Natural Heritage Trust

Helping Communities Helping Australia

An Australian Government Initiative

Introductory weed management manual

Australian Government

Department of the Environment and Heritage

CRC weed management

Introduction

This manual has been prepared as a training aid for the use of private landholders, conservation groups, catchment management groups, local, state and territory governments and industry. It is an introductory guide for those with little experience with weed management, particularly environmental weeds. It will be of use to those who wish to develop their weed management knowledge and skills, and as an extension resource for those who need to develop the weed management capacity of others. The manual is presented in four modules:

Module 1: *Developing and implementing a weed management plan*

Module 2: *Weed control methods for community groups*

Module 3: *Collecting and preparing plant specimens for identificatio*n

Module 4: *Presentation of information sessions to small groups*

This manual also compliments the weed management guide series prepared by the Weeds CRC for each of the species listed as *Weeds of National Significance* and the Department of the Environment and Heritage's *Alert List* for environmental weeds. These brochure-sized publications are available via the Australian Government's Natural Resource Management network or can be downloaded via the Australian Governments Biodiversity Publications web page at:

http://www.deh.gov.au/biodiversity/invasive/publications/index.html#weeds

or the Weeds CRC's website at:

http://www.weeds.crc.org.au

The information presented in this manual is general in nature so that a wide audience can appreciate the principles outlined. The reader is encouraged to use the knowledge and guidance available at local, regional and state levels from natural resource management agencies so that weed management activities can be adapted for local situations. It also needs to be appreciated that regulations relevant to weed control, for example those applying to the use of herbicides, vary over time and from place to place so it is essential to check with relevant agencies before embarking on weed control projects.

Relationship to National Competencies

The Rural Training Council of Australia has developed vocational training packages relevant to a number of industries in rural and regional areas. Nationally recognised qualifications can be attained by formal recognition of self-acquired skills and knowledge or 'Recognition of prior learning', as measured against national competencies outlined in the training packages. A package has been developed entitled 'Conservation and Land Management' (CLM) which incorporates units which outline competencies for weed management. For readers who may be interested, the relationship between this manual and CLM units is detailed in Appendix 1 to this introduction. Appendix 1 is provided to help readers appreciate which competencies outlined in the CLM training package relate to which module in the manual. Please note this manual does not necessarily satisfy the requirements of the CLM training package. Anyone wishing to make further enquires regarding training packages are encouraged to contact the RTCA at:

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Acknowledgement of permissions

Module 1 – Figure 3, *A Guide for the visual assessment of weed infestation as a percentage of ground cover* is reproduced with permission of NSW Agriculture and is derived from:

Bayley, D. 2001, *Efficient Weed Management*, NSW Agriculture, Paterson NSW.

Module 2 – Illustrations by Norman Yeend, whose drawings were based on originals by Virginia Bear; The website www.weedsbluemountain.org.au; and the free booklet weeds of Blue Mountain bushland, available from bushcare@bmcc.nsw.gov.au. Tables throughout the text summarising the advantages and disadvantages of various weed control methods reproduced with permission of Mr. Adam Muyt and are derived from:

Muyt, A. 2001 *Bush Invaders of South-East Australia: A guide to the identification and control of environmental weeds found in South-East Australia,* R.G & F.J.Richardson, Melbourne.

Module 3 – Derived from:

Storrie, A. 2003, *Collecting Specimens*, which can be seen at:

http://www.weeds.crc.org.au/weed_management/collecting_specimens.html

Module 4 – Developed with the Department for Employment, Training & Further Education, Torrens Valley TAFE, Adelaide.

Images

Cover images:

upper left: Victorian serrated tussock working group
lower left: Rosey Boehm
upper right: Peter Martin
lower right: Peter Matin
background: *Acacia karroo* Peter Martin

References:

Ainsworth, N. 2003, 'Herbicide use in riparian areas', *Proceedings of the first biennial weed conference, Developments in Weed Management*, Weed Society of Victoria Inc; Bendigo, pp. 46-9.

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Appendix 1: Relationship between modules in this manual and units contained in the Conservation & Land Management (CLM) training package

CLM Training Package unit number	Unit Name	Selected Unit Elements & Performance criteria (describes issues covered by the RTC unit)	Manual module which relates to the unit
RTC 1801A	**Prepare for work**	***1.Observe safe work practices*** 1.1 Protective clothing	Module 2
RTC 1701A	**Follow Basic safety rules**	***1. Follow workplace requirements and instructions concerning chemicals*** 1.2 Safety procedures involved with chemical handling are recognised and followed as required ***2. Recognise risks associated with chemicals*** 2.2 Chemical labels and symbols are recognised and hazards identified 2.5 Instructions for use of personal protective equipment and application equipment are identified and observed ***3. Follow chemical handling and storage rules*** 3.1 Chemical handling and storage instructions on labels are followed	Module 2 Module 2 Module 2
RTC 2016A	**Recognise Plants**	***1. Prepare plant for recognition.*** 1.1 Range of plants requiring recognition is identified according to supervisors/customers needs 1.2 Resources and equipment for use in recognition activity are located and identified 1.3 Available processes for plant recognition are identified, selected and prepared for use 2.2 Brief descriptions of plant habits, characteristics and significant features are recorded	Module 3

RTC 2401A	**Treat weeds**	***1. Prepare to treat weeds*** 1.2 Details of weed occurrence are recorded and reported to supervisor 1.3 Treatment methods are selected in consultation with the supervisor 1.5 OHS hazards are identified, risks assessed and reported to the supervisor ***2. Treat Weed*** 2.1 Suitable personal protective equipment is selected, used and maintained 2.2 Treatments are prepared according to supervisors instructions and manufacturers guidelines 2.3 Treatments are applied in such a way that non-target damage is minimised ***3. Carry out post treatment operations*** 3.3 Records are maintained according to enterprise guidelines	Modules 1 & 2 Module 2 in part Modules 1 & 2
RTC 3218A	**Undertake a site assessment**	***2. Collect and collate base information*** 2.3 Base plan is prepared of the site ***3. Prepare for site visit*** 3.1 OHS hazards associated with undertaking a site visit are assessed for potential risks and controls implemented accordingly 3.2 Location ownership and site boundaries are verified 3.4 Climate and weather conditions are ascertained from historical data 3.5 Where required, formal approval is sought to visit site ***4. Undertake site inspection*** 4.1 Site orientation is undertaken 4.2 Existing on-site and adjacent features that may impact upon the project objectives are identified and recorded ***5. Document information*** 5.1 Site survey information is documented in accordance with enterprise procedures	Module 1 Module 1 Module 1 Module 1

CLM Training Package unit number	Unit Name	Unit Element & Performance criteria (describes issues covered by the RTC unit)	Manual module which relates to the unit
RTC 3401A	**Control weeds**	***1. Assess weed infestation*** 1.1 Scope and size of the infestation is assessed 1.2 Pests and beneficial organisms are identified and reported or recorded in field notes 1.5 Professional advice is obtained as required according to enterprise guidelines ***2. Plan the implementation of control measures*** 2.1 Control measures suitable for the infestation are selected from the IPM strategy 2.4 Suitable safety equipment and personal protective equipment are selected used and maintained ***4. Monitor control methods*** 4.1 Control methods are monitored to identify side effects to other plants, animals or external environment 4.2 Effectiveness of control methods are assessed in reference to specified industry or enterprise standards 4.3 Adjustments to IPM control methods are implemented where necessary to meet enterprise specifications	Module 1 Module 2 Module 1

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Module 1

Developing and implementing a weed management plan

Module 1

Australian Government

Department of the Environment and Heritage

CRC Weed management

Natural Heritage Trust

Helping Communities Helping Australia

An Australian Government Initiative

Developing and implementing a weed management plan

Module 1

General Disclaimer

Australian Government

Department of the Environment and Heritage

CRC Weed management

Introduction

This module is intended as an introductory guide for anyone who has an interest in weed management but little previous experience or knowledge in weed management planning. It should be read in conjunction with other modules in this manual and used with information specific to the species and situation being addressed.

Why plan?

Good weed management is about good land management. It is not just about trying to eradicate this or that weed. Good weed management is about making the landscape resistant to invasion by weeds and thus preventing weeds from establishing. This is true whether you are dealing with weeds in natural environments (environmental weeds) or weeds that threaten agriculture (agricultural weeds). We need to think in terms of restoring natural ecosystems, or restoring the productivity of agricultural land and protecting sites that are weed free. This approach will, in the long run, reduce the damage done by weeds to our environment, and our economy, and will prevent weeds reinvading areas where time, money, sweat and tears have already been expended to control them.

Making landscapes resistant to weed invasion requires the planned integration of control techniques, or integrated weed management. This means using a variety of control methods in order to target vulnerable aspects of a weed, its lifecycle or its environment, in order to achieve more effective control.

As you may have gathered, weed management is a long-term exercise. ***Do not despair!*** With planning and regular weed work, done at the right time, you can have a real impact on weeds.

Developing a weed management plan is important because:

- By developing a plan you will find out important information that will increase your chances of success.
- A plan will help you identify the best time to control weeds and the best methods to use.
- A plan will help you to prioritise the use of the limited resources available to control weeds in the most effective manner.
- Following a plan will ensure that you monitor results, measure progress against objectives, adapt to changing conditions and be able to take advantage of any opportunities that occur.
- A plan will also be very useful to support funding applications and will also provide a basis to report progress to funding bodies.

Prevention is better than cure

As you go through the planning process and implement your plan imagine if the weeds were never there in the first place! It is far more cost effective to prevent weed problems than to cure them. The majority of Australia's weeds were deliberately introduced from overseas either as garden species or plants for agriculture. For tips on how to prevent weed problems visit www.weeds.crc.org.au

Developing the plan

Developing a weed management plan requires a little strategic thought. This means following some steps to make sure all relevant factors are considered when you develop and carry out the plan. It is also important, yet often overlooked, to allow time to review progress against objectives and explore ways to improve the effectiveness of your work. The environment we work in is not static and many factors may change from month to month, season to season or year to year that impact on the effectiveness of weed work.

Appreciate from the outset that your plan will probably need to change as you go along, but it is important that changes are made based on evidence gained whilst monitoring the results of the work carried out.

The following are suggested steps to develop your weed plan. These steps relate best to developing a plan for a bushland site, perhaps as part of an Natural Heritage Trust project or similar. Nonetheless many of the principles will apply to those looking to control weeds on their own property.

Step 1. Carry out a site assessment.

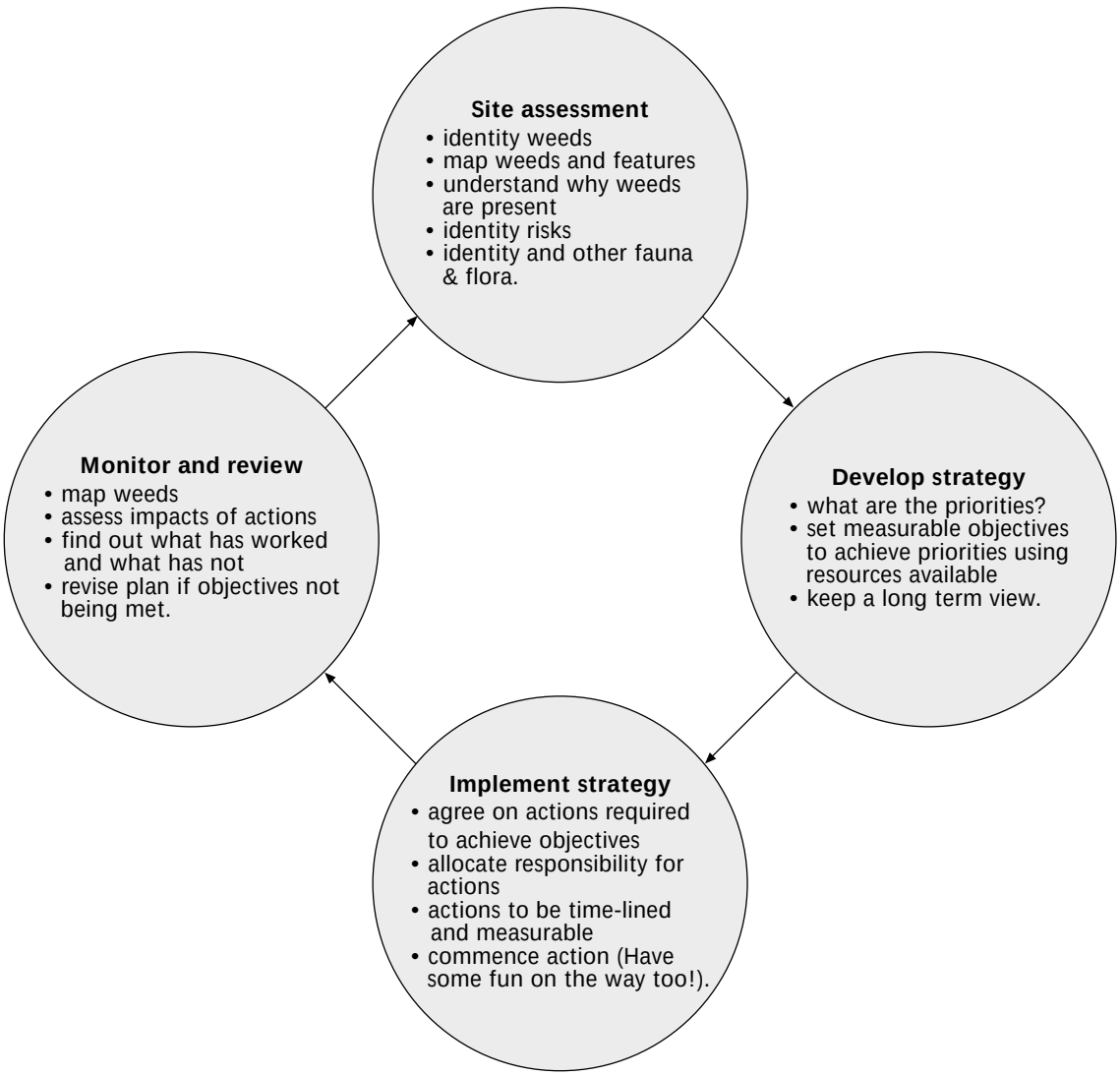
Step 2. Set objectives based on resources available and priorities.

Step 3. Develop and implement an action plan to achieve objectives.

Step 4. Monitor performance and change actions as necessary.

These steps need to be repeated over time. Weed management is an ongoing process of planning, doing, reviewing and replanning and doing and reviewing again and so on, as set out in the following figure.

Figure 1: Weed management cycle



Step 1: Site assessment

Many of the tasks in the planning process will be made easier if you can get assistance from appropriate experts. This may be a Landcare or Bushcare officer, a local council or shire Weed Control officer, a state or territory agency officer (from departments of environment, agriculture and the like), a local agronomist or a person with expertise in local plants and natural resource management. A list of state and territory departments who can help with weed control advice is included with this module (Appendix 1).

To carry out a site assessment an understanding of weeds, local plants and animals will be very useful. Do not underestimate the time needed to complete your site assessment. It will be time well spent as a comprehensive collection of relevant information in the early stages of your weed work will save considerable time down the track and help you to avoid a range of potential problems.

To simplify the task of conducting a site assessment it is suggested that it be broken down to the following tasks:

1. Preparation of a site information sheet.
2. Preparation of a weed management map.
3. Establishment of photo points.

Preparation of a site information sheet

To assist with the task of collecting information a format for a simple site information sheet is included as Appendix 2. This represents basic data only and you may wish to add information that you consider useful. Together with a weed management map and photo point images, the site information sheet allows you to record essential information. This will aid your weed management planning and weed work. It can also provide useful information to others who may be involved in planning at local, regional, state or national levels.

Before completing a site information sheet, take time to walk around and observe the site to gain an appreciation of what weeds, other vegetation and animals are present. Make notes on these and other aspects that you observe which may affect your work on the site. For example the presence of hazards (disused wells, dumps, feral bee hives etc.) or weeds on neighbouring properties. It may take a few visits over several months to get to know the site, especially if it is new to you. Plants will be much easier to identify when in flower, so time visits to coincide with the range of flowering times of known weeds in the area and in nearby areas. Check under tall trees where birds are likely to perch, each time you visit your site, for new bird-dispersed weeds.

Note that if isolated occurrences of weeds are encountered at this stage, and you are sure of their identity, then it may be worthwhile to remove or treat them immediately before they have a chance to spread and become harder to control. If at all unsure about the identity of a plant or how to treat it consult local authorities.

Please refer to the "Collecting and preparing plant specimens for identification" module of this manual if you need to send plant material away to get a positive identification.

As part of the site assessment it will be useful to collect a range of background information about the site including:

- establishing the location of the site using a map or GPS coordinates (see Appendix 3 '**Establishing your location**' later in this module)
- land ownership. If it is not you, ensure the landowner has given permission for access to the site and for the work, including weed mapping, to be undertaken. If it is public land obtain permission from the appropriate authority. Ensure you know where all the boundaries are located
- find out what regulations exist that will impact on your work. For example herbicide legislation, regulations regarding the use of fire, or laws protecting native vegetation
- find out who else uses the area and what other people have an interest or association with the site. Determine if they need to be made aware of the work that will be undertaken or encouraged to avoid certain areas.

- if possible find out how weeds invaded the area. The manner in which weeds came to be present on the site may be evident. For example from a neighbouring property, dumped garden waste, spread by recreational activity, established following ground works or spread along stream banks. Knowing how the weed got there will enable the cause to be addressed to prevent reinfestation from other areas
- fire history. For example history of fires over the last decade or two, their intensity and the area of the effected. Find out if the site is subject to periodic hazard reduction burning
- disturbance history in general. For example previous land use, floods, livestock grazing and so on
- safety risks. For example locations of wells, dumped metals, barbed wire, stinging insect nests, power lines, underground cables, cliffs, loose rocky slopes and so on. This knowledge will help people working on the site ensure their own safety. Make sure risks get included in a site map
- management issues such as site accessibility, location of gates and so on.

Preparation of a weed management map

A weed management map is more than a map of where weeds are on your site. It should also be a record of what other features are present that will impact on your planning.

Time spent mapping may seem non productive but the information provided will allow you to:

- accurately target your weed control activities
- budget costs and time required to implement controls
- monitor how well controls are working
- identify other important issues that will influence the restoration of the land that you are working with.

Mapping helps you keep the planning ahead of the doing. It will also allow you to communicate your progress with weed activities effectively with volunteers, contractors, funding bodies and other interested parties. Most importantly mapping can provide information that will allow you to review progress with weed management and help identify changes that can be made to adapt your management to changing conditions.

At a local level, and for the purposes of your own site assessment, it is not necessary to develop elaborate maps. The idea is to keep it as simple as possible, but to still produce a map or maps that are useful.

> *It will be important to plan your mapping activity to minimise disturbance and avoid trampling to protect desirable vegetation, especially in sensitive bushland.*

There is no need to map every weed species that occurs on your site. It is a matter of deciding what are the priority weeds to manage in light of the seriousness of the problems they represent and the resources available to do the work. See *Determining weed priorities* on page 10.

Keep things manageable and consider the nature of the weeds, size of the site, terrain, ease of access and how many helpers you will have and their mapping experience.

