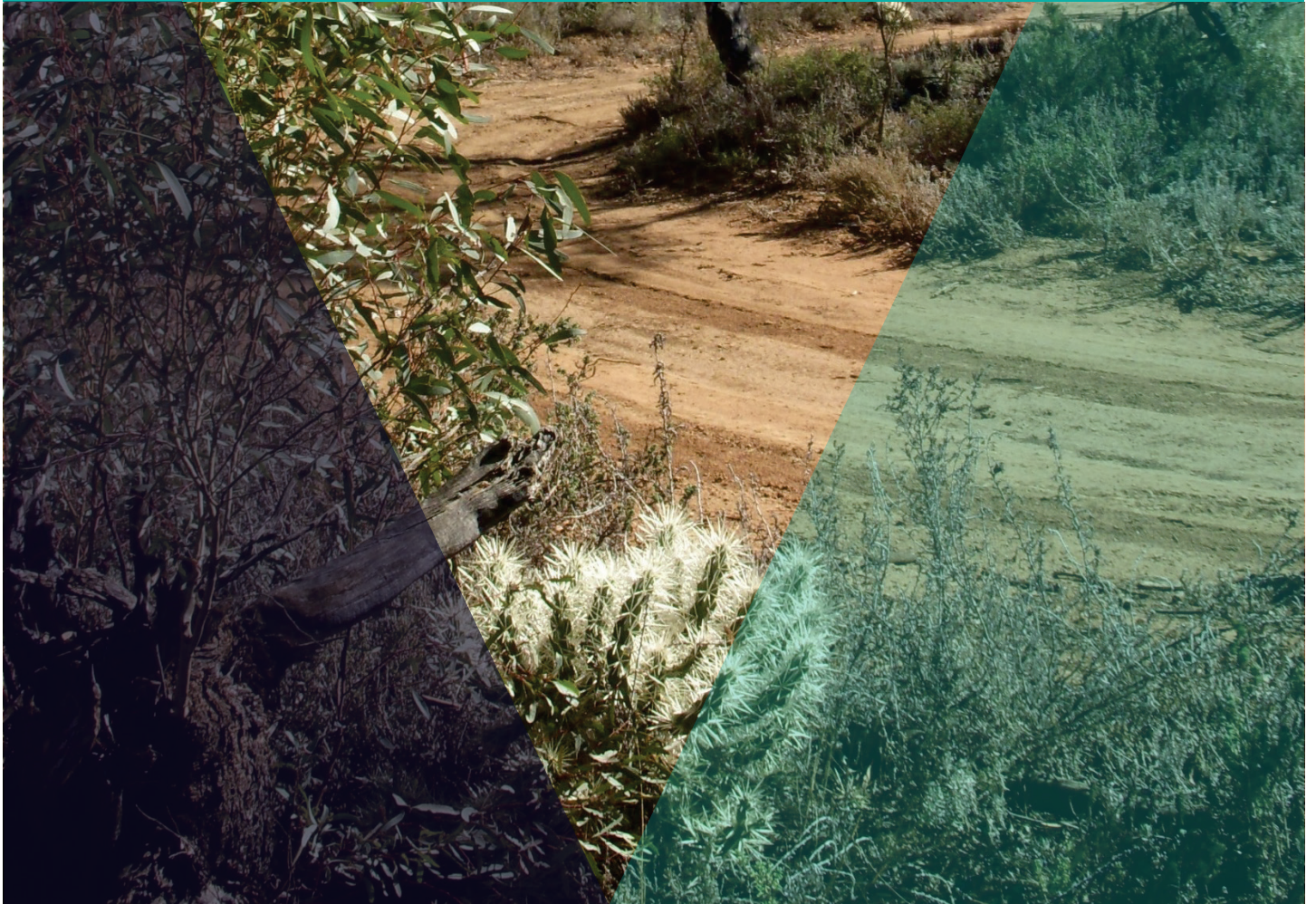


Looking for weeds: delimiting survey guide

A guide for planning and undertaking delimiting
surveys for weeds at the early stage of invasion on
public land in Victoria



2nd Edition

Photo credit

Cover photo: White-spined Hudson Pear (*Cylindropuntia pallida*) (foreground and far side of track) at Ouyen State Forest, March 2014 (Photo by Bec James).

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Victorian environmental weed risk database (2018), search online for 'early invader weeds'.

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About this guide

Once you have identified a high risk weed, you need to find out how far the infestation has spread. Knowing this information will provide clarity on the scale and task ahead for managing the infestation.

Invasive species management is an integral component of any landscape or reserve scale conservation program. This includes weed management.

Increasingly around the world, the benefits of preventing and 'nipping new weeds in the bud' before they become widespread are being appreciated.

About WESI

The Weeds at the Early Stage of Invasion (WESI) Project was created to promote these benefits and enable Department of Environment, Land, Water and Planning (DELWP) and Parks Victoria public land managers adopt this approach.

The WESI project focuses on high risk invasive species at the early stage of invasion that threaten biodiversity. We work with DELWP and Parks Victoria staff looking after public land anywhere in Victoria.

WESI is funded through the Weeds and Pests on Public Land Program. Project information and tools are available at: www.environment.vic.gov.au/invasive-plants-and-animals/early-invaders

Working within a framework

The WESI project has developed a decision making framework that guides public land managers through the process of dealing with invasive plants at the early stage of invasion (see Figure 1). This guide describes in detail a component of the larger framework.

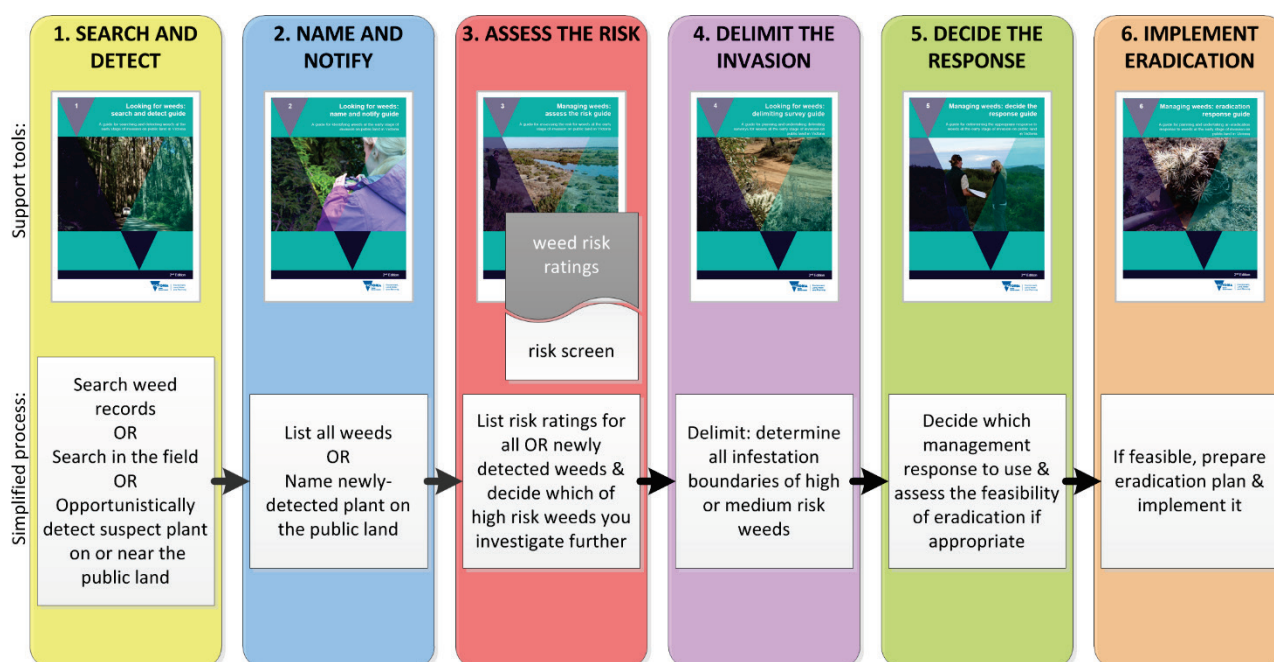


Figure 1 - This is the WESI decision making framework that guides the process for dealing with weeds at the early stage of invasion. There is an enlargement of the framework with scenarios in Appendix 1.

The guide series

Through research and trialling different approaches in the field, there is a growing amount of information about prevention and early intervention for weeds.

This document draws on that research and experience to offer a guide for public land managers, whether they do the work in the field, design the work or authorise the delivery of the work.

By using all the guides in this series, public land managers can improve their decision making about what are the highest risk weeds, how to search for and identify them, determine where the infestation boundaries are, work out which management approach is best and where feasible, respond with local eradication.

The early invader guide series is one of a number of tools available through the WESI project. The series provides step-by-step guides to plan and undertake the following work:

- Search and detect
- Name and notify
- Assess the risk
- Delimit the invasion (comprising all infestations present)
- Decide the response
- Implement eradication (if appropriate)

A summary of the guide series is available with all the blank templates in “Early invader manual: managing early invader environmental weeds in Victoria” (Blood *et al.* 2019). The tools are available at: www.environment.vic.gov.au/invasive-plants-and-animals/early-invaders

Weed management including eradication

Weed activities fall into four broad categories: prevention, eradication, containment and asset-based protection. By better understanding these different management approaches, public land managers can make better decisions, invest resources more wisely, and have better biodiversity outcomes.

Eradication is the elimination of every single individual (including propagules e.g. seeds and buds) of a species from a defined area in which recolonisation is unlikely to occur (Panetta 2016).

There is no denying that eradication is hard to achieve, can take a long time and should only be undertaken for candidates that have a good probability of success. Using these guides will help you make better decisions.

Weed management should not simply be dismissed as ‘too hard’, but, through some careful planning and a continued and sustained response, can achieve great benefits for biodiversity.

What is ‘in the early stage of invasion’?

There is ongoing debate about what area and number of infestations could be classified as eradicable. In reality, the answer depends on the weed and the situation because of the wide variation in the biology and ecology of weeds and the many different environments in which they grow. As a consequence, the relationship between the infestation area and the effort needed to achieve eradication will also vary (Panetta and Timmins 2004).

Through this guide series, we refer to ‘weeds at or in the early stage of invasion’. The shortened term is ‘early invaders’.

Early invaders are plants that have naturalised and have started to spread. Naturalised plants are non-indigenous species that sustain self-replacing populations for several life cycles without direct intervention by people, or despite human intervention. When spread has just begun, such plants are not at all widespread and are generally encountered only by chance, unless specifically targeted by search efforts. Co-ordinated management intervention, i.e. eradication or containment,

is at its most feasible for plants at this stage of invasion, owing to their highly restricted distributions (Panetta 2016).

The aim of this guide

The aim of this guide is to assist users with the process of how to plan and perform a delimiting survey on public land. This guide supports the 'Delimiting survey' step in the framework shown in Figure 1. Use Figure 2 to help you navigate your way around this guide and the others in the series.

Before you start

These guides are full of different 'tools' and hints to help you through the weed management process. You may want to start at the beginning and work your way through step-by-step or browse for ideas in your topic of interest. Managing public land involves balancing many requirements of which weeds are only one. Making decisions about which weeds to manage must be made in this broader context.

These guides lead you through the process to eradication of early invaders, but generally eradication will not be the aim for most weeds. It is essential to be aware of the limitations of these guides, as well as the ongoing need for their modification in light of experience, intuition and local knowledge. Effective environmental weed management comes through long-term observations, learned skills and being able to make decisions based on the local conditions. These guides are to help, not substitute for, these important skills (Blood *et al.* 1996).

Why do I need to undertake a delimiting survey?

The aim of carrying out a delimiting survey is to determine the full extent of a weed invasion (Panetta and Brooks 2008) i.e. how far has the weed spread in the landscape, in order to determine if the weed is at or beyond the early stage of invasion. This includes the identification of the core infestation and associated satellite infestations, which have locally arisen from the core.

Confirming the true boundary of a new weed infestation is a fundamental task required to make a decision on whether eradication is feasible. It will also provide you with clarity on the scale of the task ahead and the resources required to survey and treat the infestation (Jeffery 2012). A recent, well documented example of the delimitation of a Boneseed (*Chrysanthemoides monilifera* subsp. *rotundata*) invasion in Western Australia is provided by Scott and Batchelor (2014).

