.0** (1)	**75.0** (3)	0	0
Cotton thistle *Onopordum acanthium*	13	10.1 (11)	72.7 (8)	27.3 (3)	0	0	57.1 (4)	28.6 (2)	14.3 (1)	0	0	0	**100** (7)	0	0
Horehound *Marrubium vulgare*	14	9.2 (10)	70.0 (7)	20.0 (2)	10.0 (1)	0	10.0 (1)	10.0 (1)	80.0 (8)	0	0	0	**100** (9)	0	0
Barley grass *Hordeum* spp.	15	7.3 (8)	50.0 (4)	25.0 (2)	25.0 (2)	0	25.0 (2)	37.5 (3)	37.5 (3)	0	0	**50.0** (4)	37.5 (3)	12.5 (1)	0
Willows *Salix* spp.	16	7.3 (8)	62.5 (5)	12.5 (1)	25.0 (2)	0	37.5 (3)	37.5 (3)	12.5 (1)	12.5 (1)	0	**42.9** (3)	**57.1** (4)	0	0
Fumitory *Fumaria muralis*	17	6.4 (7)	28.6 (2)	57.1 (4)	14.3 (1)	0	28.6 (2)	28.6 (2)	42.8 (3)	0	0	0	42.9 (3)	**57.1** (4)	0
Wild oats *Avena* spp.	18	5.5 (6)	16.7 (1)	50.0 (3)	33.3 (2)	0	16.7 (1)	0	83.3 (5)	0	0	16.7 (1)	16.7 (1)	**66.6** (4)	0
Dock *Rumex* spp.	19	7.3 (8)	37.5 (3)	62.5 (5)	0	0	75.0 (6)	12.5 (1)	0	12.5 (1)	0	**37.5** (3)	0	**62.5** (5)	0
Storksbill *Erodium* spp.	20	5.5 (6)	50.0 (3)	16.7 (1)	33.3 (2)	0	0	0	66.7 (4)	33.3 (2)	**16.7** (1)	16.7 (1)	**66.6** (4)	0	0

[1] To rank weeds, the three status categories (major, moderate or minor) were added separately to give a score for each category. This was weighted (major x 3, moderate x 2, minor x 1) and added to give a total score for each weed.

[2] Percent total is % of total of 109 respondents who consider the weed to be having an economic impact on their property. The level of impact is then categorised as % minor, moderate and major. Percentages in these categories are based on figures in brackets, which indicate the number of respondents in each particular category.

[3] Problem status refers to the perceived change in the level of a weed infestation for the northern midlands region over the last 10 years, based on the replies from 109 landholders indicating whether their weed problem had increased, decreased or was stable. Some landholders did not specify status, hence the 'not specified' category. Percentages are based on the number of respondents (in brackets) to this particular category. A weed was classified in the 'increase' category (figure underlined) if the figure in the '% increase' column for the weed was approximately equal to or greater than the sum of the figures for '% decrease' and '% stable'. A weed was classified in the 'decrease' category (figure underlined) if the figure in the '% decrease' column, was approximately equal to or greater than the sum of the figures for '% increase' and '% stable'. Similarly, a weed was classified in the 'stable' category (figure underlined) if the figure in the '% stable' column, was approximately equal to or greater than the sum of the figures for '% increase' and '% decrease'. A weed was also classified in the stable category if the difference between the sum of the '% stable' and '% increase' categories and the sum of '% stable' and '% decrease' categories was equal to or less than 10%. If this difference was greater than 10%, the weed was classified either as 'increasing / stable' or 'decreasing / stable' (range indicated by two figures underlined).

Note: these categories are for use as a general indicator only and should be treated with caution depending on the number of respondents. Obviously, the status of any weed can vary considerably between locations.

[4] Percentages based on the number of respondents (in brackets) to this particular category. Figures in bold indicate the weed is a particular problem in the enterprise(s), as a higher proportion of landholders listed the weed as a problem in the enterprise in comparison to the proportion of landholders involved in that enterprise for the region (Table A.13).

[5] Respondents did not always specify a particular thistle or brassica species, leaving a large number of unspecified thistles and brassicas. For a more accurate ranking of these weeds, the status (major, moderate and minor) of unspecified species in these two groups were added to each identified species in the proportions they occurred.

Note: Numbers in brackets are total numbers. As there were always variable responses to the survey categories (economic impact, perceived change in weed status, main enterprise) and the status of some thistle and brassica species were estimated (see footnote 5), the total of the numbers across each subsection in this table will not be equal.

Table A.5 List of the first 20 agricultural weeds in the east coast region ranked using survey responses from 40 landholders, together with their perceived economic impact, problem status and the main enterprises affected

Weeds in order of importance[1]		Percentage of respondents considering the weed to be having an economic impact on their farm[2]					Perceived problem status over previous 10 years[3]				Main enterprise of landholders listing the weed as a problem on their property[4]				
	Rank	% Total	% Minor	% Moderate	% Major	% Not specified	% Decrease	% Stable	% Increase	% Not specified	% Dairy	% Beef	% Sheep	% Cropping	% Other
Gorse	1	65.0	26.9	34.6	38.5	0	38.5	0	53.8	7.7	0	19.2	**76.9**	3.8	0
Ulex europaeus		(26)	(7)	(9)	(10)		(10)		(14)	(2)		(5)	(20)	(1)	
Horehound	2	30.0	41.7	33.3	25.0	0	25.0	0	66.7	8.3	0	9.1	**90.9**	0	0
Marrubium vulgare		(12)	(5)	(4)	(3)		(3)		(8)	(1)		(1)	(10)		
Californian thistle[5]	3	32.5	53.8	38.5	7.7	0	0	10.0	90.0	0	**12.5**	12.5	**62.5**	**12.5**	0
Cirsium arvense		(13)	(7)	(5)	(1)			(1)	(9)		(1)	(1)	(5)	(1)	
Capeweed	4	30.0	66.6	16.7	16.7	0	25.0	8.3	66.7	0	**9.1**	**27.3**	**63.6**	0	0
Arctotheca calendula		(12)	(8)	(2)	(2)		(3)	(1)	(8)		(1)	(3)	(7)		
Ragwort	5	22.5	55.6	22.2	22.2	0	33.3	0	66.7	0	**37.5**	**62.5**	0	0	0
Senecio jacobaea		(9)	(5)	(2)	(2)		(3)		(6)		(3)	(5)			
Blackberry	6	27.5	63.6	36.4	0	0	63.6	9.1	27.3	0	**27.3**	**36.4**	36.3	0	0
Rubus fruticosus agg.		(11)	(7)	(4)			(7)	(1)	(3)		(3)	(4)	(4)		
Bracken	7	20.0	62.5	12.5	25.0	0	62.5	25.0	12.5	0	**25.0**	**50.0**	25.0	0	0
Pteridium spp.		(8)	(5)	(1)	(2)		(5)	(2)	(1)		(2)	(4)	(2)		
Spear thistle[5]	8	17.5	57.1	28.6	14.3	0	33.3	33.4	33.3	0	**16.7**	**33.3**	50.0	0	0
Cirsium vulgare		(7)	(4)	(2)	(1)		(2)	(2)	(2)		(1)	(2)	(3)		
Tea tree	9	7.5	0	0	100	0	0	0	100	0	0	0	**100**	0	0
Melaleuca pustulata		(3)			(3)				(3)				(3)		
Rushes	10	12.5	40.0	60.0	0	0	20.0	80.0	0	0	**20.0**	20.0	20.0	**40.0**	0
Juncus spp.		(5)	(2)	(3)			(1)	(4)			(1)	(1)	(1)	(2)	
Dock	11	12.5	40.0	60.0	0	0	0	0	80.0	20.0	**20.0**	**40.0**	20.0	**20.0**	0
Rumex spp.		(5)	(2)	(3)					(4)	(1)	(1)	(2)	(1)	(1)	

Slender thistle[5]	12	7.5	33.3	33.4	33.3	0	66.7	33.3	0	0	0	**50.0**	50.0	0	0
Carduus spp.		(3)	(1)	(1)	(1)		(2)	(1)				(1)	(1)		
Variegated thistle	13	7.5	33.3	66.7	0	0	33.3	0	66.7	0	0	**33.3**	**66.7**	0	0
Silybum marianum		(3)	(1)	(2)			(1)		(2)			(1)	(2)		
Bent grass	14	5.0	0	0	100	0	50.0	0	50.0	0	0	**50.0**	50.0	0	0
Agrostis spp.		(2)			(2)		(1)		(1)			(1)	(1)		
Willows	15	5.0	0	50.0	50.0	0	100	0	0	0	**50.0**	**50.0**	0	0	0
Salix spp.		(2)		(1)	(1)		(2)				(1)	(1)			
Hemlock	16	5.0	0	50.0	50.0	0	0	50.0	50.0	0	0	**50.0**	50.0	0	0
Conium maculatum		(2)		(1)	(1)			(1)	(1)			(1)	(1)		
Barley grass	17	7.5	66.7	33.3	0	0	33.3	0	66.7	0	**66.7**	0	33.3	0	0
Hordeum spp.		(3)	(2)	(1)			(1)		(2)		(2)		(1)		
African boxthorn	18	7.5	66.7	33.3	0	0	66.7	0	33.3	0	0	0	**100**	0	0
Lycium ferocissimum		(3)	(2)	(1)			(2)		(1)				(3)		
Hawthorn	19	7.5	100	0	0	0	33.3	0	66.7	0	0	**66.7**	33.3	0	0
Crataegus monogyna		(3)	(3)				(1)		(2)			(2)	(1)		
Tussock grass	20	2.5	0	0	100	0	0	0	100	0	0	0	**100**	0	0
Poa spp.		(1)			(1)				(1)				(1)		

[1] To rank weeds, the three status categories (major, moderate or minor) were added separately to give a score for each category. This was weighted (major x 3, moderate x 2, minor x 1) and added to give a total score for each weed.