Drawing your map

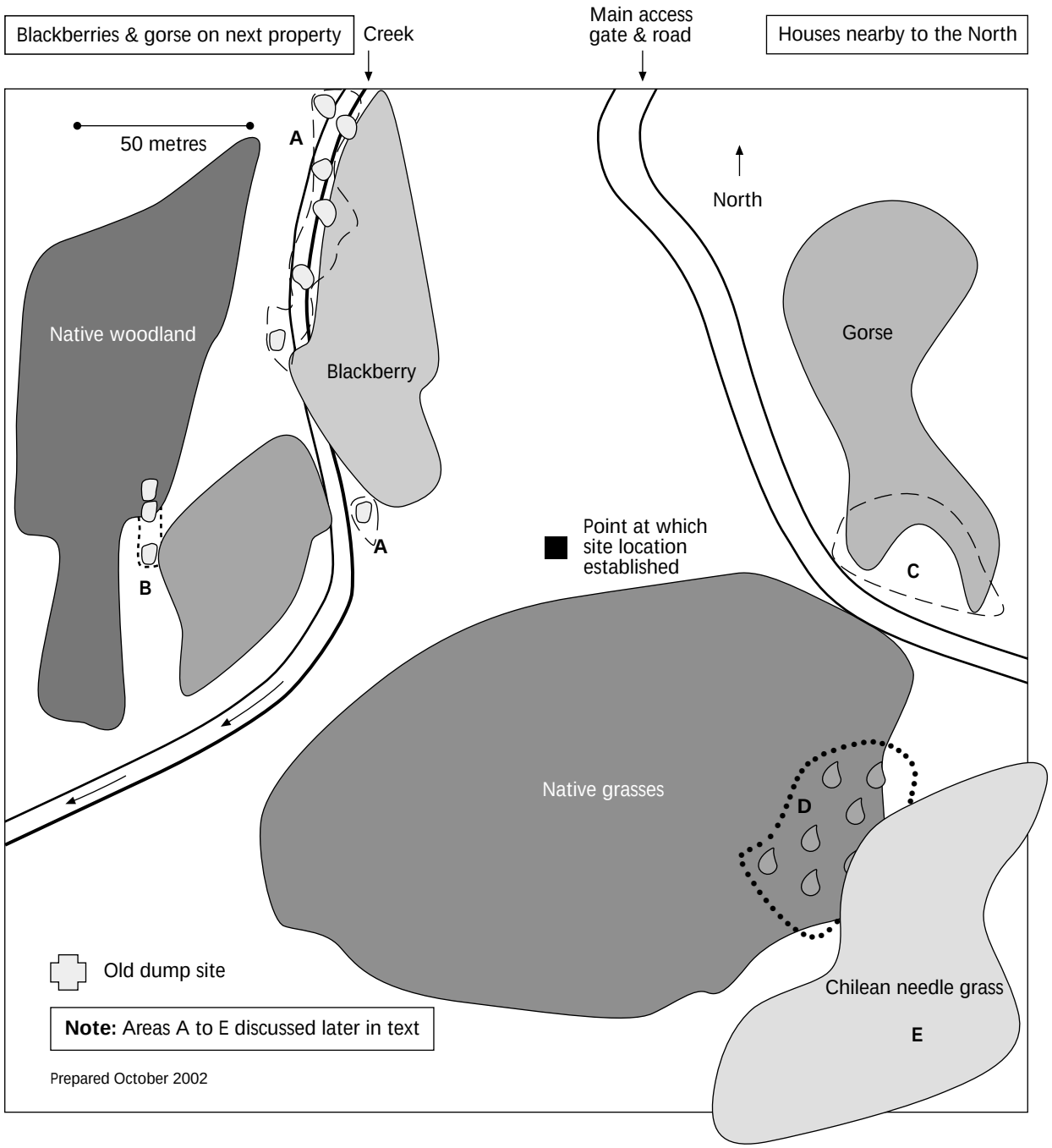
To assist you to prepare your weed map it may be helpful to obtain a large-scale topographic map. For example a 1;10,000 or 1:5,000, unless the area involved is large in which case 1:25,000 may be okay. An aerial photograph of the site can also provide an excellent format on which to base your map. Topographic maps and aerial photographs can be obtained from state or territory government departments or private suppliers. A list of state contacts for maps and aerial photography is included in Appendix 1. The idea, in either case, is to get an accurate representation of the site or property that you are dealing with over which you can overlay a clear transparency sheet upon which information can be recorded using colour markers. Make sure to use permanent, waterproof marker pens. Separate transparent overlays are useful when developing the map. You could use one overlay to indicate site features and another devoted solely to weed infestations. The use of different overlays can make each section of the map easier to interpret and will also help determine management options.

It is vital that you have correctly located your site on the map or aerial photo and double check that features on the ground agree with those on the map or photo (note that some features may have changed since the map or photo was created). If an appropriate topographic map or aerial photo is not available then the preparation of a hand drawn map can make quite an acceptable alternative although you will still need to:

- accurately locate the site on a smaller scale map (eg a 1:125,000 or 1:250000) or by using Global Positioning System equipment (GPS) see Appendix 3, *Establishing your location*
- estimate the scale that you have used, (how far does say 10mm on the map represent on the ground?) and record it on the map
- include key features of the site on the map so it can be correctly orientated in the future, and use a compass to establish a North arrow.

Figure 2 is an example of a simple sketch map incorporating basic information and using different shades to identify weed location and extent. When preparing your map you could use different colous for each weed species. Areas containing native vegetation and a possible danger (old dump) are also included to aid planning. The approximate scale for this map is 1:2000 so 25mm on the map represents 50 m on the ground.

Figure 2: Sketch map example



To help you accurately portray features on your map, you may find it useful to use graph paper or divide the sheet of paper you are using into even grids. Once you have established the approximate scale of the grid you can better represent the area of infestations, extent of native vegetation, the length of roads and so on. The Hawkesbury Nepean Catchment Management Trust utilise a grid system to estimate areas on maps, an example is included at Appendix 4. This system requires that you know the map scale. By photocopying the grid onto a transparency you can then overlay it on your map to calculate the area of each zone of infestation. It could also be useful to help you make your hand drawn map more accurate. Using this approach the following approximate information can be determined about the example site:

Total area	10.2ha
Area infested with Chilean needle grass	0.70ha
Area infested with gorse	0.44ha
Area infested with blackberry	0.67ha
Area of Native grassland	2.1ha
Area of Native woodland	0.71ha

It is important to keep a balance between trying to make an accurate map, the time needed to prepare it and the needs of the people who will use it. The goal is to have a map that is accurate enough to allow you to monitor your progress and so that others working on the site can find their way around and identify the locations of weeds and relevant features. In the case of the example site a simple hand drawn map is fine. If however you are involved in a larger situation that includes numerous infestations on many properties then more elaborate mapping may be required. In these more complex situations mapping may need to be carried out with appropriate local or state/territory authorities and/or private contractors.

Mapping your weeds

It is best to map your site a section at a time, mapping all the target weeds that occur in that section. This reduces the amount of walking needed over the area, minimising impacts, which is particularly important for bushland sites. If there are several people available you could provide each of them with a copy of the site or sketch map with clearly defined sections and allocate a section for them to map. Ensure that each site map is clearly labelled with the date and the section being mapped to avoid confusion later.

When to map

The weed species that you are mapping will determine the best time to map. Larger woody weeds, trees and shrubs that are easy to identify can be mapped at any time. For smaller shrubs, herbs and grasses that are more difficult to distinguish it may be easier to map when the weeds are in flower and easier to identify, or at other stages of their life cycle when they are distinctive. For example, it may be best to do pasture weeds in temperate regions in winter when winter annuals have germinated and pastures are short so species can be more easily seen.

As with all weed work consider prevailing weather conditions, safety of site access (e.g. roads not too wet and boggy) and so on before commencing work.

Surveying the site for weeds

Start at one edge of the site and walk across it at regular, parallel intervals. The intervals may be 10 to 50 m apart depending on the vegetation type and the visibility of the weed. A compass may be useful to help maintain direction of your crossing. If vegetation or other obstacles obstruct your mapping make observations from the best available position.

Weeds may occur in discrete clumps, in which case mark their location on the site or sketch map. Use known features on the map, and the map scale, to estimate their location. It might also be useful to provide written notes of where to find small infestations (even a single plant), for example a brief comment like '*go north past the dump for about 20 metres then look to the western side of river red gum*' will help others locate small occurrences. In Figure 2 isolated occurrences of blackberry and Chilean needle grass are marked. Where a species dominates it is more appropriate to mark the boundaries of the infestation and this is how most of the blackberry and Chilean needle grass, and all of the gorse is mapped on Figure 2.

Determining weed density

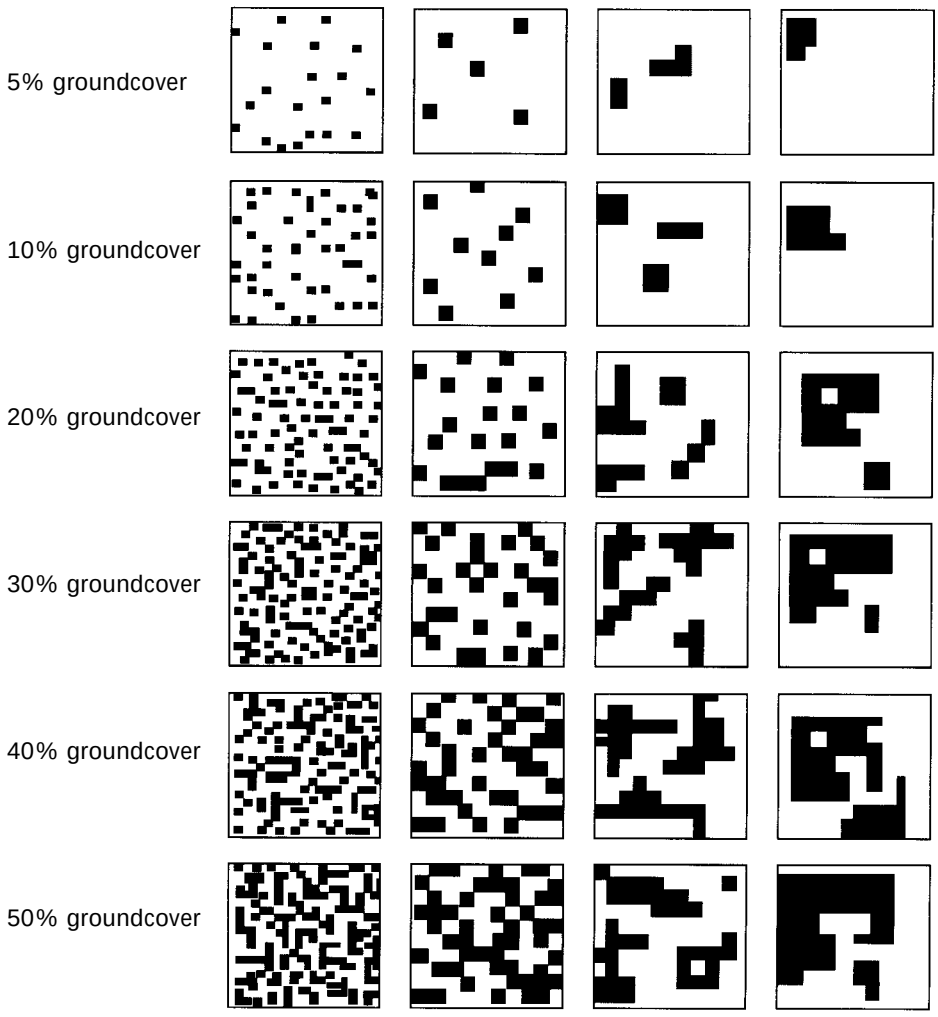
Knowing the density of weeds on your site can help you decide where to direct your weed control efforts and assess how well those controls have worked. Being able to measure weed density will allow you to set measurable objectives for weed control on your site.

By density we mean what proportion of the area of each infestation is covered by each weed species, this is usually expressed as a percentage of the area of infestation. There are a number of ways that weed density may be determined each with advantages and disadvantages. Much like weed mapping, weed density needs to be determined with sufficient accuracy to be useful, but without exhausting available resources. For the purposes of community based, local scale weed work a visual assessment of density will suffice. It should be noted that this will not produce results as accurate as scientific quadrat or transect sampling.

Visual assessment of density

Visual assessment is the simplest way to determine weed density. It is quick and easy and useful for smaller sites and most species, but can be subjective. To improve the accuracy of visual assessments please refer to Figure 3, which gives you an idea of how different weed densities, as a percentage of ground cover, may look. Note how dense a cover of 50% appears.

Figure 3: A guide for the visual assessment of weed infestation as a percentage of ground cover.



Bayley, D (2001) Efficient Weed Management. NSW Agriculture Paterson NSW.

Establishing photo points

Periodically take pictures of the site to indicate changes in vegetation over time. This will be useful to assess regeneration of the site as well as changes in weed populations. Photographs should be taken using clearly marked photo points.

Establishing photo points involves marking out reference points on the ground to obtain a photo of the same area over the seasons and years to determine changes in vegetation. Some tips for setting up and using photo points:

- mark location of each photo point. For example using a star dropper or a tin lid fixed securely into the ground, and note features to allow it to be relocated (mark location on your map)
- use a 'camera post', 1.4-1.6 m high, to rest camera on. This may be the location marker if you have used a star dropper, or similar, of appropriate height. Alternatively, use a post, such as a stake or star dropper, of the appropriate height placed on the location marker if it is on the ground (tin lid etc.). It is important that the height is the same for each photo
- place another marker 10 m in the direction of the photo area. Each time a photo is taken place a sighter pole (eg a star dropper) at this point and affix a label with sufficiently large writing on it that it will be clear in the resulting photo (keep the label to file with the photo). Note an identification number and date the photo was taken on the label so that there can be no confusion as to where and when the photo was taken
- if possible align photo direction North – South to avoid excessive sun or shadow
- if possible avoid steep terrain
- use a 50mm lens and the same camera and film type on each occasion
- take photos as frequently as necessary to reflect changes in vegetation but make sure you have photos taken at the same time each year to allow comparisons to be made
- establish enough photo points to get good sample coverage of your site, the vegetation on it and the particular weed species with which you are concerned.

Step 2: Setting your objectives

By analysing your weed map together with the information that you have collected on your site information sheet you can determine your weed priorities and develop objectives and actions to address them.

Determining weed priorities

The decision on what weeds are to be the highest priority to manage should be based on an assessment of the significance of the impact of each weed present on the site and the feasibility of their control. The following approach may help you to decide:

	Weed threat	
	Low	High
Feasibility of control		
Hard	Lowest Priority	2nd Priority
Easy	3rd Priority	1st Priority

Table 1: Determining weed management priorities

Whether a weed represents a low or high threat, is dependant upon a number factors that relate to its invasiveness and impacts, for example:

- its ability to establish amongst existing vegetation
- its competitiveness when established
- likelihood of long distance dispersal (eg by birds, stock, wind or water, on machinery etc.)
- extent of reduction in desired vegetation caused by the weed
- the change the weed causes to natural ecosystems
- potential losses to agriculture.

To make an informed decision you will need knowledge about the weeds that are present and the nature of the problems that they represent. Consult weed control agencies in your state or territory for assistance. A list of useful resources is included in Appendix 5 of this module.

Setting your objectives

Objectives are statements of intended outcomes that you want to achieve over a certain time and that can be measured. It can be useful to set objectives to be achieved in the near term, say 1–2 years and the medium or longer term up to 5 to 10 years or beyond.

Objectives should reflect your focus on what you are trying to protect or restore rather than weed management alone, for example:

- A near term objective for the example site in Figure 2 may be to protect the remnant native woodland and grassland from weed invasion. To achieve this priority weed species will need to be treated that occur within the native vegetation.
- Medium to long-term objectives may be to reduce the extent of gorse, blackberry and Chilean needle grass by 50 per cent, establish native species in the area treated and reduce the amount of time needed for ongoing control work by half.
- A long-term objective may be to completely restore the site with appropriate indigenous native vegetation and stop the site being a source of gorse, blackberry and Chilean needle grass spread downstream and onto neighbouring properties.

Objectives should be chosen that will bring satisfaction to those involved. Unachievable objectives will only produce exhaustion and disillusionment.

> *Weed management is important for the success of native vegetation regeneration or revegetation work but it is not the only factor. Consult with local experts to determine the best ways to encourage regeneration or improve the success of revegetation for your site.*

If the property is used for stock grazing, realistic objectives may relate to reduction in weed control costs, improved soil condition, improved productivity and other improvements that will occur as a consequence of weed management.

Management approaches

When determining your objectives also consider the main management approaches available, particularly eradication and containment.

Eradication of the weed in your area of concern whilst desirable may not be realistic. For a weed to be eradicated the following features need to apply:

- the weed occupies only a small area and will not reinvade from adjoining areas
- all of the infested area is known
- the weed is obvious and easy to find at low density
- the control method used kills all plants before maturity
- the weed seed does not remain dormant on the soil, or the infestation is detected before seeds are released
- if the plant has produced seeds they have not dispersed
- the available resources must enable initial treatment, regular surveys and control for the lifespan of the seed bank.

Weeds that are in the early stages of invasion may be candidates for eradication on your site. If this can be done ongoing vigilance will still be required to identify any new occurrences.

Containment of weed species to prevent and control new infestations is likely to be a more realistic management approach if you are dealing with widespread, well established species. Containment is a worthwhile exercise as it protects areas of good native vegetation, reduces new weed infestations and reduces the need for future control by limiting the extent and intensity of infestations.

The key to containment programs is to focus on treating isolated satellite infestations, rather than core infestations. The objective is to prevent weed populations extending beyond the perimeter of the core infestation.

Containment also involves the restoration of treated areas through regeneration of native vegetation or revegetation of the area where weeds have been removed. Preferably this is done with local provenance native plants (species that are native specifically to the area you are working in), pasture establishment or the establishment of other desirable species as suits the situation. The restoration of the site will limit opportunities for weeds to reinvade.

If you are working in a group discuss your weed priorities and management approaches together and try to reach consensus. If the entire group is involved in setting the objectives then all members are more likely to feel a sense of ownership for them and a desire to achieve them.

Keep in mind that some level of weed infestation is probably going to be a fact of life; the main objective will usually be to keep infestations to a level that the threat to the natural ecology of the site is reduced or productivity of the land is maintained at acceptable levels.

Step 3: Develop and implement the action plan

You need to decide actions, what will be done by whom and when so that you can work towards achieving the objectives that have been set. A simple action plan is included in this section, which records actions for the example site we have been looking at. The actions included in this plan were arrived at after consideration of the following principles of weed management.

1. Always work from the best areas to the worst
2. Minimise soil disturbance
3. If restoring natural bushland let native plant regeneration or revegetation establishment dictate the rate of weed removal.

Consideration was also given to drainage patterns on the site. It is best to "start at the top" as many weeds can spread by movement of their seed or other plant parts down watercourses and slopes. By starting at the top you reduce the risk of weeds reinfesting treated sites downstream or down slope. Of course if infestations exist on neighbouring properties a lot of weed work can be undone as a result of reinfestation by seeds or other propagules from weeds on neighbouring properties. This highlights the importance of engaging with those responsible for neighbouring properties in order that weed management can be coordinated.

Your action plan needs to be written with the following questions in mind.

