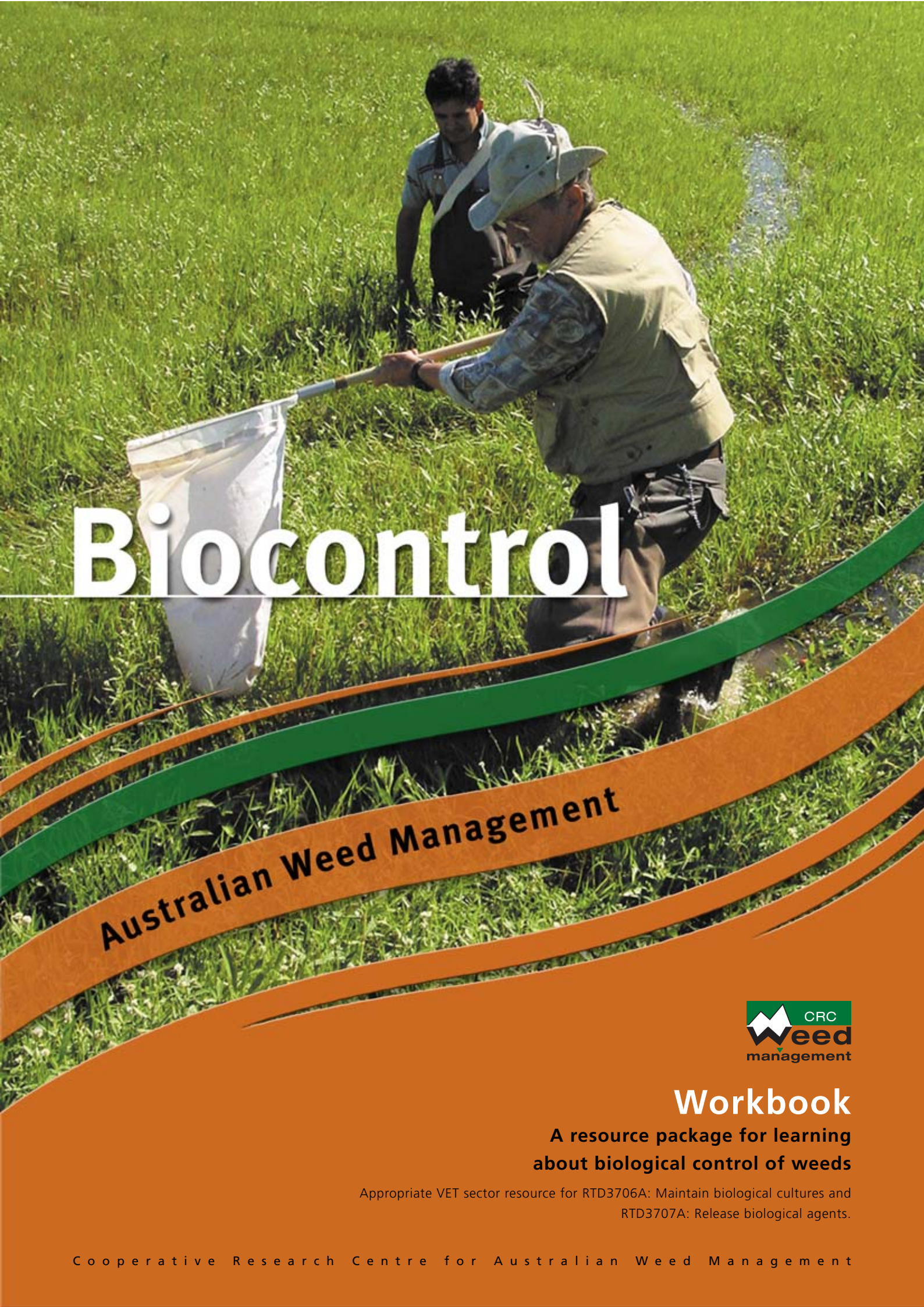

Biocontrol

Australian Weed Management

CRC Weed management

Workbook

A resource package for learning about biological control of weeds

Appropriate VET sector resource for RTD3706A: Maintain biological cultures and RTD3707A: Release biological agents.

Cooperative Research Centre for Australian Weed Management

The resources developed by the Weeds CRC (PowerPoint slides, teacher notes and workbook) will provide an overview of biological control methods used in Australia (with an emphasis on classical biological control). They cover introductory information on the history of biological control in Australia and the theory and practice behind maintaining and releasing biological control agents for weed management. The resources can be used either as a complete session (or series of sessions) or alternatively, the information and individual parts of the resources provided can be included in an existing training program (with appropriate acknowledgment).