It is important to remember that while identification of the extent of the infestation is mainly restricted to the area of public land that the public land manager has responsibility for, this doesn't mean that an attempt should not be made to identify core or satellite infestations on adjoining land tenure. On the contrary, the latter is a vital step in determining how suitable a weed might be for eradication. If it is not possible to reliably prevent reinvasion from surrounding land, there is little point in attempting local eradication.

If private land does become a factor with your delimiting survey, seek voluntary cooperation from the private landowner and/or talk to your local Department of Economic Development, Jobs, Transport and Resources (DEDJTR (to be replaced by Department of Jobs, Precincts and Regions (DJPR) on 1 January 2019)) Agriculture Victoria biosecurity contact to see whether the area is subject to a compliance program.

Prior to planning and undertaking a delimiting survey a number of steps outlined in the decision making framework (Figure 1) should be completed. These include:

- initial detection of a suspect plant;
- reporting the suspect plant to the WESI project team;
- correct and verified identification of the detected plant;
- notification to the relevant agency/land manager of the presence of the detected plant;
- recording the infestation or individual plant into the Victorian Biodiversity Atlas (VBA);
- undertaking an assessment of the risk the identified weed poses to the surrounding landscape; and
- a determination that the weed is of high risk to the surrounding landscape.

Once all the above are completed, you are now ready to plan and perform a delimiting survey. Figure 2 shows you how to use this guide. A quick guide to planning and performing a delimiting survey is shown in Figure 3.

How do I delimit a weed infestation?

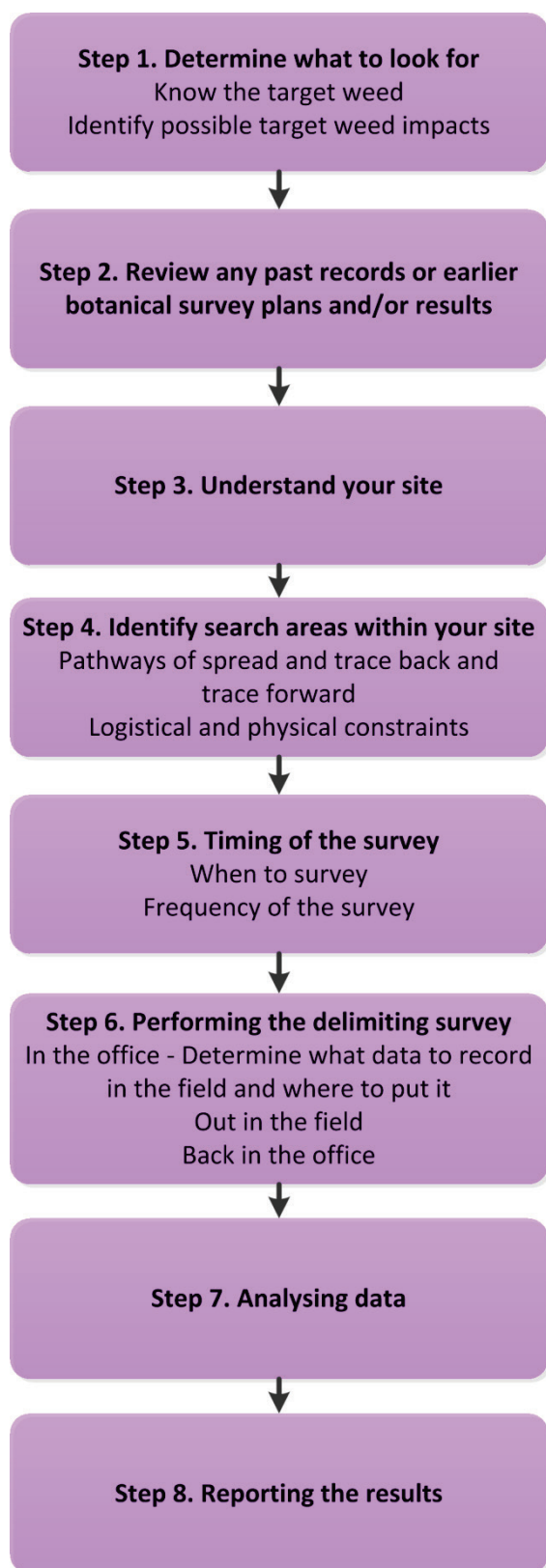
I want to plan and undertake a delimiting survey to determine how far a weed has spread at my site. Here is the process to follow.



Figure 2 - How to use this guide.

Quick guide to planning and performing a delimiting survey

A delimiting survey requires pre-planning to maximise the likelihood of detecting the target weed within the search area. This section lists eight steps that will assist in planning and undertaking a delimiting survey.



If you are planning a delimiting survey from scratch, follow this guide in its logical order. Alternatively, you can go to the relevant section of the guide for the advice you require.

Figure 3 - Steps to planning and undertaking a delimiting survey.

Step 1. Determine what to look for

Know the target weed

Once you have located a weed in the field, the true extent of its spread in a landscape needs to be determined. The first step is to become familiar with the weed's biology and ecology. Knowing these will assist in determining the optimum time to carry out a survey, where to search, how often to search and the length of time it may take you to eradicate a weed (if applicable) (Jeffery 2012). It will also make searching for the target weed more efficient.

Characteristics of a weed that you should investigate include:

- identification characteristics (e.g. Figure 4) and look-alikes so you make a confident identification in the field;
- method of reproduction e.g. seed and/or vegetatively (i.e. via suckers, bulbs, corms);
- seed longevity, seedbank and budbank;
- time the plant takes to reach maturity;
- annual growth cycle (e.g. when does it flower? Is it dormant below ground during certain seasons?);
- dispersal mechanisms (e.g. attractive fruit, barbs);
- dispersal vectors (e.g. wind, water, vehicles, birds, foxes);
- habitat suitability (e.g. does the target plant prefer shade, riparian areas, disturbed areas, open areas, frost free habitats etc.); and
- particular conditions that would make it easier to find in the field e.g. flowering period, or leaf coloration at certain times of the year.

Information on how to identify a plant can be found in the "Looking for weeds: name and notify guide".

The preferred habitat of the weed will influence where you should search; the majority of survey effort should be directed to the areas most favourable for the plant.

Weeds often invade due to some change in the landscape. Weeds can be a symptom of these changes so looking for where landscape changes have occurred e.g. where a fire has burnt, can help influence where you should search.

It is vital when undertaking a delimiting survey that you know as much as possible about the biology and ecology of the weed. This will provide you with the best chance of identifying all the likely sites that it might have infested, and ultimately correctly delimiting an infestation (McMaugh 2005).



Figure 4 - Photographs of the characteristics that are useful for the identification of a plant. The plant shown above is a Black Locust (*Robinia pseudoacacia*). Left: whole plant; top right: flowers; middle right: leaf arrangement; bottom right: any distinguishing feature i.e. thorns on stems or fruit. Images by Bec James, DELWP.

Step 2. Review any past records or earlier botanical survey plans and results

Investigate whether there have been any previous sightings or recorded information of the target weed or any other weeds in the immediate and surrounding areas. Databases and sources of information that should be checked include:

- Spatial, Temporal, Activity Recorder (STAR) (for DELWP and Parks Victoria): <https://star.biodiversity.vic.gov.au/STAR.UI.Web/>
- Victorian Biodiversity Atlas (VBA): <https://vba.dse.vic.gov.au/vba/#/>
- VICFLORA: <https://vicflora.rbq.vic.gov.au/>
- Flora Information System (FIS) (Viridans Pty Ltd);
- Environmental Information System (EIS) (access through Parks Victoria);
- Bioweb, Bioweb2, MAX (access through Agriculture Victoria);
- Crown Land Manager (CLM) Pest Infestation Sites (access through DELWP);
- Australia's Virtual Herbarium (AVH): <http://avh.chah.org.au/>

- Atlas of Living Australia (ALA): <http://www.ala.org.au/>
- herbarium specimens and records viewable through AVH & ALA otherwise by appointment with National Herbarium of Victoria;
- Victorian Resources Online (VRO): http://vro.agriculture.vic.gov.au/dpi/vro/vrosite.nsf/pages/invasive_plants_common_a
- local databases, spread sheets, maps, Geographic Information System (GIS) layers, works plans of weed infestations, note books, filing systems, and registry files;
- local reserve, forest, and park etc. management plans that may include weed lists; and
- other local DELWP or Parks Victoria staff for information and tap into local community networks.

Step 3. Understand your site

Clearly identify the area you wish to undertake the survey in and work out what the characteristics are of the area. It is important to understand the following:

- land use and tenure (i.e. private land, Crown land including State Forest, National Park, and reserves);
- topography (i.e. flat or steep terrain);
- access (some areas may be in closed catchments or not safe to access in the winter months or during the fire season);
- climate/ weather conditions;
- vegetation types (e.g. Ecological Vegetation Classes) (if required); and
- potential vectors that may be present (e.g. foxes).

Understanding the characteristics of the survey area will inform how the survey could be carried out and assists in identifying any potential barriers and/or opportunities there will be for carrying out the survey.

Step 4. Identify search areas within your site

This guide uses a series of terms to describe how to partition your management area for undertaking a delimiting survey. This includes terms such as public land, site, search area/s and targeted survey area. These are illustrated in Figure 5, with the area in green being the whole public land area. This could be a reserve, State forest, national park etc., wherever you are working.

The *site* is the area within the broader reserve, State forest, national park etc. that is considered during the delimiting survey.

The *search areas* are nominated areas that will be actively searched during the survey for the target weed.

The *targeted survey area* is where a detailed small scale survey is conducted and where close attention is required (this is explained further in the section titled 'Targeted survey').



Figure 5 - An illustration of the different scales of site and the terminology assigned to them - the concept of public land, site, search area and targeted survey area.

Once you have located the target weed, researched its ecology and biology, identified any past records of the weed and become familiar with the survey site, it is now time to determine which areas should be surveyed.

Pathway analysis, trace forward and trace back

For small sites the whole site may be able to be searched in its entirety. However, for medium to large sites, this is usually not practical. Therefore, areas within these sites need to be prioritised. One way of prioritising areas to be searched is to carry out a pathway analysis.

A pathway analysis identifies the invasion pathways (for both deliberate and accidental introductions), assesses the degree of risk associated with each and the management options needed for high risk pathways (Downey *et al.* 2010). It involves identifying the characteristics of how the target weed spreads i.e. the vectors and mechanisms it utilises to spread in a landscape.

A list of vectors and mechanisms of spread are listed over the page to help you determine these for your target weed.

The next step is to trace forward from an identified infestation and determine where else the target weed may have spread to within the public land concerned. Then, if possible, trace back to where you think the weed may have come from outside the public land (the source).

Trace forward and trace back are usually related to human assisted transport of weeds, both deliberate and unintentional. These terms are more commonly used during biosecurity emergency responses but can also be used by public land managers when considering the arrival or spread of weeds into and from a public land area. Tracing dispersal by natural means such as wind, water or wildlife is usually concerned with much shorter distances than is dispersal via human assisted transport.

Refer to the following pages for a list of locations and potential sources for your particular weed (also refer to Figure 6 for some examples).

Using the information collected on the pathways of spread and the trace forward and trace back investigation, identify which one(s) of these will be your highest priority to consider when searching for the target weed and factor this into deciding where the search areas will be. It may also be worth considering refining the search areas to make them practical when out in the field. For example, use roads, rivers, streams, land marks etc. as the boundaries of your search areas.

Factor into the search areas any species that are able to disperse over long distances. These are the most unpredictable and can result in plants being located in new and unexpected parts of a landscape (Fox *et al.* 2009).

Once you have identified the search areas within your site, draw these on a map and include this in your search plan (refer to Appendix 2).