[2] Percent total is % of total of 40 respondents who consider the weed to be having an economic impact on their property. The level of impact is then categorised as % minor, moderate and major. Percentages in these categories are based on figures in brackets, which indicate the number of respondents in each particular category.

[3] Problem status refers to the perceived change in the level of a weed infestation for the east coast region over the last 10 years, based on the replies from 40 landholders indicating whether their weed problem had increased, decreased or was stable. Some landholders did not specify status, hence the 'not specified' category. Percentages are based on the number of respondents (in brackets) to this particular category. A weed was classified in the 'increase' category (figure underlined) if the figure in the '% increase' column for the weed was approximately equal to or greater than the sum of the figures for '% decrease' and '% stable'. A weed was classified in the 'decrease' category (figure underlined) if the figure in the '% decrease' column, was approximately equal to or greater than the sum of the figures for '% increase' and '% stable'. Similarly, a weed was classified in the 'stable' category (figure underlined) if the figure in the '% stable' column, was approximately equal to or greater than the sum of the figures for '% increase' and '% decrease'. A weed was also classified in the stable category if the difference between the sum of the '% stable' and '% increase' categories and the sum of '% stable' and '% decrease' categories was equal to or less than 10%. If this difference was greater than 10%, the weed was classified either as 'increasing / stable' or 'decreasing / stable' (range indicated by two figures underlined).

Note: these categories are for use as a general indicator only and should be treated with caution depending on the number of respondents. Obviously, the status of any weed can vary considerably between locations.

[4] Percentages based on the number of respondents (in brackets) to this particular category. Figures in bold indicate the weed is a particular problem in the enterprise(s), as a higher proportion of landholders listed the weed as a problem in the enterprise in comparison to the proportion of landholders involved in that enterprise for the region (Table A.13).

[5] Respondents did not always specify a particular thistle or brassica species, leaving a large number of unspecified thistles and brassicas. For a more accurate ranking of these weeds, the status (major, moderate and minor) of unspecified species in these two groups were added to each identified species in the proportions they occurred.

Note: Numbers in brackets are total numbers. As there were always variable responses to the survey categories (economic impact, perceived change in weed status, main enterprise) and the status of some thistle and brassica species were estimated (see footnote 5), the total of the numbers across each subsection in this table will not be equal.

Table A.6 List of the first 20 agricultural weeds in the central and southern midlands region ranked using survey responses from 115 landholders, together with their perceived economic impact, problem status and the main enterprises affected

Weeds in order of importance[1]		Percentage of respondents considering the weed to be having an economic impact on their farm[2]					Perceived problem status over previous 10 years[3]				Main enterprise of landholders listing the weed as a problem on their property[4]				
	Rank	% Total	% Minor	% Moderate	% Major	% Not specified	% Decrease	% Stable	% Increase	% Not specified	% Dairy	% Beef	% Sheep	% Cropping	% Other
Gorse	1	49.6	35.1	42.1	22.8	0	31.6	10.5	57.9	0	**2.0**	8.2	**75.5**	14.3	0
Ulex europaeus		(57)	(20)	(24)	(13)		(18)	(6)	(33)		(1)	(4)	(37)	(7)	
Capeweed	2	35.7	41.5	48.8	9.7	0	21.9	4.9	73.2	0	0	**14.7**	**70.6**	11.8	2.9
Arctotheca calendula		(41)	(17)	(20)	(4)		(9)	(2)	(30)			(5)	(24)	(4)	(1)
Californian thistle[5]	3	32.2	35.1	43.3	18.9	2.7	20.0	10.0	65.0	5.0	0	**17.7**	52.9	**29.4**	0
Cirsium arvense		(37)	(13)	(16)	(7)	(1)	(4)	(2)	(13)	(1)		(3)	(9)	(5)	
Spear thistle[5]	4	26.1	26.7	40.0	30.0	3.3	31.2	18.7	43.8	6.3	0	**15.4**	**61.5**	**15.4**	**7.7**
Cirsium vulgare		(30)	(8)	(12)	(9)	(1)	(5)	(3)	(7)	(1)		(2)	(8)	(2)	(1)
Horehound	5	28.7	45.5	33.3	21.2	0	15.2	18.2	63.6	3.0	0	0	**74.1**	**25.9**	0
Marrubium vulgare		(33)	(15)	(11)	(7)		(5)	(6)	(21)	(1)			(20)	(7)	
Variegated thistle	6	18.0	38.1	42.9	19.0	0	18.2	36.4	45.4	0	0	0	**80.0**	**20.0**	0
Silybum marianum		(21)	(8)	(9)	(4)		(2)	(4)	(5)				(8)	(2)	
Blackberry	7	18.3	52.4	33.3	14.3	0	52.4	9.5	33.3	4.8	**5.5**	**27.8**	38.9	**16.7**	**11.1**
Rubus fruticosus agg.		(21)	(11)	(7)	(3)		(11)	(2)	(7)	(1)	(1)	(5)	(7)	(3)	(2)
Bracken	8	12.2	21.4	64.3	14.3	0	35.7	21.4	42.9	0	0	0	**72.7**	9.1	**18.2**
Pteridium spp.		(14)	(3)	(9)	(2)		(5)	(3)	(6)				(8)	(1)	(2)
Wild radish[5]	9	12.2	21.4	71.5	7.1	0	50.0	33.3	0	16.7	0	**16.7**	50.0	**33.3**	0
Raphanus raphanistrum		(14)	(3)	(10)	(1)		(3)	(2)		(1)		(1)	(3)	(2)	
Slender thistle[5]	10	12.2	28.6	71.4	0	0	37.5	37.5	25.0	0	0	0	**85.7**	14.3	0
Carduus spp.		(14)	(4)	(10)			(3)	(3)	(2)				(6)	(1)	
Wireweed	11	8.7	10.0	80.0	10.0	0	10.0	30.0	60.0	0	0	0	**70.0**	**30.0**	0
Polygonum aviculare		(10)	(1)	(8)	(1)		(1)	(3)	(6)				(7)	(3)	

Fat hen	12	8.7	20.0	60.0	20.0	0	20.0	20.0	60.0	0	**10.0**	0	**70.0**	**20.0**	0
Chenopodium album		(10)	(2)	(6)	(2)		(2)	(2)	(6)		(1)		(7)	(2)	
Willows	13	7.8	22.2	44.5	33.3	0	11.1	22.2	44.5	22.2	0	**16.7**	**83.3**	0	0
Salix spp.		(9)	(2)	(4)	(3)		(1)	(2)	(4)	(2)		(1)	(5)		
Sorrel	14	9.6	36.4	54.5	9.1	0	27.3	45.4	27.3	0	0	**40.0**	30.0	**30.0**	0
Rumex acetosella		(11)	(4)	(6)	(1)		(3)	(5)	(3)			(4)	(3)	(3)	
Barley grass	15	6.1	0	42.9	57.1	0	0	57.1	42.9	0	0	0	**100.0**	0	0
Hordeum spp.		(7)		(3)	(4)			(4)	(3)				(6)		
Briar	16	9.6	63.6	9.1	27.3	0	36.4	18.2	45.4	0	0	**33.3**	55.6	11.1	0
Rosa spp.		(11)	(7)	(1)	(3)		(4)	(2)	(5)			(3)	(5)	(1)	
Hawthorn	17	7.0	25.0	37.5	37.5	0	12.5	0	87.5	0	0	**14.3**	**71.4**	14.3	0
Crataegus monogyna		(8)	(2)	(3)	(3)		(1)		(7)			(1)	(5)	(1)	
Cat's ear[6]	18	5.2	0	66.7	33.3	0	16.7	33.3	50.0	0	0	0	**75.0**	**25.0**	0
Hypochaeris radicata		(6)		(4)	(2)		(1)	(2)	(3)				(3)	(1)	
Rushes	19	5.2	0	83.3	16.7	0	33.3	0	50.0	16.7	0	**50.0**	50.0	0	0
Juncus spp.		(6)		(5)	(1)		(2)		(3)	(1)		(2)	(2)		
Saffron thistle	20	6.2	26.6	73.4	0	0	25.0	25.0	50.0	0	0	**33.3**	**66.7**	0	0
Carthamus lanatus		(7)	(2)	(5)			(1)	(1)	(2)			(1)	(2)		

[1] To rank weeds, the three status categories (major, moderate or minor) were added separately to give a score for each category. This was weighted (major x 3, moderate x 2, minor x 1) and added to give a total score for each weed.

[2] Percent total is % of total of 115 respondents who consider the weed to be having an economic impact on their property. The level of impact is then categorised as % minor, moderate and major. Percentages in these categories are based on figures in brackets, which indicate the number of respondents in each particular category.