At the time of compilation, this resource covered the following units of competency in the Conservation and Land Management Training Package and the Agriculture and Horticulture Training Packages:

RTD3706A Maintain biological cultures
RTD3707A Release biological agents

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Part I: History of biological control in Australia

1. What is biological control?

Biological control should aim to:

Create an ecological balance between a plant and its natural enemies in the introduced range, to reduce the weed population to an equilibrium level below that at which the weed causes economic damage.'

(Briese 2000)

However it should be noted that biocontrol on environmental weeds is not necessarily motivated by economics.

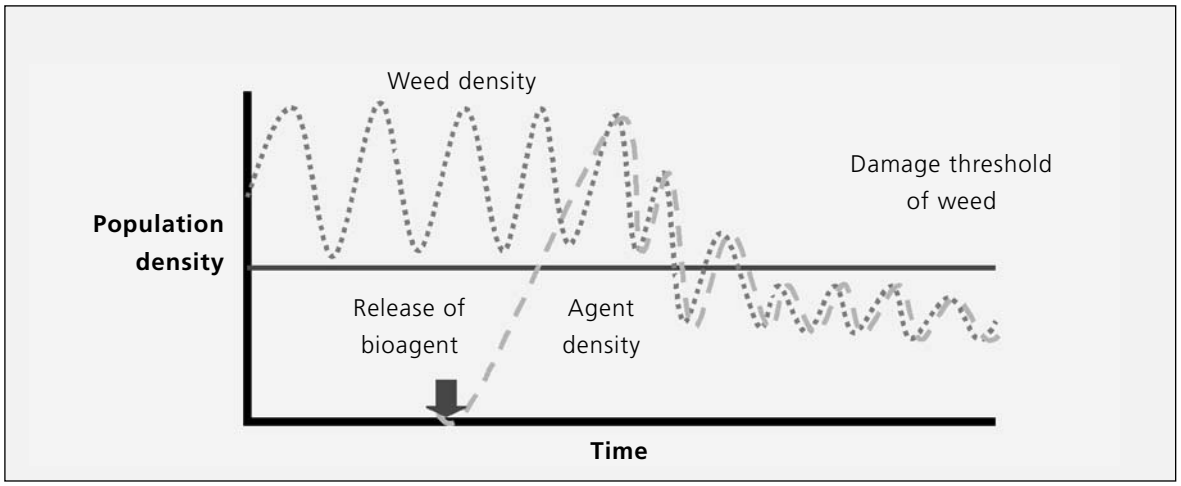
Biological control should NOT aim for complete eradication:

It is neither a desirable nor an achievable objective - remember that part of the lifecycle of most plants comprises a dormant stage such as seed bank reserves or tubers.

Eradication of the weed from a particular area would result in the extinction of the natural enemy due to lack of food resources and subsequent reinfestation of the weed from propagules stored in the soil.

Thus it is essential to have some weed patches for agents to colonise and maintain the lower equilibrium.

A 'typical' and successful biocontrol program should look like this:



(adapted from Briese 2000)

Four types of biological control (Wapshere *et al.* 1989):

- **Classical**: introduction of natural enemies against invasive alien plants (requires no further intervention once the agents are established over the range of the target. This process can take a decade or more eg Paterson's curse); is the oldest and most common and effective type of biological control employed in Australia.
- **Conservative**: management and protection of existing natural enemies to keep host-weed populations low.
- **Broad-spectrum**: use of polyphagous herbivores in both aquatic and terrestrial habitats eg grazing animals, grass carp.
- **Inundative/augmentative**: mass production and release of natural enemies at regular intervals to reduce targeted weed populations eg mycoherbicides (**Slide 1.8**).

Reference:

Wapshere, A.J., Delfosse, E.S. and Cullen, J.M. (1989). Recent developments in biological control of weeds. *Crop Protection* **8**, 237-50.

2. When is biological control appropriate?

There are positive and negative aspects to all weed control methods, including biocontrol.

Positive aspects include:

- It is environmentally sound (normally only the target weed is affected, no residual effects).
- There are high benefits for small implementation and maintenance costs.
- There is no risk of missing a weed control opportunity as the bioagent activity is linked to the weed's lifecycle.
- It provides a long-term solution to the weed problem.

Negative aspects include:

- Not all weeds are suitable targets for a biocontrol program.
- The initial cost of a program many be high due to the cost associated with finding a suitable agent, safety testing and mass distributing it.
- It can take a large amount of time to have an impact on a weed population.
- Some introduced agents may not contribute to weed control once they are established.

3. Myths about biological control

Biological control is dangerous – look at the cane toad!!