Vectors or mechanisms

How the weed got there

- Wind dispersal (consider wind direction and local topographic influences)
- People dumping garden waste
- Water e.g. flood, drainage lines
- Wildlife including birds, kangaroos, bats (internal and external spread)
- Livestock (internal and external spread)
- Pest animals e.g. fox, deer, pigs (internal and external spread)
- Roadside and maintenance equipment
- Vehicles e.g. 4WDs, trail bikes
- Horses (including recreational riding)
- Contaminated hay and fodder, including at campgrounds where horse riders congregate with horse floats and trucks, and where hay and produce may have been deposited to feed wildlife after bushfires
- Soil
- Recreational and camping equipment, skis, ski runs and ski tow-lines/chair lifts
- Overseas builders, where they have worked
- Contractors
- People (i.e. footwear)
- Boats and boat trailers
- Trailers
- Fishing nets and equipment
- Companion dogs (i.e. being walked)
- Weed surveyors and weed management activities
- Emergency vehicles and equipment

Locations – within the survey area

Places the weed is more likely to establish

- When in fragmented landscapes, focus first on edges
- When in large areas of continuous vegetation, focus first on pathways of spread into and through the areas, and then the edges
- Coastal dunes, especially where close to gardens and if rehabilitated using non local species
- Places modified by humans e.g. railways, quarries, disused agricultural land, old homesteads (DOC, 2000)
- Rabbit and other animal diggings
- Track and road edges
- Earth works
- Sites where road and track making materials are stored
- Riparian areas
- Dumping sites for garden waste etc.
- Along pathways of animal movement e.g. deer, foxes, wild pigs
- Under prominent perch trees and fence lines
- After a wildfire or flood event

Sources – outside the survey area

Where the weed is likely to have come from

- Nursery and propagation trade
- Garden cultivation (not necessarily urban gardens)
- Deliberate planting on or adjoining public land.
- Camp sites/grounds
- Old rehabilitation sites e.g. sand dunes
- Garden waste dumping – look along secluded tracks, car parks, across the street and over back fences
- Places modified by humans e.g. railways, quarries, disused agricultural land, old homesteads (DOC 2000)
- Historic land marks e.g. mine sites, township sites
- Arboreta, street trees
- Cemeteries and memorial sites
- Drainage lines
- Drain outlets
- Dams
- Bridge crossings
- Four wheel drive or quad bike tracks



Figure 6 - Examples of sites and sources where weeds may occur. Far left: Bulbil Watsonia (*Watsonia meriana* var. *bulbillifera*) along a railway line; middle: Wild Statice (*Limonium sinuatum*) in a reserve abutting a residential property; top right: Bluebell Creeper (*Billardiera heterophylla*) occurring on dam bank; bottom right: Riverina Pear (*Opuntia elata*) and Century Plant (*Agave americana*) present amongst rubble and wire. Images by Bec James, DELWP.

Logistical and physical constraints

The ideal scenario is to be able to search all sites in all areas for the target weed (McMaugh 2005). In many delimiting surveys, however, this is not possible due to the costs and the limited resources available. So, in addition to identifying the priority search areas through a pathway analysis and the trace forward and trace back exercise, it is also important to identify and consider what are the logistical and physical constraints of carrying out a delimiting survey.

Consider the following:

- Budget available
- Resources available:
 - staff and volunteers
 - vehicles and survey equipment
 - specialist knowledge for plant identification
- Access to survey area (i.e. permits, permission from landowner, keys to locked gates)
- Wellbeing and safety e.g. fire season, flooding, heat, cold, steep slopes, mine sites, snakes, tides in coastal areas, unexpected snow at elevations, mobile phone reception

When you have determined all of the above, identify the search areas that are considered most important to survey and then work back from there.

When planning, it is also important that any permits or permission for access is obtained by the relevant authority or land owner prior to undertaking the survey. Permits for collecting and transporting declared weed specimens also need to be taken into account. Contact your local DEDJTR Agriculture Victoria biosecurity officer or Parks Victoria officer if you want to collect on Parks Victoria managed land, for further assistance.

Step 5. Timing of the survey

When to survey

The timing of the delimiting survey will depend on when the weed is found for the first time, and how quickly the survey can be planned and organised.

The more quickly a survey can be planned and organised the better, as this will reduce the opportunity for the weed to spread further.

A delimiting survey should be planned for good conditions and with sufficient time allowed. A rushed survey due to lack of time, failing light conditions or poor weather is likely to result in an incomplete survey. Revisiting to complete the survey is not efficient. Long term weather forecasts make it possible to predict weather conditions for field work. Also allow sufficient time to photograph the plants.

Ideally the best time to look for a weed is when the growing conditions are ideal and the plant is flowering or exhibiting some other form of growth that makes it easy to see e.g. brightly coloured fruit or spines that are easy to see against a low sun. However, this might not be the case when a weed is first found (e.g. during winter) so it is important to get your 'eye in' on the weed under less than ideal conditions.

Other factors to consider that may affect the timing of the commencement of a survey include (McMaugh 2005):

- accessibility and availability of resources (i.e. people, vehicles);
- timing of other activities (i.e. planned burning, timber harvesting);

- seasonal growth of surrounding plants; and
- flowering of other co-occurring plants that are similar to the target weed.

Step 6. Performing the delimiting survey

Delimiting surveys are generally performed on the ground, but aerial survey may also be relevant for some species and can be highly cost-effective. Aerial survey (subject to current aviation regulations) may be carried out from fixed winged aircraft or helicopters, or by remote-controlled craft, an unmanned aerial vehicle (UAV) such as a rotocopter or drone. The “Looking for weeds: name and notify guide” includes a photography and video guide that could be useful.

There is some preliminary work to undertake before you go into the field and start looking for your target weed. This will put you in a good position to be prepared for all scenarios when out in the field.

In the office

Complete search plan template (optional)

To assist in completing steps 1-4 outlined in this guide, fill out the search plan template (see Appendix 2) for your target weed and for the site where you want to carry out the delimiting survey. The completed search plan will assist you in becoming familiar with the biology and ecology of your target weed and characteristics of the site.

Identify search areas within the site

Using the information collected in the search plan, identify and prioritise the search areas within your site. Include these on any maps you create to take out in field.

Create maps to take out in the field

Creating a variety of maps to take out in the field will greatly assist in orientating yourself at the site, identifying areas that may need to have a targeted survey undertaken (this is explained further in targeted survey section) and identifying any correlations between the presence of the target weed and factors such as vegetation type, land use etc.

A list of useful maps to take out in the field includes:

- location of the search areas within your site;
- locations of previously recorded infestations of the target species;
- the land status of the site, including its boundaries and adjoining land use; and
- an aerial photograph of the site to draw on in the field.

Pre-load data onto a GPS

It is a good idea to load the road network, property/ parcel boundaries and any previous recording of your target weed onto your GPS. This will make it a lot easier when orientating yourself in the field, and in relocating previous infestations of your target weed.

Equipment to be used for the delimiting survey

Gather the equipment you will require to perform a delimiting survey. A list of suggested equipment can be found in Appendix 3.

Determine what data to record in the field and where to put it

Consider what data you will collect in the field. A field recording template has been provided in Appendix 4, which outlines the relevant site data required, along with the details for any recordings of your target weed. This template covers all the mandatory Victorian Biodiversity Atlas (VBA) data requirements.

Another option is to enter data straight into the VBA using the VBAGo app, or use the VBA data recording template and follow its data entry protocol to input the survey data (refer to <https://vba.dse.vic.gov.au/vba/#/> for further details). The VBA is an information system that stores information on the distribution and abundance of indigenous and naturalised species in Victoria. It includes all plants, animals and fungi known from Victoria.

Remember for any contractors undertaking a delimiting survey and collecting data, these data recording requirements need to be built into contractor job specifications (i.e. Request for Quote documentation).

Store the information and data collected where future staff can access it on the Spatial, Temporal, Activity Recorder (STAR).

Other important things to consider when undertaking a delimiting survey include the equipment required for undertaking a survey (see Appendix 3), hygiene and the wellbeing and safety of staff involved (see Appendix 5).

Out in the field

Once you are out in the field and ready to perform your delimiting survey, below is list of suggested steps to follow.

Turn tracking on GPS

When you are at your site and about to begin your survey, set your GPS or mobile application (app) to track where you have walked/driven during your delimiting survey. This will help you to determine exactly where you have searched. After the survey this should be stored in a GIS mapping system (i.e. ArcGIS) for future reference.

Surveying the site using search areas

Using your pathway analysis and the trace back and trace forward investigation from Step 4, begin to survey the search area with the intention of locating the core and satellite infestations of your target weed. Appendix 6 has some good hints on how to improve walking surveys for delimiting.

If the target weed is unfamiliar, carry photos or laminated parts of the plant (printed or on a mobile device) with you to refer to while in the field (or visit a reference plant in situ or in a quarantine nursery). It will help to imprint the search object, making it easier to recognise when it is located in the field. Take time at the start of the survey to get your eye in and to get the GIST (General Impression of Size and Texture) of the weed. The first part of the survey area could be revisited to ensure no weeds have been missed while adjusting to the new situation.

When conducting a delimiting survey it is important never to assume that all infestations have been identified (Jeffery 2012). There is almost always more than you think.

It is vital to remember the probability of finding a weed (i.e. its visibility) varies depending on the weed's growth form, the habitat, its biological capacity to spread (Timmins *et al.* 2002), and the conditions on the day, including weather and light conditions. The extremes of movement and spread should always be considered when looking for infestations (Lawes and Panetta 2004).

Take particular care of areas where your target weed has been previously recorded. If you are unsure that you have covered all the area, and therefore located all potential infestations, a targeted survey maybe appropriate (see over page).

Remember to record whether the weed was absent in your search area. Absence data should only be recorded if a delimiting survey is conducted, otherwise the area should be mapped as unsearched. The benefit of recording absence data is that it allows you to assess where you have looked for a weed and provides the ability to inform resource allocation decisions in the future (Jeffery 2012). It also helps to plan which areas still need to be searched.

When a single plant or infestation of your target weed is located

When an infestation or single plant is found, mark it with your GPS and flagging tape (if appropriate) and record its details using your digital field data capture tool or the field recording template (Appendix 4). Then walk about five or so meters from the newly found infestation in a circle searching for further plants. Record an additional location on the GPS every time you see the plant. Geographic information systems can calculate the boundaries to give the gross infestation (see Figure 7). If you haven't seen any more plants in about 5-10 minutes of searching it might be safe to say that it is an isolated infestation. If you keep finding more infestations then a targeted survey should be carried out to ensure all likely infestations are located (see over page). Further information on how to collect a GPS point and place a marker (flagging tape) can be found in Appendix 7.

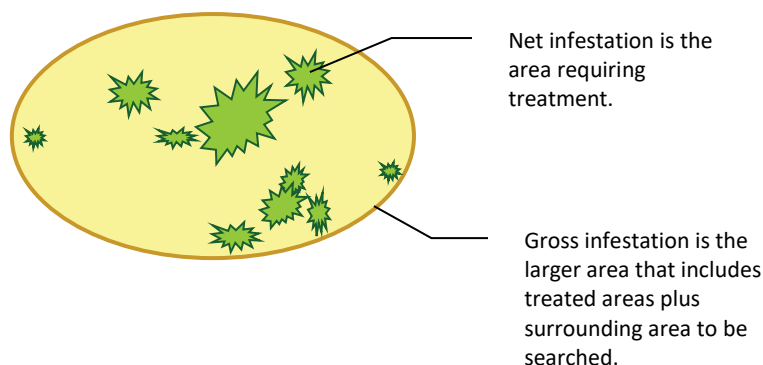


Figure 7 - Illustration explaining the difference between net and gross infestations.

Estimate how long you think the weed could have been at the site. This can be done by estimating the age of the discovered plants (McMaugh 2005) and the number and age of the subsequent generations it may have produced. Land managers or neighboring properties may also have knowledge of when they first saw the weed. Collecting this information is useful when deciding where to expand the delimiting survey. For example, if a satellite infestation contains mature plants this may indicate the need to expand the search area or re-evaluate the survey plan. Record this information on your device or use the field recording template (Appendix 4).

Remember to take photos of any infestations or other areas of interest, record locations using a GPS and geotag the images (see the photography guide in the “Looking for weeds: name and notify guide”). Figure 8 highlights the importance of correct weed identification before conducting a delimiting survey.

Targeted survey

A targeted survey is a detailed, small scale survey that is conducted in areas of a delimiting survey where close attention is required i.e. areas that have had previous infestations of a target weed. In conducting this type of survey you can have a thorough look for any infestations that may have arisen from a core infestation or would be likely to have been missed (i.e. off road network, secluded area).

In general a targeted survey is carried out by two or more people, walking straight lines (transects) approximately 5-10 m apart (depending on the detectability of the target and obstacles in the way), scanning the ground for any of the targeted plants as you walk along. Flagging tape can be used to designate completed transects as you walk, or you can follow along using an appropriate mobile app. An example of a targeted survey is outlined in the case study for *Cylindropuntia pallida* later in this guide.

