

# SA WEED RISK MANAGEMENT GUIDE

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## INTRODUCTION

The SA Weed Risk Management System was developed by the Animal and Plant Control Commission, in cooperation with Animal and Plant Control Boards, to help in prioritising weeds for control programs. A series of questions are answered to compare the relative risk and feasibility of control of different weeds. Weeds are assessed separately for various **land uses**, so that the most important weeds of different land uses can be identified.

The System was originally devised for Animal & Plant Control Boards in South Australia (now integrated into Natural Resource Management Boards). However, it can be broadly applied to many geographic scales (replace the term 'Board' with a more relevant one) and for any land use.

Use this guide when filling out the accompanying scoresheet. The questions can apply to any type of weed in any land use. There may be **questions where you don't know the answer** for a certain weed, especially if it is not present in your area. In such cases choose the "don't know" option, and seek opinions from others (e.g. landholders, advisers, other Boards, researchers). "Don't know" is treated as a "0" for the Comparative Weed Risk scoring and gets a maximum score for the Feasibility of Containment scoring. This avoids bias against weeds which have a score for all questions. However, weeds which have one or more questions answered as "don't know" are indicated as such at their final score. Sharing information and scores is the key to building up knowledge and getting the most out of the SA Weed Risk Management System. Answering questions as a group is better than individually. It's particularly important to get consensus on assumptions about typical weed control in the land use.

This scoring system is a tool to help in making standard, informed decisions on weed control priorities. Comments on the system are welcome for future improvements in its accuracy and ease of use.

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See the following references for example uses of the SA Weed Risk Management System:

Virtue, J. G. and Melland, R. L. (2003). The Environmental Weed Risk of Revegetation and Forestry Plants. DWLBC Report 2003/02. The Department of Water, Land and Biodiversity Conservation. (Available at [www.dwlbc.sa.gov.au](http://www.dwlbc.sa.gov.au))

Anderson, N., Drew, J. and Virtue, J. (2005). South East Weed Risk Assessment. Lacepede Tatiara Robe Animal & Plant Control Board. For the South East Natural Resource Consultative Committee. (Available as a pdf file from John Virtue)

## LAND USES

Different types of weeds are important in different land uses. For example, annual weeds are problems in grain crops, and woody weeds are problems in native vegetation. If you were to compare the risk of weeds of different land uses, then you would also need to compare the importance of the land uses themselves. This is too difficult to do (i.e. you need \$/ha values for each land use). An easier approach is to compare weeds within land uses only. Animal and Plant Control/Natural Resource Management Boards can then decide for themselves the amount of time and resources devoted to protecting each land use from weeds.

The following land uses are suggested:

1. **Aquatic** (Permanent water bodies. e.g. rivers, swamps, canals, lakes, estuaries)
2. **Crop/Pasture rotation** (e.g. dryland cereals, pulses, oilseeds, legume pastures, hay)
3. **Forestry** (e.g. pines, blue gums)
4. **Irrigated crops and pastures** (e.g. vegetables, lucerne. Prone to summer weeds.)
5. **Native vegetation** (For nature conservation purposes. Public and private reserves.)
6. **Non-arable grazing** (Includes permanent pastures and rangelands.)
7. **Perennial horticulture** (e.g. vineyards, citrus, stonefruits)
8. **Urban** (e.g. sports fields, parks, footpaths)

Within each Board, land uses will vary in terms of what is grown and how crops/pastures/vegetation are managed. However, to keep the scoring system relatively simple and to answer at a Board or regional level, it is necessary to **think in averages**. There are two main aspects to keep in mind:

- (i) **Where a weed is only prevalent at certain phases in a land use.** For example, the typical *crop/pasture rotation* land use in a Board may have cereals, canola, pulses and pasture phases. In answering questions, average the *invasiveness* and *impacts* of a weed amongst these four vegetation types. Thus a weed which is only a problem in cereals will score less than a similar weed which is a problem in all crops and pasture. In the *potential distribution* section these two weeds will get the same score, as they will occupy the same area.
- (ii) **Where a weed only occurs in certain parts of a land use.** For example, the *perennial horticulture* land use in a Board may contain citrus, stonefruit, olives and vines. For a weed which only occurs in citrus and vines, average the *invasiveness* and *impacts* of a weed amongst these two vegetation types only. Then in the *potential distribution* section, the weed's score may be reduced because it is not a problem in all perennial horticulture crops in the Board area.

**Decide which land uses apply to your Board. Then decide which weeds cause problems in which land uses. There is no need (and it makes little sense) to assess every weed in every land use. The idea is simply to determine the important weeds of each land use.**

**Assumptions about a land use can be recorded on the scoresheets.**

# 1) COMPARATIVE WEED RISK

The weed risk questions are divided into three main criteria; invasiveness, impacts and potential distribution. **Invasiveness** looks at the weed's rate of spread, faster spreading weeds being a higher priority for control. **Impacts** are the economic, environmental and social effects the weed has. **Potential distribution** indicates what total area the weed could spread to. Scores for each of these criteria are multiplied (each ranging between 0 and 10), to give a weed risk score out of 1000.

## INVASIVENESS

This section indicates how fast the weed can spread within a particular land use. It takes account of how well the weed can establish, reproduce and disperse. Answer all questions with the land use in mind, except for question 5(a).