In actual fact, the cane toad was introduced prior to the enactment of the stringent quarantine regulations. Initial releases were made without any testing of the host-range of the toad and despite advice to the contrary from professional biological control researchers and wildlife scientists.

Weed biological control agents, in particular, have stringent host-specificity testing and can only be approved after satisfying strict legislative requirements.

There are no examples in Australia of an introduced weed control agent causing serious long-term damage to a non-target plant. In the few cases where an agent has fed on a non-target plant, this possibility was known from studies of its host-range and the risk to the plant demonstrated to be acceptable.

Biological control is a magic bullet – look how it wiped out prickly pear!!

The use of Cactoblastis in controlling prickly pear in Australia is probably the most used example of a successful biological control. However in reality, the control program began in 1912 and involved the study of 48 potential agents. Twelve of these were released up until 1940. It took seven years for the Cactoblastis to control two forms of prickly pear and other agents such as the cochineal insects helped to control other cactus species.

Although other dramatic results have been seen with the use of a fungus on narrow leafed skeleton weed and a weevil on the aquatic weed, salvinia, many terrestrial weeds have large soil seed banks and large and rapid decline in weed densities may not be so evident.

When dealing with terrestrial weeds, biological control is often best achieved using a combination of agents as they can target different stages of the weeds lifecyle and can stress a plant over a longer period of time.

It is therefore very important to expect a lag-time of several years before the number of bioagents reach damaging levels and have a significant impact on the target weed. Typically, a biological control project may require at least 15 years before there is financial return on the work. Once this return is realised, the benefits continue indefinitely without additional cost.

4. The Australian story – successes and failures

Since the 20th century, Australian researchers have been leaders in the development of biological control.

How many weeds have been targeted by biocontrol in Australia?

Over 60 weeds have been targeted and now these introduced natural enemies contribute in some way to the control of almost half of these weed species and play a major role in the control of 19.
It is important to realise that many of these programs are still in progress and thus it is too early to determine the degree of control many of these bioagents will have.

Biological control is used on a number of weed types in Australian habitats

	Habitat				
Weed type	**Pasture**	**Rangeland**	**Cropping**	**Natural**	**Aquatic**
Grass	2	0	0	2	0
Forb	31	12	14	10	4
Shrub	10	9	2	10	0
Tree	0	6	0	7	0
Vine	0	1	1	3	0
Succulent	11	11	0	1	0
Total	**54**	**39**	**17**	**33**	**4**

(adapted from Briese 2000)

Where is biocontrol used?

Biocontrol in Australia has been used in a range of habitats but has been particularly successful in rangelands and managed pastures. This reflects the perceived greater effectiveness of biological control in less intensively managed and distrubed agricultural systems. Often it is not considered to be an economical form of control in a cropping system and thus weeds of crops have not been extensively targeted. However, one of the most successful biological control programs in Australia was aimed at controlling the narrow-leafed form of skeleton weed using the rust fungus *Puccinia*.

In the last 15 years, projects have now also concentrated on areas of native vegetation. Biocontrol of aquatic weeds comprise of 10% of projects, forbs (herbaceous, non-grass plants) are targeted in over 50% and more recent projects have targeted woody shrubs and trees eg *Mimosa pigra* (giant sensitive plant or mimosa), *Acacia nilotica* (prickly acacia) and *Cytisus scoparius* (Scotch broom).

Although grass weeds are an extremely serious problem in Australia, only recently have there been attempts to identify possible biocontrol agents. Biocontrol of grasses has been considered too difficult due to fears that it would be extremely difficult to identify agents with a host-specificity that would then not post a threat to cereal crops and desirable pasture and turf grass species. In 1998, funding was obtained to undertake an initial survey of potential agents to control two closely related grass weeds, *Nassella trichotoma* (serrated tussock) and *N. neesiana* (Chilean needle grass).