Back in the office

Collation of collected data

After the survey is completed, store and organise your survey data, ready for analysis.



Figure 8 - Plant identification is important before performing a delimiting survey. In some circumstances when you opportunistically detect a plant you know is not local, doing a delimiting survey while there in the field can be efficient use of time (if the infestation is not very large). Top left: record a GPS point of the site where the weed was detected; top right: record the identification characteristics of the weed and site details; bottom left: when an infestation is found, walk and record its boundaries as a polygon, look for any outlying plants; bottom right: take a photo of the different elements of the plant (i.e. flowers, leaves) to assist in identification when back in the office. Images by Kate Blood, DELWP.

Step 7. Analysing data

The results should be interpreted with respect to the aim of the survey and why it was established in the first place (Ainsworth *et al.* 2008). The main reason for carrying out a delimiting survey is to determine whether the target weed is at the early stage of invasion.

The results (raw data) of a delimitation survey can also be used to:

- produce a distribution map;
- help determine the management approach for the weed (e.g. is eradication feasible?);

- identify trends in the movement and spread of weeds in the landscape;
- identify trends in location and species e.g. a species mainly present along waterways;
- develop a cost benefit analysis relating to the time spent undertaking the survey and the value of the data created (McMaugh 2005);
- calculate basic statistics;
- measure species abundance between sites; and
- review and make recommendations for further survey work, future management actions and priorities, including adaptive management to influence changes in management approach.

Comparisons can be made as to whether the results confirm or contradict the expected outcomes. If you are not confident about doing this, seek advice (see the WESI project team contact details in Appendix 8). Consider value adding to your data by collaborating with other individuals or groups.

It is important to remember that delays in analysis are likely to result in delays in treatment.

Step 8. Reporting the results

It is important to report and communicate any findings or recommendations from the analysed survey data to the appropriate people. These may include:

- team members;
- project team;
- manager;
- land manager/owner;
- sponsor/investor;
- steering/Working Group;
- Statewide Weed and Pest Team;
- Friends Groups; and
- neighbours.

In doing this you could generate more work, potential funding or increase the interest in the weed. Reporting and communicating results is also important as it could have flow on consequences for other adjoining areas and open collaborative opportunities. Consider developing and keeping updated a simple communication plan concerning the stakeholders to be kept informed and how information about the delimitation effort will be communicated e.g. in the media and/or on social media. If this is done early enough it may stimulate reports of the target species on land bordering the public land where you are working. Seek advice from your agency communication staff.

What next?

Where are you up to?

Based on the results of the delimiting survey, you have determined if the weed is at or beyond the early stage of invasion at your site. Now you must decide the most appropriate management response, using the information you have collected from the delimiting survey.

Planning your next move

To work out your next step (see Figure 9), use the following guides with the help of the WESI team:

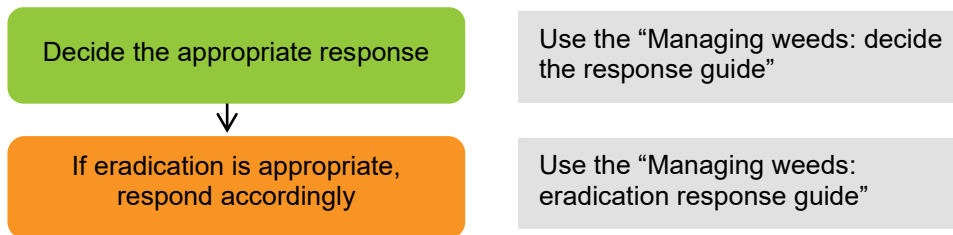


Figure 9 - Planning what to do next.

Case study

Cylindropuntia pallida (White-spined Hudson Pear)

On 17 March 2014 a delimiting survey was carried out for *Cylindropuntia pallida* (White-spined Hudson Pear) in a part of the Ouyen State Forest, approximately 1 km south of the township of Ouyen, north west Victoria. The aim of this delimiting survey was to determine the full extent of *C. pallida* within the Ouyen State Forest.

Cylindropuntia pallida is also known by a former name *Cylindropuntia rosea*.

In the office

Complete search plan template

The search plan template (as found in Appendix 2) was used to develop an understanding of how *C. pallida* functions as a plant (i.e. its biology and ecology) and to get an idea of the current situation of *C. pallida* at Ouyen State Forest. This step also included investigating where *C. pallida* has been recorded previously, the vegetation and habitat present at the site, where the weed might have come from and where it has spread to.

The completed search plan for *C. pallida* at Ouyen State Forest and the relevant steps completed are found in Appendix 9.

Create maps

A number of maps were created using ArcGIS and were taken out in the field for use. These included:

- the Ecological Vegetation Classes (EVCs) present and any previously recorded infestations of *C. pallida* at Ouyen State Forest and surrounding areas (refer to Appendix 10). Records from a previous survey undertaken in 2012 were placed on the map, along with those of *C. tunicata* (Brown-spined Hudson Pear) from the Integrated Pest Management System (IPMS). *C. tunicata* records were considered to result from misidentification and have since been added to those of *C. pallida*;
- the land status of Ouyen State Forest, location of its boundaries and adjoining land use. It was identified that in the south eastern corner of the site there was a refuse site and cemetery; and
- an aerial photograph of Ouyen State Forest to draw on in the field.

Define search areas for the site

Using the information collected in the search plan it was decided to partition the site into five search areas (see Appendix 11). The search areas in this case were defined by the road network due to practical considerations.

Pre-load data onto a GPS

The road network, property boundaries, aerial photography and previous recordings of *C. pallida* at the site were loaded onto a GPS before heading out to the field.

Equipment used for the delimiting survey

A variety of equipment was used for the delimiting survey, these included:

- x1 Vehicle;
- x3 Staff members (x1 driver and x2 searchers);
- x2 rolls of flagging tape (x1 pink and x1 orange);
- x1 clipboard & pen with 'Field recording template';
- x1 A3 map of land status and road network on aerial photography;

- x1 A3 map of Ecological Vegetation Classes (EVCs) and previously recorded sightings (from IPMS & local records);
- x1 A3 map of pre-defined search areas with aerial photography;
- x1 GPS with pre-loaded road network, property boundaries, aerial photography and previous records of *C. pallida* at the site; and
- x1 camera.

Out in the field

Turn tracking on GPS

In order to track the areas that were covered during the survey, the tracking function on the GPS was turned on immediately before the survey was commenced.

Surveying the site using search areas

The road network was considered to be the main pathway of spread into and around the site, so it was decided that all the trafficable roads/tracks would be surveyed for each search area. Each trafficable road/track was driven at 20-30 km/hr with two observers on either side of the vehicle looking at a distance of 15-20 m from the road/track (observable area from the vehicle in Mallee vegetation) for any *C. pallida* infestations.

When driving around in each search area, particular care was taken in areas where *C. pallida* had been previously recorded. If we were unsure that we had seen all of the area, we got out of the vehicle and had a look on foot.

To ensure all tracks/roads had been driven in the search area, we used the GPS and hard copy maps to verify our location.

When an infestation of *C. pallida* was spotted

When a *C. pallida* plant was spotted, we tagged the site using pink flagging tape, took a GPS point and photo of the plant and recorded the information required in the field recording template (Appendix 4) (Figure 10).

When the plant was located, a general search of the area was undertaken in all directions, including both sides of the road. If no other infestations were found in 5-10 minutes of searching, it was decided that the plant was isolated and we continued on with the rest of the survey. If another infestation was found, this process was repeated.



Figure 10 - A flagged *Cylindropuntia pallida* plant located just off the road in search area D at Ouyen State Forest. Image by Bec James, DELWP.

Targeted survey

In the northern section of search area B, there were historically a number of *C. pallida* infestations located off the road network, particularly along the northern boundary, where there had been a large amount of disturbance. It was decided it would be a valuable exercise to undertake a targeted survey in this area in order to identify those infestations which would not be seen via a vehicle survey and to ensure no *C. pallida* plants were left undetected.

To undertake the targeted survey in Mallee vegetation, three people walked in a line (a transect), approximately 10 m apart (depending on obstacles in the way), scanning the ground for any *C. pallida* plants as they walked along (Figure 11). Orange flagging tape was used to designate completed transects. The targeted survey area (6.7 ha) was searched in its entirety (results in Figure 12) and resulted in three *C. pallida* plants being located.



Figure 11 - Walking in a transect undertaking a targeted survey for *Cylindropuntia pallida* in Ouyen State Forest. Image by Sally Lambourne, DELWP.

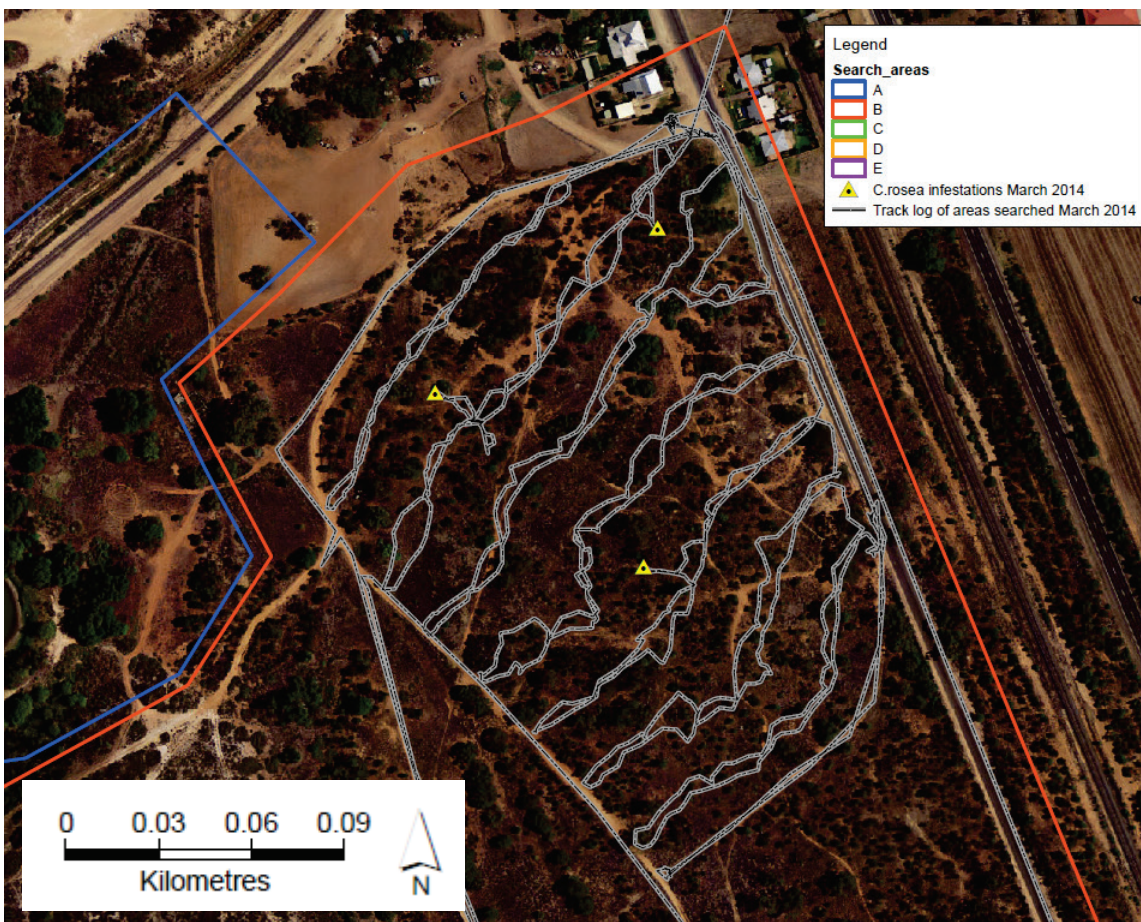


Figure 12 - The targeted survey area with the track log of transects walked and located infestations of *Cylindropuntia pallida* (formerly *C. rosea* as stated in the map legend) at Ouyen State Forest. Digital mapping compilation by Bec James, DELWP.