[3] Problem status refers to the perceived change in the level of a weed infestation for the central and southern midlands region over the last 10 years, based on the replies from 115 landholders indicating whether their weed problem had increased, decreased or was stable. Some landholders did not specify status, hence the 'not specified' category. Percentages are based on the number of respondents (in brackets) to this particular category. A weed was classified in the 'increase' category (figure underlined) if the figure in the '% increase' column for the weed was approximately equal to or greater than the sum of the figures for '% decrease' and '% stable'. A weed was classified in the 'decrease' category (figure underlined) if the figure in the '% decrease' column, was approximately equal to or greater than the sum of the figures for '% increase' and '% stable'. Similarly, a weed was classified in the 'stable' category (figure underlined) if the figure in the '% stable' column, was approximately equal to or greater than the sum of the figures for '% increase' and '% decrease'. A weed was also classified in the stable category if the difference between the sum of the '% stable' and '% increase' categories and the sum of '% stable' and '% decrease' categories was equal to or less than 10%. If this difference was greater than 10%, the weed was classified either as 'increasing / stable' or 'decreasing / stable' (range indicated by two figures underlined).

Note: these categories are for use as a general indicator only and should be treated with caution depending on the number of respondents. Obviously, the status of any weed can vary considerably between locations.

[4] Percentages based on the number of respondents (in brackets) to this particular category. Figures in bold indicate the weed is a particular problem in the enterprise(s), as a higher proportion of landholders listed the weed as a problem in the enterprise in comparison to the proportion of landholders involved in that enterprise for the region (Table A.13).

[5] Respondents did not always specify a particular thistle or brassica species, leaving a large number of unspecified thistles and brassicas. For a more accurate ranking of these weeds, the status (major, moderate and minor) of unspecified species in these two groups were added to each identified species in the proportions they occurred.

[6] Likely to be mainly cat's ear, but probably also contains hawkbit *(Leontodon taraxacoides)*, dandelion *(Taraxacum officinale)* and other broadleaf weeds.

Note: Numbers in brackets are total numbers. As there were always variable responses to the survey categories (economic impact, perceived change in weed status, main enterprise) and the status of some thistle and brassica species were estimated (see footnote 5), the total of the numbers across each subsection in this table will not be equal.

Table A.7 List of the first 20 agricultural weeds in the southern region ranked using survey responses from 114 landholders, together with their perceived economic impact, problem status and the main enterprises affected

Weeds in order of importance[1]		Percentage of respondents considering the weed to be having an economic impact on their farm[2]					Perceived problem status over previous 10 years[3]				Main enterprise of landholders listing the weed as a problem on their property[4]				
	Rank	% Total	% Minor	% Moderate	% Major	% Not specified	% Decrease	% Stable	% Increase	% Not specified	% Dairy	% Beef	% Sheep	% Cropping	% Other
Blackberry	1	52.2	40.0	46.7	11.6	1.7	55.0	16.7	21.7	6.6	0	**72.4**	17.2	5.2	5.2
Rubus fruticosus agg.		(60)	(24)	(28)	(7)	(1)	(33)	(10)	(13)	(4)		(42)	(10)	(3)	(3)
Capeweed	2	37.4	25.6	44.2	30.2	0	16.3	9.3	69.8	4.6	0	48.8	**36.6**	**9.7**	4.9
Arctotheca calendula		(43)	(11)	(19)	(13)		(7)	(4)	(30)	(2)		(20)	(15)	(4)	(2)
Spear thistle[5]	3	31.3	36.1	63.9	0	0	26.3	31.6	42.1	0	0	50.0	**33.3**	**11.1**	5.6
Cirsium vulgare		(36)	(13)	(23)			(5)	(6)	(8)			(9)	(6)	(2)	(1)
Bracken	4	26.1	40.0	43.3	16.7	0	63.3	13.3	16.7	6.7	0	**75.9**	20.7	3.4	0
Pteridium spp.		(30)	(12)	(13)	(5)		(19)	(4)	(5)	(2)		(22)	(6)	(1)	
Californian thistle[5]	5	22.6	30.8	50.0	29.2	0	46.1	23.1	23.1	7.7	0	38.4	23.1	**30.8**	**7.7**
Cirsium arvense		(26)	(8)	(13)	(5)		(6)	(3)	(3)	(1)		(5)	(3)	(4)	(1)
Rushes	6	20.0	30.4	52.2	17.4	0	26.1	21.7	47.8	4.4	0	**77.3**	18.2	0	4.5
Juncus spp.		(23)	(7)	(12)	(4)		(6)	(5)	(11)	(1)		(17)	(4)		(1)
Gorse	7	17.4	40.0	45.0	15.0	0	40.0	5.0	55.0	0	0	**58.8**	**29.4**	5.9	5.9
Ulex europaeus		(20)	(8)	(9)	(3)		(8)	(1)	(11)			(10)	(5)	(1)	(1)
Ragwort	8	19.3	77.3	13.6	9.1	0	63.6	9.1	27.3	0	0	**75.0**	15.0	5.0	5.0
Senecio jacobaea		(22)	(17)	(3)	(2)		(14)	(2)	(6)			(15)	(3)	(1)	(1)
African boxthorn	9	11.3	30.8	46.1	23.1	0	30.8	15.4	53.8	0	0	16.7	**75.0**	**8.3**	0
Lycium ferocissimum		(13)	(4)	(6)	(3)		(4)	(2)	(7)			(2)	(9)	(1)	
Slender thistle[5]	10	11.3	14.3	57.1	21.4	7.2	28.6	28.5	28.6	14.3	0	33.3	**66.7**	0	0
Carduus spp.		(13)	(2)	(8)	(3)	(1)	(2)	(2)	(2)	(1)		(2)	(4)		
Spanish heath	11	7.0	62.5	12.5	25.0	0	0	0	100	0	0	42.9	**42.8**	0	**14.3**
Erica lusitanica		(8)	(5)	(1)	(2)				(8)			(3)	(3)		(1)

Whiteweed	12	4.3	20.0	20.0	60.0	0	20.0	0	80.0	0	0	20.0	**40.0**	**40.0**	0
Cardaria draba		(5)	(1)	(1)	(3)		(1)		(4)			(1)	(2)	(2)	
Wireweed	13	4.3	20.0	60.0	20.0	0	40.0	20.0	20.0	20.0	0	20.0	20.0	**40.0**	**20.0**
Polygonum aviculare		(5)	(1)	(3)	(1)		(2)	(1)	(1)	(1)		(1)	(1)	(2)	(1)
Tussock grass	14	5.2	33.3	66.7	0	0	0	33.3	66.7	0	0	40.0	20.0	**20.0**	**20.0**
Poa spp.		(6)	(2)	(4)				(2)	(4)			(2)	(1)	(1)	(1)
Wild turnip[5]	15	3.5	25.0	25.0	50.0	0	33.3	0	66.7	0	0	0	**66.7**	0	**33.3**
Brassica rapa ssp. *silvestris*		(4)	(1)	(1)	(2)		(1)		(2)				(2)		(1)
Serrated tussock	16	3.5	25.0	25.0	50.0	0	50.0	0	25.0	25.0	0	0	**75.0**	**25.0**	0
Nassella trichotoma		(4)	(1)	(1)	(2)		(2)		(1)	(1)			(3)	(1)	
Buzzies	17	3.5	25.0	25.0	50.0	0	0	25.0	75.0	0	0	0	**75.0**	0	**25.0**
Acaena nova-zelandiae		(4)	(1)	(1)	(2)			(1)	(3)				(3)		(1)
Storksbill	18	4.3	40.0	60.0	0	0	0	0	80.0	20.0	0	40.0	20.0	**40.0**	0
Erodium spp.		(5)	(2)	(3)					(4)	(1)		(2)	(1)	(2)	
Barley grass	19	3.5	25.0	50.0	25.0	0	0	0	75.0	25.0	0	50.0	**50.0**	0	0
Hordeum spp.		(4)	(1)	(2)	(1)				(3)	(1)		(2)	(2)		
Charlock	20	3.5	50.0	25.0	25.0	0	50.0	0	50.0	0	0	0	**75.0**	0	**25.0**
Sinapis arvensis		(4)	(2)	(1)	(1)		(2)		(2)				(3)		(1)

[1] To rank weeds, the three status categories (major, moderate or minor) were added separately to give a score for each category. This was weighted (major x 3, moderate x 2, minor x 1) and added to give a total score for each weed.

[2] Percent total is % of total of 114 respondents who consider the weed to be having an economic impact on their property. The level of impact is then categorised as % minor, moderate and major. Percentages in these categories are based on figures in brackets, which indicate the number of respondents in each particular category.