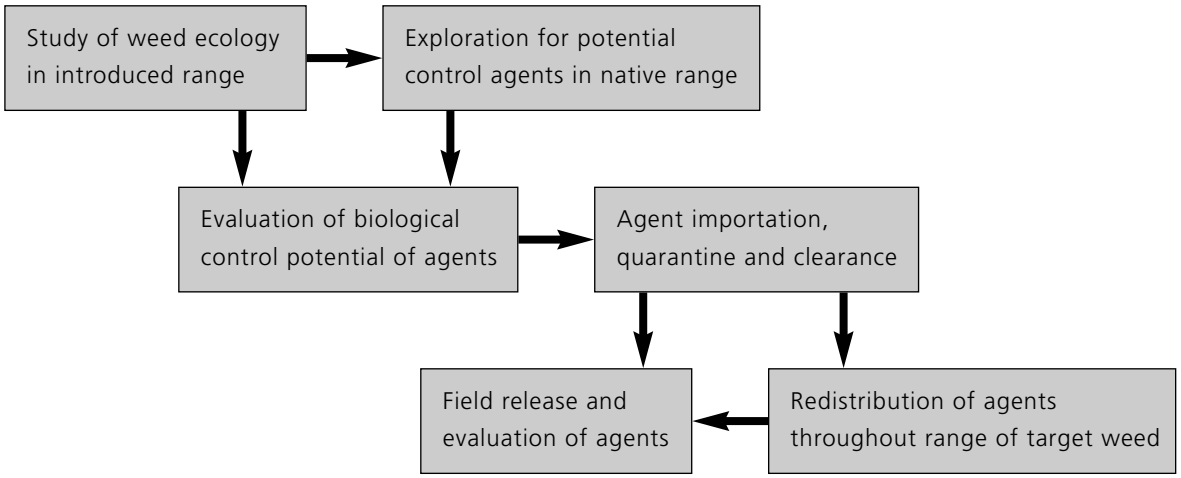
5. Key steps in a biological control program

There are a number of key steps that make up the framework of a biological control project ie from the initial investigation through to the release and redistribution phase.

The release and evaluation of agents in the field, and the redistribution of agents for a range of target weeds, uses existing networks such as professional weed managers and community groups. This is the entry point in a biological control program for most weed managers.

Some agents can spread quite rapidly and quickly and require little redistribution. However, in other cases, the spread of the bioagents can be made more efficient by devising a redistribution program. Many projects now use community groups to help increase the number of release sites. Although these networks can require a high level of coordination, they provide an excellent method of maintaining and redistributing biocontrol agents. For example, St John's wort mite nursery sites in many areas are now set up by research and extension personnel but maintained and redistributed by Landcare groups. Information kits have been devised to assist the landholders to carry out the required tasks associated with maintaining and releasing the bioagents. This network also offers immense amounts of feedback to the researcher on bioagent establishment and impact on the weed.

Steps in a biological control program



(adapted from Briese 2000)

References:

Further reading and examples can be found in the textbook:

Australian Weed Management Systems (Ed. Brian M. Sindel). Cooperative Research Centre for Weed Management Systems. R.G. and F.J. Richardson, Victoria, Australia.

Particularly Chapters 9 and 10:

Briese, D.T. (2000). Classical Biological Control *In* 'Australian Weed Management Systems' (Ed. Brian M. Sindel). Cooperative Research Centre for Weed Management Systems. R.G. and F.J. Richardson, Victoria, Australia. pp.161-192.

McRae, C.F. and Auld, B.A. (2000). Inundative Biological Control of Weeds – the bioherbicide tactic. *In* 'Australian Weed Management Systems' (Ed. Brian M. Sindel). Cooperative Research Centre for Weed Management Systems. R.G. and F.J. Richardson, Victoria, Australia. pp.193-208.

Part II: Maintain biological cultures

1. To determine the appropriate biological control agent for a particular weed infestation

When deciding to use a bioagent as a weed management option, the following points need to be considered:

- target weed
- biocontrol options
- weed location
- weed density
- weed threat
- time frame
- barriers
- community links
- biology and ecology
- seasonal conditions
- _____
- _____
- _____
- _____
- _____

2. To determine what is required after deciding to proceed with a biocontrol program

Before deciding to progress with propagating a biocontrol agent, many things need to be considered:

- bioagent acquisition
- bioagent transport
- permits and compliance
- accessibility of growth media
- consultation and cooperation
- requirements of bioagent before and after propagation
- method of bioagent release
- records required
- _____
- _____
- _____
- _____
- _____

3. To determine what is required when maintaining and monitoring cultures

Bioagents need to be regularly monitored once they are transferred.

Reasons for this include the need for:

- detecting and recording of abnormalities in growing conditions
- recording all observations for later reference
- determining establishment, population increase and impact
- monitoring for future harvest and release programs
- determining any off target effects of agent (condition of release permit).

When monitoring you should look for:

- presence of bioagent
- increase in bioagent numbers
- reduction in feed source
- changes in environmental conditions.

What would you record when monitoring?

There are many techniques that can be used to monitor a site eg:

- quadrats in the designated area (fixed or random)
- points in the designated area (fixed or random)
- agent presence or weed damage using eg visual estimates, rankings, counts and photographs.
- _____
- _____

When you assess your bioagent, there are factors that will influence your results, you must take into consideration:

- bioagent lifecycle
- weed lifecycle
- environmental conditions
- time of release.

What equipment would be necessary to monitor the culture?