Back in the office

Collation and analysis of collected data

All the data from the field (including GPS points, track log, photos) were downloaded and collated when we arrived back at the office. Using this data a map was created with all the newly recorded infestations in each of the search areas, along with the previous recordings of *C. pallida* (see Figure 13).

In total 18 *C. pallida* plants were located during the delimiting survey, with the majority being located in search area D and in the northern corner of search area B. The core infestation was considered to comprise those infestations located in search area B. This was due to the high number of previously recorded *C. pallida* infestations in the last five years and also to the high level of disturbance that is present there (i.e. it is the main vehicle entry point into the State Forest).

Interestingly, when comparing the infestations located in this survey in search area D to those found in the 2012 survey, it was evident that this species is still spreading within the site, perhaps due to vectors such as wildlife, motorbikes and other vehicles that frequent the area.

The data also demonstrates a significant reduction of the presence of *C. pallida* plants with the State Forest from 2009 (IPMS data) to 2014 when this delimiting survey was undertaken. This is due to the concerted efforts of local land managers controlling *C. pallida* in the State Forest.

In summary, the extent of *C. pallida* is currently restricted to the southern and northern ends of the State Forest, with the core infestation potentially being in the northern corner of the forest. There also appears to be some movement of *C. pallida* plants through the site, potentially through wildlife, motorbikes and other vehicles driving along or near the tracks. Considering the small and isolated infestations found within the State Forest, it was considered that *C. pallida* was at the early stages of invasion at this particular site.

Reporting the results

The local land managers were informed of the results of the delimiting survey and a shapefile of the recorded infestations was provided. The data was also put into the Victorian Biodiversity Atlas for future reference.

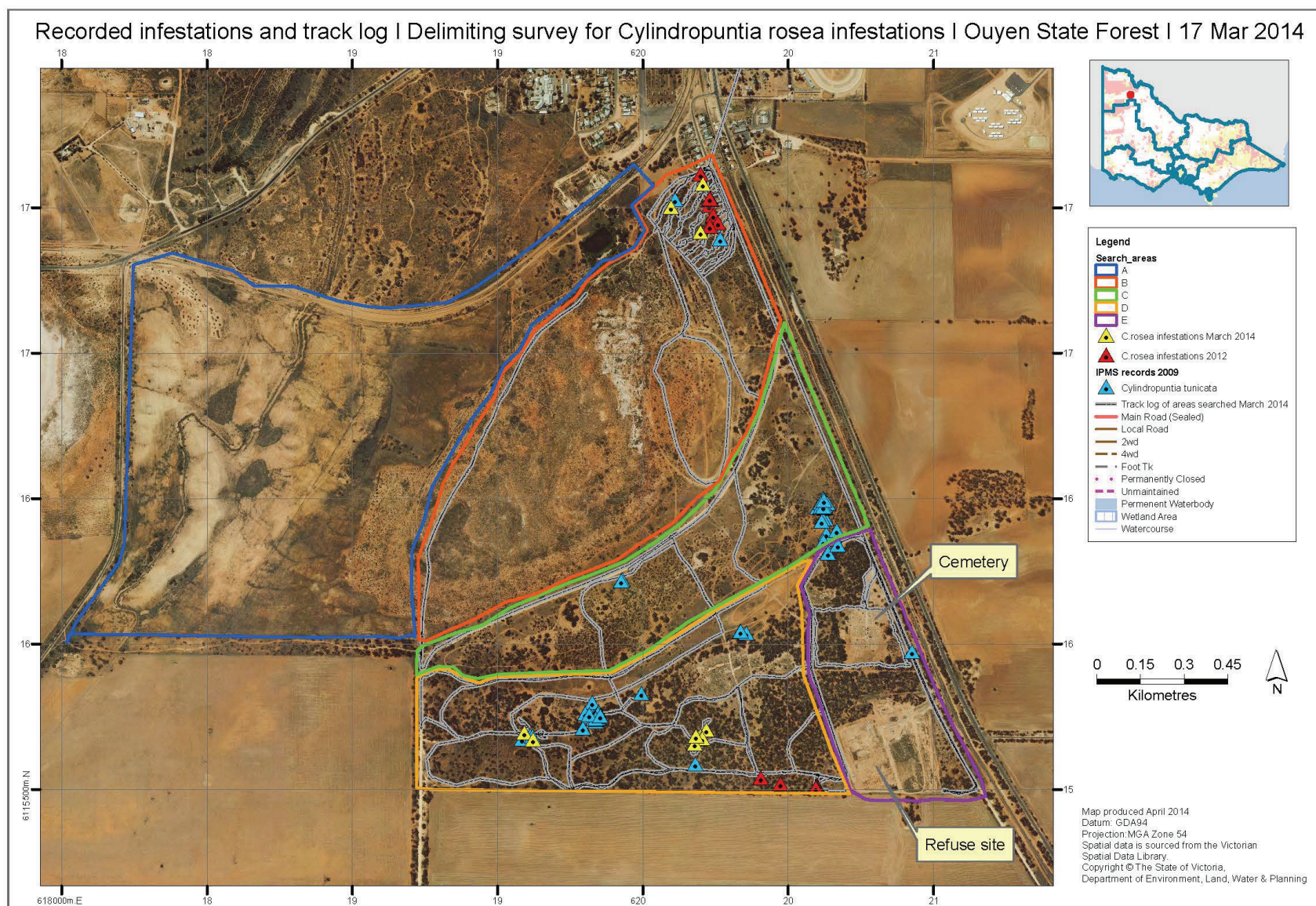


Figure 13 - The results (recorded infestations) and track log of the delimiting survey for *Cylindropuntia pallida* (formerly *C. rosea* as stated in the map legend) at Ouyen State Forest. Digital mapping compilation by Bec James, DELWP.

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Appendix 1 - Decision making framework (with scenarios)

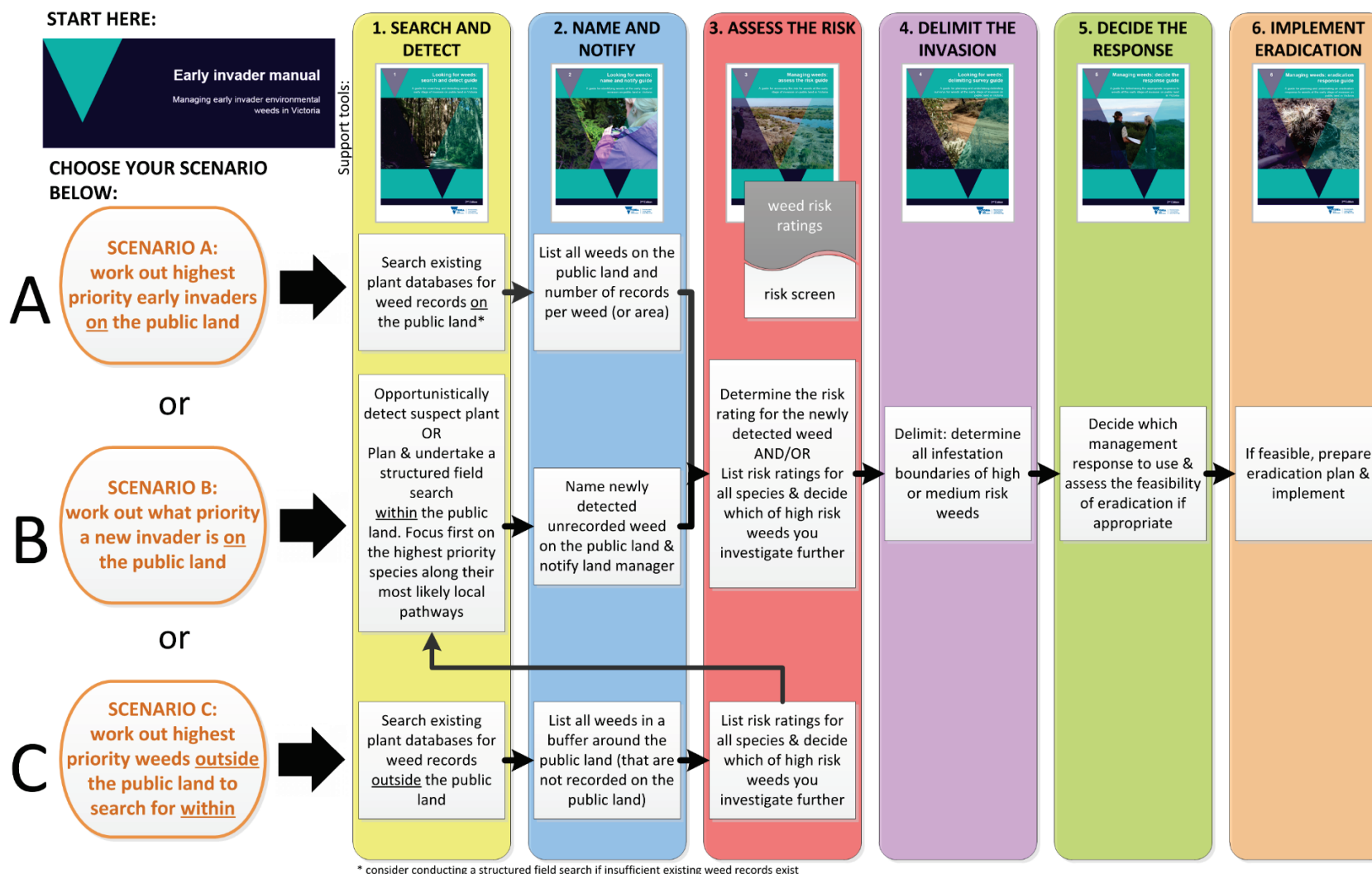


Figure 14 - This is the WESI decision making framework that guides the process for dealing with weeds at the early stage of invasion. This version illustrates three typical scenarios faced by public land managers.

Appendix 2 – Weed search plan template (optional)

Common name/s: Botanical name:	Photo Source:
-----------------------------------------------------	------------------------------------------------------------

Purpose of the search: (For search and detect, delimiting, or monitoring? Simple statement)

Identification characteristics: (e.g. Life form, flowers, seeds, fruit, stems)
Life form: Leaves: Flower: Fruit: Spines: Stems/bark: Look-alike plants:

Biology and spread mechanisms: (e.g. reproduction method, annual growth cycle, dispersal mechanisms, vectors)	
Method of reproduction (e.g. seed, vegetative, suckering)	•
Seed longevity (e.g. seeds can remain dormant in the soil up to x years)	•
Budbank (e.g. tubers underground)	•
Timing of flowering and fruiting	•
Time between flowering and seed set	•
Spread by (e.g. wind, water, garden dumping, humans, animals)	•
Dormancy (Is the plant dormant below the ground at certain times of the year?)	•

Understand your site

Consider: Habitat preference, Land use/tenure of survey area, topography, access, vegetation types present

Previous recorded sightings locations

(e.g. any previous surveys indicate plant was present in the past, or where it could spread. Check VBA, AVH, ALA, CLM, local records etc)

Potential sites, sources and vectors in the survey area

(i.e. where the weed is likely to have come from, places the weed is more likely to establish, how the weed got there and where it could spread to)

Identify, prioritise and map the search areas within your site

Operational information related to carrying out survey

Absence data: (did you record if weed was absent?)

Preferred search period:

(e.g. during flowering from mid-August to mid-September)

Expected time required to complete search:

(e.g. 4 days with 2 people)

Search intervals:

(times between subsequent searches; how often are repeat surveys required?)

Special notes (e.g. people to contact or particular site/weed hazards, permits or special equipment required)

Data collection method: (paper, mobile device, specify software/method)

Search focus: (was the focus on a weed species, pathway or site?)

Search technique(s): (vehicle, on foot, aerial, detector dog etc?)

Data storage: (where have you recorded your data e.g. VBA, STAR etc?)