[3] Problem status refers to the perceived change in the level of a weed infestation for the southern region over the last 10 years, based on the replies from 114 landholders indicating whether their weed problem had increased, decreased or was stable. Some landholders did not specify status, hence the 'not specified' category. Percentages are based on the number of respondents (in brackets) to this particular category. A weed was classified in the 'increase' category (figure underlined) if the figure in the '% increase' column for the weed was approximately equal to or greater than the sum of the figures for '% decrease' and '% stable'. A weed was classified in the 'decrease' category (figure underlined) if the figure in the '% decrease' column, was approximately equal to or greater than the sum of the figures for '% increase' and '% stable'. Similarly, a weed was classified in the 'stable' category (figure underlined) if the figure in the '% stable' column, was approximately equal to or greater than the sum of the figures for '% increase' and '% decrease'. A weed was also classified in the stable category if the difference between the sum of the '% stable' and '% increase' categories and the sum of '% stable' and '% decrease' categories was equal to or less than 10%. If this difference was greater than 10%, the weed was classified either as 'increasing / stable' or 'decreasing / stable' (range indicated by two figures underlined).

Note: these categories are for use as a general indicator only and should be treated with caution depending on the number of respondents. Obviously, the status of any weed can vary considerably between locations.

[4] Percentages based on the number of respondents (in brackets) to this particular category. Figures in bold indicate the weed is a particular problem in the enterprise(s), as a higher proportion of landholders listed the weed as a problem in the enterprise in comparison to the proportion of landholders involved in that enterprise for the region (Table A.13).

[5] Respondents did not always specify a particular thistle or brassica species, leaving a large number of unspecified thistles and brassicas. For a more accurate ranking of these weeds, the status (major, moderate and minor) of unspecified species in these two groups were added to each identified species in the proportions they occurred.

Note: Numbers in brackets are total numbers. As there were always variable responses to the survey categories (economic impact, perceived change in weed status, main enterprise) and the status of some thistle and brassica species were estimated (see footnote 5), the total of the numbers across each subsection in this table will not be equal.

Table A.8 List of the first 20 agricultural weeds on King Island ranked using survey responses from 23 landholders, together with their perceived economic impact, problem status and the main enterprises affected

Weeds in order of importance[1]		Percentage of respondents considering the weed to be having an economic impact on their farm[2]					Perceived problem status over previous 10 years[3]				Main enterprise of landholders listing the weed as a problem on their property[4]				
	Rank	% Total	% Minor	% Moderate	% Major	% Not specified	% Decrease	% Stable	% Increase	% Not specified	% Dairy	% Beef	% Sheep	% Cropping	% Other
Spear thistle[5]	1	82.6	15.8	73.7	10.5	0	36.3	27.3	27.3	9.1	10.0	**90.0**	0	0	0
Cirsium vulgare		(19)	(3)	(14)	(2)		(4)	(3)	(3)	(1)	(1)	(9)			
Capeweed	2	34.8	12.5	62.5	25.0	0	25.0	12.5	50.0	12.5	12.5	**87.5**	0	0	0
Arctotheca calendula		(8)	(1)	(5)	(2)		(2)	(1)	(4)	(1)	(1)	(7)			
Rushes	3	30.4	14.3	71.4	14.3	0	42.9	14.3	14.3	28.5	0	**100**	0	0	0
Juncus spp.		(7)	(1)	(5)	(1)		(3)	(1)	(1)	(2)		(5)			
Ragwort	4	39.1	55.6	11.1	22.2	11.1	44.5	11.1	33.3	11.1	0	**100**	0	0	0
Senecio jacobaea		(9)	(5)	(1)	(2)	(1)	(4)	(1)	(3)	(1)		(9)			
Slender thistle[5]	5	30.4	42.8	28.6	28.6	0	60.0	20.0	20.0	0	**20.0**	**80.0**	0	0	0
Carduus spp.		(7)	(3)	(2)	(2)		(3)	(1)	(1)		(1)	(4)			
Tall fescue	6	8.7	0	50.0	50.0	0	50.0	0	50.0	0	0	**100**	0	0	0
Festuca arundinacea		(2)		(1)	(1)		(1)		(1)			(2)			
Tea tree	7	8.7	0	50.0	50.0	0	0	0	100	0	0	**100**	0	0	0
Leptospermum spp., *Melaleuca* spp.		(2)		(1)	(1)				(2)			(1)			
Bracken	8	13.0	33.3	66.7	0	0	100	0	0	0	**33.3**	66.7	0	0	0
Pteridium spp.		(3)	(1)	(2)			(3)				(1)	(2)			
Gorse	9	8.7	50.0	0	50.0	0	100	0	0	0	**50.0**	50.0	0	0	0
Ulex europaeus		(2)	(1)		(1)		(2)				(1)	(1)			
Bridal creeper	10	13.0	66.7	33.3	0	0	0	0	100	0	0	**100**	0	0	0
Asparagus asparagoides		(3)	(2)	(1)					(3)			(3)			
Spurge	11	4.3	0	0	100	0	0	0	100	0	0	**100**	0	0	0
Spergela arvensis		(1)			(1)				(1)			(1)			

Blackberry *Rubus fruticosus*	12	13.0 (3)	100 (3)	0	0	0	0	0	<u>100</u> (3)	0	0	**100** (3)	0	0	0
Californian thistle[5] *Cirsium arvense*	13	13.0 (3)	100 (3)	0	0	0	0	0	<u>100</u> (2)	0	0	**100** (2)	0	0	0
Cat's ear[6] *Hypochaeris radicata*	14	8.7 (2)	0	50.0 (1)	0	50.0 (1)	50.0 (1)	<u>0</u>	50.0 (1)	0	**50.0** (1)	50.0 (1)	0	0	0
Wild onion *Allium vineale*	15	4.3 (1)	0	100 (1)	0	0	0	0	<u>100</u> (1)	0	-	-	-	-	-
Variegated thistle *Silybum marianum*	16	4.4 (1)	100 (1)	0	0	0	<u>100</u> (1)	0	0	0	0	**100** (1)	0	0	0
Pennyroyal *Mentha pulegium*	17	4.3 (1)	100 (1)	0	0	0	0	0	<u>100</u> (1)	0	0	**100** (1)	0	0	0
Nettle *Urtica* spp.	18	4.3 (1)	100 (1)	0	0	0	0	0	0	100 (1)	0	**100** (1)	0	0	0
Coprosma *Coprosma repens*	19	4.3 (1)	100 (1)	0	0	0	0	0	<u>100</u> (1)	0	0	**100** (1)	0	0	0
African boxthorn *Lycium ferocissimum*	20	4.3 (1)	100 (1)	0	0	0	<u>100</u> (1)	0	0	0	**100** (1)	0	0	0	0

[1] To rank weeds, the three status categories (major, moderate or minor) were added separately to give a score for each category. This was weighted (major x 3, moderate x 2, minor x 1) and added to give a total score for each weed.

[2] Percent total is % of total of 23 respondents who consider the weed to be having an economic impact on their property. The level of impact is then categorised as % minor, moderate and major. Percentages in these categories are based on figures in brackets, which indicate the number of respondents in each particular category.

[3] Problem status refers to the perceived change in the level of a weed infestation for the King Island region over the last 10 years, based on the replies from 23 landholders indicating whether their weed problem had increased, decreased or was stable. Some landholders did not specify status, hence the 'not specified' category. Percentages are based on the number of respondents (in brackets) to this particular category. A weed was classified in the 'increase' category (figure underlined) if the figure in the '% increase' column for the weed was approximately equal to or greater than the sum of the figures for '% decrease' and '% stable'. A weed was classified in the 'decrease' category (figure underlined) if the figure in the '% decrease' column, was approximately equal to or greater than the sum of the figures for '% increase' and '% stable'. Similarly, a weed was classified in the 'stable' category (figure underlined) if the figure in the '% stable' column, was approximately equal to or greater than the sum of the figures for '% increase' and '% decrease'. A weed was also classified in the stable category if the difference between the sum of the '% stable' and '% increase' categories and the sum of '% stable' and '% decrease' categories was equal to or less than 10%. If this difference was greater than 10%, the weed was classified either as 'increasing / stable' or 'decreasing / stable' (range indicated by two figures underlined).

Note: these categories are for use as a general indicator only and should be treated with caution depending on the number of respondents. Obviously, the status of any weed can vary considerably between locations.

[4] Percentages based on the number of respondents (in brackets) to this particular category. Figures in bold indicate the weed is a particular problem in the enterprise(s), as a higher proportion of landholders listed the weed as a problem in the enterprise in comparison to the proportion of landholders involved in that enterprise for the region (Table A.13).

[5] Respondents did not always specify a particular thistle or brassica species, leaving a large number of unspecified thistles and brassicas. For a more accurate ranking of these weeds, the status (major, moderate and minor) of unspecified species in these two groups were added to each identified species in the proportions they occurred.

[6] Likely to be mainly cat's ear, but probably also contains hawkbit *(Leontodon taraxacoides)*, dandelion *(Taraxacum officinale)* and other broadleaf weeds.

Note: Numbers in brackets are total numbers. As there were always variable responses to the survey categories (economic impact, perceived change in weed status, main enterprise) and the status of some thistle and brassica species were estimated (see footnote 5), the total of the numbers across each subsection in this table will not be equal.