- _____
- _____
- _____
- _____
- _____
- _____
- _____
- _____
- _____
- _____

After collating the results, what and to whom would you report your findings?

Reported results:

- background of project
- level of agent colonisation
- future project direction.

Findings to:

- collaborators
- supervisors.

The success of the program is determined by:

- density of agent and survival
- benchmarking results with other biocontrol programs
- successful harvesting of bioagents for future release sites.

4. To determine what is required when harvesting and storing cultures

In a situation where bioagents can be collected and redistributed to a new release site, list what would need to be considered before harvesting bioagents from the initial culture or release site.

5. To apply the acquired knowledge about maintaining biological cultures to a real scenario

You will be asked to complete an assessment task or exercise to determine what is required:

- **before** deciding to propagate the bioagent (including acquisition of agents, methodology, record keeping).
- **during** the implementation of the propagation process (including preparation of area, release methodology, records, equipment).
- **after** establishing the bioagents (including monitoring, record taking, reporting of results) and what decisions would need to be made before deciding to harvest and store them for a release program.

Part III: Release biological agents

Appropriate for VET sector resource RDT3707A Release biological agents

1. To determine if a biological control program may be an effective method of weed control for a particular weed infestation

Before using a biological control program to manage weeds at a location, many things should be considered when deciding if the program could be successfully implemented at that site. Factors to consider include:

- weed that is to be targeted
- possible biocontrol options
- location of the infestation and assessment of site (map of the area)
- density of weed infestation
- threat of target weed spread to other surrounding areas
- time frame required for adequate level of weed management
- barriers that may need to be overcome for a successful program
- amount of community consultation and involvement that will be required
- biology and ecology of target species, agent and site
- seasonal conditions.

2. To determine what is required after deciding to proceed with a biocontrol program

Once the decision has been made that the site could be suitable for biocontrol, you should construct a general checklist or protocol that should be followed detailing step by step how you would proceed with a biocontrol program.

- Where can the bioagents be acquired from?
- How easily can the bioagents be acquired and transported?
- Are permits needed?
- What sort of consultation and cooperation needs to occur?
- What methods and site requirements for introducing a biological control agent (equipment and water) are required?
- What records should be kept at the time of establishment and when monitoring the area subsequently?

3. To determine what is required when monitoring an establishment site

Why is it important to monitor a biocontrol establishment site?

_____

_____

_____

_____

When monitoring an established site, look for:

- presence of bioagent
- expansion of bioagent area
- damage to target weed
- reduction to target weed density.

Recording your findings.

On the following page, construct a simple recording sheet for monitoring your biocontrol site. This information will be used when you produce reports for your supervisor.

What techniques could you use to assess the site?

- quadrats (fixed or random)
- points (fixed or random)
- visual estimates (agent/weed)
- ranking (agent/weed)
- counts (agent/weed)
- photographs (agent/weed).

What would influence when you assessed the site?

- _____
- _____
- _____
- _____
- _____
- _____
- _____
- _____

Example recording sheet

What equipment would you take to help assess the site for biocontrol damage?

Choose a biocontrol agent and construct a list of equipment that you would take with you to monitor the site. Write it in such a form that it could be used as a checklist for others who may be required to collect the equipment for you.

Agent _____

Monitoring equipment

- _____
- _____
- _____
- _____
- _____
- _____
- _____
- _____
- _____
- _____
- _____
- _____

Inclusions on the list of equipment could be:

- tape measures
- rope line with marked points on – the rope can then be strung between two permanent pegs if the same points in the release area are to be revisited
- clip board and pen
- recording sheet
- camera
- quadrat
- site map
- GPS
- plastic bags (+ rubber bands) or containers; tags and marker pens if samples are to be brought back
- fencing wire and pliers to repair any damaged fencing
- hammer and pegs or posts to replace any damaged marker pegs or posts.

Once the results have been collated, you should report the findings.

The report could include information on:

- background of project
- level of weed control
- future developments.

The report and its findings would go to:

- supervisors
- relevant land holders and/or managers of the area where the site is located and areas surrounding the site
- community groups
- collaborators
- media.

The success of the program will be determined by:

- spread of agent
- density of insect and its survival
- density of weed and damage
- benchmarking results with other control programs.

4. To apply the acquired knowledge about biocontrol programs to a real scenario

You will be asked to complete an assessment task or exercise to determine what is required:

- **before** implementing the biocontrol program (including acquisition of agents, methodology, record keeping).
- **during** the implementation of the biocontrol program (including site preparation, release methodology, records, equipment).
- **after** implementing the biocontrol program (including monitoring the area, record taking, reporting of results).

Assessment for RTD3706A: Maintain biological cultures

Aim: To apply the acquired knowledge about maintaining biological cultures to a real scenario.