VBA: Victorian Biodiversity Atlas, FIS: Flora Information System, AVH: Australian Virtual Herbarium, CLM: Crown land manager

Prepared by:

Date:

References:

Appendix 3 - Equipment for a field search/survey

Develop a checklist for field surveys that can be used on each trip. A list in 'Word' with check boxes can easily be updated and printed for future field trips. Keep a field kit in an easy-to-lift plastic box or two ready for quick deployment. Some items to take when surveying for weeds include:

- ☐ hand-held GPS and spare batteries or charger;
- ☐ maps or pre-loaded maps & search polygons on the GPS;
- ☐ native plant and weed identification books/pamphlets/mobile device applications (apps) etc.;
- ☐ recording equipment such as clipboard, notebook, datasheets, pen, pencil or electronic device;
- ☐ camera with spare batteries and capacity;
- ☐ materials for marking infestations (i.e. bright coloured survey ribbon);
- ☐ recording sheets – digital and/or printed (see Appendix 4);
- ☐ hygiene equipment to reduce weed and soil-borne disease spread;
- ☐ plastic bags, secateurs;
- ☐ gloves and BBQ tongs for handling prickly plants;
- ☐ plant press – if you are trained and competent in collecting plant specimens, including a plant press might be appropriate;
- ☐ hand lens;
- ☐ relevant permits and access permission documentation; and
- ☐ first aid and snake bite kits.

Refer to your agency's Occupational Health and Safety requirements for personal protective equipment and safety requirements. Items that should be considered include:

- ☐ first-aid kit and snake bite kit;
- ☐ personal protective equipment; and
- ☐ satellite phone and emergency position-indicating radio beacon (EPIRB) if in remote locations.

Appendix 4 - Field recording template – multiple records

If you don't have digital field data capture, use this optional sheet for recording multiple species or multiple sites of the same species on public land during structured field searches.

Recorder details		Name: Name of people assisting:					Inspection date:		
Site details (site = the property/parcel boundary within which the weed propagules are located)		Location					GPS accuracy (m):		
		Site address/name:					Datum <input type="checkbox"/> GDA 94 <input type="checkbox"/> WGS84		
		Location description:					MGA Zone <input type="checkbox"/> Zone 54 <input type="checkbox"/> Zone 55		
		Land tenure (e.g. State Forest, National Park):					Survey method: <input type="checkbox"/> Searching <input type="checkbox"/> Delimiting survey <input type="checkbox"/> Ad hoc (opportunistic detection)		
GPS ref #	Species	Pattern of infestation Individual, Scattered, Continuous For point data	Density % cover <1%, 1-5% 6-25%, 26-50% 51-75%, 76-100% For line & polygon data	Area of infestation For point data	Count	Age class (e.g. seedling, juvenile, sapling, mature)	Eastings	Northings	Comments (e.g. roadside, gully)
e.g. 1	<i>Cenchrus ciliaris</i>	<i>Scattered</i>	6-25%	5x5m	20	seedling	548011	6207117	2 m from road edge on north side

Appendix 5 - Wellbeing, safety and hygiene for field work

Wellbeing and safety

Refer to your agency's Occupational Health and Safety (OH&S) requirements for personal protective equipment and safety requirements. Items that should be considered include:

- first-aid kit and snake bite kit;
- personal protective equipment; and
- satellite phone and emergency position-indicating radio beacon (EPIRB) if in remote locations.

Consider these points when you are planning and conducting field work:

- Avoid sun damage to skin – wear appropriate clothing, broad-brimmed hat, gloves, sunscreen, and sunglasses.
- Avoid field work on days of extreme fire danger.
- Be aware of flood and other emergency and weather warnings for the area and take appropriate precautions.
- Have a safety plan and reporting procedure in place for working remotely (refer to your agency's OH&S guidelines).
- When working near roadsides, park safely and wear high visibility clothing such as a reflective vest.
- Wear gaiters and carry a snake bite kit and know how to use it.
- Wear appropriate protective clothing when handling weeds. Be aware of plants which have:
 - spines or barbs that may have sheaths, toxins or irritants. Avoid stick injuries and treat punctures immediately.
 - sap that can cause skin irritation immediately or after exposure to sunlight.
 - fine hairs that can cause skin irritation and become lodged in clothing.
 - pollen and perfumes that can cause allergic reactions including respiratory irritation and hayfever.
- If working with cacti, carry pliers to remove cacti spines from footwear. Always check the back of boots before crouching down. Some cacti have spines with sheaths that remain in the body when the spine is removed. The "Managing Opuntoid cacti in Australia" manual has a chapter on safety and welfare (Sheehan and Potter 2017).
- Seek prompt medical advice if reactions, injuries or infections occur.

Hygiene

It is very important not to spread weeds, pests, wildlife diseases, soil-borne and plant-borne diseases between and within sites. Examples of things that may spread other than weeds include soil and plant-borne pathogens such as Phytophthora, [Myrtle Rust](#), Chytrid fungus of frogs, and crazy ants. Consider these hygiene points when you are planning and conducting field work and check your agency's hygiene protocols:

- Carry a hygiene cleaning kit with instructions in vehicles, and a sealable container (e.g. plastic bottle with screw-top lid) in which to place loose or seeds removed from clothing for later safe disposal.
- Wear cotton clothing that seeds do not readily adhere to and avoid cuffs on trousers and shorts.

- Wear gaiters over socks and boots.
- Clean footwear and clothing including seeds in laces and socks, and soil on soles before and immediately after a site visit.
- Avoid placing carry bags and packs on weeds that are in seed.
- Regularly check camera bags and clothing pockets for seeds.
- Plastic sample bags can build up static electricity to which weed seeds can readily adhere.
- Avoid driving vehicles into weed infestations and check and clean the vehicle regularly including within the cabin and boot or tray.
- Consider undertaking [WeedStop](#) training to maintain suitable vehicle hygiene standards.
- Ensure other staff and contractors conducting field work are following appropriate hygiene standards.
- Be aware that the transportation of plant propagules of declared noxious weeds without a permit is prohibited. If collection of a sample or herbarium specimen is required for identification purposes, contact 136 186 for further advice.
- Companion and conservation working dogs readily pick up and spread weed seeds on their coat and between their toes.
- Consider using a footbath before entering and leaving wetland areas to reduce the risk of spreading Root Rot (*Phytophthora cinnamomi*) or frog disease, Chytrid fungus (*Batrachochytrium dendrobatidis*).

Support

Working with invasive species can be overwhelming at times. Seek help if you are feeling down or overwhelmed. Check in with your local workplace peer support person, OH&S person or contact:

Beyond Blue: www.beyondblue.org.au 1300 224 636

Lifeline Australia: www.lifeline.org.au 13 11 14

Appendix 6 - Tips on how to improve walking surveys for delimitation

These simple practices can be used to improve the effectiveness of walking surveys at finding invading species:

- Survey speed should not be increased as plants become either more or less visible, as more attention is given to walking than to looking for the plant.
- “Contouring” which involves walking parallel to imaginary elevation contour lines and by using landmarks to prevent overlapping or creating gaps on successive sweeps, helping to ensure complete coverage.
- GPS units are highly effective at ensuring complete coverage is achieved (see “Looking for weeds: search and detect guide” and “Looking for weeds: delimiting survey guide”).
- Shifting positions in the sequence of surveyors in sweeps alleviates monotony and maintains concentration. Using several survey methods also will increase accuracy and dependability (Zamora *et al.* 1989).
- Initial searching should involve systematic and intensive surveys in the local vicinity of known occurrences (see “Looking for weeds: search and detect guide”), and other areas selected, based on dispersal behaviour of the weed and potential pathways of spread.
- Presence and absence data should be collected which can be used to improve future survey designs (Lawes and Panetta 2004).
- Surveys usually work progressively outward from the centre of the infestation and along dispersal pathways (Robison *et al.* 2013). The search area can be narrowed by identifying the invading plant's habitat type and plant associations.
- Thorough surveys require pessimism and training. Pessimism is assuming that an infestation is larger than expected and expanding the search area around the initial sighting.
- The amount to expand the survey depends on the plant's potential dispersal distance. A useful rule of thumb is to expand the survey to a geographical border or the limits of the habitat.
- Using multiple search images in a survey improves concentration by preventing the surveyors from fixating on one image. Use multiple images of the plant's various forms, distinctive characteristics such as colours or silhouettes, habitat(s), and plant associations (Zamora *et al.* 1989).
- Trained sniffer dogs are proving to be highly effective at locating hard to locate plants. Dogs are more accurate than humans, especially for detection of small plants, and from greater distances. Invasive plant monitoring using detection dogs can provide greater overall accuracy of plant detection (Goodwin *et al.* 2010).

Appendix 7 - Information on how to tag a site using a GPS and a marker in the field

Tagging a site using a GPS

A quick and effective way of relocating yourself back in a site is to load locational information (i.e. road, watercourse, and land use datasets) into your GPS, along with any data points from previous surveys that can assist you in returning to a site.

If you require more information on how to use your GPS, refer to the Global Information System (GIS) Help desk on the Department's intranet. This provides a wealth of information on GIS software, spatial information and 'how to' guides. A number of useful guides on the use of a GPS are listed below:

- If you are new to using a GPS, there is a document titled "Guide to users" which provides a good introduction to GPS.
- For standards, specifications and best practice field guide for a GPS, refer to the "Global positioning system handbook".
- For techniques in collecting data using a GPS refer to "Using a GPS for spatial data collection".

Tagging the site using a marker/tag

Another good method to enable easier detection when returning to the site is to physically tag survey sites in the field. One option is to tag sites with a marker. Remember to choose tags/markers that will be able to survive all weather conditions (McMaugh 2005) and are of sufficient visibility to be found again but not so visible as to attract vandalism or removal. Also consider tag design to reduce the chance of removal by animals, including foxes and bower birds. Options for marking include:

- placing a marker in the ground i.e. a star picket or peg;
- spray painting a mark (remember that tree bark often peels off annually);
- attaching a bright coloured tag to a tree, branch etc. (nails can damage living tree tissue); and
- establishing photopoints.

As the tags may be lost in the future due to deliberate removal or disintegration, it is important to take a GPS recording of the site. Take photos to help find sites, including prominent land marks.

Appendix 8 - Further contacts

Contact the WESI project team

The WESI project team can assist with planning and conducting delimiting surveys, and working out what to do next.

Having some information ready when making contact will make it easier for the WESI project team to help you:

- Your name and contact details (email, mobile phone etc.);
- The botanical name of the weed(s) you want to delimit;
- Where and when the weed was detected (location name, land tenure, directions, and GPS reading);
- Any notes on what it looks like and the situation it is growing in e.g. growing in sand or clay or in a water body;
- Observations about how the weed may have got there, what is spreading it and how far it has spread. An estimate of how many plants there are and the area covered;
- What are its impacts and what are the biodiversity values under threat?

Have you taken photographs of plant features and landscape that can be emailed? Electronic images can be emailed to the WESI project team to assist with identification (if images are large, only one image should be attached to each email). Alternatively, let WESI know that you have placed images in the WESI folder on the DELWP corporate drive statewide: L:\Department Business Share\WESI early invaders

For assistance with a possible weed at the early stage of invasion contact the WESI project team.

Bianca Gold

bianca.gold@delwp.vic.gov.au

Kate Blood

kate.blood@delwp.vic.gov.au

Phone via the Customer Service Centre 136 186.

The WESI project has a seasonal newsletter “Early invader update” that you can receive for free. Contact us to subscribe.

The project team is active on social media. Search for handle @weedyk8 and hashtags #WESIProj #weedID #invasivespecies

Agency contacts

Victorian Government Customer Service Centre: 136 186 (for DELWP and DEDJTR Agriculture Victoria)

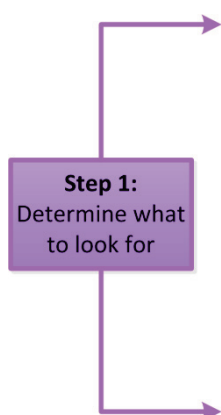
<https://www.environment.vic.gov.au/>

<https://economicdevelopment.vic.gov.au/>

Parks Victoria: 13 1963

<http://parkweb.vic.gov.au/>

Appendix 9 - Case study: completed search plan for *Cylindropuntia pallida* (White-spined Hudson Pear) at Ouyen State Forest



Common name/s:
Hudson Pear (White-spined)

Botanical name:
Cylindropuntia pallida
(formerly known as *C. rosea*)

Photo



Source: Bec James' photo – Ouyen State Forest
1.5.2012

Identification characteristics:

(e.g. Life form, flowers, seeds, fruit, stems)

Life form: Low spreading shrub 0.5 – 1 m tall. Up to 3 m wide. Old plants can develop trunks, but not commonly seen.

Leaves: Deciduous, grey – pale green, 4.5 – 26 cm long. Easily detached. Prominent tubercles (a small raised area or nodule on a plant surface). Cylindrical rope like segments.