- What weeds and what locations are the highest priorities?
- What resources are available?
- What management options will be most effective, minimise environmental damage and make the site more resilient to weed invasion?

In the example site it could be argued that Chilean needle grass should be the highest priority for management because it represents the highest threat. It is very invasive in native grasslands and develops a large soil seed bank. The National Strategy for Chilean needle grass describes it as the worst environmental weed of native grasslands in southeastern Australia. However, it is particularly hard to control. Herbicides alone will not control Chilean needle grass but early removal by digging out isolated plants can be very effective (Area D). Mowing of the established area (Area E) of Chilean needle grass, using a catcher, when flowers are present will reduce seed set. Chilean needle grass also produces seed in the base of its stem, which will still add to the soil seed bank. Note that the extent of the Chilean needle grass infestation extends beyond the site boundary and coordination with neighbouring properties would be highly desirable. Clippings must be burnt and the mower must be thoroughly cleaned before it is used anywhere else. See the Chilean needle grass management guide in the *Weeds of National Significance* series for more detailed information.

Blackberry and gorse are both invasive species that can threaten natural ecosystems. On the example site the blackberry may be a higher priority than gorse as it is starting to invade the native woodland and it is growing along the stream. Keep in mind that both the blackberry and the gorse may be providing habitat for native fauna. If so, their removal needs to be staged gradually to allow native vegetation to regenerate or revegetation to establish so that alternate habitat is available.

Having decided your priorities the most important decisions to be made are:

- select what control methods will be applied to each weed
- when and how often they will be applied
- who will do the work
- what monitoring needs to take place to measure the impacts of the methods used.

As well as keeping weed management principles in mind you will need to assess the resources that you have available.

Assessing your resources

People: This is the most important resource in any weed work. Whether it is yourself, your family or a community group undertaking a weed project, building skills and maintaining motivation of all involved is the key to long-term success. Think about the following 'people' aspects when developing your action plan:

- what skills and experience do people bring to the project? What training and advice is available to give people the skills they need? Allow time for this to occur
- if working with a group, be aware that individuals will have varying amounts of time to commit to the project and this needs to be accommodated
- make sure people are aware of safety issues and understand the risks associated with weed work, eg safe herbicide handling, use and clean up, avoiding insect and snake bite and sunburn (wear protective clothing), correct lifting procedures for heavy items, use of sharp tools etc. In the example map everyone working on the site would need to be aware of the old dump. Make sure that well equipped first aid kits are on hand and that people know how to use them
- ensure people know what they are expected to do on the site during each session and who to go to for help and advice
- assess if people need to be covered by insurance and if so ensure the policy covers appropriate risks
- avoid burnout. This is the biggest problem that groups and individuals encounter with weed projects. It is essential therefore that action plans set realistic tasks that can be carried out in a reasonable time and that plans are made to enjoy the process. Celebrate milestones, share experiences and pat each other on the back every now and then!

Finance: A financial plan should be prepared to budget funds available against the costs associated with implementing the plan. It is important to budget for the long term and allow for a sustained effort and ongoing follow up work. When dealing with well-established infestations it is preferable to use resources to contain the infestations and remove weed threats from the best native vegetation and carry out ongoing follow up. Do not spend all your resources in one season to attack major infestations leaving nothing for follow up. This will only create disturbance, encouraging reinfestation or new infestations by other weed species.

Many costs are self evident such as the purchase of chemicals if you are using herbicides, or the purchase or rental of machinery and equipment. Some costs may be less apparent. For example if you are going to use herbicide will you need to establish safe lockable storage in which to store chemicals? Will you need to buy protective clothing and safety equipment, a first aid kit and so on? Will dumping costs be involved if you are going to take weed material away for disposal? Will you need fencing to protect revegetation? If you are working with large areas of land, for example in a rangeland environment, will you need to purchase aerial photographs to help with mapping work? Will people involved with the plan need to attend training for which fees will be charged? Carefully think through all the likely costs that may be involved. To save costs it will be worthwhile checking what equipment and supplies are available for loan or at reduced cost through various groups, such as Landcare or Catchment groups that may operate in your area. If you are unfamiliar with developing a financial plan for weed management contact your local state or territory weed control contact for assistance.

Funding

There may be a number of sources of funding to assist with your weed management work. Over recent years the Australian Government's Natural Heritage Trust has been a major source of funding for many weed projects, directly and indirectly. Applications for funding need to demonstrate that a clear plan exists to meet objectives that are in line with those of the funding provider. Applications also need to show how success will be measured and progress monitored. By developing a weed plan, which includes clear objectives, budgeted actions to achieve the objectives and monitoring activities to evaluate progress, you will be well on the way to meeting a funding providers' need for information. Weed control contacts in your state or territory will be able to assist with more information on sources of funding.

Time: Allow enough. Learn from experience – the time taken to carry out tasks in the first instance will provide a guide for future planning. Be aware that seasonal changes will impact on your plan. Favourable conditions will not always be available to carry out control and wetter or drier years will impact on weed populations and factors such as site regeneration. These impacts need to recognised and schedules adjusted accordingly. Be sure to inform funding providers of changes to plans and why they are necessary.

Selecting control options

Each control method has its own advantages and disadvantages and these need to be considered in light of the situation on your site and the objectives that you have set. The module *Weed control methods for community groups* discusses the major methods used and highlights the advantages and disadvantages of each.

Integrated weed management

In many cases the most cost effective and sustainable way to control weeds is to combine or integrate a number of different control methods. Each method chosen needs to target weed species when they are most vulnerable. Knowledge of the life cycle of each species is essential to determine the timing of different treatments.

Table 2 is a simple example of a first year action plan based on the site in Figure 2.

Table 2: Example action plan. Year 1

Month	Blackberry	Gorse	Chilean needle grass	Location	Who
Site assessment, mapping and photo pont establishment completed in spring of the previous year					
JANUARY	Spray		Mow	A	
FEBRUARY	Spray		Mow	A	
MARCH					
APRIL	Cut & Paint			B	
MAY	Cut & Paint			B	
JUNE			Dig isolated plants	D	
JULY			Dig isolated plants	D	
AUGUST				C	
SEPTEMBER				C	
OCTOBER	Map & Take photos	Map & Take photos	Map & Take photos	All	
NOVEMBER	Spray		Mow	A	
DECEMBER	Spray		Mow	A	

Note: This calendar is a simple example only, actual methods used and timing of application will depend on local conditions, seek advice from appropriate authorities.

Blackberry treatments have been divided into two areas. Area A on the map, where the infestation is away from native vegetation, and Area B where isolated plants are occurring near or in native vegetation. Note that area A includes an isolated patch to the south of the main infestation. In this example spraying of blackberry has only been planned for infestations away from native vegetation. Because of the proximity of native vegetation considerable care will still be needed to avoid spray drift and off target damage. Also as the infestation is near a stream, as is often the case with blackberry, the herbicide used will need to be registered for use near waterways.

As herbicides are unlikely to completely kill blackberry in one application follow up is included in the plan. For area B cut and paint applications have been planned to minimise risk to native vegetation. This is a labour intensive method and blackberry plants, prickly as they are, are not the easiest to work with so protective clothing, heavy gloves and footwear will be required.

Each activity has been timed with the intention that the method used will be most effective relative to the weed's growth stage.

Step 4: Monitoring performance and making changes

Monitoring is often the most neglected area of weed management, yet it is a vital part of the weed management cycle. Monitoring allows you to identify how well control measures are working, the rate of spread of weeds or the establishment of desirable vegetation, new threats to native vegetation, and factors that have arisen that will effect your site restoration. As a result of gathering fresh information, through a monitoring process, your weed management plan can be altered as needed to improve results and respond to changes in the environment.

Monitoring involves mapping the site at regular intervals, taking photos at selected photo points and revisiting site information to check if any data that impacts on your management needs to be updated. Monitoring activity should focus on:

- changes in the extent of weed populations, ie is more or less area covered
- changes in the density of weed cover
- occurrences of other weed species
- unexpected impacts of weed control activity, eg off target damage, erosion or invasion by other species
- changes in the extent and condition of native vegetation or other desirable vegetation
- changes in any conditions which will impact on site restoration work.

Mapping needs to take place at a similar time to that when the original map was done to allow valid comparisons. By creating another site map and using the area grid mentioned previously (Appendix 4) and by making a fresh assessment of weed density you will be able to make useful comparisons between areas of native vegetation and weeds and what changes have occurred over time. Comparisons with photographs previously taken from photo points will also help you to identify changes. Whilst photographs can effectively portray change, the reasons for change may not always be evident in the images.

You will need to make observations about seasonal conditions or other factors that may be impacting on the results that you see. For example, if the season that has passed was particularly dry, weed populations may have declined due to water stress rather than weed work. Unexpected site disturbances such as fire and vehicle impacts also need to be considered when monitoring results and setting plans for the following season and beyond. Any of these or other events may result in you needing to revisit your priorities and change your action plans and possibly even your objectives.

Recording

By recording the information that you have gathered during the monitoring process on the map and a fresh site information sheet and by reviewing regular photographs taken at photo points you will be able build a picture of what is happening on the site over time. This will enable informed management decisions to be made. You are then in a good position to review your plan make the necessary changes and commence the cycle again. It might be a good time to have a celebration!

Appendix 1: Weed control contacts

State / Territory	Department	Phone	Email	Website
Australian Capital Territory	Environment ACT	Ph: (02) 6207 9777 Fax (02) 6207 2227	EnvironmentACT@act.gov.au	whttp://www.environment.act.gov.au/ie4/petsandlocalwildlife/pests.html
New South Wales	NSW Agriculture	Ph. 02 6391 3100 1800 680 244 Fax 02 6391 3336	weeds@agric.nsw.gov.au	http://www.agric.nsw.gov.au/weeds
Northern Territory	Dept. of Infrastructure, Planning and Environment	Ph. 08 89992020 Fax: 08 89992015	weedinfo.DIPE@nt.gov.au	http://www.nt.gov.au/
Queensland	Dept. of Natural Resources and Mines	Ph. 07 3375 0700 Fax: 07 3379 6815	enquiries@nrm.qld.gov.au	http://www.nrm.qld.gov.au/pests/index.html
South Australia	Dept. of Water, Land and Biodiversity Conservation	Ph. 08 8303 9500	apc@saugov.sa.gov.au	http://www.dwlbc.sa.gov.au/
Tasmania	Dept. of Primary Industries, Water and Environment	Ph. (cost of a local call) 1300 368 550	Quarantine.Enquiries@dpiwe.tas.gov.au Christian.Goninon@dpiwe.tas.gov.au	http://www.tas.gov.au/ OR http://www.dpiwe.tas.gov.au/inter.nsf/ThemeNodes/SSKA-52J2K4?open
Victoria	Dept. of Primary Industries	Ph. 03 9210 9379	ktri@dpi.vic.gov.au	http://www.dpi.vic.gov.au/
Western Australia	Dept. of Agriculture	Ph. 08 9368 3333	enquiries@agric.wa.gov.au	http://www.agric.wa.gov.au/progserv/plants/weeds/index.htm

Mapping/Aerial photography contacts

State / Territory	Department	Phone	Email	Website
Australian Capital Territory	Planning & Land Authority	Ph. 02 62071925	actpla.customer.services@act.gov.au	http://www.actpla.act.gov.au/actlic/mapping/index.htm
New South Wales	Land & Property Information	Ph. 02 92286666	feedback@lands.nsw.gov.au	http://www.lpi.nsw.gov.au/maps/
Northern Territory	Dept. of Infrastructure, Planning & Development	Ph. 08 89996636	mapsnt@nt.gov.au	http://www.lpe.nt.gov.au/airphoto/
Queensland	Natural Resources & Mines	Ph. 07 38963216	geoinfo@nrm.qld.gov.au	http://www.nrm.qld.gov.au/property/mapping/aerial_photography.html
South Australia	Dept. of Environment & heritage	Ph. 08 82264919	mapland@saugov.sa.gov.au	http://www.environment.sa.gov.au/mapland/aerial.html
Tasmania	Information & Land Services Division: TASMAP	Ph. 03 62337741	Maree.Holmes@dpiwe.tas.gov.au	http://www.dpiwe.tas.gov.au/inter.nsf/ThemeNodes/JGAY-548VJT?open
Victoria	Land Victoria Dept. of Sustainability and Environment	Ph. 136 186	customer.service@dse.vic.gov.au	http://www.land.vic.gov.au/
Western Australia	Dept. of Land Information	Ph. 08 92737555	sales@dli.wa.gov.au	http://www.dola.wa.gov.au/corporate.nsf/web/index.html

Appendix 2: Site assessment sheet

Site Name	**Date sit mapped: / /**	**Contact responsible for this information** Name: Tel: Email:	**Land owner/access contact details** Name: Tel: Email:

Site Location

Using map coordinates Easting _ _ _ _ _ _ Map title _____

Map scale (eg: 1:25,000 or 1:50,000) Zone _ _ Northing _ _ _ _ _ _ Year map published _ _ _ _

OR Sheet Number _ _ _ _ _ _

GPS Coordinates (use Datum WGS 84) S_ _ ^{0} _ _ . _ _ _ ' E _ _ _ ^{0} _ _._ _ _ '

Site area in hectares _ _ _ _ (ha)

Photo points marked on map Yes / No

Weed species mapped on site

Scientific name:	**Common name**	**Area infested (ha)**	**% Density of cover of infestation** (also note if species now absent)	**Treatments applied** **Method** **Date** **Cost** (if herbicides used note type & rate also note $ costs of treatment)		

Site information sheet cont. Comments (Date all comments)

Site management issues access comments/ risks on site, where are they? regulations that need to be followed	
Monitoring observations/seasonal impacts	
Stakeholders who are they? /relationship with site/contact notes	
Weed origins How did weeds get here (invasion from other properties, wind or water transport, garden waste, recreational vehicle use, soil disturbance etc.)	
Disturbances History of disturbance, fire, flood ground works, land use etc.	
Other comments	

Appendix 3: Establishing your location

The purpose of establishing your location is to enable you to communicate clearly to others where your site is. The valuable information you have collected can then be amalgamated with that from other sites to develop an overall picture of what is happening in your region, state or territory and for the entire nation. The idea is to record the location at or near the centre of your site.

The location of your site can be readily established in a couple of ways.

Using a map

Topographic maps are readily available from many sources, via state or territory government departments or private mapping suppliers, and are relatively inexpensive. Topographic maps show landforms, streams, dams, and the location of roads, railways, buildings and so on. These maps can be used to locate your site and provided that they are of a large enough scale, may also be useful to help you with your site mapping. At this point we are only concerned with using these maps to determine the location of your site. Map suppliers will be able to help you find a map that covers your area.

Map scales, what are they about:

Simply defined, map scale is the relationship between distance on the map and distance on the ground. Scales are normally expressed as ratios for example 1:10,000 or 1:100,000. A scale of 1:10,000 means that every millimetre on the map represents 10,000 millimetres (or 10 metres) in the real world, at 1:100,000 every millimetre on the map represents 100,000 millimetres (or 100 metres) in the real world.

With map scales bigger is smaller. A 1:5,000 scale map will show more detail and features will be much clearer and larger than a map with a 1:250,000 scale. But to represent the same area a 1:5000 map needs to be 50 times bigger than a 1:250,000 scale map.

When using a map to establish the location of your site use full Australian Map Grid (AMG) coordinates. A full grid reference will include a map *sheet* number, a *zone* number and "*Eastings*" and "*Northings*". This will ensure that your information is compatible with other mapping projects.

The map sheet number is simply the unique combination of numbers and letters, which identifies the map. It is normally located near the map title.

For mapping purposes the entire Australian continent has been divided up into zones of 6 degrees of longitude. The zone that applies to your map will be recorded under information entitled either 'Universal Grid Reference', 'Grid', 'Grid Zone Designation' or similar and will be a two digit number. The zones covering Australia range from 49 in the West to 56 in the East.

To quote Eastings and Northings the recommended method for weed mapping is the 'thirteen figure' method (also known as the '6–7' method), which produces an Easting reading of 6 digits, and a Northing reading of 7 digits.

What are Eastings and Northings?

Official maps employ a grid system, similar in concept to that used for street directories, but much more detailed. This allows coordinates to be used to accurately locate positions on the map. All points on the map can be referenced by their position within the grid squares created by the grid system. Maps are printed so that North is approximately at the top. Vertical lines on the map are numbered from West to East (i.e. from left to right) and these are called **EASTINGS** because positions on the map are determined by the extent that they are to the East (or to the right) of these lines.

Horizontal grid lines on the map are numbered from South to North (i.e from the bottom of the map sheet to the top) and are called **NORTHINGS** because positions on the map are determined by the extent that they are to the North of (or above) these lines.

When using Eastings and Northings to give a location on a map it is vital to remember that **EASTINGS** are always given before **NORTHINGS**.

Do not confuse the Eastings and Northings grid system (AMG) with lines of latitude and longitude that will also appear on the map. These are expressed in degrees, minutes and seconds for example S 38^0 50' and E140^0 10' 30", where the symbols ^{0} ,' , "denote degrees, minutes and seconds respectively.

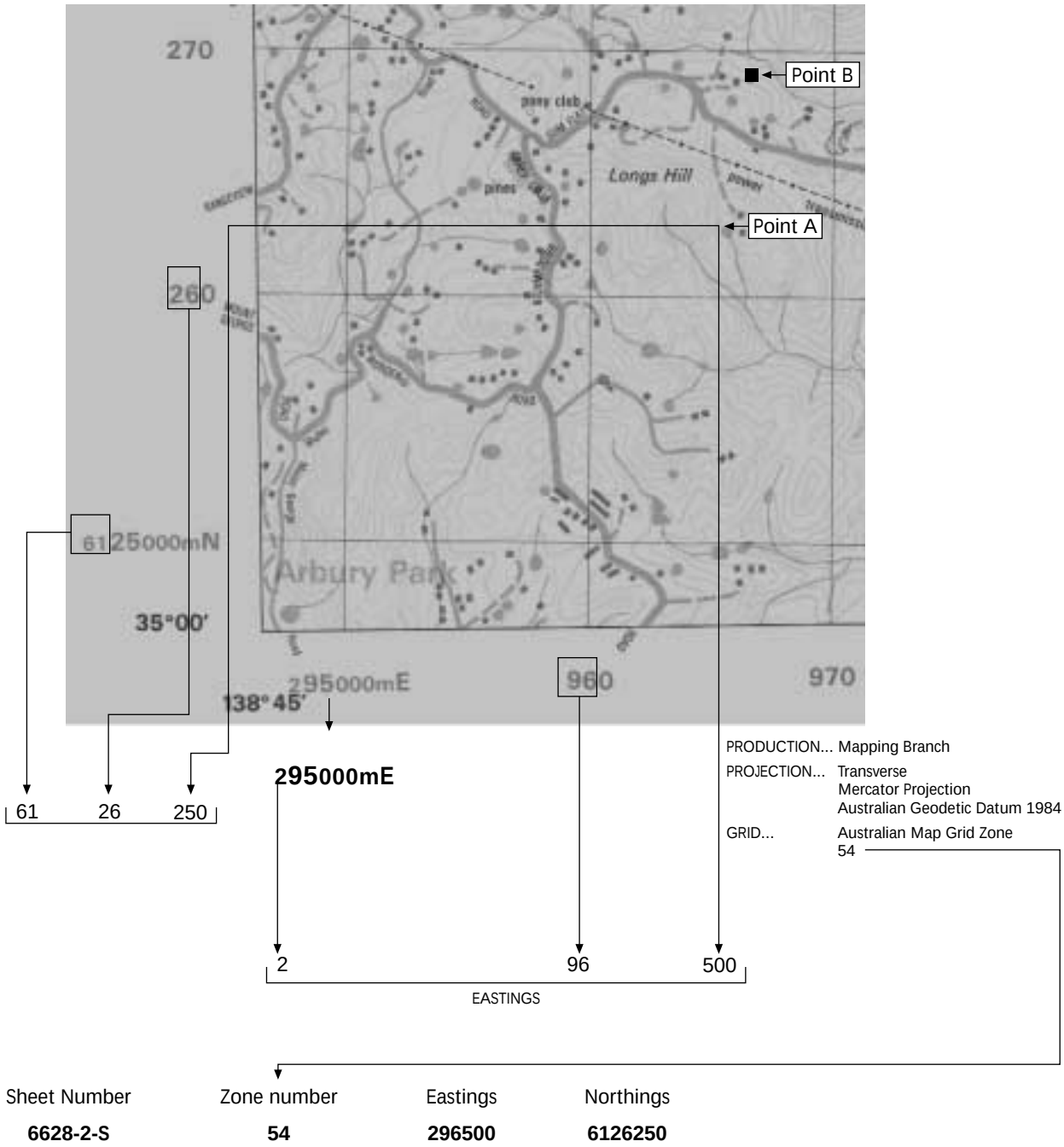
To demonstrate how full grid references are determined we will work through how the coordinates are obtained for Point A in the example map shown in Figure 2.