1 Select a biocontrol agent that could be eventually propagated and released at a weed infestation site that is known to you.

2 Briefly outline the reason behind why you selected that bioagent to be used in a future biocontrol program.

3 For the bioagent propagation, construct a protocol or checklitst of steps that you would need to take:
- **before** deciding to propagate the bioagent (including acquisition of agents, methodology, record keeping).
- **during** the implementation of the propagation process (including preparation of area, release methodology, records, equipment).
- **after** establishing the bioagents (including monitoring, record taking, reporting of results) and what decisions would need to be made before deciding to harvest and store them for a release program.

4 Provide a portfolio of pictures or video footage detailing your involvement in the propagation of the biocontrol agent (to be provided after the workshop or lecture).

Assessment for RTD3707A: Release biological agents

Aim: To apply the acquired knowledge about biocontrol programs to a real scenario.

1 Select two weed infestation sites (of the same or different weed species) that are known to you. One site should be where a biocontrol program could be used successfully and the other site should be one where it would seem to be an inappropriate form of weed management (either on its own or in combination with other management options).

2 Briefly outline the history of **both sites** with regard to their location, use and target weed infestation. Outline the reasons behind why the sites may or may not be appropriate for the selected biocontrol method.

3 For **both sites** construct a simple map of the weed infestation site and surrounding area showing important landmarks, waterways, buildings, fencelines etc.

4 For the **proposed biocontrol site**, construct a portfolio of steps that you would need to take:

- **before** implementing the biocontrol program (including acquisition of agents, methodology, record keeping).
- **during** the implementation of the biocontrol program (including site preparation, release methodology, records, equipment).
- **after** implementing the biocontrol program (including monitoring the area, record taking, reporting of results).

5 Provide a **portfolio of pictures or video footage** detailing your involvement in the establishment of the biocontrol agent (to be provided after the workshop or lecture).

Assessment for RTD3706A: Maintain biological cultures and RTD3707A: Release biological agents

Aim: To apply the acquired knowledge about biocontrol programs maintaining and releasing agents) to a real scenario.

1 Select three weed infestation sites (of the same or different weed species) that are known to you. One site should be where a biocontrol program could be used successfully and the other sites should be one where it would seem to be an inappropriate form of weed management (either on its own or in combination with other management options).

2 Briefly outline the history of **all sites** with regard to their location, use and target weed infestation. Outline the reasons behind why the sites may or may not be appropriate for the selected biocontrol method.

You must report on landholder cooperation, providing comments on the following;

a) willingness to implement integrated weed management principles

b) willingness to maintain weeds outside release the release area

c) willingness to allow future inspections.

3 Provide with your report a map of your local control area showing key infestations of the target weed. Highlight on the map future release sites of biocontrol agents.

4 Please submit the monitoring sheet you developed or amended during the course. Outline your intended monitoring program to cover:

- establishment and spread
- problems
- agent population with a view to harvest
- frequency of site inspections.

Topic & resource title	Type of resource
Biological control of weeds	Agnote (Northern Territory Dept. Primary Industries and Fisheries) www.dpif.nt.gov.au/dpif/pubcat
Biological control of weeds	Landcare Notes (Victorian Dept. Natural Resources and Environment) www.nre.vic.gov.au
Chapter 9. Classical biological control. (author D. Briese) In 'Australian Weed Management Systems'.	Text (published 2000) produced by Weeds CRC (editor Brian Sindel). www.weeds.crc.org.au
Chapter 10. Inundative biological control of weeds – the bioherbicide tactic. (authors C.F. McRae & B.A. Auld) In 'Australian Weed Management Systems'.	Text (published 2000) produced by Weeds CRC (editor Brian Sindel). www.weeds.crc.org.au
Biological control of weeds: a handbook for practitioners and students	Text by Harley, K.L.S. and Forno, I.W. (1992). Inkata Press, Melbourne and Sydney.
Weed Biocontrol: the theory and practical application of biological control of weeds	Interactive CD-ROM (video, images & text) produced by University of Qld, Qld Dept NRM, ACIAR & CSIRO. www.cbit.uq.edu.au/software/weedbiocontrol/
Improving the selection, testing and evaluation of weed biological control agents	Technical Series #7 by Weeds CRC www.weeds.crc.org.au
Biocontrol of weeds in Victoria A supplement to 'Under Control Pest Plant and Animal News' No. 27 2004.	Newsletter supplement (with information on 16 weed biocontrol programs) produced by Department of Primary Industries, Frankston, Victoria