Table A.9 List of the first 20 agricultural weeds on Flinders Island ranked using survey responses from 23 landholders, together with their perceived economic impact, problem status and the main enterprises affected

Weeds in order of importance[1]		Percentage of respondents considering the weed to be having an economic impact on their farm[2]					Perceived problem status over previous 10 years[3]				Main enterprise of landholders listing the weed as a problem on their property[4]				
	Rank	% Total	% Minor	% Moderate	% Major	% Not specified	% Decrease	% Stable	% Increase	% Not specified	% Dairy	% Beef	% Sheep	% Cropping	% Other
Spear thistle[5]	1	65.2	13.3	73.4	13.3	0	45.4	18.2	27.3	9.1	0	**55.6**	**44.4**	0	0
Cirsium vulgare		(15)	(2)	(11)	(2)		(5)	(2)	(3)	(1)		(5)	(4)		
Capeweed	2	60.9	28.6	42.9	21.4	7.1	42.9	7.1	21.4	28.6	0	**63.6**	**36.4**	0	0
Arctotheca calendula		(14)	(4)	(6)	(3)	(1)	(6)	(1)	(3)	(4)		(7)	(4)		
Slender thistle[5]	3	60.9	42.9	42.9	14.2	0	27.3	18.2	45.4	9.1	0	**72.7**	27.3	0	0
Carduus spp.		(14)	(6)	(6)	(2)		(3)	(2)	(5)	(1)		(8)	(3)		
Bent grass	4	13.0	33.3	33.4	33.3	0	33.3	0	33.4	33.3	0	**100**	0	0	0
Agrostis spp.		(3)	(1)	(1)	(1)		(1)		(1)	(1)		(3)			
Dock	5	17.4	50.0	50.0	0	0	25.0	0	75.0	0	0	33.3	**66.7**	0	0
Rumex spp.		(4)	(2)	(2)			(1)		(3)			(1)	(2)		
Onion weed	6	8.7	0	100	0	0	0	0	100	0	0	0	**100**	0	0
Asphodelus fistulosis		(2)		(2)					(2)				(1)		
Tussock grass	7	13.0	0	66.7	0	33.3	0	33.3	33.4	33.3	0	**66.7**	**33.3**	0	0
Poa spp.		(3)		(2)		(1)		(1)	(1)	(1)		(2)	(1)		
Bracken	8	8.7	0	100	0	0	50.0	0	50.0	0	0	0	**100**	0	0
Pteridium spp.		(2)		(2)			(1)		(1)				(1)		
Wild radish[5]	9	4.3	0	0	100	0	100	0	0	0	0	**100**	0	0	0
Raphanus raphanistrum		(1)			(1)		(1)					(1)			
Wild onion	10	4.3	0	0	100	0	0	0	100	0	0	**100**	0	0	0
Allium vineale		(1)			(1)				(1)			(1)			
Variegated thistle	11	8.7	0	100	0	0	0	0	0	100	0	**100**	0	0	0
Silybum marianum		(2)		(2)						(1)		(1)			

Onion grass *Romulea rosea*	12	4.3 (1)	0	0	100 (1)	0	0	0	100 (1)	0	-	-	-	-	-
Fog grass *Holcus lanatus*	13	4.3 (1)	0	0	100 (1)	0	100 (1)	0	0	0	0	**100** (1)	0	0	0
Rat's tail fescue *Vulpia bromoides*	14	4.3 (1)	0	0	100 (1)	0	0	0	100 (1)	0	-	-	-	-	-
Rushes *Juncus* spp.	15	4.3 (1)	0	100 (1)	0	0	100 (1)	0	0	0	-	-	-	-	-
Paterson's curse *Echium plantagineum*	16	4.3 (1)	0	100 (1)	0	0	0	0	0	100 (1)	0	**100** (1)	0	0	0
Espartillo grass *Stipa caudata*	17	4.3 (1)	0	100 (1)	0	0	0	0	0	100 (1)	0	**100** (1)	0	0	0
Horehound *Marrubium vulgare*	18	4.3 (1)	100 (1)	0	0	0	0	0	100 (1)	0	0	0	**100** (1)	0	0
Parramatta rat's-tail *Sporobulus* spp.	19	4.3 (1)	100 (1)	0	0	0	0	0	100 (1)	0	0	0	**100** (1)	0	0
Sweet vernal grass *Anthoxanthum odoratum*	20	4.3 (1)	100 (1)	0	0	0	0	0	0	100 (1)	0	**100** (1)	0	0	0

[1] To rank weeds, the three status categories (major, moderate or minor) were added separately to give a score for each category. This was weighted (major x 3, moderate x 2, minor x 1) and added to give a total score for each weed.

[2] Percent total is % of total of 23 respondents who consider the weed to be having an economic impact on their property. The level of impact is then categorised as % minor, moderate and major. Percentages in these categories are based on figures in brackets, which indicate the number of respondents in each particular category.

[3] Problem status refers to the perceived change in the level of a weed infestation for the Flinders Island region over the last 10 years, based on the replies from 23 landholders indicating whether their weed problem had increased, decreased or was stable. Some landholders did not specify status, hence the 'not specified' category. Percentages are based on the number of respondents (in brackets) to this particular category. A weed was classified in the 'increase' category (figure underlined) if the figure in the '% increase' column for the weed was approximately equal to or greater than the sum of the figures for '% decrease' and '% stable'. A weed was classified in the 'decrease' category (figure underlined) if the figure in the '% decrease' column, was approximately equal to or greater than the sum of the figures for '% increase' and '% stable'. Similarly, a weed was classified in the 'stable' category (figure underlined) if the figure in the '% stable' column, was approximately equal to or greater than the sum of the figures for '% increase' and '% decrease'. A weed was also classified in the stable category if the difference between the sum of the '% stable' and '% increase' categories and the sum of '% stable' and '% decrease' categories was equal to or less than 10%. If this difference was greater than 10%, the weed was classified either as 'increasing / stable' or 'decreasing / stable' (range indicated by two figures underlined).

Note: these categories are for use as a general indicator only and should be treated with caution depending on the number of respondents. Obviously, the status of any weed can vary considerably between locations.

[4] Percentages based on the number of respondents (in brackets) to this particular category. Figures in bold indicate the weed is a particular problem in the enterprise(s), as a higher proportion of landholders listed the weed as a problem in the enterprise in comparison to the proportion of landholders involved in that enterprise for the region (Table A.13).

[5] Respondents did not always specify a particular thistle or brassica species, leaving a large number of unspecified thistles and brassicas. For a more accurate ranking of these weeds, the status (major, moderate and minor) of unspecified species in these two groups were added to each identified species in the proportions they occurred.

Note: Numbers in brackets are total numbers. As there were always variable responses to the survey categories (economic impact, perceived change in weed status, main enterprise) and the status of some thistle and brassica species were estimated (see footnote 5), the total of the numbers across each subsection in this table will not be equal.

Table A.10 List of the first 20 agricultural weeds in the north-western (Cradle Coast) NRM region ranked using survey responses from 347 landholders, together with their perceived economic impact, problem status and the main enterprises affected

Weeds in order of importance[1]		Percentage of respondents considering the weed to be having an economic impact on their farm[2]					Perceived problem status over previous 10 years[3]				Main enterprise of landholders listing the weed as a problem on their property[4]				
	Rank	% Total	% Minor	% Moderate	% Major	% Not specified	% Decrease	% Stable	% Increase	% Not specified	% Dairy	% Beef	% Sheep	% Cropping	% Other
Blackberry	1	39.5	44.5	40.9	13.1	1.5	56.2	9.5	26.3	8.0	**23.6**	**56.7**	**4.7**	10.3	**4.7**
Rubus fruticosus agg.		(137)	(61)	(56)	(18)	(2)	(77)	(13)	(36)	(11)	(30)	(72)	(6)	(13)	(6)
Spear thistle[5]	2	34.0	30.5	57.6	11.9	0	34.1	27.1	31.8	7.0	**33.8**	**54.5**	2.6	7.8	1.3
Cirsium vulgare		(118)	(36)	(68)	(14)		(29)	(23)	(27)	(6)	(26)	(42)	(2)	(6)	(1)
Ragwort	3	39.8	50.0	33.3	13.0	3.7	57.3	6.5	32.6	3.6	16.3	**62.0**	3.1	15.5	3.1
Senecio jacobaea		(138)	(69)	(46)	(18)	(5)	(79)	(9)	(45)	(5)	(21)	(80)	(4)	(20)	(4)
Wild radish[5]	4	20.2	15.7	50.0	32.9	1.4	26.1	18.5	50.8	4.6	7.1	14.3	3.6	**75.0**	0
Raphanus raphanistrum		(70)	(11)	(35)	(23)	(1)	(17)	(12)	(33)	(3)	(4)	(8)	(2)	(42)	
Capeweed	5	25.6	37.1	40.4	16.9	5.6	37.1	10.1	48.3	4.5	18.2	**54.5**	2.6	**19.5**	**5.2**
Arctotheca calendula		(89)	(33)	(36)	(15)	(5)	(33)	(9)	(43)	(4)	(14)	(42)	(2)	(15)	(4)
Slender thistle[5]	6	21.6	28.0	50.7	21.3	0	35.2	11.1	48.1	5.6	18.4	**67.3**	4.1	10.2	0
Carduus spp.		(75)	(21)	(38)	(16)		(19)	(6)	(26)	(3)	(9)	(33)	(2)	(5)	
Californian thistle[5]	7	17.0	49.2	33.9	16.9	0	34.9	11.6	46.5	7.0	**37.5**	42.5	0	15.0	**5.0**
Cirsium arvense		(59)	(29)	(20)	(10)		(15)	(5)	(20)	(3)	(15)	(17)		(6)	(2)
Dock	8	13.0	31.1	55.6	11.1	2.2	26.7	17.8	44.4	11.1	**28.2**	38.5	**5.1**	**25.6**	2.6
Rumex spp.		(45)	(14)	(25)	(5)	(1)	(12)	(8)	(20)	(5)	(11)	(15)	(2)	(10)	(1)
Gorse	9	12.4	55.8	23.3	18.6	2.3	53.5	7.0	32.5	7.0	**33.3**	**51.3**	2.6	12.8	0
Ulex europaeus		(43)	(24)	(10)	(8)	(1)	(23)	(3)	(14)	(3)	(13)	(20)	(1)	(5)	
Wild turnip[5]	10	9.1	18.8	50.0	31.2	0	24.1	6.9	58.6	10.4	8.3	25.0	0	**62.5**	**4.2**
Brassica rapa ssp. *silvestris*		(32)	(6)	(16)	(10)		(7)	(2)	(17)	(3)	(2)	(6)		(15)	(1)
Amaranthus	11	7.5	11.5	26.9	57.7	3.9	11.5	3.9	76.9	7.7	4.5	4.5	**9.1**	**77.3**	**4.6**
Amaranthus spp.		(26)	(3)	(7)	(15)	(1)	(3)	(1)	(20)	(2)	(1)	(1)	(2)	(17)	(1)