The map sheet number is 6628-2-S, and the zone number is 54. In this simple case the zone number is listed with "Grid" information, its location may vary a little between maps.

To start, calculate the **EASTING** by recording the small number (always 1 digit for Eastings) at the far left hand side of the bottom horizontal grid line in our example this is 2.

Next locate the first vertical line to the left of Point A. Record the first 2-digits of this number, in our example this is 96. Finally estimate the distance point A is to the East (or to the right) of the 96. On a map with a 1:25,000 scale, as in this case, the distance between grid lines is 1 kilometre. A is approximately half way between 96 and the next grid line 97 so it is about 500 metres from 96. We would then record the easting as 2 96 500.

Next calculate the Northing. Record the small number (always 2 digits for northings) at the bottom corner of the first vertical grid line. Our example shows 61. Next record the first 2 digits of the grid line immediately below Point A in our example this is 26. Then estimate how far Point A is to the North (or above) 26. It is approximately one quarter of the distance between 26 and 27 which equates to 250 metres. The Northing coordinate then is seven digits 61 26 250.



The full grid reference for Point A then is:

Sheet Number	Zone	Easting	Northing
6628_2_S	**54**	**296500**	**6126250**

Have a go at working out the coordinates for Point B on the example map.

The answer is

6628-2-S	*54*	*296600*	*6126850*

Using a GPS

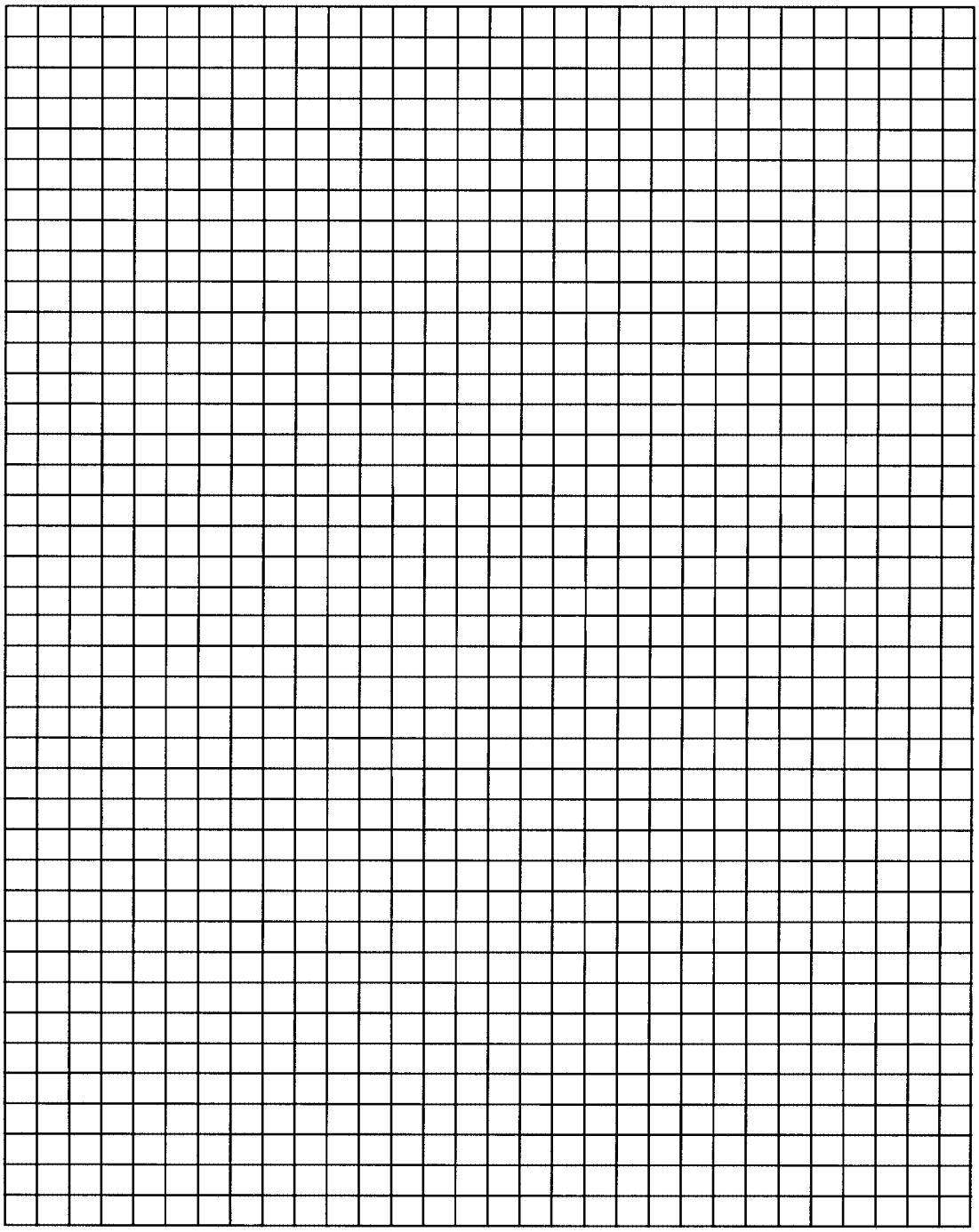
If you are able to access a Global Positioning System unit (GPS) this can make the task of locating your site easier. Certainly GPS units are relatively commonplace now and used in many walks of life. There are still a few things to make sure of to ensure that others can readily understand your information. Different setting options available on GPS units may mean that the way your information looks may vary from that given by a different unit at the same site. Most importantly ensure that the unit you use is set to the WGS 84 Datum that should be an option available under the units system or navigational set up menu. You can also select the way the GPS unit reads out the coordinates for example either by using Latitude and Longitude or by using Map Grids. For consistency use Map Grid readings.

When taking a GPS reading allow the unit a few minutes to settle on a reading before recording it.

Appendix 4: Grid sheet

Photocopy the attached grid onto an overhead transparency and overlay onto zones of your maps to calculate the area of each zone.

Scale	Area of one cell	Scale	Area of one cell	Scale	Area of one cell
1:100	0.25 m^2	1:800	16 m^2	1:5000	625 m^2
1:200	1 m^2	1:1000	25 m^2	1:10,000	2500 m^2
1:500	6.25 m^2	1:2000	100 m^2	1:25,000	15,625 m^2 or 1.56 ha



Appendix 5: Useful resources

Web links

	Web address
National	
Natural Heritage Trust	www.nht.gov.au
Weeds of National Significance	deh.gov.au/biodiversity/invasive/weeds/wons.html
Australian Government Dept. of the Environment & Heritage	www.deh.gov.au
Weeds Australia – National weeds Strategy	weeds.org.au
The CRC for Australian Weed management	weeds.crc.org.au
Council of Australian Weed Science Societies	http://home.vicnet.net.au/%7Eweedss
Weedbuster week	www.weedbusterweek.info.au
Australian Association of Bush Regenerators	www.zipworld.com.au/~aabr/
Weedeck national guides to weed identification	www.sainty.com.au
Landcare Australia	www.landcareaustralia.com.au
NSW	
New South Wales Agriculture	www.agric.nsw.gov.au/
Northcoast weeds advisory committee	www.northcoastweeds.org.au/
The Weed Society of New South Wales	http://nb.au.com/nswweedsoc/
Weeds of Blue Mountains bushland	www.weedsbluemountains.org.au/control.asp
Victoria	
Dept of Primary Industries	www.dpi.vic.gov.au
Dept of Sustainability and Environment	www.dse.vic.gov.au
Weeds Society of Victoria Inc.	http://home.vicnet.net.au/~weedsoc/
South Australia	
Dept. of Water, Land & Biodiversity Conservation	www.dwlbc.sa.gov.au
Trees for life	www.treesforlife.org.au
Tasmania	
Dept. of Primary Industries, Water & Environment	www.dpiwe.tas.gov.au
Tasmanian Weeds Society Inc.	www.tasweeds.org
Tamar Valley Weeds Strategy	www.weeds.asn.au
Western Australia	
Dept. of Agriculture	www.agric.wa.gov.au
Environmental weeds action network (EWAN)	http://members.iinet.net.au/%7Eewan
Plant Protection Society of Western Australia	http://members.iinet.net.au/~weeds/
Northern Territory	
Dept. of Infrastructure, Planning & Environment	www.nt.gov.au
ACT	
Environment ACT	www.environment.act.gov.au

Further reading

Weed management

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J.M.Parsons.
Inkata Press. 1995.

Australian Weed Management Systems.
B. Sindel.
F.G and F.J.Richardson publications. 2000.

Efficient Weed Management: Protecting your investment in the land
D. Bayley
Natural Heritage Trust and NSW Agriculture 2001

Gardener's Companion to WEEDS
S. Ermert and L. Clapp
Louise Egerton 2001

Noxious and Environmental Weed Control Handbook.
R Ensbey.
NSW Agriculture publication. 2001.

Precision Weed Management in Crops and Pastures.
R.W.Medd and J.E. Pratley.
CRC for Weed Management. Uni. South Australia. 1998.

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NSW Agriculture publication. 2002.

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A. Storrie.
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C.L.Mullen, J.J.Dellow and C.J.Tonkin.
NSW Agriculture publication. 2002.

Weed Navigator: Resource guide
Kate Blood, Ursula Taylor, Toni Nugent and Susan Timmins
CRC for Weed Management Systems. 1998

Crop and Pasture Weeds

Crop Weeds in Northern Australia.
B. Wilson, D. Hauton, and N. Duff.
Dept. of Primary Industries Queensland publication. 1995.

Crop Weeds.
J.L.Wilding, A.G.Barnett and R.L.Amor.
R.G and F.J.Richardson Publications. 1993.

More Crop Weeds.
M.R.Moerkerk and A.G.Barnett.
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D.Henry, T.Hall, D.Jordon, J.Milson, C.Schefe and R.Selcock.
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Natural Heritage Trust

Helping Communities Helping Australia

An Australian Government Initiative

Weed control methods for community groups

Module 2

Module 2

Australian Government

Department of the Environment and Heritage

CRC Weed management

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Introduction

This module is an introductory guide for community group members and other individuals who have an interest in weed management but little previous experience or knowledge in weed control techniques. It should be read in conjunction with other modules in this manual and used together with information specific to the species and situation being confronted.

Why can weeds be hard to control?

The vast majority of plants that have become weeds have been introduced deliberately from overseas for agricultural, horticultural or ornamental reasons. Plants that become a problem, either to the natural environment or to agriculture, often do so because they have characteristics that enable them to colonise areas quickly, for example:

- the capacity to reproduce prolifically, either from seed or plant fragments
- seeds that can endure prolonged dormancy
- many dispersal mechanisms, including human activity
- fast growth rates enabling them to out-compete slower growing species
- introduced species are often free of the predators and diseases which keep their population in check in their countries of origin.

These factors make weeds difficult to manage.

Integrated weed management

Effective long-term weed management, where both effort and expense reduce over time, will generally only be achieved by the planned use of a number of appropriate methods in conjunction with other land management practices, such as revegetation. It is the bringing of various weed control and land management methods together that is often referred to as *integrated weed management* (IWM).

The aim is to incorporate methods which are cost effective, practical and which will help reduce reliance on herbicides. The methods used should reinforce each other with the ultimate goal of achieving long-term weed control without damaging the environment. Successful implementation of integrated weed management requires long term planning based on knowledge of the weeds life cycle, control methods and the environment (eg soil, climate, other vegetation). Plans also need to include regular monitoring to evaluate progress and allow actions to be adapted to changing conditions (see Module 1 *Developing and implementing a weed management plan*).

A common example of IWM is the use of fire or slashing to destroy large vigorous weeds, followed by herbicide applications to control seedlings. This is then followed by hand removal of plants before they can re-seed. This may be complemented with either regeneration or revegetation with desirable species. An IWM approach generally means that less herbicide is needed and less follow up time required than if just one method of control was applied.

This module presents many of the methods used to control various weeds, especially environmental weeds.

In particular the following control categories are discussed:

- herbicides
- hand control
- mechanical
- cultivation
- mulching and smothering
- competition
- use of fire
- biological control
- grazing.

Discussion on each method concludes with a summary table of it's advantages and disadvantages to help you make better control decisions. When used in conjunction with weed management guides, for example the Natural Heritage Trust series covering the *Weeds of National Significance* and the *Alert List* for environmental weeds, and local expertise this module can help you achieve your weed management objectives.

Prevention

The best, and most cost effective, means of weed control is prevention by detecting the presence of weeds early and treating them before they spread. However, in a bushland situation it is particularly important to ensure the plant is properly identified before it is removed.

Timing

Whilst reading this manual keep in mind that, irrespective of the methods used to control weeds, correct timing of control is crucial to success. An understanding of each weed's growth cycle and the impact that the particular method used will have are important considerations when planning control activity. The best results are achieved when the weed is at its most vulnerable stage for the method being used. Correct timing will improve results and reduce future effort and cost.

The importance of local advice

Situations vary from location to location and different jurisdictions have different regulations concerning weed control. In all cases it is important to check with local weed control authorities to determine what are the appropriate and approved methods (see Appendix 1 'Weed control contacts table').

Herbicides

Herbicides are chemicals that are applied to kill plants.

Herbicides are often a very useful tool in the management of weeds. However, herbicides are poisons and the risks associated with herbicide preparation, use, handling and storage need to be understood. Proper procedures must be followed to ensure the safety of users and other people, and to minimise risks to the broader environment. The use of herbicides is controlled by legislation in each state and territory and specific regulations apply. These are detailed on the registered label of each herbicide container. In special circumstances specific permits are issued for the use of herbicides in situations other than that specified by the label.

The aim of herbicide application is to get the right herbicide at the right dose, applied using the right method, at the right time and delivered by the right operator in an economical and safe way with minimal impacts on the environment.

This discussion on herbicide use is not intended for agricultural or commercial operations although many of the points will still apply. Recommendations made do not replace or supersede information on herbicide product labels or other regulations.

The right herbicide at the right dose

The way in which herbicide is applied and the dose used are as important to the success of control as the selection of the herbicide itself.

As each state and territory has its own legislation with respect to herbicides, the types of herbicide registered for use on a given species, the rates of application and even the method of application permitted may vary between state and territories and over time.

The label attached to all herbicide containers sold in Australia contains important information to help you select the correct product and apply it properly. You have a legal obligation to read and follow instructions given on the label. Label information includes:

- species on which the herbicide is registered for use
- key safety advice
- recommended protective equipment required when handling the herbicide
- application rates
- accidental spill and disposal instructions.

READ AND HEED THE LABEL!

For up-to-date information on herbicides contact your state or territory weed management agency or local shire or council. State and territory contact details are listed in Appendix 1 together with details for the Australian Pesticides and Veterinary Medicines Authority, which hosts the PUBCRIS database. This database contains information on all herbicides that are registered for use on weeds in each Australian state and territory.

Choosing the right herbicide application method

Herbicides may be applied in many different ways including foliar spray, stem injection, cut stump, drill-and-fill, frilling (or chipping), basal bark, scrape-and-paint and granular soil applications. Your decision on what application method to use needs to be made after considering:

- the weed to be treated
- label instructions
- all the risks involved

- the resources available to do the work, including follow-up
- your weed management objectives.

Foliar spraying

Foliar spraying is the application of herbicides, usually diluted with water or possibly diesel, at a specific rate using spray equipment onto the foliage of plants (until every leaf is wetted, but not dripping). Spray equipment may vary from a simple garden sprayer or a backpack sprayer to boom sprays operated from vehicles, including aircraft. All other options should be considered before using foliar spraying, particularly in bushland applications, because of the increased potential for off-target damage (see below).

Minimising off-target damage

When herbicides are used there is always some potential to damage plants and animals other than those that you wish to control, resulting in 'off-target damage'. The potential for off-target damage depends on the herbicide used, soil type and landform, weather, application method used and the skill of the operator. To minimise off-target damage consider the following:

- Only use spray application of herbicides if this is clearly the best option. Consider other methods such as stem injection, cut and swab and basal bark applications.
- If spraying is the best option
  - minimise spray drift (see separate section)
  - if practical use 'hoods' on spray equipment to focus spray
- Select a herbicide and application rate that is most effective at controlling the weed with the least damage to desirable plants, humans and the broader environment. Note that in some instances it may be appropriate to use higher rates (within label regulations) if this means that follow up spraying can be reduced and therefore herbicide use is actually reduced over the longer-term.
- Develop a plan for storing, mixing, transporting, handling of spills and disposing of unused herbicides and containers **before** you purchase herbicides. Make sure all who will be involved in herbicide use know the plan and agree to follow it.
- Ensure equipment is well maintained and leak free. Do not place herbicide concentrate or mixture in unlabeled containers, or containers from which it can be easily spilt.
- The person applying herbicide needs a good understanding of safe spraying techniques and limiting off target damage.
- Establish a mixing area on a site which has easy access, is flat, has no desirable species present, is not subject to erosion or run off and is rarely visited by the public.
- Use a dye to minimise missed areas and avoid over-spraying. This is also useful for other herbicide methods. Dyes, normally made from vegetable matter, allow you to see where you have sprayed and help to detect over-spraying.
- Always spray at the best possible time, when the plant is most susceptible to the herbicide used (usually when it is at its most vigorous growth stage) and when climatic conditions are most suitable (low wind, appropriate humidity and no rain expected). This will improve results and reduce the amount of herbicide that needs to be used in the future.
- Regular monitoring of treated areas is important to identify the effectiveness of the method and check for off-target damage. If impacts on target species are not as expected, or if off-target impacts are occurring, reconsider the use of spraying, equipment used, spraying technique, type of herbicide used and operator training to determine what needs to be changed to avoid future problems.
- Always follow up weed control work. If treatments are not followed up with further control of overlooked or surviving plants the initial treatment will have been wasted.