Target weed and biocontrol agent information

Aquatic weeds

Salvinia *Salvinia molesta*

Biological control of salvinia	Agnote (Northern Territory Dept. Primary Industries and Fisheries) **www.dpif.nt.gov.au/dpif/pubcat**
Salvinia: Weed Management Guide	National Heritage Trust & Weeds CRC **www.weeds.crc.org.au**
Integrated Weed Management: salvinia	Factsheet casestudy **www.weeds.crc.org.au**

Alligator Weed *Alternanthera philoxeroides*

A community approach: alligator weed	Factsheet casestudy **www.weeds.crc.org.au**
Alligator weed: Weed Management Guide	National Heritage Trust & Weeds CRC **www.weeds.crc.org.au**

Woody weeds

Bellyache bush *Jatropha gossypiifolia*

Sustainable Rangeland Management	Brochure CSIRO entomology **www.ento.csiro.au**

Blackberry *Rubus fruiticosus* aggregate

Best practice management guide: blackberry	Weeds CRC publication **www.weeds.crc.org.au**
Blackberry rust	Landcare Notes (Victorian Dept. Natural Resources and Environment) **www.nre.vic.gov.au**
Blackberry: Weed Management Guide	National Heritage Trust & Weeds CRC **www.weeds.crc.org.au**
Blackberry management handbook	Booklet by E.Bruzzese & M.Lane (1996) (Keith Turnbull Research Institute, Department of Conservation and Natural Resources, Melbourne)

Bitou bush *Chrysanthemoides monilifera* ssp. *rotundata*

Leaf rolling moth	Brochure by CSIRO/NSW Ag/Weeds CRC **www.ento.csiro.au**
Best practice management guide: bitou bush	Weeds CRC publication **www.weeds.crc.org.au**
Bitou bush: Weed Management Guide	National Heritage Trust & Weeds CRC **www.weeds.crc.org.au**

Boneseed *Chrysanthemoides monilifera* ssp. *monilifera*	
Boneseed moth	Landcare Notes (Victorian Dept. Natural Resources and Environment) **www.nre.vic.gov.au**
Best practice management guide: boneseed	Weeds CRC publication **www.weeds.crc.org.au**
Boneseed: Weed Management Guide	National Heritage Trust & Weeds CRC **www.weeds.crc.org.au**
English broom *Cytisus scoparius*	
English broom beetle	Landcare Notes (Victorian Dept. Natural Resources and Environment) **www.nre.vic.gov.au**
English broom moth	Landcare Notes (Victorian Dept. Natural Resources and Environment) **www.nre.vic.gov.au**
English broom psyllid	Landcare Notes (Victorian Dept. Natural Resources and Environment) **www.nre.vic.gov.au**
Gorse *Ulex europaeus*	
Gorse spider mite	Landcare Notes (Victorian Dept. Natural Resources and Environment) **www.nre.vic.gov.au**
Gorse thrip	Landcare Notes (Victorian Dept. Natural Resources and Environment) **www.nre.vic.gov.au**
Gorse: Weed Management Guide	National Heritage Trust & Weeds CRC **www.weeds.crc.org.au**
Lantana *Lantana camara*	
Lantana: Weed Management Guide	National Heritage Trust & Weeds CRC **www.weeds.crc.org.au**
Mesquite *Prosopis* species	
Sustainable Rangeland Management	Brochure CSIRO entomology **www.ento.csiro.au**
Mequite: Weed Management Guide	National Heritage Trust & Weeds CRC **www.weeds.crc.org.au**

Mexican poppy *Argemone mexicana*	
Sustainable Rangeland Management	Brochure CSIRO entomology **www.ento.csiro.au**
Mimosa *Mimosa pigra*	
Biological control of Mimosa pigra	Agnote (Northern Territory Dept. Primary Industries and Fisheries) **www.dpif.nt.gov.au/dpif/pubcat**
Sustainable Rangeland Management	Brochure CSIRO entomology **www.ento.csiro.au**
Mimosa: Weed Management Guide	National Heritage Trust & Weeds CRC **www.weeds.crc.org.au**
Integrated Weed Management: mimosa	Factsheet casestudy **www.weeds.crc.org.au**
Noogoora burr *Xanthium occidentale*	
Noogoora burr	Agnote (Northern Territory Dept. Primary Industries and Fisheries) **www.dpif.nt.gov.au/dpif/pubcat**
Parkinsonia *Parkinsonia aculeata*	
Sustainable Rangeland Management	Brochure CSIRO entomology **www.ento.csiro.au**
Parthenium weed *Parthenium hysterophorus*	
Parthenium: Weed Management Guide	National Heritage Trust & Weeds CRC **www.weeds.crc.org.au**
Sida *Sida* spp.	
Biological control of sida	Agnote (Northern Territory Dept. Primary Industries and Fisheries) **www.dpif.nt.gov.au/dpif/pubcat**
Sustainable Rangeland Management	Brochure CSIRO entomology **www.ento.csiro.au**
Managing Calligraph beetles on sida	Agnote (Northern Territory Dept. Primary Industries and Fisheries) **www.dpif.nt.gov.au/dpif/pubcat**