Bracken	12	11.8	53.7	26.8	12.2	7.3	58.5	14.6	17.1	9.8	17.5	**62.5**	**5.0**	5.0	**10.0**
Pteridium spp.		(41)	(22)	(11)	(5)	(3)	(24)	(6)	(7)	(4)	(7)	(25)	(2)	(2)	(4)
Fat hen	13	8.6	13.3	66.7	16.7	3.3	23.3	30.0	46.7	0	3.9	15.4	**11.5**	**69.2**	0
Chenopodium album		(30)	(4)	(20)	(5)	(1)	(7)	(9)	(14)		(1)	(4)	(3)	(18)	
Nightshade	14	9.2	15.6	65.6	12.5	6.3	15.6	12.5	65.6	6.3	0	16.0	0	**80.0**	**4.0**
Solanum nigrum		(32)	(5)	(21)	(4)	(2)	(5)	(4)	(21)	(2)		(4)		(20)	(1)
Fumitory	15	8.4	17.2	51.7	27.6	3.5	24.1	17.2	48.3	10.4	0	9.1	**4.5**	**86.4**	0
Fumaria muralis		(29)	(5)	(15)	(8)	(1)	(7)	(5)	(14)	(3)		(2)	(1)	(19)	
Cat's ear[6]	16	9.5	36.4	57.6	3.0	3.0	51.5	12.1	30.3	6.1	16.7	**66.7**	3.3	10.0	3.3
Hypochaeris radicata		(33)	(12)	(19)	(1)	(1)	(17)	(4)	(10)	(2)	(5)	(20)	(1)	(3)	(1)
Rushes	17	8.6	33.3	46.7	13.3	6.7	56.7	6.7	23.3	13.3	15.4	**61.6**	3.8	15.4	3.8
Juncus spp.		(30)	(10)	(14)	(4)	(2)	(17)	(2)	(7)	(4)	(4)	(16)	(1)	(4)	(1)
Wireweed	18	6.3	9.1	63.6	27.3	0	27.3	9.1	54.5	9.1	5.9	0	**5.9**	**88.2**	0
Polygonum aviculare		(22)	(2)	(14)	(6)		(6)	(2)	(12)	(2)	(1)		(1)	(15)	
Barley grass	19	5.8	20.0	40.0	35.0	5.0	15.0	15.0	65.0	5.0	16.7	**72.2**	**11.1**	0	0
Hordeum spp.		(20)	(4)	(8)	(7)	(1)	(3)	(3)	(13)	(1)	(3)	(13)	(2)		
Twitch grass	20	5.5	15.8	57.9	26.3	0	42.1	21.1	26.3	10.5	16.7	16.7	**5.5**	**55.6**	**5.5**
Agropyron repens		(19)	(3)	(11)	(5)		(8)	(4)	(5)	(2)	(3)	(3)	(1)	(10)	(1)

[1] To rank weeds, the three status categories (major, moderate or minor) were added separately to give a score for each category. This was weighted (major x 3, moderate x 2, minor x 1) and added to give a total score for each weed.

[2] Percent total is % of total of 347 respondents who consider the weed to be having an economic impact on their property. The level of impact is then categorised as % minor, moderate and major. Percentages in these categories are based on figures in brackets, which indicate the number of respondents in each particular category.

[3] Problem status refers to the perceived change in the level of a weed infestation for the north-western NRM region over the last 10 years, based on the replies from 347 landholders indicating whether their weed problem had increased, decreased or was stable. Some landholders did not specify status, hence the 'not specified' category. Percentages are based on the number of respondents (in brackets) to this particular category. A weed was classified in the 'increase' category (figure underlined) if the figure in the '% increase' column for the weed was approximately equal to or greater than the sum of the figures for '% decrease' and '% stable'. A weed was classified in the 'decrease' category (figure underlined) if the figure in the '% decrease' column, was approximately equal to or greater than the sum of the figures for '% increase' and '% stable'. Similarly, a weed was classified in the 'stable' category (figure underlined) if the figure in the '% stable' column, was approximately equal to or greater than the sum of the figures for '% increase' and '% decrease'. A weed was also classified in the stable category if the difference between the sum of the '% stable' and '% increase' categories and the sum of '% stable' and '% decrease' categories was equal to or less than 10%. If this difference was greater than 10%, the weed was classified either as 'increasing / stable' or 'decreasing / stable' (range indicated by two figures underlined).

Note: these categories are for use as a general indicator only and should be treated with caution depending on the number of respondents. Obviously, the status of any weed can vary considerably between locations.

[4] Percentages based on the number of respondents (in brackets) to this particular category. Figures in bold indicate the weed is a particular problem in the enterprise(s), as a higher proportion of landholders listed the weed as a problem in the enterprise in comparison to the proportion of landholders involved in that enterprise for the region (Table A.13).

[5] Respondents did not always specify a particular thistle or brassica species, leaving a large number of unspecified thistles and brassicas. For a more accurate ranking of these weeds, the status (major, moderate and minor) of unspecified species in these two groups were added to each identified species in the proportions they occurred.

[6] Likely to be mainly cat's ear, but probably also contains hawkbit *(Leontodon taraxacoides)*, dandelion *(Taraxacum officinale)* and other broadleaf weeds.

Note: Numbers in brackets are total numbers. As there were always variable responses to the survey categories (economic impact, perceived change in weed status, main enterprise) and the status of some thistle and brassica species were estimated (see footnote 5), the total of the numbers across each subsection in this table will not be equal.

Table A.11 List of the first 20 agricultural weeds in the northern NRM region ranked using survey responses from 392 landholders, together with their perceived economic impact, problem status and the main enterprises affected

Weeds in order of importance[1]		Percentage of respondents considering the weed to be having an economic impact on their farm[2]					Perceived problem status over previous 10 years[3]				Main enterprise of landholders listing the weed as a problem on their property[4]				
	Rank	% Total	% Minor	% Moderate	% Major	% Not specified	% Decrease	% Stable	% Increase	% Not specified	% Dairy	% Beef	% Sheep	% Cropping	% Other
Gorse	1	39.0	41.8	30.7	26.2	1.3	44.4	6.6	40.5	8.5	12.4	38.7	**40.2**	8.0	0.7
Ulex europaeus		(153)	(64)	(47)	(40)	(2)	(68)	(10)	(62)	(13)	(17)	(53)	(55)	(11)	(1)
Spear thistle[5]	2	38.8	32.9	55.9	10.5	0.7	49.5	12.9	30.1	7.5	**17.3**	**43.2**	**27.1**	9.9	2.5
Cirsium vulgare		(152)	(50)	(85)	(16)	(1)	(46)	(12)	(28)	(7)	(14)	(35)	(22)	(8)	(2)
Capeweed	3	32.9	25.6	49.6	24.0	0.8	26.4	5.4	60.5	7.7	3.4	**48.3**	**39.7**	6.9	1.7
Arctotheca calendula		(129)	(33)	(64)	(31)	(1)	(34)	(7)	(78)	(10)	(4)	(56)	(46)	(8)	(2)
Ragwort	4	39.0	49.0	33.3	15.7	2.0	43.1	9.2	40.5	7.2	**32.4**	**49.6**	10.1	5.8	2.1
Senecio jacobaea		(153)	(75)	(51)	(24)	(3)	(66)	(14)	(62)	(11)	(45)	(69)	(14)	(8)	(3)
Slender thistle[5]	5	38.8	42.8	48.0	8.5	0.7	38.7	15.1	34.4	11.8	**20.2**	**48.8**	23.8	6.0	1.2
Carduus spp.		(152)	(65)	(73)	(13)	(1)	(36)	(14)	(32)	(11)	(17)	(41)	(20)	(5)	(1)
Blackberry	6	34.9	47.5	44.5	8.0	0	56.9	6.6	25.6	10.9	**24.0**	**48.7**	14.9	8.3	**4.1**
Rubus fruticosus agg.		(137)	(65)	(61)	(11)		(78)	(9)	(35)	(15)	(29)	(59)	(18)	(10)	(5)
Wild radish[5]	7	15.1	15.2	39.0	45.8	0	29.6	11.1	46.3	13.0	2.2	15.2	**26.1**	**56.5**	0
Raphanus raphanistrum		(59)	(9)	(23)	(27)		(16)	(6)	(25)	(7)	(1)	(7)	(12)	(26)	
Bracken	8	9.9	35.9	41.0	20.5	2.6	46.2	23.1	17.9	12.8	**18.2**	**60.6**	15.2	3.0	3.0
Pteridium spp.		(39)	(14)	(16)	(8)	(1)	(18)	(9)	(7)	(5)	(6)	(20)	(5)	(1)	(1)
Nightshade	9	7.9	19.3	48.4	32.3	0	6.4	19.4	71.0	3.2	0	18.5	11.1	**63.0**	**7.4**
Solanum nigrum		(31)	(6)	(15)	(10)		(2)	(6)	(22)	(1)		(5)	(3)	(17)	(2)
Fat hen	10	8.7	32.3	55.9	11.8	0	26.5	23.5	35.3	14.7	7.1	17.9	14.3	**60.7**	0
Chenopodium album		(34)	(11)	(19)	(4)		(9)	(8)	(12)	(5)	(2)	(5)	(4)	(17)	
Dock	11	9.2	55.5	41.7	2.8	0	38.9	19.5	33.3	8.3	9.1	**51.5**	12.1	**24.3**	3.0
Rumex spp.		(36)	(20)	(15)	(1)		(14)	(7)	(12)	(3)	(3)	(17)	(4)	(8)	(1)