Preventing spray drift

When using foliar spraying as an application method you need to be acutely aware of the risk of spray drift. When spraying you have an obligation to prevent the drift of herbicide onto desirable vegetation and beyond the boundaries of the site or property that you are working on.

Some general guidelines to avoid spray drift are:

- Identify where desirable vegetation is located and areas at risk of off-target damage on neighbouring properties. Avoid spraying when wind will blow spray towards these. Maintain a buffer distance from these areas.
- Spray only in suitable weather conditions. Milder temperatures and higher humidity are best. The higher humidity of tropical areas may allow spraying at higher temperatures than in temperate regions but consult with local, state or territory agencies to find out the best conditions for your situation. Consistent light winds are preferable (5–15kph), blowing away from areas at risk.
- Avoid spraying during
  - very calm conditions, as spray may travel in any direction, including toward sensitive areas
  - strong winds (greater than 15kph)
  - changing weather conditions
- Stop if conditions change whilst spraying.
- Select the least volatile herbicides (i.e. least likely to become a vapour). Seek expert advice if unsure.
- Notify neighbours of your spraying intentions.
- Minimise spray release height.
- Set equipment to produce the largest droplets which still give adequate spray cover.

Spraying and herbicide use in water catchments

The use of herbicides and herbicide additives near waterways, or in situations where herbicides may eventually enter waterways, requires very careful consideration and special care. If at all possible it is best to avoid herbicide use in these situations because of the potential risk to aquatic life and other users of water. If herbicides are to be used they must be registered for use near waterways or in aquatic situations and label instructions need to be strictly adhered to. Special permits may be required from state or territory environmental protection authorities to use herbicides near or on waterways.

Here are some tips on how you may reduce environmental risks associated with herbicide use near waterways:

- High volume foliar spray applications increase chances of direct or indirect contamination of waterways. Consider alternatives such as knapsack spraying, basal bark application, wick wiping or cut-stump/stem injection to reduce contamination risks.
- It is better to treat riparian weed infestations (situated near a waterway or water body) progressively rather than in one large-scale operation. This will reduce the risks of stream bank destabilisation and habitat loss. A progressive process will allow native vegetation to regenerate or revegetation to become established. Of course, as with all weed work, ongoing follow-up and vigilance will be required.
- Select herbicides that have the lowest tendency to leach, are persistent in the environment for the shortest time and have the lowest toxicity that will still be effective against the target weed. Talk to weed control contacts in your state or territory for advice.
- Mixing of chemicals and cleaning of equipment should be done well away from waterways in situations from which run-off will not directly enter waterways.
- Avoid spraying weeds that overhang waterways.
- Wherever possible direct spray away from waterways.
- Move upstream when spraying rather than downstream to aid dilution of any contamination and to avoid creating a ‘slug’ of herbicide entering the waterway.
- If land near waterways is cultivated run furrows across the slope to minimise run off. Establishment of a grass buffer strip between cultivated land and a waterway is also useful to intercept run off.
- Only spray when rain is not expected for some days.
- Keep records of spraying activity.

Check with local authorities to find out what regulations apply in your area for the application of herbicides near waterways.

Water used to mix with herbicides

The quality of the water you use to mix with herbicides can affect your results. Always use clean, good quality water. Dirty water contains particles that can absorb active ingredients and reduce the effectiveness of herbicide. Dirty water may also lead to blocked and damaged spray equipment.

Hard water, which contains high concentrations of calcium and magnesium, and water that is either too alkaline or acidic, can reduce herbicide performance. When the only available water is too hard, alkaline or acidic, additives can be obtained which overcome these problems.

Basal bark spraying

This method involves mixing an oil-soluble herbicide in diesel and spraying the full circumference of the trunk or stem. Basal bark spraying is often used to treat thinly barked woody weeds and undesirable trees. It is an effective way to treat saplings, regrowth and multi-stemmed shrubs and trees.

This method works by allowing the herbicide to enter the weed's underground storage organs, slowly killing it.

The stem or trunk needs to be reasonably free of mud or dust and should be fairly dry. It should be sprayed or painted with herbicide solution from ground level. The height to be covered varies with the species and maturity of the plant being treated. Check with local authorities for recommended coverage.

Basal bark spraying is a useful method in difficult terrain and usually works well, provided bark is not too thick for the solution to penetrate.

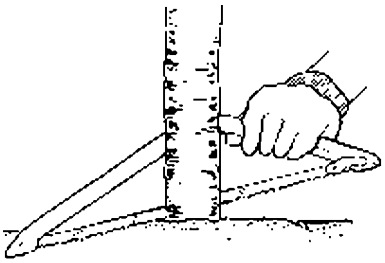
Basal bark spraying of mesquite. Lower stems are sprayed from ground level up to a height of 750 mm.
Photo: Rachele Osmond

Cut and paint, cut and swab, cut and daub and cut and spray

All of these names describe similar methods to apply herbicides directly to plants and are particularly useful for woody weeds.

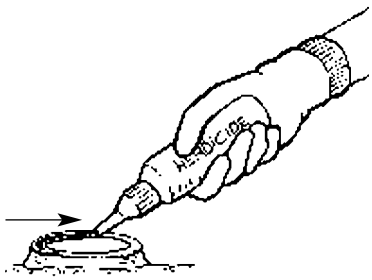
To use these methods clear the area around the base of the stem, then cut the stem horizontally as close to the ground as possible, using secateurs, loppers, bush saw or chain saw. It is important that the cut is horizontal to avoid run off of herbicide, and sharp angled cuts may also present an injury risk. Herbicide is then applied as soon as possible (preferably within 10 seconds) to the exposed surface before the plant's cells close up and inhibit the entry of the herbicide. On larger stems focus herbicide application on the sap wood and not the heartwood, as herbicide will not be translocated through the stump by the heartwood and will be wasted. It is easiest to have two people for this process, one to cut and one ready to apply the herbicide as soon as possible. This approach, though reliable, does not always provide a 100 % kill rate, and ongoing follow up and monitoring of treated plants will be required.

Step 1



Cut stem horizontally

Step 2



Herbicide only applied to sapwood

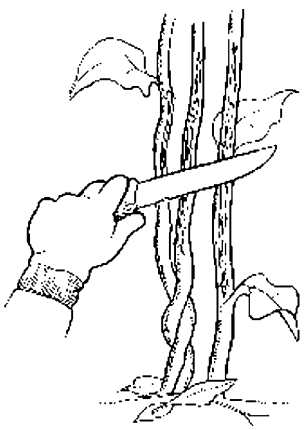
A variation to the cut and swab method, in this case cut and spray, with a chain saw being a handy tool to use on a tough prickly acacia bush (Acacia nilotica). Herbicide is best applied within 10 seconds after cutting. Prickly acacia field day, northwestern Qld.
Photo: Nathan March

Scrape and paint

This method is useful on vines and scrambling plants with a woody stem. Use a knife and, starting from the base, scrape 20 mm to 1 m of the stem to expose the sapwood and apply herbicide to the scraped area within 10 seconds. Do not ringbark the stem. Scrape about one third of the stem diameter. Larger stems (>10 mm) can be scraped on two sides.

Vine "curtains" can be cut at chest level, then again at about 300 mm above the ground. Scrape or cut and paint these lower stems, or spray new growth. Pulling vines out of trees may cause a lot of damage to tree foliage or bark. It may be better to leave the vine to die in the tree after treatment.

As with all herbicide methods avoid using cut and swab or scrape and paint and similar methods if rain is expected. Herbicide labels have information on the amount of time needed after application before rain for the chemical to still be effective.



Stem scrape

Stem injection

There are a variety of methods in this category. The aim is to get herbicide into the sapwood tissue (cambium layer) of woody weeds and weed trees so that it will be transported throughout the plant. These methods target individual plants and the risk of off-target damage is diminished (provided accidental spillages do not occur).

Use a cordless drill or a brace and bit to drill holes into the base of the plant. Holes should be drilled at an angle of 45^{o} and be made no more than 50 mm apart right around the trunk. This angle will aid herbicide retention in the hole, increasing absorption by the plant and reducing the risk of spillage. Herbicide must be injected in the holes within 10 seconds of the hole being made. Again it will be easiest to have two people on hand for this task, one to drill and one to fill with herbicide. Be careful not to overfill the holes as excess herbicide running out of the hole is wasted and will contaminate the environment. Injection guns enable you to deliver a precise amount of herbicide to each hole. A squeeze bottle with a firmly fixed tube to dispense herbicide or veterinary syringes may also be useful.

An alternative method, if a drill or injection gun is not available, is to use a chisel or tomahawk to make angled cuts into the sapwood around the base of the stem/trunk (chipping or sometimes referred to as frilling). These cuts are then filled with herbicide immediately. It is important not to ringbark the plant as this may kill vegetation above the ringbark but will prevent transportation of the herbicide through the plant's entire system and allow trees to resprout below ringbark lines.

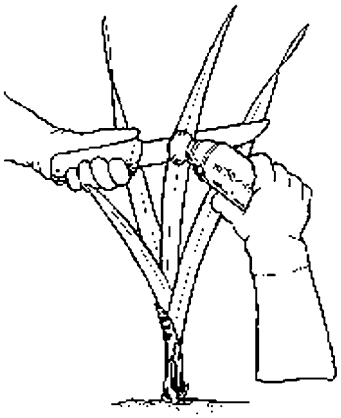
Chipping is an alternate means to get herbicide into a willow (Salix spp.). Evenly spaced downward cuts are made around the trunk with a chisel or a tomahawk and filled with herbicide.
Photo: Lisa Menke NSW Dept of Environment and Conservation

A stem injection gun being used to apply herbicide to a willow.
Photo: Trish Chadwick NSW DIPNR

Stem and leaf swiping

This method is useful for leafy herbaceous plants. If fruit or seed is present remove and bag this first to prevent additions to the soil seed bank. The method involves the use of a wick or rope applicator (equipment is available commercially), to swipe stems and/or leaves with herbicide. A flat bladed device may be required to provide some resistance for the applicator when leaf or stem being treated is soft.

Extreme care is needed to avoid spillage and contact with skin.



Leaf swipe

Other herbicide application methods

Granular or soil residual herbicides

These are herbicides that are mixed into a solid medium, such as clay, and formed into pellets or granules. They are then spread over the soil, either manually or by a mechanised dispenser or even an aircraft. The release of the herbicide is usually triggered by rain, which allows the active ingredient to be released from the pellet so that it can then be absorbed into the roots of plants. The herbicide may remain active in the soil for some time helping to control newly emerging weeds. This type of application is most suitable for weeds in agricultural and forestry situations where sensitive desirable vegetation is not at risk from the herbicide. Heavy rain may wash herbicide off site, potentially contaminating catchments and reducing effectiveness in the intended area of control. Granular applications can be a useful alternative to sprays where spray drift is a major problem or where access is difficult and aerial application onto large infestations may be warranted.

Aerial applications

Helicopters or fixed wing aircraft may be useful to apply herbicides where the area to be treated is large and/or inaccessible. Clearly the risk of off-target damage may be high, but if an area is dominated by a particular weed it can be appropriate and, at a large scale, economical to employ this method. Mimosa (*Mimosa pigra*) in the Northern Territory is an example of a species where aerial applications are often employed. However, it is essential that follow-up work is carried out to treat regrowth after spraying.

Helicopter spraying of a large parkinsonia (Parkinsonia aculeata) infestation in central Queensland.
Photo: John McKenzie

Wickwipers or weed wipers

This method employs vehicle-mounted or hand-held equipment to wipe or brush herbicide onto weeds. The herbicide is applied from wicks, sponges or other material saturated with herbicide. The level of application can be adjusted so that only species growing above a certain height will receive herbicide and in this way the method can be very selective. Problems with spray drift are also avoided. This method is particularly useful in pasture or grassland situations. Serrated tussock (*Nassella trichotoma*) is an example of a pasture-invading weed that can be treated in this way. Desirable species need to be grazed first so that they are well below the height of mature serrated tussock

plants. This method is more effective if a second pass in the opposite direction is done but is not suitable if obstacles such as rocks and stumps are present. If weeds are present that are below the height of application, follow-up spot spraying or manual removal will be required.

The right time

Usually it is best to apply herbicides when weeds are actively growing. Also time applications when plants are smaller if possible as less herbicide will be needed and they are easier to kill. Get to know the life cycle of the plant to assess when the most suitable conditions are likely to occur, but also take account of seasonal variations and local conditions which may impact on plant health. Avoid using herbicide when weeds are under stress, for example from extremes of heat or cold, drought, waterlogging or disease.

Do not apply during wet, windy or very hot weather or when these conditions are anticipated.

The right operator: Training

It is beyond the scope of this module to cover all aspects of herbicide use. All people using herbicides are encouraged to undertake appropriate herbicide training. In most states and territories short courses are available, such as 'Chemcert' which provide information and hands-on training in herbicides, equipment and safety precautions. In some states and territories, and in certain situations, training may be a prerequisite to using herbicides. Check with local authorities to determine what is required for your situation.

Keeping records

It is good practice to keep records of herbicide applications. This enables you to review the effectiveness of herbicide treatments as part of your weed management planning. It will also allow you to demonstrate to others what has been happening on the site in respect of herbicide treatments. A simple example of a record sheet is included with this module (Appendix 2). Commercial or agricultural operators are usually required to maintain more detailed records and this may also be required if special permits or restrictions apply to a particular herbicide.

Personal safety and herbicide use

Herbicides need to be handled with care. Herbicides should always be kept well away from children and preferably stored in a locked cabinet and in the original labelled container.

Ensure that all who are going to use herbicides read and understand the label and can speak to someone qualified in herbicide use if they have any questions.

Herbicides can enter the human body through the skin, by inhalation or swallowing. Basic safety precautions that should always be observed when using herbicides are:

- Read the label **before** opening the container and follow instructions exactly. If you do not understand the instructions seek advice from appropriate people eg local or state government authorities.
- Store only the amount of herbicide that you need. Surplus chemicals remain a hazard.
- Wear protective clothing: Long sleeves, long pants, sturdy shoes and gloves and eye protection (goggles/safety glasses). Cotton, leather, canvas and other absorbent materials are not resistant to herbicides so the more layers the better. A PVC apron covering from shoulders to boots should be worn during the mixing process. Note that protective equipment should be worn during:
  - mixing of herbicides. Be extremely cautious at this point as herbicide is in its concentrated form
  - application
  - entering a treated area before the herbicide has dried or dissipated
- Always wear chemical-resistant gloves. A respirator is advised when mixing or pouring liquid herbicides.
- Do not eat, drink or smoke while using herbicide and wash hands after handling.
- Wash skin and equipment afterwards. Shower and wash hair at the end of the workday. Wash contaminated clothing separately.
- Know what the correct procedures are in the event of an accidental spill.

Additives

There are a range of products available designed to be added to herbicides to improve their performance. These additives are sometimes called adjuvants. Adjuvants are available to help herbicide stick to plant surfaces or penetrate deeper into plants. Adjuvants that help herbicides stick or wet plant surfaces are called 'surfactants', whilst those that help herbicides to enter the plant are called 'penetrants'. Control of weed species with waxy leaf surfaces or with other properties that repel liquid herbicide may be improved with the use of adjuvants. However, care needs to be taken to ensure that excessive run off does not result from their use (foliage may become saturated more rapidly) and that the adjuvant itself is safe to use. Some adjuvants for example may be harmful to aquatic life, even if the actual herbicide is not. As always check with local authorities to determine what is appropriate to use in your situation.

Treatment	Advantages (Benefits)	Disadvantages (Limitations)
Herbicides (sprays)	• Selective (depending on choice of herbicide, timing, plant life cycles, operator skills) • Can prevent weeds seeding and spreading • Appropriate on small and large weed infestations • Minimises direct soil disturbances • Inexpensive	• Potential for non-selective damage / may destroy local flora • Potential impacts on the broader environment • Technical proficiency required • Operator / public hazards
Woody Weed Treatments (Cut & swab, stem injection, scrape & paint etc)	• Selective • Minimises risks to local flora • Prevents seeding and vegetative spread • Inexpensive (on small infestations)	• Site disturbances can be excessive, care is needed • Can spread weed propagules • Can destroy native fauna habitat • Can encourage weed growth / germination • Operator / public hazards • Costly and labour intensive (on large infestations)

Hand control

Hand, or manual, methods offer alternatives to herbicide treatments particularly in sensitive areas with high conservation value. They also form a useful part of an integrated approach, especially for follow-up control after herbicide applications or other methods have been used. These techniques are, of course, labour intensive and they are generally not suited to the treatment of extensive infestations. However, they do provide an opportunity to get close to the weed, which can improve your identification skills and aid your understanding of the weed's biology.

Hand pulling

Hand pulling is useful for isolated occurrences of seedlings or other small, soft, non-bulbous weeds.

It is best undertaken when soil is moist and loose so that you have a better chance of removing the entire plant whilst minimising soil disturbance. Remove any seeds or fruit that are present and bag these for disposal.

For small seedlings and soft plants take hold of the plant firmly at ground level and pull. Avoid grabbing the plant too high as it is likely to break and remaining plant material may reshoot. After removing the plant tamp the disturbed soil down.

For small woody plants like young boneseed and bitou bush (*Chrysanthemoides monilifera* spp.) take hold of the stem at ground level, and manipulate it backwards and forwards gently until it comes away cleanly. If the plant has a spreading root system it may be necessary to pull roots individually. If so always pull roots horizontally through the soil towards the plant, this reduces disturbance and the risk that roots will break. A screwdriver or similar may be useful to loosen roots.

Plants that do not regrow from their roots can be crowned. Hold leaves and stems together and use a knife to cut through all the roots below the crown (the parts of the plant above the roots).

Cutting out the crown

Digging

In a bushland situation, digging, hoeing or grubbing out weeds can be effective for isolated weed occurrences and are useful follow-up techniques. With practice, gentle digging and grubbing out of weeds will keep soil disturbance to a minimum. However, digging is not always the best method for species with extensive tuber, rhizome or root systems. For example, larger woody weeds may be more effectively treated with herbicides, which will cause minimal soil disturbance compared with digging out deep or extensive root systems. Species like bridal creeper (*Asparagus asparagoides*) develop extensive tubers and rhizomes underground that are difficult to completely remove and older established infestations may be better controlled with careful use of herbicides.

Treatment	Advantages (Benefits)	Disadvantages (Limitations)
Manual removal (hand-weeding, digging, grubbing etc)	• Selective • Minimises risks to local flora • Supplements other controls • Can prevent seeding and spread • Effective on small infestations • Develops plant identification skills and familiarity with sites	• Can disturb soils if poorly done • Timing limitations, needs moist soils • Can spread weed propagules • Unsuited to large infestations • Inappropriate for some weed species and large plants • Labour intensive

Mechanical

Machines, from lawn mowers to large earth moving equipment, can play an important role in weed management. The use of any machinery introduces risks of site disturbance and the potential to spread weeds as a consequence of plant material attaching to machinery and redepositing elsewhere. Good planning to minimise site disturbance and restore treated sites is essential, as is attention to machinery hygiene.

Slashing and mowing

Slashing and mowing may be valid components of an integrated weed management plan, depending on the weed being treated. These methods will not eradicate weeds but they can stress weeds, providing desirable vegetation with a competitive edge, leaving weeds more susceptible to biocontrol agents and also preventing or greatly reducing weed seed production.