St John's wort *Hypericum perforatum*	
St John's wort beetle	Landcare Notes (Victorian Dept. Natural Resources and Environment) **www.nre.vic.gov.au**
St John's wort mite	Landcare Notes (Victorian Dept. Natural Resources and Environment) **www.nre.vic.gov.au**
Best practice management guide: St John's wort	Weeds CRC publication **www.weeds.crc.org.au**
Integrated Weed Management: St John's wort	Factsheet casestudy **www.weeds.crc.org.au**

Broadleaf weeds

Dock *Rumex* spp.	
Release of biocontrol agents: dock	Factsheet casestudy **www.weeds.crc.org.au**
Dock moth	Farmnote (Ag WA)
Horehound *Marrubium vulgare*	
Biological control of horehound with the horehound clearwing moth	Landcare Notes (Victorian Dept. Natural Resources and Environment) **www.nre.vic.gov.au**
Biological control of horehound with the horehound plume moth	Landcare Notes (Victorian Dept. Natural Resources and Environment) **www.nre.vic.gov.au**
Best practice management guide: horehound	Weeds CRC publication **www.weeds.crc.org.au**

Paterson's curse *Echium plantagineum*	
Biological control of Paterson's curse with the flower feeding beetle	Landcare Notes (Victorian Dept. Natural Resources and Environment) **www.nre.vic.gov.au**
The Paterson's curse pollen beetle	CSIRO **www.ento.csiro.au**
Biological control of Paterson's curse with crown and root boring weevils.	Landcare Notes (Victorian Dept. Natural Resources and Environment) **www.nre.vic.gov.au**
The Paterson's curse crown weevil	CSIRO **www.ento.csiro.au**
The Paterson's curse root weevil	CSIRO **www.ento.csiro.au**
Biological control of Paterson's curse with the stem boring weevil	Landcare Notes (Victorian Dept. Natural Resources and Environment) **www.nre.vic.gov.au**
Biological control of Paterson's curse with the taproot flea beetle	Landcare Notes (Victorian Dept. Natural Resources and Environment) **www.nre.vic.gov.au**
The Paterson's curse flea beetle	CSIRO **www.ento.csiro.au**
A guide to managing nursery sites of the Paterson's curse crown and root weevils	NSW Agriculture, CSIRO entomology, Ag WA, DNRE (Vic)
Monitoring biocontrol agents: Paterson's curse	Factsheet casestudy **www.weeds.crc.org.au**
Release of biocontrol agents: Paterson's curse	Factsheet casestudy **www.weeds.crc.org.au**
Ragwort *Ambrosia artemisiifolia*	
Biological control of ragwort with the ragwort plume moth.	Landcare Notes (Victorian Dept. Natural Resources and Environment) **www.nre.vic.gov.au**
Thistles *Carduus* spp. *Onopordum* spp.	
Spear, variegated and nodding thistle suppression with the thistle receptacle weevil	Landcare Notes (Victorian Dept. Natural Resources and Environment) **www.nre.vic.gov.au**
Spear thistle suppression with the spear thistle gall fly	Landcare Notes (Victorian Dept. Natural Resources and Environment) **www.nre.vic.gov.au**

Creepers and trailing weeds

Bridal creeper *Asparagus asparagoides*

Biological control research	CSIRO **www.ento.csiro.au**
Biological control of bridal creeper with the bridal creeper leaf hopper	Landcare Notes (Victorian Dept. Natural Resources and Environment) **www.nre.vic.gov.au**
Biology of leaf hopper and rust fungus	CSIRO **www.ento.csiro.au**
Leaf hopper release procedure	CSIRO **www.ento.csiro.au**
Releasing the rust fungus	CSIRO **www.ento.csiro.au**
Experiment to determine how to infect bridal creeper with the bridal creeper rust fungus.	CSIRO/Weeds CRC **www.ento.csiro.au**
Best practice management guide: bridal creeper	Weeds CRC publication **www.weeds.crc.org.au**
Bridal creeper: Weed Management Guide	National Heritage Trust & Weeds CRC **www.weeds.crc.org.au**

Rubber vine *Cryptostegia grandiflora*

Rubber vine: Weed Management Guide	National Heritage Trust & Weeds CRC **www.weeds.crc.org.au**