Flower: Pink – purple to 5 cm, late spring - summer

Fruit: Oblong to egg shaped 2 – 4 cm long. Green – yellow green. Sterile hybrid

Spines: 7 -14 mm spines, 1 – 4cm long. White to light brown.

Stems/bark: n/a

Look-alike plants: *Cylindropuntia tunicata* (Brown-spined Hudson Pear)

Step 1:
Determine what
to look for

Biology and spread mechanisms:

(e.g. reproduction method, annual growth cycle, dispersal mechanisms, vectors)

Method of reproduction

(e.g. seed, vegetative, suckering)

- Vegetative reproduction is the most common form of dispersal. This can occur year round when segments, immature fruit or flowers detach and make contact with the ground.
- Rarely forms seeds, which appear to be sterile.

Seed longevity

(e.g. seeds can remain dormant in the soil up to x years)

- It is believed that this plant does not produce viable seed.

Budbank (e.g. tubers underground)

- n/a

Timing of flowering and fruiting

- Unknown

Time between flowering and seed set

- Unknown

Spread by

(e.g. wind, water, garden dumping, humans, animals)

- Most spread in Australia has been through people
- Vehicles
- Equipment
- Rubbish dumping (tips, bushland)
- Water (along drainage lines, water courses)

Dormancy

(Is the plant dormant below the ground at certain times of the year?)

- Unknown

Step 2:
Review any past
records or
earlier botanical
survey plans
and/or results

Previous recorded sightings locations

(e.g. any previous surveys indicate plant was present in the past, or where it could spread)

VBA: No *C. pallida* records in 10 km buffer around the township of Ouyen

FIS: No *C. pallida* records in 10km buffer around the township of Ouyen. x 1 record in 2012 of *C. tunicata* var. *tunicata* located near Ouyen in 2006.

AVH: x2 records located north and south of Ouyen Cemetery (refer to map). x 1 record 2012 and x1 in 2006. Specimen lodged.

CLM (Pest infestation sites): Approx. 42 records of *C. tunicata* located in 2009 at Ouyen State Forest. This could be a misidentification.

Local records: Previous survey titled 'Targeted distribution survey of Hudson Pear (*Cylindropuntia rosea* and *Cylindropuntia tunicata*) in known areas in the North-West of Victoria' written for the Mallee CMA identified x 15 plants at two sites in the Ouyen State Forest: east of the Ouyen Cemetery; west of the beginning of Railway Terrace (railway).

Step 3:
Understand
your site

Understand your site

Consider: Habitat preference, Land use/tenure of survey area, topography, access, vegetation types present

Habitat: Victoria is highly suitable for further growth of this species. In Australia, Opuntoid cacti appear to have no preference for soil types. Cacti flourish around old homesteads, dumps and mine sites.

Land use/tenure: The infestations are on Crown land (Ouyen State Forest). In CLM the reserve is listed as Unreserved. Needs to be confirmed. In the south-east corner of the State Forest there is a cemetery, bushland reserve and refuse

site (refer to map).
Topography: Flat terrain
Access: Access is via Railway Terrace to the north of the site. Also the west is Ouyen – Patchewollock Road.
Vegetation types present: **Bioregion:** Murray Mallee
EVC/s: Chenopod Mallee; Chenopod grassland; Semi-arid woodland; Semi-arid chenopod woodland.

Step 4:
 Identify search areas within your site

Potential sites, sources and vectors in the survey area

(i.e. where the weed is likely to have come from, places the weed is more likely to establish, how the weed got there and where it could spread to)

- Cemetery
- Refuse site
- Recreational users (i.e. 4WD, motorbike riders).

Step 4:
 Identify search areas within your site

Identify, prioritise and map the search areas within your site

Refer to attached map

Step 5:
 Timing of the survey

Operational information related to carrying out delimiting survey

Preferred search period:

(e.g. during flowering from mid-August to mid-September)

- Anytime, but easier to detect when the sun is out. Therefore December – February would be ideal.

Expected time required to complete search:

(e.g. 4 days with 2 people)

- 1 day with 3 people (x 2 observers and 1 driver)

Special notes (e.g. people to contact or particular site/weed hazards or special equipment required)

- Contact local District Manager, Mallee when arrive on site and when leaving.

VBA: Victorian Biodiversity Atlas, FIS: Flora Information System, AVH: Australian Virtual Herbarium, CLM: Crown land manager

Prepared by: Bec James

Date: 7 March 2014

References:

- Potter, S. (2011) Weed Management Guide, Weed of National Significance: Opuntoid cacti, including *Austrocylindropuntia*, *Cylindropuntia* and *Opuntia* species.
- Mallee CMA, 2012, Mallee Catchment Facts: Hudson Pear (*Cylindropuntia rosea* and *Cylindropuntia tunicata*).
- Weeds of National Significance: Field Identification Guide, *Austrocylindropuntia*, *Cylindropuntia* and *Opuntia* species.

Appendix 10 - Case study: Ecological Vegetation Classes (EVCs) and previous infestations of *Cylindropuntia pallida* (White-spined Hudson Pear) at the Ouyen State Forest

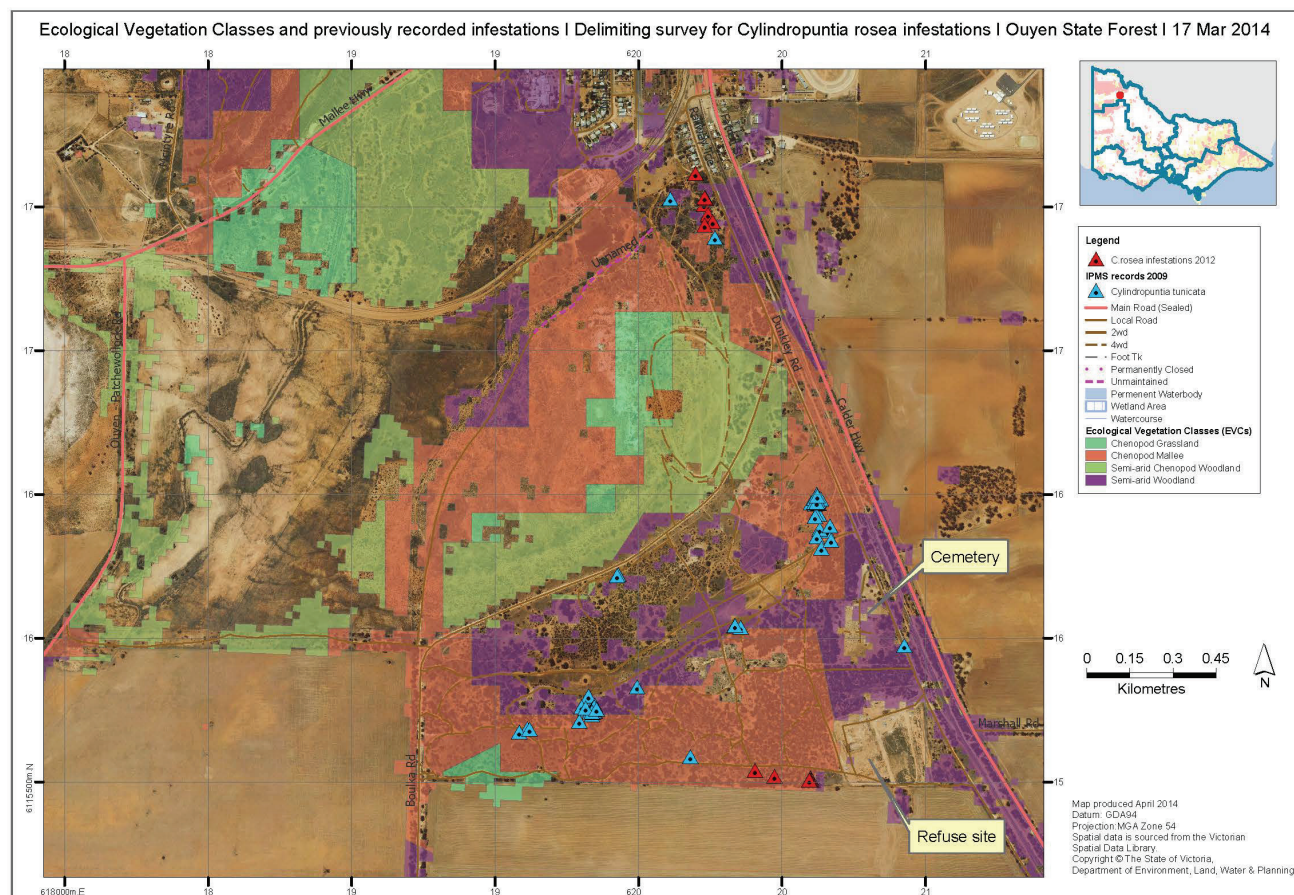


Figure 15 - Ecological Vegetation Communities and previous infestations of *Cylindropuntia pallida* (formerly *C. rosea* as stated in the map legend) in Ouyen State Forest. Digital mapping compilation by Bec James, DELWP.

Appendix 11 - Case study: identified and mapped search areas for delimiting survey of *Cylindropuntia pallida* (White-spined Hudson Pear) at the Ouyen State Forest

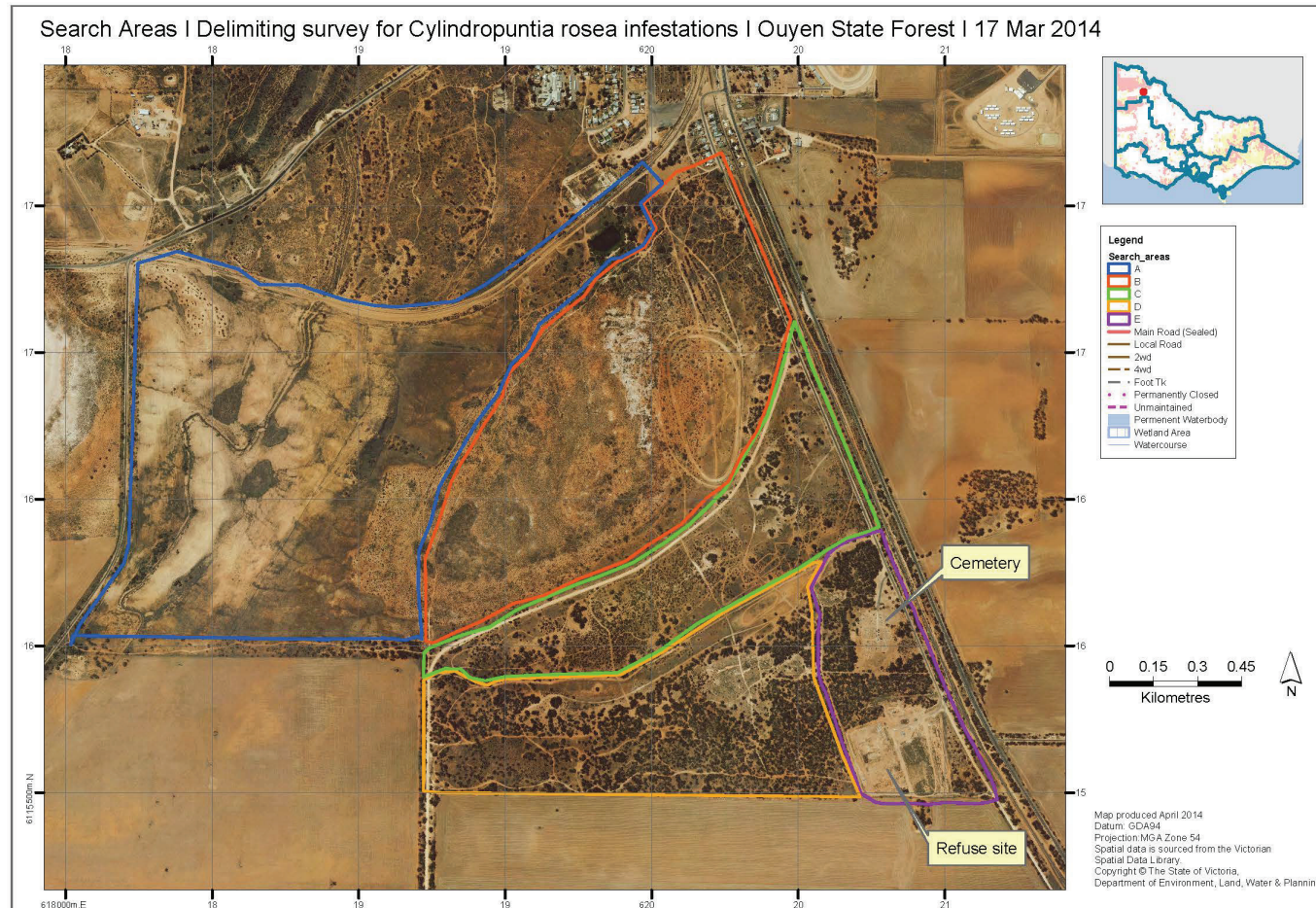


Figure 16 - Identified and mapped search areas for delimiting survey of *Cylindropuntia pallida* (formerly *C. rosea* as stated in the map legend) in Ouyen State Forest. Digital mapping compilation by Bec James, DELWP.