Proper timing of the use of slashing or mowing is required for optimal results, otherwise these methods can actually spread weeds. Timing should be based on the growth stage of the weed species and the growth stage of desirable vegetation. Ideally mowing should be carried out at a time that is not so early that seed heads emerging later produce an abundance of seed, and not so late that viable seed has already been set. It should also coincide with the time when desirable plants are dormant. The idea is to exploit differences in the growth habits of grassy weeds and desirable grass species. This happy coincidence will not always be achievable and decisions will need to be made based on priorities for action. For example, in areas with little or no native vegetation that are already heavily degraded with weed infestations, mowing may provide an effective means to reduce weed seed production. This will help protect better quality areas from invasion. Resources can then be devoted to removing weeds from less infested areas.

Timing decisions will be further complicated if multiple weed species are present with different flowering and seeding times. Again, it will be a matter of prioritising which species are most important for the management of the site and what opportunities exist to integrate mowing with other methods to manage priority species.

Some weeds will regrow readily after mowing, and mowing can actually encourage fresh growth (eg Coolatai grass *Hyparrhenia hirta*). This new growth is more responsive to herbicide treatments.

Where catchers can be used as part of mowing, seed heads can be collected for subsequent destruction or appropriate disposal – further helping to suppress subsequent generations of weeds and weed spread.

Be mindful of the damage that heavy mowers can cause, particularly when the ground is wet. Thorough cleaning of machinery used in slashing and mowing is essential to ensure that seed from the area treated is not inadvertently transported to new areas. Machinery like mowers and slashers can potentially become major dispersers of grasses like Chilean needle grass (*Nassella neesiana*).

Slashing trials being conducted on a Chilean needle grass (Nassella neesiana) infestation. This species produces seed at the base of its stem as well as normal seed heads, so follow up work will also be required as well as careful machinery hygiene to prevent seed spread.
Photo: DPI Vic

Slashing with a brushcutter can help open up dense stands of blackberry (Rubus fruticosus aggregate) for follow-up control by other methods. Photo: Adam Whitchurch, DPI Victoria

Mechanical control of parkinsonia (parkinsonia aculeata) with an Ellrott front-mounted bladeplough. Photo: John McKenzie

Bulldozers and tractors

For some species, and in certain circumstances, heavy earth moving equipment can form an effective part of integrated weed management, particularly for severe infestations of larger woody weeds. Bulldozers are important in dealing with large infestations of prickle bush species including prickly acacia, mesquite (*Prosopis* spp.) and parkinsonia and allow treatments such as blade ploughing, chain pulling, dozer pushing and stick-raking. The method used will depend on the extent of the infestation and the maturity of the plants to be treated.

Blade ploughing employs a large plough device attached to a bulldozer which cuts off trees below the soil surface and below the zone from which they can rebud. This is best done when trees are young and easier to cut through. Chaining, where two bulldozers drag a heavy chain through dense infestations, is used to knock plants down to the ground to provide fuel for follow-up fires. Ongoing control with herbicides is required to treat regrowth. Dozer pushing is used to destroy individual trees and stick-raking attachments to bulldozers are used to cut the trees below ground level and mound them into windrows for burning.

Heavy machinery can also be usefully integrated into the treatment of other woody weeds such as blackberry (*Rubus fruiticosus* agg.) and gorse (*Ulex europaeus*) where bulldozers or heavy tractors can be used to cut bushes off at or below the soil surface. Follow-up treatments and planned revegetation or pasture establishment will be required to help keep these weeds under control.

Bulldozers, or heavy tractors, using blade ploughs can be used to ‘scalp’ weed infested land to depths often around 200–300 mm to remove plant crowns and as much seed and root material as possible. This method also removes soil nutrients that may have accumulated from land use practices (applications of fertilizer etc.), which actually favour many weeds over native vegetation since the latter is generally adapted to low nutrient conditions. Scalping may be appropriate for highly degraded areas but expert assessment of the soil profile and selection of species to revegetate the site is needed to avoid causing serious damage.

A gorse infestation in Zeehan, Tasmania being mechanically cleared and mulched.
Photo: Greening Australia, Tasmania

Grooming

Tractors and earth moving equipment fitted with specialised 'grooming' arms can be effective at treating large infestations of woody weeds in hard to reach places. The grooming devices shred plant material down to ground level, reducing biomass. Follow-up treatments of any regrowth, with herbicides or manual methods, require far less chemical and effort than would have been the case if the original infestation was treated. Initial use of grooming can be expensive but this needs to be balanced against long-term reduction in herbicide costs. The method has been useful for large infestations of blackberry where regrowth has revealed that the original large infestation was based on a few parent plants which could then become the focus of treatment.

Clearly these methods cause major disturbance to vegetation and soil and should only be contemplated where resources exist to carry out necessary follow-up work. This includes restoration of the site with desirable vegetation.

Earth moving equipment fitted with a grooming head treating a dense stand of blackberry.
Photo: Sandy Cummings, Fleurieu APCB

Cultivation

Cultivation, defined as working the soil with implements, is often used in cropping situations to prepare the soil for sowing and to destroy competing plants. Its use is diminishing in order to conserve soil, with herbicides being used more extensively to control weeds.

Cultivation works by cutting, uprooting and burying shallow rooted plants. It has a limited application in bushland settings where the disturbance caused would only serve to stimulate weed growth and help spread seeds and other propagules whilst destroying native vegetation. It may form a useful part of managing weeds invading pasture, such as serrated tussock, provided cultivation is followed up with the establishment of vigorous pasture to suppress germination of weed seeds from the soil seed bank.

Treatment	Advantages (Benefits)	Disadvantages (Limitations)
Soil Cultivation and Scalping	• Can eradicate weeds • Reduces nutrient loads • Removes soil-stored seedbank • Can aid site rehabilitation	• Non-selective • Disturbs soils • Spreads propagules • Destroys local flora and fauna habitat • Removes soil-stored local flora seedbank • Potential for erosion / run-off • Expensive • Site rehabilitation required • Technical proficiency required
Slashing, Mowing, Cutting (brushcutters, mowers, slashers)	• Minimises soil disturbances • Minimises risks to local flora • Can prevent seeding and spread • Removes excess foliage (for follow-up treatments) • Supplements other methods • Helps to weaken plants, making them susceptible to other forms of control • Inexpensive	• Usually doesn't eradicate weeds • Can prevent seeding by local flora • Can introduce / spread weed propagules • Can encourage weed growth • Can increase fuel loads (dried material)
Mechanical (grooming, bulldozer)	• Can be quick • Can be cost effective for extensive infestations (prickle bushes)	• Significant disturbance • Vehicle hygiene risks • Expense for small infestations • Comprehensive follow-up may be required

Mulching and smothering

Mulch may help to control weeds by excluding light from the soil surface, reducing temperature variations that would otherwise stimulate weed seed germination and by physically impeding weed growth. Many forms of vegetative material including bark, wood chips or mats made from vegetative material are used, as are synthetic materials such as black plastic sheeting or mineral aggregates.

The application of mulches outside the garden or horticultural environment is probably limited, except perhaps for highly disturbed or degraded areas where no indigenous species regeneration will be affected by the mulch, or around seedlings planted as part of revegetation work. It is important that sheet materials used for mulching, synthetic or otherwise, are well secured to prevent them being torn (introducing gaps), blown or washed away.

Mulching may assist revegetation establish by suppressing weeds around young native plants and improving retention of soil moisture. Organic mulches such as hay or straw, however, may also contain weed seeds and can temporarily tie up nitrogen in the soil.

Solarisation

This method also employs sheeting, usually black or clear plastic, to cover weeds and allow the sun's energy to raise temperatures under the sheeting to an extent that weeds and their seeds are destroyed. It can be useful to treat small infestations of tenacious grass and herbaceous species and is best used in the warmer months and in locations with open and sunny aspects.

Black plastic sheeting has been used to control some aquatic weeds, for example *Lagarosiphon major*, in still water conditions. This species is on the *Alert List* for environmental weeds.

It is also a method to sterilise weeds to be disposed of, by accelerating composting and subjecting the material to high temperatures. This can eliminate the need to take material off-site and reduces the risk of inadvertently aiding weed spread.

Treatment	Advantages (Benefits)	Disadvantages (Limitations)
Mulches and smothering treatments	• Inhibits / prevents weed seeding and spread • Can compliment site rehabilitation • Erosion / run-off control • Aesthetics enhanced	• Usually non-selective • Can encourage weed growth • Prevents local plant growth and spread • Can introduce weed propagules • Can alter soil chemistry • Affects soil conditions and soil micro-fauna • On-going maintenance required • Aesthetics undermined • Costly and labour intensive
Solarisation (plastic sheeting)	• Can be selective • Can control tenacious weeds • Inhibits / prevents seeding and spread • Supplements other methods • Appropriate on a small scale • Low costs (once installed)	• Usually non-selective • Ineffectual on many weeds • Unsuitable for large infestations • Prevents local plant growth and spread • Affects soil conditions and soil micro-fauna • On-going maintenance required

Competition

Ultimately, the best way to keep an area free of weeds, or at least to keep weed numbers down to a manageable level, is to have a good cover of desirable vegetation which prevents weeds establishing. In bushland settings, this cover should be comprised of native species indigenous to the area (local provenance). In agricultural settings, pasture species might be desirable.

The objective of most site plans involving bushland settings is to restore the original ecosystem by establishing local native species to replace the weeds. This may not always be possible, for example, if seeds of original species are unobtainable or if the site has been so extensively changed that original species would no longer grow there (eg a mine or quarry site). In these cases alternate species need to be found but these should still be from native species as close as possible to the site. Natives from other regions may themselves become weeds, for example Cootamundra wattle (*Acacia baileyana*) is a weed in Australia outside its original range in New South Wales.

Regeneration

Native species can be allowed to regenerate from seed stored in the soil-seed bank or seed held in remnant native canopy species. In these circumstances weed control should be paced so that gaps are not created for fresh invasion. This approach is embodied in the "Bradley" method developed by the sisters Joan and Eileen Bradley during the 1960s–1970s. The main principles of this method are to:

- work from minimally disturbed sites in towards the most weed infested areas
- minimise disturbance to the soil
- allow the rate of native plant regeneration to dictate the rate of weed removal.

Manipulation of the seed bank

Where a substantial native seed bank exists in the soil or the plant canopy this may be exploited by direct manipulation, such as burning, to stimulate germination. This technique should only be applied to sites where monitoring confirms the presence of a substantial seed resource and the ecosystem is fire adapted. It would not be appropriate for example, in rainforest ecosystems. Otherwise a more interventionist revegetation technique is required.

Sowing of seed

Direct seeding with desirable species requires knowledge about their germination and seedling establishment requirements so that the plants can be given the best opportunity to successfully establish in the shortest time possible, thus reducing the chances of reinvasion by weeds. Many seeds require some form of pre-treatment (eg scarification, heat or smoke) to stimulate germination. Timing of the sowing to take advantage of reliable rainfall or low seed predator activity may help to maximise chances of establishment.

Planting seedlings

Planting native seedlings is a more labour intensive and expensive task than seeding but generally achieves higher establishment rates. Planting should be carried out at times that will give plants the best chance of establishment and some temporary protection from grazing may be required. Mulch may also assist to suppress weeds and retain soil moisture whilst seedlings become established.

Selection and revegetation timing can be complex matters and advice from suitably qualified and experienced people is well worth obtaining.

Treatment	Advantages (Benefits)	Disadvantages (Limitations)
Competition strategies & practices (direct seeding, plantings, natural recruitment)	• Suppresses weeds • Can alter light levels and nutrient – moisture availability • Restores vegetation structure • Restores floristic diversity • Enhances fauna habitat	• Altered conditions can favour weeds • Can undermine vegetation structure with inappropriate species selection • Often entails intensive management input during establishment phase • Can be labour intensive (costly) • Specialist knowledge required

Using fire for weed control

The use of fire is particularly relevant to the long-term management of environmental weeds in Australia, as the ecology of many native species is closely tied to, or even dependent upon fire. However, areas left bare by fire are susceptible to erosion and new weed invasions so it is advisable to restrict the area that requires follow-up after planned fires to manageable levels. In areas with good native vegetation, fire should not be used in frequent succession on the same site as this is more likely to favour weedy species. Moreover, the risks to people, fauna and property need be understood and managed and appropriate measures taken and legal permissions obtained before fire is used.

If fire is to be used as a control method at least four aspects need to be considered.

The response of the weed to burning

Some weeds do not burn well whilst alive. Even when shoots are successfully burnt the plant may still regenerate. Fire may also affect germination from the soil-seed bank, either detrimentally by killing the native seeds exposed to excess heat or conversely by stimulating weed germination. In the case of bitou bush (*Chrysanthemoides monilifera* ssp. *rotundata*), seeds on the surface are killed by fire whilst seeds buried 30 mm or deeper in the soil may actually be stimulated to germinate. If the new bitou bush growth that occurs following fire is treated (with herbicide or hand pulling depending on scale of infestation), this can help deplete the soil seed bank of bitou bush seed.

Habitat

As burning may destroy fire-sensitive ecosystems, such as rainforest, it is not always an option for controlling weed invasions. Lantana (*Lantana camara*), for example, invades the margins between rainforest and sclerophyll forest. Fire may kill the lantana but it may also promote certain sclerophyll species and be detrimental to the rainforest species. If the management aim of such areas is to maintain or increase the rainforest boundaries, fire is not appropriate.

The fire regime employed

Not all fires are alike. The factors which govern the impact of a fire on the native and weed flora include the fuel load, weather, topography and soil moisture, all of which influence the intensity of a fire, rate of spread and penetration of heat into the soil seed-bank. Fires of low-intensity, as is the case for many prescribed fires in a specified area, can produce responses substantially different from those of high-intensity wildfire. This is particularly the case for native species, which require a relatively high minimum temperature to shed seed stored in the canopy or a relatively high transmission of heat into the soil to germinate the seed bank. Thus the fire regime has implications beyond its potential to kill the weed species – it can also affect the composition of regenerating native species and hence the post-fire plant community.

With sufficient fuel (grasses, rubber vine leaves, other vegetation) fire can successfully control rubber vine (cryptostesia grandiflora). Fire is especially efficient in combination with the biological control agent, rubber vine rust (maraualia cryptostegiae).
Photo: Joe Vitelli

The season of fire

If the fire is mis-timed, with respect to fruiting maturity or seed shed of desirable species, it may deplete the seed bank. In terms of management, there are clearly seasons when the use of fire is dangerous because of the risk of escape, especially into adjacent urban areas. The level of risk may also depend upon seasonal conditions. The use of fire will also need to be outside fire ban seasons and requires the appropriate legal permissions from fire and native vegetation authorities.

When dealing with large infestations, it may be inadvisable to use fire to burn the entire infestation. Apart from the risk of fire escaping control, large fires can cause significant change to organisms in the soil and the ecology of an area. It may be better to limit annual burning to 10 or 20 per cent of the area to be controlled.

In addition to the above considerations fire should only be used when there are:

- adequate resources to control it
- adequate resources to do the follow-up weed control and revegetation
- appropriate approvals from relevant local authorities.

Wildfires or unplanned fire

If your site is subjected to an unplanned fire then regular examination of the area will be needed to see what weed activity is taking place after the fire and how desirable vegetation is coping. The information gained can inform ongoing management of the site. Your objectives may need to change and you might be able to capitalise on the opportunity to get easier access to weed seedlings and to re-establish desirable vegetation.

Treatment	Advantages (Benefits)	Disadvantages (Limitations)
Fire (control burns, spot-burns)	• Removes rank and excessive foliage (for follow-up spray treatments) • Supplements other methods • Encourages local flora regeneration • Encourages germination of soil-stored weed seedbank (for follow-up treatments) • Relatively inexpensive • Kill weed seedbanks	• Usually does not eradicate weeds • Inappropriate for non-fire adapted ecosystems • Seasonal and timing limitations • Encourages weed growth / germination • Altered nutrient-moisture availability can favour weeds • Potential for run-off / erosion • Fauna, people, property risks • Can be costly if establishment of fire breaks, spelling of pasture and personnel required to control fire are involved • Specialist knowledge required

Flame weeding and steaming

These techniques employ a burst of intense heat to kill weeds and are generally used in horticultural applications and by some councils to treat roadside and footpath weeds where there is an objective to reduce chemical use. They are more effective on broadleaf weeds than grasses, which are more resistant to heat methods.

Flame weeding

Flame burners are devices that employ propane gas or kerosene as fuel to provide a constant flame and use a hand wand to allow the flame to be applied onto the target weeds. The method does not require that the plant is burnt; in fact for many species this may actually stimulate regrowth. Rather, the method works best when plant leaves are severely wilted as a result of exposure to the intense heat and subsequently die.

Steam weeding

This method uses apparatus to produce pressurised heated water directly onto target weeds to break down cell structure leading to plant death.

Flame and steam weeding are expensive to use, may require repeated applications and are also characterised by slow work rates. The risk of off-target damage and, in the case of flame weeding, the risk of fire escaping needs also to be considered. Prolonged use of these methods in urban areas has seen a change in the weed flora to favour deeper-rooted perennials that are more resistant to heat treatments.

Biological control (or biocontrol)

Biological control of weeds offers the potential to deliver inexpensive, long-term control. Additionally, impacts associated with other methods such as herbicide or mechanical controls are reduced. However, it needs to be appreciated that the establishment of effective agents requires considerable initial investment and time to find the agents, confirm that their actions are specific to the target species and establish them in the field. Although the return on this initial investment can be substantial, there are no guarantees that effective agents, suitable for release, will be found. Once a successful agent is established it becomes self-sustaining with target weed populations reduced to a level where investment in other weed control methods can be reduced.

Classical biological control is based on the principle that populations of plants in their native range are held in check by organisms such as insects, birds and mammals, that feed on them or diseases which control them. When a plant is taken out of its native range and introduced into a new area these controls are absent and, if other conditions are right, the population of the plant may explode. This is one reason why many introduced species have become weeds in our environment.

Biological control seeks to find organisms in the weed's native range that are specific to that plant and will not damage native or desirable vegetation. Most often insects or organisms like fungus or rusts are likely candidates for biocontrol agents. Complete eradication is not a desirable or achievable objective of biological control. The aim is to create an ecological balance between a plant and its natural enemies in the introduced range and to reduce weed density to a level below that at which it causes economic or environmental damage.

Prioritising sites for biological control

If biological agents are available for weeds that you are looking to control you will need to assess how appropriate your site is for their use. Knowing where your weeds are and the characteristics of their distribution, is the first step in prioritising the use of biocontrol as part of your weed management plan. The mapping of weeds is discussed in some detail in Module 1 *Developing and implementing a weed management plan*.

Established weeds normally consist of three different types of infestations:

- small, isolated infestations
- the core of large infestations
- infestation perimeters.

The core of large infestations are usually the most expensive to control, have well developed soil seed banks and are often spread over a number of properties or sites where it may be difficult to coordinate chemical, manual or mechanical control activities. In these circumstances, biological control can help by suppressing the growth rate and reproductive capacity of target weeds, whilst chemical and or physical methods are used to control isolated populations and contain the spread of weeds at the perimeter of the larger infestation.