Wireweed	12	5.6	22.7	59.1	18.2	0	13.6	31.8	45.5	9.1	0	16.7	16.7	**66.6**	0
Polygonum aviculare		(22)	(5)	(13)	(4)		(3)	(7)	(10)	(2)		(3)	(3)	(12)	
Barley grass	13	6.1	50.0	25.0	20.8	4.2	20.8	25.0	41.7	12.5	**23.8**	**42.9**	23.8	9.5	0
Hordeum spp.		(24)	(12)	(6)	(5)	(1)	(5)	(6)	(10)	(3)	(5)	(9)	(5)	(2)	
Willows	14	5.4	42.9	23.8	28.5	4.8	47.6	19.0	19.1	14.3	21.1	36.8	**36.8**	0	**5.3**
Salix spp.		(21)	(9)	(5)	(6)	(1)	(10)	(4)	(4)	(3)	(4)	(7)	(7)		(1)
Wild turnip[5]	15	5.4	42.9	38.1	19.0	0	31.6	15.8	42.1	10.5	0	**40.0**	20.0	**40.0**	0
Brassica rapa ssp. *silvestris*		(21)	(9)	(8)	(4)		(6)	(3)	(8)	(2)		(6)	(3)	(6)	
Variegated thistle	16	4.6	11.1	88.9	0	0	36.3	18.2	18.2	27.3	**27.3**	18.2	**54.5**	0	0
Silybum marianum		(18)	(2)	(16)			(4)	(2)	(2)	(3)	(3)	(2)	(6)		
Fumitory	17	4.3	23.5	53.0	23.5	0	17.7	23.5	52.9	5.9	0	6.3	**25.0**	**68.7**	0
Fumaria muralis		(17)	(4)	(9)	(4)		(3)	(4)	(9)	(1)		(1)	(4)	(11)	
Californian thistle[5]	18	5.6	45.5	31.8	18.2	4.5	0	7.7	76.9	15.4	**36.4**	9.1	**36.3**	9.1	**9.1**
Cirsium arvense		(22)	(10)	(7)	(4)	(1)		(1)	(10)	(2)	(4)	(1)	(4)	(1)	(1)
Tussock grass	19	3.8	6.7	46.7	40.0	6.6	13.3	20.0	60.0	6.7	0	38.5	**53.8**	7.7	0
Poa spp.		(15)	(1)	(7)	(6)	(1)	(2)	(3)	(9)	(1)		(5)	(7)	(1)	
Cat's ear[6]	20	4.6	33.3	50.0	16.7	0	16.7	50.0	27.8	5.5	12.5	**37.5**	**31.3**	**12.5**	6.2
Hypochaeris radicata		(18)	(6)	(9)	(3)		(3)	(9)	(5)	(1)	(2)	(6)	(5)	(2)	(1)

[1] To rank weeds, the three status categories (major, moderate or minor) were added separately to give a score for each category. This was weighted (major x 3, moderate x 2, minor x 1) and added to give a total score for each weed.

[2] Percent total is % of total of 392 respondents who consider the weed to be having an economic impact on their property. The level of impact is then categorised as % minor, moderate and major. Percentages in these categories are based on figures in brackets, which indicate the number of respondents in each particular category.

[3] Problem status refers to the perceived change in the level of a weed infestation for the northern NRM region over the last 10 years, based on the replies from 392 landholders indicating whether their weed problem had increased, decreased or was stable. Some landholders did not specify status, hence the 'not specified' category. Percentages are based on the number of respondents (in brackets) to this particular category. A weed was classified in the 'increase' category (figure underlined) if the figure in the '% increase' column for the weed was approximately equal to or greater than the sum of the figures for '% decrease' and '% stable'. A weed was classified in the 'decrease' category (figure underlined) if the figure in the '% decrease' column, was approximately equal to or greater than the sum of the figures for '% increase' and '% stable'. Similarly, a weed was classified in the 'stable' category (figure underlined) if the figure in the '% stable' column, was approximately equal to or greater than the sum of the figures for '% increase' and '% decrease'. A weed was also classified in the stable category if the difference between the sum of the '% stable' and '% increase' categories and the sum of '% stable' and '% decrease' categories was equal to or less than 10%. If this difference was greater than 10%, the weed was classified either as 'increasing / stable' or 'decreasing / stable' (range indicated by two figures underlined).

Note: these categories are for use as a general indicator only and should be treated with caution depending on the number of respondents. Obviously, the status of any weed can vary considerably between locations.

[4] Percentages based on the number of respondents (in brackets) to this particular category. Figures in bold indicate the weed is a particular problem in the enterprise(s), as a higher proportion of landholders listed the weed as a problem in the enterprise in comparison to the proportion of landholders involved in that enterprise for the region (Table A.13).

[5] Respondents did not always specify a particular thistle or brassica species, leaving a large number of unspecified thistles and brassicas. For a more accurate ranking of these weeds, the status (major, moderate and minor) of unspecified species in these two groups were added to each identified species in the proportions they occurred.

[6] Likely to be mainly cat's ear, but probably also contains hawkbit *(Leontodon taraxacoides)*, dandelion *(Taraxacum officinale)* and other broadleaf weeds.

Note: Numbers in brackets are total numbers. As there were always variable responses to the survey categories (economic impact, perceived change in weed status, main enterprise) and the status of some thistle and brassica species were estimated (see footnote 5), the total of the numbers across each subsection in this table will not be equal.

Table A.12 List of the first 20 agricultural weeds in the southern NRM region ranked using survey responses from 251 landholders, together with their perceived economic impact, problem status and the main enterprises affected

Weeds in order of importance[1]		Percentage of respondents considering the weed to be having an economic impact on their farm[2]					Perceived problem status over previous 10 years[3]				Main enterprise of landholders listing the weed as a problem on their property[4]				
	Rank	% Total	% Minor	% Moderate	% Major	% Not specified	% Decrease	% Stable	% Increase	% Not specified	% Dairy	% Beef	% Sheep	% Cropping	% Other
Gorse	1	38.6	34.0	40.2	25.8	0	34.0	6.2	57.7	2.1	1.2	20.9	**67.4**	9.3	1.2
Ulex europaeus		(97)	(33)	(39)	(25)		(33)	(6)	(56)	(2)	(1)	(18)	(58)	(8)	(1)
Capeweed	2	36.3	36.3	43.9	19.8	0	17.6	6.6	73.6	2.2	0	32.1	**54.3**	9.9	3.7
Arctotheca calendula		(91)	(33)	(40)	(18)		(16)	(6)	(67)	(2)		(26)	(44)	(8)	(3)
Blackberry	3	33.5	45.2	41.7	11.9	1.2	53.6	15.5	25.0	5.9	1.3	**59.5**	25.3	7.6	**6.3**
Rubus fruticosus agg.		(84)	(38)	(35)	(10)	(1)	(45)	(13)	(21)	(5)	(1)	(47)	(20)	(6)	(5)
Californian thistle[5]	4	29.1	34.3	47.9	16.4	1.4	25.0	12.5	57.5	5.0	0	25.0	44.4	**27.8**	2.8
Cirsium arvense		(73)	(25)	(35)	(12)	(1)	(10)	(5)	(23)	(2)		(9)	(16)	(10)	(1)
Spear thistle[5]	5	26.3	34.9	53.0	10.6	1.5	29.7	27.0	40.6	2.7	0	**35.3**	**47.0**	**11.8**	**5.9**
Cirsium vulgare		(66)	(23)	(35)	(7)	(1)	(11)	(10)	(15)	(1)		(12)	(16)	(4)	(2)
Bracken	6	18.3	37.0	47.8	15.2	0	52.2	19.6	23.9	4.3	0	**52.4**	38.1	4.7	**4.8**
Pteridium spp.		(46)	(17)	(22)	(7)		(24)	(9)	(11)	(2)		(22)	(16)	(2)	(2)
Horehound	7	17.9	51.1	28.9	20.0	0	20.0	15.6	60.0	4.4	0	2.6	**82.0**	**15.4**	0
Marrubium vulgare		(45)	(23)	(13)	(9)		(9)	(7)	(27)	(2)		(1)	(32)	(6)	
Slender thistle[5]	8	12.7	21.9	59.4	15.6	3.1	38.9	33.3	22.2	5.6	0	20.0	**73.3**	6.7	0
Carduus spp.		(32)	(7)	(19)	(5)	(1)	(7)	(6)	(4)	(1)		(3)	(11)	(1)	
Variegated thistle	9	10.2	34.6	47.2	19.2	0	21.4	35.7	42.9	0	0	7.7	**76.9**	**15.4**	0
Silybum marianum		(26)	(9)	(12)	(5)		(3)	(5)	(6)			(1)	(10)	(2)	
African boxthorn	10	9.6	41.7	45.8	12.5	0	29.2	8.3	62.5	0	0	13.6	**59.1**	**27.3**	0
Lycium ferocissimum		(24)	(10)	(11)	(3)		(7)	(2)	(15)			(3)	(13)	(6)	
Ragwort	11	9.6	75.0	12.5	12.5	0	62.5	8.3	29.2	0	0	**75.0**	15.0	5.0	**5.0**
Senecio jacobaea		(24)	(18)	(3)	(3)		(15)	(2)	(7)			(15)	(3)	(1)	(1)