Glossary and abbreviations

Glossary

Absent, absence data - Locations searched where the weed was not observed (Sheehan *et al.* 2016). These data provide a record of effort expended on searching, help in the planning of future searches, and are useful in quantifying the spread of an infestation over time (MacKenzie *et al.* 2002).

Asset-based approach - Involves prioritising control actions for a number of threats, based on the relative value of identified assets that will be protected by the actions. The aim of prioritisation is to maintain the viability of important environmental assets and optimise outcomes for asset protection and management (Victorian Government 2010).

Biodiversity - The variety of life forms: the different plants, animals and microorganisms, the genes they contain and the ecosystems they form (Victorian Government 2010).

Budbank, bud bank - The viable growing points underground (other than seeds) that can grow into new plants e.g. bulbs, rhizomes (Blood and James 2016b).

Containment - The aim of preventing or reducing the spread of invasive species, e.g. by preventing invasions into new areas and eradicating any species that are found outside a defined area or beyond a defined line (Panetta 2016).

Core infestation - An established population of a pest animal or weed from which satellite infestations may arise (Victorian Government 2010).

Cost-benefit analysis - A technique to compare options by analysing the total costs expected for an option versus the total expected benefits, to determine if the benefits outweigh the costs, and to what extent.

Decision making framework - Information organised in such a way to lead the user through a logical step-by-step process to make decisions (Blood and James 2016a).

Delimit, delimiting survey, delimitation - The process of determining the full extent of an invasion. This usually involves intensive surveys of areas in which the species is considered likely to be present (Panetta 2016).

Drone - See 'unmanned aerial aircraft'.

Early intervention - The timely action to prevent a small problem becoming a large one.

Early invaders, early weed invaders - These are plants that have naturalised and that have started to spread. Since spread has just begun, such plants are not at all widespread and are generally encountered only by chance, unless specifically targeted by search efforts. Co-ordinated management intervention, i.e. eradication or containment, is at its most feasible for plants at this stage of invasion, owing to their highly restricted distributions (Panetta 2016).

Early stage of invasion - See 'early invader'.

Environmental weed - Exotic or Australian native plant growing beyond its natural range that has, or has the potential to cause, a detrimental effect on natural values (DSE 2009).

Eradication - The elimination of every single individual (including propagules) of a species from a defined area in which recolonisation is unlikely to occur (Panetta 2016).

Extirpation - Denotes local, as opposed to global, elimination of a species (Panetta 2007). For this guide series 'park-scale eradication' is used instead.

Feasibility of eradication - The probability that eradication will be achieved (Blood and James 2016b). All other factors being equal, a potential target that has a low feasibility of eradication will require considerably more effort to eradicate than one having a high eradication feasibility. Ultimately, the assessment of eradication feasibility must take into account the amount of resources that is likely to be available (Panetta 2009).

General impression of size and texture (GIST) - A picture formed in our heads as we become more familiar with, in this case, a weed. It makes it easier to instantly recognise the plant when observed in the field (Blood and James 2016a).

Geotagging - The process of adding geographical identification metadata to various media such as a geotagged photograph or video, constituting a form of geospatial metadata. These data usually consist of latitude and longitude coordinates, though they can also include altitude, bearing, distance, accuracy data, and place names (Reference viewed online 1/9/2015: <https://en.wikipedia.org/wiki/Geotagging>).

Gross infestation area - The larger infested area including the net areas that require treatment plus the surrounding area that must be searched in return trips following treatments (Panetta and Timmins 2004).

Habitat - The kind of place in which a plant grows (FloraOnline 2010).

Hygiene - For weed practitioners, hygiene relates to the cleaning of equipment, machinery, vehicles, personal clothing and footwear etc. to avoid spreading weed propagules, pests, wildlife diseases, soil-borne and plant-borne diseases within and between sites (Blood and James 2016a).

Identification - The process of naming a plant, if not instantly from your knowledge, then through a more structured process, either by using a botanical key or other reference. Until a plant identification has been verified through the collection and submission of a specimen to the National Herbarium of Victoria (Herbarium), a proposed or preliminary name can be called a 'provisional' identification (Blood and James 2016a).

Indigenous - Native to the area; not introduced (FloraOnline 2010).

Invasive plants - Naturalised plants that produce reproductive offspring, often in very large numbers, at considerable distances from parent plants (approximate scales: greater than 100 m; under 50 years for plants spreading by seeds and other propagules; greater than 6 m in 3 years for plants spreading by roots, rhizomes, stolons, or creeping stems), and thus have the potential to spread over a considerable area (Richardson *et al.* 2000).

Land tenure - The status of the land e.g. private or Crown land (Blood and James 2016b).

Look-alikes - Plants that look similar and can be confused with another species of plant (Blood and James 2016a).

Monitor - To observe and check the local performance of a plant species over a period of time, in order to detect increases in invasiveness and impact should these occur. If practicable, monitoring at yearly intervals is recommended (Panetta 2016).

Native species - Species that is believed to have occurred in a specified part of Australia prior to European settlement (Victorian Government 2010).

Naturalised plants - Non-indigenous species that sustain self-replacing populations for several life cycles without direct intervention by people, or despite human intervention. Naturalised species are not necessarily invasive, that is they have not (yet) spread any significant distance (Panetta 2016).

Net infested area, net infestation - The area requiring actual treatment (Panetta and Timmins 2004).

Parcel - A defined piece of land.

Pathogen - An infectious agent such as a virus, bacterium, prion, fungus, viroid, or parasite that causes disease in its host (Reference viewed online 3/9/2015: <https://en.wikipedia.org/wiki/Pathogen>).

Pathway analysis - Identifies the invasion pathways (for both deliberate and accidental introductions), assesses the degree of risk associated with each and the management options needed for high risk pathways. Pathway analysis also identifies weak links in the invasion pathways and the species which use high risk pathways (Downey *et al.* 2010).

Polygon - A number of joined spatial points representing an area when the first point is joined to the last (Sheehan *et al.* 2016).

Present, presence data - Information collected to indicate that, in this case, a weed exists at a location (Sheehan *et al.* 2016).

Prevention - Is the act of preventing, to keep from occurring (Delbridge *et al.* 1998).

Propagule - An independent part of a plant (i.e. a seed or other vegetative structure) that is capable of being dispersed and growing into a new plant (Panetta 2016).

Public land - Land set aside for the use and benefit of the community/public e.g. State forest, national park, public park.

Riparian - Of plants growing by rivers or streams (FloraOnline 2010).

Risk - The chance of something happening that will have an impact on objectives. NOTE: The level of risk (e.g. high, medium or low) is defined by the particular method being used. Estimating the level of risk requires an objective, evidence-based consideration of the likelihood and consequences of a particular set of circumstances (Victorian Government 2010).

Satellite infestation - A potentially eradicable population of a weed arising as a result of spread from an established population (Hester *et al.* 2010).

Search areas - The specific area(s) within the site that will be actively searched during the survey for the target weed. These may be vegetation communities, or high risk locations such as roadsides.

Search, searching - The act of looking for something.

Seedbank, seed bank - The accumulated viable seed buried in the soil or in the leaf litter on top of the soil.

Site - The boundary of the area of interest for the search, survey or treatment within the broader reserve, State forest, or national park etc. It may be defined by vegetation communities, land type most susceptible to invasion, roads or river boundaries that divide the land parcel into more manageable areas (Sheehan *et al.* 2016).

Surveillance - The collection, collation, analysis, interpretation and timely dissemination of information on the presence, distribution or prevalence of pests or diseases and the plants or animals that they affect (Hester *et al.* 2010).

Targeted survey - A detailed, small scale survey that is conducted in areas of a delimiting survey where close attention is required i.e. areas that have had previous infestations of a target weed. It involves having a thorough look for any infestations that may have arisen from a core infestation or would be likely to have been missed (i.e. off road network, secluded area).

Target survey area - An area within the search area that is intensively surveyed (detailed small scale survey), especially during delimiting surveys (Sheehan *et al.* 2016).

Trace forward, trace back - Trace forward and trace back are usually related to human assisted transport of weeds, both deliberate and unintentional. Trace forward considers where the weed might have been moved on to from the detected infestation. Trace back considers where did the detected infestation come from and how did it get here? These terms are more commonly used during biosecurity emergency responses but can also be used by public land managers when considering the arrival or spread of weeds into and from a public land area. Tracing unassisted dispersal by means such as wind, water or wildlife is usually concerned with much shorter distances and is a component of delimitation (Nigel Ainsworth DEDJTR pers comm, 4/9/2015).

Transect - A straight line used during surveys.

Treatment - Is a technique applied to a weed to kill or reduce the vigour of the weed and/or its propagules.

Unmanned aerial vehicle - An aircraft without a human pilot onboard. Its flight is controlled remotely by a person or autonomously by onboard computers. Also known as drones or remotely piloted aircraft (Reference viewed online 3/9/2015: https://en.wikipedia.org/wiki/Unmanned_aerial_vehicle).

Vector - Something that carries, in this case, weed propagules (Sheehan *et al.* 2016).

Verify, verified, verification - Confirming the correct identification and name for a plant through the collection of a specimen, and submission to a herbarium.

Weed - Plants (not necessarily alien) that grow in sites where they are not wanted and which usually have detectable economic or environmental effects (synonyms: plant pests, harmful species, problem plants) (Richardson *et al.* 2000).

Weeds at the early stage of invasion - See 'early invaders'.

Abbreviations

ALA	Atlas of Living Australia
APC	Australian Plant Census
APNI	Australian Plant Names Index
app	application
AVH	Australia's Virtual Herbarium
CaLP	Catchment and Land Protection
CLM	Crown Land Manager
CSC	Customer Service Centre
DEDJTR	Department of Economic Development, Jobs, Transport and Resources (to be replaced by DJPR on 1 January 2019)
DELWP	Department of Environment, Land, Water and Planning
DJPR	Department of Jobs, Precincts and Regions (to replace DEDJTR 1 January 2019)
DMF	decision making framework
Ecodev	URL abbreviation for DEDJTR
EIS	Environmental Information System
EPIRB	Emergency Position Indicating Radio Beacon
<i>et al.</i>	et alia
EVC	Ecological Vegetation Class
FIS	Flora Information System
GBIF	Global Biodiversity Information Facility
GDA	Geocentric Datum of Australia
GIS	Geographic Information System
GIST	general impression of size and texture
GPS	Global Positioning System
id, ID	identification
IPMS	Integrated Pest Management System
IPNI	International Plant Names Index
I-SPEI	Invasive Species Prevention and Early Intervention
ISSG	Invasive Species Specialist Group
IUCN	International Union for Conservation of Nature
MGA	Map Grid of Australia
OH&S, OHS	Occupational Health and Safety
STAR	Spatial, Temporal, Activity Recorder
UAV	unmanned aerial vehicle
URL	Uniform Resource Locator
VBA	Victorian Biodiversity Atlas
VRO	Victorian Resources Online
Weeds CRC	Cooperative Research Centre for Australian Weed Management
WESI Project	Weeds at the Early Stage of Invasion Project
WONS	Weed of National Significance

List of figures and tables

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Figure 4 - Photographs of the characteristics that are useful for the identification of a plant. The plant shown above is a Black Locust (*Robinia pseudoacacia*). Left: whole plant; top right: flowers; middle right: leaf arrangement; bottom right: any distinguishing feature i.e. thorns on stems or fruit. Images by Bec James, DELWP.

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Notes:

[illegible]