Generally speaking, biological control is most appropriate where weed infestations are a low priority for immediate control. In agricultural situations, weed control is normally focused on protecting economic return in the short-term. Therefore biological control, which takes some time to establish, is more appropriate on agricultural lands or rangelands of relatively low productive potential. Similarly, control of weeds in areas of particularly high conservation or heritage value is best addressed by appropriate chemical or physical methods in order to achieve more immediate results.

The feasibility of using conventional chemical or physical methods will also influence the decision to use biological methods. If access to the infestation is difficult due to the terrain, or if an area is sensitive to herbicide uses (eg aquatic or riparian locations where sensitive native plant species are present or the land is used for organic agriculture) then biological control may be a preferable option.

Integration with other techniques

The previous section addressed where you might use biological control as a priority method but what about its use in conjunction with other methods? Each weed species, where biological control is available, will require different integration strategies to achieve the best results of combining biological control with conventional methods in light of both the life cycle of the weed and that of the biological agent. For example, some agents are dormant at certain times of the year. By using herbicide applications during the hibernation period the agent will not be directly affected and, when they emerge from hibernation, will attack any target weeds that survived the herbicide treatment.

In other cases it may not be feasible to alter the timing of control methods to suit the life cycle of a biological control agent. If the agent is likely to be killed as a consequence of the use of other methods (eg pesticides), then it may be necessary to maintain a small population of the weed species to act as a refuge for the agent. New weed infestations can then be recolonised by the agents from the refuge. An example of this approach can be seen in the Sunraysia district along the Victorian/New South Wales border where biological control is used in the battle against bridal creeper (*Asparagus asparagoides*). Bridal creeper causes problems in citrus orchards and herbicides can kill off agents such as the leafhopper (*Zygina* spp.) and rust fungus (*Puccinia myrsiphilli*). These agents have been released in roadside infestations and shelter belts near orchards and so provide a reservoir of agents, if needed, whilst at the same time suppressing bridal creeper spread in these unmanaged areas. This, in turn, helps to reduce reinfestation back into the orchards.

In some cases agents can be so effective that no other control is needed. For example, the aquatic weed salvinia (*Salvinia molesta*) has been successfully controlled, though not eradicated, where it occurs in tropical and sub tropical climates by the salvinia weevil (*Cyrtobagous salviniae*).

Setting up biological control

If a decision has been made that a site could be suitable for the use of biological control, the following general protocol should be followed:

- establish where agents can be acquired
- determine the requirements to acquire and transport the agents
- determine what permits are required
- consult with others in the area and establish cooperation for the implementation and monitoring of the program
- determine the methods and site requirements for introducing an agent (equipment, water etc)
- find out what records should be kept at the time of establishment and for subsequent monitoring.

The bridal creeper rust fungus attacks leaves and stems, reducing the amount of green plant material. Photo : John Virtue

Treatment	Advantages (Benefits)	Disadvantages (Limitations)
Biological controls	• Selective • Can suppress weed growth and spread • Supplements other methods • Value for money • Minimal labour inputs (in the field) • Minimal direct environmental impacts	• Timing limitations • Variable results • Does not eliminate weeds • Other controls required • Expensive to develop • Limited range of weeds have agents

Grazing

Livestock such as cows, sheep, horses and goats can contribute to weed control by:

- reducing flowering and seed dispersal
- stressing weed plants
- preventing weed domination of pastures.

Grazing, however, requires careful management that accommodates:

- the timing of grazing with critical stages in weed life cycle whilst minimising permanent damage to desirable pasture species
- the dietary needs of stock
- different grazing habits of livestock species; goats for example will preferentially graze fibrous plants like blackberry that other stock will avoid. Other livestock may preferentially graze desirable species
- the need to contain stock with good fencing to avoid off-target damage
- condition of the land with intensity of grazing. For example, avoid heavy grazing pressure on regenerating pasture plants. Overgrazing may also leave bare ground – encouraging weed invasion.

Grazing animals can damage native vegetation and soil structure and may introduce weed species transported on fur, hooves or in droppings from other areas. Cattle, for example, are major agents in the spread of prickly acacia. After cattle eat prickly acacia pods the seeds pass through their gut (scarified by gut acids) and are subsequently deposited on the soil in a perfect environment for germination. Also, a number of weed species palatable to stock are toxic. Paterson's curse, also known as salvation Jane (*Echium plantagineum*), rubber vine (*Cryptostegia grandiflora*) and the fruit of lantana (*lantana camara*) are toxic to stock , so it is important to confirm that stock will not be harmed by the weed to be grazed.

Treatment	Advantages (Benefits)	Disadvantages (Limitations)
Grazing (goats, cows, sheep, horses)	• Selective (depending on grazing animal and weed species being targeted) • Can remove excess foliage (for follow-up treatments) • Supplements other controls • Inexpensive	• Timing limitations • Disturbs soils • Can introduce / spread weed propagules • Encourages weed growth • Destroys local flora • Inappropriate for many ecosystems • Can elevate nutrient levels • Potential for erosion / run-off • Site rehabilitation required • On-going management required • Danger to stock if weed toxic

Appendix 1: Weed control contacts

State / Territory	Department	Phone	Email	Website
Australian Capital Territory	Environment ACT	Ph: (02) 6207 9777 Fax: (02) 6207 2227	EnvironmentACT@act.gov.au	whttp://www.environment.act.gov.au/ie4/petsandlocalwildlife/pests.html
New South Wales	NSW Agriculture	Ph: (02) 6391 3100 1800 680 244 Fax: (02) 6391 3336	weeds@agric.nsw.gov.au	http://www.agric.nsw.gov.au/weeds
Northern Territory	Dept. of Infrastructure, Planning and Environment	Ph: (08) 89992020 Fax: (08) 89992015	weedinfo.DIPE@nt.gov.au	http://www.nt.gov.au/
Queensland	Dept. of Natural Resources and Mines	Ph: (07) 3375 0700 Fax: (07) 3379 6815	enquiries@nrm.qld.gov.au	http://www.nrm.qld.gov.au/pests/index.html
South Australia	Dept. of Water, Land and Biodiversity Conservation	Ph: (08) 8303 9500	apc@saugov.sa.gov.au	http://www.dwlbc.sa.gov.au/
Tasmania	Dept. of Primary Industries, Water and Environment	Ph: (cost of a local call) 1300 368 550	Quarantine.Enquiries@dpiwe.tas.gov.au Christian.Goninon@dpiwe.tas.gov.au	http://www.tas.gov.au/ OR http://www.dpiwe.tas.gov.au/inter.nsf/ThemeNodes/SSKA-52J2K4?open
Victoria	Dept. of Primary Industries	Ph: (03) 9210 9379	ktri@dpi.vic.gov.au	http://www.dpi.vic.gov.au/
Western Australia	Dept. of Agriculture	Ph: (08) 9368 3333	enquiries@agric.wa.gov.au	http://www.agric.wa.gov.au/progserv/plants/weeds/index.htm

Appendix 2: Herbicide Application Record Sheet

Site Details: Location: **Contact details of owner/manager:**								
Date, start & finish time	**Operator details: Name address & contact details** (if not self)	**Weed species treated & method used**	**Name of herbicide and any additives used**	**Amount of concentrated product used (Litres/millilitres or grams)**	**Total quantity applied:** Total amount of water, oil or other substances mixed with concentrated product	**Area sprayed (ha)** (Mark on weed map)	**Estimated wind speed & direction**	**Comments:** Other weather details, risks identified etc.

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Collecting and preparing plant specimens for identification

Module 3

Module 3

Australian Government

Department of the Environment and Heritage

CRC Weed management

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Collecting and preparing plant specimens for identification

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Introduction

It is essential to identify plants correctly to ensure that you are dealing with the weed that you think you are and that the right control plan is developed. Some species are well known while others can be very difficult to identify and may be confused with plants that are not weeds, or even species that are rare or endangered. The *Weed of National Significance* Chilean needle grass (*Nassella neesiana*), for example, can be very difficult to differentiate from other tussock forming grasses including native *Austrostipa* species. The *Alert List* species *Asystasia gangetica* ssp. *micrantha* can also be difficult to separate from native *Asystasia* species. In cases like these, or where you have any doubt at all over the identity of a plant that you think may be a weed, it is essential to get it correctly identified. This module explains how to prepare plant specimens for presentation to botanists, state herbaria or other experts who can correctly identify the plant for you.

Collecting and preparing plant specimens for identification

The key to accurate identification of plants is to supply the agronomist or botanist with good quality specimens and sufficient information about the plant, including the conditions in which it was collected. This can be helped by photos of the plant in its habitat.

Inadequate or poorly preserved and presented specimens will often not be accepted for identification. Always collect several sets of the same specimen so that you can keep a specimen for your later reference following correct identification. Specimens sent to a herbarium for identification won't be returned and may be kept for herbaria reference collections.

Materials required for successful plant collecting

- a mattock or spade to ease plant specimens from the soil, leaving the roots and other underground organs intact. Never pull plants from the soil.
- secateurs and/or small saw for removing small branches from trees and shrubs
- plastic bags, rubber bands and "Esky" if weather is hot OR non-gloss newspaper and a portable plant press
- pencil or permanent marker, jewellers tags to tie to individual specimens
- notebook for recording details
- camera for recording plants in position in their habitat before you collect them
- a GPS unit is the best way to accurately determine the location of the specimen you are collecting. If this is not available then a topographic map may be used, see Appendix 3 of Module 1, *Establishing your location*.

Collection details

Supplying sufficient information about the size and habitat of the plant will help in identification.

Completing the attached template will give sufficient details.

What to collect

Many plants have similar features and it is not possible to identify them from leaves alone. Therefore, it is important to supply different parts of the plant for correct identification, particularly flowering parts and seedpods. Identification of perennial species will often require underground parts such as roots, tubers, underground stems (rhizomes) or corms. Include a sample of bark if present.

For plants with separate male and female flowers collect both sets of flowers. Record flower colour, as this may change when the specimens are dried.

Grasses, sedges and small plants

Include roots, basal leaves, flowers and fruits. An example of basal leaves are the rosette leaves of brassicas (such as turnip weed, and wild radish). Always include underground parts such as rhizomes, corms, tubers, and bulbs, if present.

Larger plants such as shrubs and trees

Collect a portion of stem that shows the branching pattern, preferably with flowers and fruits. Fruits include dry fruits like eucalyptus 'gum nuts' and pods which split open to release seeds and berries where the seeds remain in the fruit. If flowers and fruits are not present on the same stems, collect several samples. Eucalypts require collection of buds, fruits, juvenile and mature leaves, plus a description of the bark.

Record the dimensions of the plant and for trees, note the trunk diameter at 1.2 m above ground level.

Specimen preparation

All specimens should be free of soil. Gently wash the roots to remove wet soil. Hard-set soil may need to be soaked off to prevent damage to the roots. Large plants such as tussock grasses and sedges can be carefully pried apart and a few tillers with seed heads can be kept for identification.

There are two methods of preparation, depending on whether the specimens will be identified locally within a few days of collection or be sent away or stored for some time.

Short term

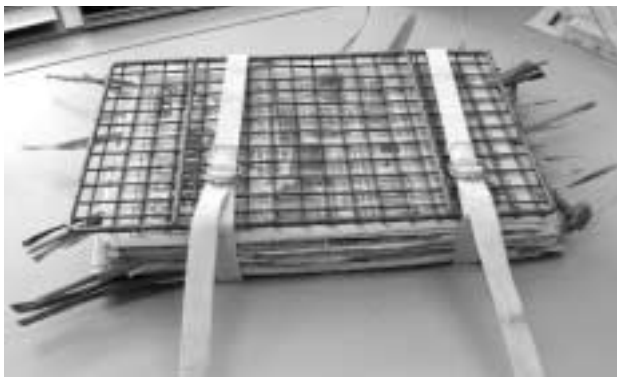
- Put plants and/or plant parts between damp newspaper and into a plastic bag with a few millilitres of water. Place roots toward the bottom of the bag.
- Tag plants with a specimen number, date, collector and locality.
- If the specimen is in sections, give each sample the same number.
- It is preferable to put a written label in the bag as writing on the bag, even with waterproof pen, often rubs off.
- Tie-off the top of the bag. This will keep the contents humid and fresh.
- Keep the specimens out of the sun. Most specimens can be kept in a refrigerator for a few days. The main exception would be specimens with large, soft flowers.

Long term – sending specimens for identification or storage in a collection.

- Place the specimens between several sheets of newspaper, or folded broadsheet.
- Arrange the samples so that leaflets/leaves and flowers can be clearly seen.
- Larger specimens can be bent into a zigzag to fit the sheet.
- Multiple samples in newspaper can be laid upon each other. These are then placed between rigid boards with weights such as bricks or books supplying pressure to flatten the specimens.
- Change the newspaper daily for the first few days then weekly until the specimens are dry.

Fleshy or succulent specimens such as cacti may need to be frozen for a few days before pressing. This ruptures the plant cells and helps drying.

Keeping track of the correct identification during drying is a lot easier if the specimens are individually tagged.



A simple plant press can be created from wire grids, newspaper and cardboard with nylon straps used to apply a constant pressure. A wooden frame, instead of wire grids, will serve equally as well.
Photo: N.W. Richards

Aquatic plants

Floating or submerged aquatic plants may be difficult to collect. This is because the entire plant body is normally supported by water and tends to collapse when removed. Leaves are also often divided into many segments making them difficult to straighten.

This method may improve results. Float the plant sample in a large shallow dish or tray part filled with water. Slip a piece of strong, thick paper under the specimen and then gently lift it whilst keeping it level so that the water drains away slowly. Done carefully the plant will be well distributed across the sheet. If initial attempts are unsuccessful then return the plant and sheet to the water and try again. When ready to press, the sheet of paper bearing the plant specimen is put into a newspaper fold in the usual way. The surfaces of aquatic specimens should be dried as much as possible before pressing, otherwise papers, blotters or cardboards will be too moist. When drying, some may tend to stick to the newspaper, and it may help to lay them out between layers of tissue paper. With rooted aquatics, wash away as much of the mud and silt from the rhizome and roots as possible before placing in paper and pressing.

Sending specimens to the herbarium

Specimens to be sent to the herbarium by mail should be forwarded in a pressed and dried state. Keep the specimens between sheets of newspaper. Insert a *Plant identification* sheet, such as the example at the end of this module, with all the collection details, and place between 2 pieces of firm cardboard. Any loose items such as seedpods or fruits should be placed in an envelope labelled with your name and collection number. If the envelope is not too bulky it can be attached to the newspaper folder.

Attach a covering letter outlining your request for identification (don't forget to include your contact details).

Contact details for various herbaria

State / Territory	Postal Address	Phone	Website
Australian National Herbarium	GPO Box 1600 Canberra, ACT, 2601	(02) 6246 5108	www.anbg.gov.au/cpbr/herbarium/index.html
National Herbarium of New South Wales	Mrs Macquaries Rd Sydney, NSW, 2000	(02) 9231 8111	www.rbgsyd.nsw.gov.au
National Herbarium of Victoria	Private Bag 2000 Birdwood Avenue South Yarra, Vic, 3141	(03) 9252 2300	www.rbg.vic.gov.au/biodiversity/herbarium.html
Northern Territory Herbarium	PO Box 496 Palmerston, NT, 0831	(08) 8999 4516	http://www.nt.gov.au/ipe/pwcnt/
Queensland Herbarium	c/- Brisbane Botanic Gardens Mt Coot-tha Rd Toowong, Qld, 4066	(07) 3896 9326	www.env.qld.gov.au/environment/science/herbarium
South Australian Plant Biodiversity Centre	PO Box 2732 Kent Town, SA, 5071	(08) 8228 2308	www.flora.sa.gov.au/index.html
Tasmanian Herbarium	Private Bag 4 Hobart, Tas, 7000	(03) 6226 2635	www.tmag.tas.gov.au/Herbarium/Herbarium2.htm
Western Australian Herbarium	Locked Bag 104 Bentley DC, WA, 6983	(08) 9334 0500	http://science.calm.wa.gov.au/herbarium/

Specimen collection details template

PLANT IDENTIFICATION Submit a separate form in duplicate for each specimen Send only specimens pressed flat between newspaper sheets						
Specimen or File no: ENQUIRER				Date: Name:		
Address:						
INFORMATION REQUIRED Unless otherwise requested only identification will be supplied.						
COLLECTION DETAILS Collector:				Date:		
Locality (Distance and direction from nearest town):						
Latitude:				Longitude:		
Habitat:	Crop (specify)		Pasture		Roadside	
Garden	Native vegetation (specify)					
Other (specify)						
Occurrence:	Growing naturally			Cultivated		
Habit: Annual	Perennial	Shrub	Tree	Other	Height m Trunk diam.	
Abundance: Rare	Occasional	>10 plants	>100	>1000	>10000	Area covered ha.
Flower colour:						
Bark colour & texture:						
Soil type:						
Remarks:						

Natural Heritage Trust

Helping Communities Helping Australia

An Australian Government Initiative

Presentation of information sessions for small groups

Module 4

Australian Government

Department of the Environment and Heritage

CRC Weed management

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General Disclaimer

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Australian Government

Department of the Environment and Heritage

CRC Weed management

Introduction

The aim of this module is to provide you with ideas and techniques that will assist you to present information to small groups. It is included in the *Introductory Weed Management Manual* as an aid to community group leaders who need to communicate weed management information to their group, but who have not had the opportunity to develop presentation skills.

These guidelines will help you prepare effective sessions for small groups and better communicate weed management principles to others.

The material in this module is derived from the TAFE short course "*Certificate IV in Assessment and Workplace Training*" Course Code BSZ404A. If you would like to further develop your training and presentation skills contact the TAFE centre in your region. Your regional TAFE centre may also be able to provide courses via distance learning and online packages.

Preparing your information session

When preparing for an information session there are three key areas to keep in mind:

1. What is your message?
2. Who are you presenting to?
3. What is the best way to get your message across?

Before designing your information session, it is important to identify the needs of the people to whom you will be presenting. A chat with group members to find out what they know, and would like to know more about, will help you to decide what needs to be covered.

What are your objectives and outcomes?

The content of your presentation will depend on the training need. When you have determined what the participants need from the information session, think about the objectives and outcomes of your session. What do you want your participants to achieve? What knowledge should they have by the end of your session? It may help you to write down a brief checklist of your objectives and outcomes for your session. This will help you with writing your session plan and designing activities for your session. Think about the key information or message that you wish to share with your audience.

Consider how the information that you are presenting addresses the identified need of the audience. The closer the match, the more relevant and effective your session is likely to be. To help you to get started with your information session consider the *What*, *Where*, *Why*, *How*, *When* and *Who* aspects of any session you may be looking to run. The following table sets out how you might look at these.

What What is the topic and content?	Site assessment for weed management planning.
Where Where will the session be held?	Meeting room at the Natural Resource Management Centre, 16 Main Street.
Why Why are you doing this? What are the benefits for the participants?	This session will inform participants of the key aspects of site assessment. This will equip participants with the knowledge necessary to contribute to planning for the NHT project.
How How will you achieve your objective?	Participants will be taken through the site assessment process, and practice basic mapping skills. The session will be followed by a field trip on Saturday the 15th May to the project site where participants will help conduct a site assessment.
When When is it scheduled?	7.00pm to 9.00pm Wednesday 12th May 20XX.
Who Who will facilitate the session? Who will you be presenting to?	Russell Coight to present. Members of the NHT project group to attend.