Rushes	12	10.4	15.4	65.4	19.2	0	23.1	23.1	50.0	3.8	0	**65.2**	**21.7**	8.7	**4.4**
Juncus spp.		(26)	(4)	(7)	(5)		(6)	(6)	(13)	(1)		(15)	(5)	(2)	(1)
Barley grass	13	4.8	8.3	50.0	41.7	0	0	33.3	58.3	8.4	0	18.2	**81.8**	0	0
Hordeum spp.		(12)	(1)	(6)	(5)			(4)	(7)	(1)		(2)	(9)		
Wireweed	14	5.6	14.3	71.4	14.3	0	21.4	28.6	42.9	7.1	0	7.1	**50.0**	**35.7**	**7.2**
Polygonum aviculare		(14)	(2)	(10)	(2)		(3)	(4)	(6)	(1)		(1)	(7)	(5)	(1)
Fat hen	15	6.0	40.0	46.7	13.3	0	20.0	13.3	60.0	6.7	**6.7**	6.7	**60.0**	**26.6**	0
Chenopodium album		(15)	(6)	(7)	(2)		(3)	(2)	(9)	(1)	(1)	(1)	(9)	(4)	
Briar	16	5.6	50.0	14.3	28.6	7.1	50.0	14.3	35.7	0	0	**33.3**	**50.0**	**16.7**	0
Rosa spp.		(14)	(7)	(2)	(4)	(1)	(7)	(2)	(5)			(4)	(6)	(2)	
Sorrel	17	5.2	38.5	53.8	7.7	0	30.8	38.4	30.8	0	0	**33.3**	41.7	**25.0**	0
Rumex acetosella		(13)	(5)	(7)	(1)		(4)	(5)	(4)			(4)	(5)	(3)	
Willows	18	4.0	30.0	40.0	30.0	0	30.0	30.0	30.0	10.0	0	**42.9**	**57.1**	0	0
Salix spp.		(10)	(3)	(4)	(3)		(3)	(3)	(3)	(1)		(3)	(4)		
Whiteweed	19	3.2	25.0	25.0	50.0	0	25.0	0	75.0	0	0	12.5	37.5	**50.0**	0
Cardaria draba		(8)	(2)	(2)	(4)		(2)		(6)			(1)	(3)	(4)	
Wild turnip[5]	20	3.9	33.9	50.8	15.3	0	40.0	0	60.0	0	0	0	**60.0**	**20.0**	**20.0**
Brassica rapa ssp. *silvestris*		(10)	(3)	(5)	(2)		(2)		(3)				(3)	(1)	(1)

[1] To rank weeds, the three status categories (major, moderate or minor) were added separately to give a score for each category. This was weighted (major x 3, moderate x 2, minor x 1) and added to give a total score for each weed.

[2] Percent total is % of total of 251 respondents who consider the weed to be having an economic impact on their property. The level of impact is then categorised as % minor, moderate and major. Percentages in these categories are based on figures in brackets, which indicate the number of respondents in each particular category.

[3] Problem status refers to the perceived change in the level of a weed infestation for the southern NRM region over the last 10 years, based on the replies from 251 landholders indicating whether their weed problem had increased, decreased or was stable. Some landholders did not specify status, hence the 'not specified' category. Percentages are based on the number of respondents (in brackets) to this particular category. A weed was classified in the 'increase' category (figure underlined) if the figure in the '% increase' column for the weed was approximately equal to or greater than the sum of the figures for '% decrease' and '% stable'. A weed was classified in the 'decrease' category (figure underlined) if the figure in the '% decrease' column, was approximately equal to or greater than the sum of the figures for '% increase' and '% stable'. Similarly, a weed was classified in the 'stable' category (figure underlined) if the figure in the '% stable' column, was approximately equal to or greater than the sum of the figures for '% increase' and '% decrease'. A weed was also classified in the stable category if the difference between the sum of the '% stable' and '% increase' categories and the sum of '% stable' and '% decrease' categories was equal to or less than 10%. If this difference was greater than 10%, the weed was classified either as 'increasing / stable' or 'decreasing / stable' (range indicated by two figures underlined).

Note: these categories are for use as a general indicator only and should be treated with caution depending on the number of respondents. Obviously, the status of any weed can vary considerably between locations.

[4] Percentages based on the number of respondents (in brackets) to this particular category. Figures in bold indicate the weed is a particular problem in the enterprise(s), as a higher proportion of landholders listed the weed as a problem in the enterprise in comparison to the proportion of landholders involved in that enterprise for the region (Table A.13).

[5] Respondents did not always specify a particular thistle or brassica species, leaving a large number of unspecified thistles and brassicas. For a more accurate ranking of these weeds, the status (major, moderate and minor) of unspecified species in these two groups were added to each identified species in the proportions they occurred.

Note: Numbers in brackets are total numbers. As there were always variable responses to the survey categories (economic impact, perceived change in weed status, main enterprise) and the status of some thistle and brassica species were estimated (see footnote 5), the total of the numbers across each subsection in this table will not be equal.

Table A.13 Regional and state-wide agricultural enterprise listings as determined from survey responses from 990 Tasmanian landholders

	Total number of responses	% Dairy[3]	% Beef[3]	% Sheep[3]	% Cropping[3]	% Other[3]	% Not specified[3]
Agricultural Regions **(Figure 2.1)[1]**							
North-western	142	31.7 (45)	43.0 (61)	1.4 (2)	11.3 (16)	2.8 (4)	9.8 (14)
Northern	319	13.5 (43)	42.6 (136)	10.0 (32)	18.8 (60)	3.2 (10)	11.9 (38)
North-eastern	103	16.5 (17)	52.5 (54)	2.9 (3)	10.7 (11)	1.9 (2)	15.5 (16)
Northern Midlands	109	2.8 (3)	22.0 (24)	49.5 (54)	15.6 (17)	2.8 (3)	7.3 (8)
East Coast	40	7.5 (3)	25.0 (10)	57.5 (23)	5.0 (2)	0.0 (0)	5.0 (2)
Central and Southern Midlands	115	0.9 (1)	12.2 (14)	55.7 (64)	13.9 (16)	1.7 (2)	15.6 (18)
Southern	114	0.0 (0)	54.3 (62)	28.1 (32)	7.0 (8)	5.3 (6)	5.3 (6)
King Island	23	13.0 (3)	78.3 (18)	0.0 (0)	0.0 (0)	0.0 (0)	8.7 (2)
Flinders Island	23	0.0 (0)	52.2 (12)	30.4 (7)	0.0 (0)	0.0 (0)	17.4 (4)
NRM regions **(Figure 2.2)**							
NRM North-western	347	18.4 (64)	46.7 (162)	3.4 (12)	17.9 (62)	2.9 (10)	10.7 (37)
NRM Northern	392	12.7 (50)	38.8 (152)	23.5 (92)	11.0 (43)	2.3 (9)	11.7 (46)
NRM Southern	251	0.8 (2)	31.5 (79)	45.0 (113)	10.0 (25)	3.2 (8)	9.5 (24)
All Tasmania[2]	**990**	**11.7** (116)	**39.6** (393)	**22.0** (217)	**13.2** (130)	**2.7** (27)	**10.8** (107)

[1] 988 out of the total of 990 responses are listed from the agricultural regions. Two responses from properties in the western sector (Figure 2.1), both of which grazed beef cattle, were not included as it is not a major agricultural region.

[2] The western sector results are included in this total.

[3] Percentages in these categories are based on figures in brackets, which indicate the number of respondents in each particular category.

Established and supported under the Commonwealth Government's Cooperative Research Centre Program