Start by jotting down your ideas as this will help you to clarify the basic information about your session. The "What" and "Why" questions are most important at this stage. The answers to the "How" question will take shape as you progress through this guide.

How can you help participants learn?

Adults often experience a number of feelings or thoughts when they are first in a training situation, especially if it is in a group. The feelings could be fear, embarrassment or anxiety and may be because they are concerned about things such as their level of confidence ('Will I make a fool of myself?'), the pace of the training, age, interaction with others in the group etc. It is important for you, as the presenter, to demonstrate and use positive approaches that enhance the learner's opportunity for learning. The 'principles of active learning,' listed below, will help you to provide this positive learning environment that will help your participants to learn.

Principles of active learning:

1. Active learning
2. Meaningful material
3. Multi-sense learning
4. First and last impressions
5. Practice and reinforcement
6. Feedback
7. Reward

Active learning:

'Participants learn more quickly and effectively when they are actively involved in the learning process' **We learn by doing**. You can help the learning process to be active by:

- asking questions
- using exercises in sessions
- using discussion and other small group methods
- providing practical work.

Meaningful material:

'Participants learn more effectively when they can relate new material to their existing knowledge':

- train at the person's/group's level – not yours
- use a definite form or sequence
- use examples, illustrations, comparisons
- teach from the known to the unknown
- check what learners already know…ask them.

Multi-sense learning:

'Learning methods which use two or more senses will be more effective than those which use only one sense.' When planning a session, use activities that combine the **use of a range of senses** – sight, hearing, smell, touch, taste' – in the learning process. You could:

- combine telling and showing
- provide audio visual aids
- make sure everyone can see and hear – ASK THEM !
- where possible, allow participants to handle the real thing.

First and last impressions:

People tend to recall best those things they have learnt first and last in a sequence. Remember the saying – '**first impressions are lasting**':

- always give a preview of the session
- emphasise key points in conclusion
- prepare your introductions carefully
- give lots of small introductions and conclusions during lengthy sessions.

Feedback:

'Effective learning is encouraged when trainers and learners share feedback with each other.' To do this, you can:

- encourage questions
- test frequently
- use your body language
- discuss and correct errors rather than criticise
- give learners immediate feedback of their progress.

Reward:

'Learning that is rewarding is more likely to be retained':

- give feedback immediately to learner responses
- provide for early successes in the course (nothing succeeds like success!)
- prevent mistakes as much as possible
- use problem solving approaches rather than information giving.

Practice and reinforcement:

Frequent revision can help learners to retain knowledge and practical skills. Learning is supported by frequent opportunities to practise and apply new skills and knowledge. You can help learners by:

- allocating adequate time for them to practise new skills in your session planning
- at the beginning of a session asking them to summarise the previous session
- providing exercises which encourage them to recall and apply previous learning
- asking questions frequently
- using case studies, problem solving, hypotheticals and other methods to apply new knowledge.

Be aware that there may be different levels of ability in your participants. Try to show them that you are concerned about meeting their particular needs. You will need to incorporate these principles of learning when you are developing the learning activities for your training session plan.

How to design a session plan for an information session

Session plans are basically notes about what will happen in a session that are sequenced in a logical order. These plans include the topic, outcomes and the steps taken towards achieving the outcomes (what the trainer will do and what the participants will do). Refer to Appendix 1 for a checklist to help you prepare your session plan. Plans also include times and the resources required. See the example of a session plan in Appendix 2.

Session plan structure

A session should be made up of three parts:

1. **Introduction** – participants interest will be high at this point
2. **Body** – the interest is likely to drop away during this stage
3. **Conclusion** – when the interest will pick up again.

The introduction

With a new group, spend a little time talking to the participants about yourself and establish a friendly atmosphere. You may have a short statement you can say about yourself, and the experience you have had with the topic being presented. You can make changes and adapt your introduction to suit the group you are presenting to.

You may now find it helpful to develop a point form introduction for your session. This can be presented on an overhead transparency, whiteboard or flip chart or just read out.

The body

The body part of a session plan contains more detail. Information sessions have a 'thinking' feel to them. At the end of a theory session the participants have to use their knowledge and skills to **THINK** or **SPEAK**.

For example, participants may be expected to:

- Identify and understand the key activities involved in site assessment for weed management planning
- Appreciate why site assessment is important for good weed management.

Because participants have to learn information, many may think that theory sessions will be boring and will not involve anything active – they will just listen to the trainer. But this doesn't have to be the case. (Remember the active learning principles?).

The body of the information session is divided into three major steps:

1. Explanation

2. Activity

3. Summary.

Step 1: Explanation

- Give an overview first, and then the details in small steps
- Provide information in a logical sequence
- Use examples to illustrate your points
- Use questions to check the knowledge and understanding of your participants
- Use training aids to emphasise key points.

Step 2: Activity

Providing an activity allows participants to apply the information or concepts from the explanation stage. Some ideas for activities include:

- Brainstorming
- Questions to the group
- Problem solving exercises
- Case studies
- Field trip.

Applying new knowledge to a practical situation, whether real or simulated, reinforces learning and increases motivation. Activities should be simple to organise and facilitate and should have direct relevance to the content covered. The activity not only maintains the involvement of participants, but it also provides you with feedback about the participants understanding of the content you have covered in the explanation stage. If you find that participants' are having difficulty applying new information you will know that more explanation is required before moving on to the next step of learning.

Step 3: Summary

When the participants have applied the information to the activity, and achieve the necessary results you are ready to summarise the key points. For example '*You have done a great job with the weed map, now lets summarise what we have covered so far*.' Key points may be reinforced using an overhead projector, flip chart, board or powerpoint slides. If you are out in the field you can simply state '*These are the key points…*', and then state them. The idea is to help people remember the most important information.

The conclusion

The conclusion part of the training session gives the trainer the chance to:

1. Remind the participants of the training **outcomes** they covered in the session
2. Give participants some constructive **feedback** about how they went during the session. For example, highlight strengths of the group or activities that were achieved well
3. Show the participants how the information and skills in this session relate to the future, whether relating to a **future** training session, future organisational plans etc.

Refer to the Session Plan in Appendix 2 to get some idea of what they contain.

Learning resource materials

Almost anything can be used as a learning resource – equipment, pictures, people, weed management guides and so on. In addition to these suggested resources there are particular items of equipment that many trainers use when conducting their sessions in a training situation. These include powerpoint presentations, slide projectors, whiteboard, overhead projector, computers, flip charts, video players, and so on. Note that it does not have to be hi-tech to be effective as simple methods work fine.

List the equipment you are most likely to use in your session.
Always check your resources prior to the session.

What information will you record?

In the preparation stage, it is important to think about the key information that you will record for your session. Common examples of information that is useful to record include dates, the topic, name of the presenter and participants names etc. It can be helpful to use the first page of your session plan to record this information.

How to deliver and review your training session

By this stage the session plan is developed and your content is organised and planned. In this section we will look at the following areas:

- the training environment
- presenting skills and Training Aids
- feedback
- asking questions
- review of training sessions
- keeping training records.

Training Environment

Learning is more likely to occur if the learning environment is a positive one. Ensure where possible that the physical aspects of the venue are conducive to learning. OH&S guidelines should be followed ensuring a safe environment is provided. Attention to the simple things is important. For example, is lighting adequate, can it be turned down/off easily during the use of visual aids, is the area quiet and so on.

An atmosphere of mutual respect can be created by recognising the vast range of experience, knowledge and skills present in a group of adult participants.

Presenting Skills

When talking to a group, there are a number of things to keep in mind. These include:

- Plan thoroughly. Know exactly what you want to achieve, and more importantly what you want the group to achieve in the session.
- Imagine the scene – visualise yourself conducting the session.
- Practice – conduct a trial run some anxiety or nervousness is usual in everyone before they do a presentation however, if you have practiced, it will flow better and you will feel better prepared.
- Posture – stand straight, but in a relaxed way and point your feet towards the group with your weight evenly balanced.
- Movements – try not to sway as you talk; your hands become an important part of any presentation, use them naturally rather than trying to keep them totally still.
- Facial expressions – a natural smile works wonders, however a pasted on smile will not be very convincing. Excessive blinking and twitching your eyes will be distracting to the audience.
- Eye contact – gain contact with each individual in the group (for short times only).
- Voice – use a clear, strong voice and don't speak too quickly, use an interesting conversational tone (not a monotone), stand tall, take deep breaths and be sure the group can hear you.

Training Aids

Training aids include resources or items that assist you with your session. They may include items such as:

- charts
- overhead projector
- examples of weeds, either actual or good images
- handouts (notes)
- equipment used in weed control or weed mapping.

Preparation and planning are an essential part of the effective delivery of a session. If you plan and prepare adequately, your session is more likely to go smoothly and, more importantly, the learners will be more likely to achieve the learning outcomes. Ensure that all equipment and resources are available for your use at the appropriate time. Make sure that you know how to use it ahead of time and that, if possible, know how to fix it (or have an alternative) for when things go wrong.

Giving and Receiving Feedback

Participants are usually interested in knowing how well they are doing. It is part of your role as a presenter to know how and when to give constructive feedback. When giving feedback it is necessary to give it in such a way that it will not be threatening to the other person and not increase their defensiveness. All feedback should be constructive – meaning we give it so the person can use it to build themselves up and move forward.

Examples of feedback given during a session.

Positive feedback	*'That's good. You have done that very well.'*
Positive constructive feedback	*'That plan looks good. All the major issues are covered, it's nice and short and easy to understand. Well done.'*
Negative feedback	*'That plan is terrible. What went wrong? It's awful.'*
Negative constructive feedback	*'I notice you're having some trouble selecting which weed treatment to use. It can be confusing when there are so many options to choose from. Let me go through the issues again with you. Do you want to have another go?'*

When you are asked or expected to spend some time giving feedback to an individual participant after a training session, the following four-part model is helpful:

1. Ask the participant what they think/feel they did well.
2. Ask them what they would do differently next time.
3. Add constructive feedback about the things not covered by the participant, both positive and negative.
4. End on a positive note.

By using these strategies during and after your training sessions you will be creating a learning environment where people feel at ease with each other. It is important to create an atmosphere of mutual trust and openness in the group. This will help everyone feel more comfortable about giving and getting feedback.

Receiving feedback

Even though we might feel nervous at the idea of it, we all need to know other people's versions of how we come across – this can help us to improve the effectiveness of sessions we run. A few points that can help when receiving feedback:

- thank the giver and respect their openness (and courage)
- value their comments and their point of view
- clarify it with them by paraphrasing or repeating it without being defensive
- reflect on the feedback and whether you think it is reasonable
- check it out honestly with others, rather than relying on this one source only
- if it is reasonable, act as soon as you can to deal with the problem
- if it is not reasonable, work through the issue with the giver
- learn from the experience
- model this process for your participants.

How to review and evaluate your information session

There are two main questions that you can consider when evaluating your sessions:

1. Did the participants achieve their goals or objectives?
2. Were the techniques and activities you used in your session the most effective ways to help participants achieve the required outcomes?

To answer the first question, you will need to look back at the original needs. Work out whether the knowledge of the participants after the session is closer to the objective (or participants expectations) than it was before the session. It is important to gather feedback from participants, colleagues and others so that you can improve the techniques, activities and delivery of your training sessions. It is also useful to gather feedback at the end of each session from participants so that you can think about whether you need to make any improvements.

Feedback can be obtained in a number of ways. You might prepare a simple form that has questions about how useful the presented material was, what participants would like to see added or changed and any other general comments that participants might like to make. Of course, you can just ask the group at the conclusion of the session the same questions, although people may be less forthcoming verbally in a group.

It will also be useful to conduct your own self-evaluation of the session and consider how well you think the session went and what areas may need to be changed.

Asking questions

Questioning is an essential skill for presenters to use. There are lots of reasons for asking questions. These days they are not used just for testing someone's knowledge. They could be used:

- to focus attention on a certain topic
- to encourage interest
- to promote activity
- to check on and extend the participant's understanding
- to slow down or speed up the pace of a training session
- to challenge the participants to think more deeply
- to assess the participants progress.

The questions a presenter asks are either thought up in advance of the session (pre-set) or arise during the session. There are two types of questions that trainers use during their sessions: 1. closed 2. open.

Closed questions

Closed questions are usually answered with **YES** or **NO** or a very short statement. Be careful when you use this type of question with participants who are a little shy or feel anxious. They may not feel confident to add anything further to their simple answers and you might never find out the real depth of their thinking. The speed and tone of voice are very important with these short, closed questions because it is easy for nervous participants to interpret them as being abrupt or even rude.

Examples:

- *Have you used this equipment before?*
- *Do you know how to conduct a site assessment?*
- *Do you understand the protocols for weed mapping?*

Open questions

Open questions **cannot** be answered with **YES** or **NO**. They are used to encourage the participants to give a more detailed answer usually containing their own feelings or opinions. They are very useful with a new group because they bring out a wide variety of responses and can get a group discussion started.

Examples:

- *What do you know about site assessments for weed management?*
- *What are the advantages and disadvantages of using herbicides?*

When asking questions

- be brief and clear
- keep it simple
- allow for time for response (silence is okay)
- show honest intentions (no trick questions)
- give praise and encouragement
- avoid sarcasm
- avoid slang, colloquialisms, confusion.

Techniques for answering participant's questions

When participants ask questions in a session you can respond in a number of ways depending on the situation:

- If you think the participant has done quite a bit of thinking about the question before asking it, you can **encourage them to try to answer it themselves**.
- If you think another participant in the group should have a pretty good chance of handling it, you can **redirect the question to another participant**.
- If it's a question that you want all the participants to focus on you can **redirect the question to the whole group to answer**.
- If the answer is fairly simple, you can **hint at it**. The extra clues may stimulate all the participants to think more broadly and possibly come up with an answer.
- You can give an answer that provides factual information, expresses your own opinion or lets the participants know that you don't have an answer but are happy to look further into it with them later.

Records

Records are an important aspect of managing your training program because they provide the details that people may need to refer back to in the future. It is helpful to record minimum details of your training session including the date, location, participants, topic, organisation and facilitator. Your evaluation of the session is also useful to keep in case you run a similar session at a later time.

Putting it all together

1. Is the venue appropriately set up considering activities, participant numbers, safety requirements and accessibility.
2. Introduction: Provide an introduction to the session, including introduction of self and participants, details of learning objectives, linking of training to previous knowledge or training, outline of training delivery methods and competency requirements.
3. Body of the information session: Use appropriate strategies and techniques to facilitate the learning of knowledge.
4. Conclusion of training session: Review the learning objectives with participants providing relevant feedback, and linking to further training opportunities.
5. Consider your presenting skills, training aids, and how you will give and receive feedback.
6. Review and evaluate the session, using self-evaluation and feedback from participants and their supervisors and measuring outcomes against training objectives.
7. Keep appropriate records.

Appendix 1: Session Plan Checklist

- Research the material
- Identify the learning outcomes
- Choose appropriate:
  - learning methods (group, role play, discussion)
  - training resources and aids
- Organise the content:
  - priorities
  - sequence
  - key points
- Write the session plan
- Check the plan (yourself, colleague)
- Prepare and check the aids and facilities
- Evaluate the plan.

Appendix 2: Session Plan

Presenter: Russell Coight

Session: Site Assessment

Duration: 2 hrs

Session Outcomes:

By the end of this session, participants will:

- Understand the key components of site assessment
- Be able to establish location using a map to obtain AMG coordinates (or GPS unit if available)
- Demonstrate an understanding of weed mapping.

Materials required (per person):

- All Handouts
- 1:25000 map which includes training venue location (group to share map and use to establish location) or GPS unit to be shared by group
- 2 x transparencies to use as overlays for site map
- Blank sheets of A4 paper for site maps.

Teaching Aids:

- White board
- Overhead projector.

Names of those attending:

Presentation: Site Assessment

Time	Content	Methodology
10 mins	**Introduction** **Get Attention:** • Welcome • Introduce self • If participants don't know each other and it is a small group get each person to introduce themselves.	
	Introduce topic: Site assessment **Link:** Describe where this session fits in with long term weed management planning **Stimulate:** • Good weed management needs good planning. The site assessment is important because we need to know what we are dealing with **before** we can start planning. It will help us develop a workable plan and also provide the means to monitor the effectiveness of our work over time. **Outcomes:** • By the end of the session participants will understand key aspects of a site assessment and why it is important. • Participants will be able to establish their location using a map (or GPS unit), get to know what's involved in completing a site assessment sheet, a simple weed map and setting up photo points. **Structure:** • Will go through each part of the site assessment process using hand outs and overheads • Participants will have a go at establishing the location of this venue using a map or GPS, creating a site map and become familiar with a site assessment sheet and photo points. • Next Saturday a field trip will be held to start a site assessment for the groups NHT site and we will then have a chance to put into practice what we have done.	Explanation (Refer to module 1 of manual).
30 mins	**Body** **Site assessment:** **Explanation:** • Go through material in manual (pages 4 through 6) plus other material relevant to your situation. • Stress value of the site assessment in helping to set realistic objectives, improving outcomes, will save time later and enable better communication with others. • Work through a sample site assessment sheet. • Explain how to establish location **Activity:** • Group to establish current location of training venue using either 1:25000/1:50000 map to find AMG coordinates (Eastings & Northings) **and/or** a GPS unit	Handouts. Overhead Transparency or whiteboard or handout. Handout Appendix 3 of module 1 (especially if map being used to establish location).

Time	Content	Methodology
	Summary: • Summarise site assessment, reasons for it and usefulness of information for planning and for others.	Have appropriate maps and/or GPS unit/s.
30 mins	**Weed mapping**	
	Explanation: • Go through material pages 4 to 9 of module 1 (up to **Photo points**) • Place emphasis on importance of mapping to assess a situation, guide work and as a tool for monitoring progress and reporting to others (eg funding bodies). • Show a worked example of a simple map (eg example in module 1 or preferably a local example).	Handout or Overhead transparency.
	Activity: • Practice mapping 1) develop a site/sketch map, consider issues of scale, map orientation, marking out boundaries, features etc. 2) using transparent overlays to mark out weed infestations (if venue has areas of vegetation nearby these could be used for a mapping exercise).	Mapping materials, transparencies, marker pens etc.
	Summary: • Review process, problems encountered and how these may be overcome. • Ask each participant to speak on how they found the process, concerns or suggestions that they may have.	Show examples of photo points and images taken over time (examples on net).
15 mins	**Break: Tea/coffee**	
25 mins	**Photo points**	
	Explanation: • Go through information on page 11 and12 of module 1. Establish why photo points are used and how they are established and used.	
	Activity: • Participants mark out what they regard as best locations for photo points on practice map they have created in previous session. • Open discussion guided by presenter and prompted by questions on why points chosen.	Handouts (Pages 11 & 12 module 1).
	Summary: • Review the photo point process and its importance as a means of seeing change over time, note that photo points do not explain why change has occurred. Other site information will be needed to establish this.	
10 mins	**Conclusion**	
	Key points: (review learning outcomes)	
	Feedback:	
	Future: Next session we will look at: • Interpretation of site information. • Setting priorities/objectives and developing the action plan.	Overhead transparency or whiteboard.
	Thank you for your participation!	