1. What is the weed's ability to establish amongst existing plants?		SCORE
<input type="checkbox"/> very high	"Seedlings" readily establish within dense vegetation, or amongst thick infestations of other weeds.	3
<input type="checkbox"/> high	"Seedlings" readily establish within more open vegetation, or amongst average infestations of other weeds.	2
<input type="checkbox"/> medium	"Seedlings" mainly establish when there has been moderate disturbance to existing vegetation, which substantially reduces competition. This could include intensive grazing, mowing, raking, clearing of trees, temporary floods or summer droughts.	1
<input type="checkbox"/> low	"Seedlings" mainly need bare ground to establish, including removal of stubble/leaf litter. This will occur after major disturbances such as cultivation, overgrazing, hot fires, grading, long-term floods or long droughts.	0
<input type="checkbox"/> don't know		?

*Ignore any weed control practices for this question. Depending on the land use, "vegetation" may be crops, pastures, lawns and/or native vegetation. Weeds that invade well-managed land uses (where a dense vegetative cover over soil is maintained) are assumed to be more important. High scoring weeds would include wild radish, bridal creeper and dodder.*

*Assume the plant has just arrived. "Seedlings" includes growth from dispersed vegetative propagules (e.g. broken fragments of couchgrass stems or silverleaf nightshade roots) and spores, in addition to seeds. "Seedlings" does not include new vegetative growth whilst still attached to the parent plant (e.g. by stolons, rhizomes or lateral roots). This feature is accounted for in question 3(c).*

*Features which can help a weed establish amongst existing plants include:*

- the ability to germinate under the canopy of other plants (e.g. weeds that have staggered germination in crops)*
- large seeds or vegetative propagules (e.g. bulbs, root fragments, tubers) provide more reserves to help the weed establish in competition with other plants*
- the ability to tolerate or avoid competitive stresses (e.g. by rapid root growth, fixing own nitrogen, or rapid vertical shoot growth)*

2. What is the weed's tolerance to average weed management practices in the land use?		SCORE
<input type="checkbox"/> very high	Over 95% of weeds survive commonly used weed management practices.	3
<input type="checkbox"/> high	More than 50% of weeds survive.	2
<input type="checkbox"/> medium	Less than 50% of weeds survive.	1
<input type="checkbox"/> low	Less than 5% of weeds survive.	0
<input type="checkbox"/> don't know		?

Assume the weed is new to an area. This question looks at whether the new weed is killed by the weed management practices which are commonly used across the land use. If most are killed then there will be few plants to reproduce and spread. If few are killed then changes to weed management practices will eventually be needed. Weed management practices include herbicides, cultivation, cutting/slashing, grazing, and fire. The types and timing of these practices may vary within land uses (e.g. for cereals and broadleaf crops, or vineyards and citrus), but average these. If a weed grows and seeds when there is normally no weed management (e.g. summer) then it is highly tolerant of the common weed management practices. Weeds with high tolerance to routine weed management would include silverleaf nightshade (difficult to kill), caltrop (quick to seed), and broomrape. In native vegetation there may be no commonly used weed management practices at a regional level - if so then include this in your assumptions about the land use.

3. What is the reproductive ability of the weed in the land use?			Total (a+b+c)	SCORE	
<b>(a) Time to seeding</b>	<b>(b) Seed set</b>	<b>(c) Vegetative reproduction</b>	<input type="checkbox"/> high	5 or 6	3
<input type="checkbox"/> 1 year            2	<input type="checkbox"/> high                    2	<input type="checkbox"/> fast                    2	<input type="checkbox"/> medium-high	3 or 4	2
<input type="checkbox"/> 2-3 yrs            1	<input type="checkbox"/> low                    1	<input type="checkbox"/> slow                   1	<input type="checkbox"/> medium-low	1 or 2	1
<input type="checkbox"/> >3 yrs/never    0	<input type="checkbox"/> none                   0	<input type="checkbox"/> none                   0	<input type="checkbox"/> low	0	0
<input type="checkbox"/> don't know        ?	<input type="checkbox"/> don't know           ?	<input type="checkbox"/> don't know           ?	<input type="checkbox"/> don't know		?

This question looks at how well the weed can reproduce, to rapidly build up its numbers at a site, and to spread quickly to other sites. If a weed never gets to reproduce in a land use then it will score 0. Three factors are considered in scoring the weed:

- (a) Time to seeding is the time from establishment (from seed or vegetative propagule) to seed production.
- (b) Consider seed set as the average number of viable seed produced per square metre of ground per year, in a patch of the weed. This may be from one large weed (e.g. a tree) or many small weeds (e.g. grasses). High would be >1000 seeds per m<sup>2</sup>. Your answer to question 2 may influence seed set.
- (c) Consider vegetative reproduction as the average number of new plants produced each year by such means as bulbs, bulbils, corms, tubers, rhizomes, stolons, root suckers, root fragments and shoot fragments. High would be >10 new plants per year from a mature parent plant. In certain land uses cultivation may increase vegetative reproduction (e.g. Lincoln weed). "New plants" are defined as shoots with their own root system. There may still be some connection to the parent plant (e.g. couchgrass).

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4. How likely is long-distance dispersal (>100m) by natural means?				Total (a+b+c+d)	SCORE
<b>(a) Flying birds</b>		<b>(b) Other wild animals</b>		6, 7 or 8	3
<input type="checkbox"/> common	2	<input type="checkbox"/> common	2	3, 4 or 5	2
<input type="checkbox"/> occasional	1	<input type="checkbox"/> occasional	1	1 or 2	1
<input type="checkbox"/> unlikely	0	<input type="checkbox"/> unlikely	0	0	0
<input type="checkbox"/> don't know	?	<input type="checkbox"/> don't know	?		?
<b>(c) Water</b>		<b>(d) Wind</b>			
<input type="checkbox"/> common	2	<input type="checkbox"/> common	2		
<input type="checkbox"/> occasional	1	<input type="checkbox"/> occasional	1		
<input type="checkbox"/> unlikely	0	<input type="checkbox"/> unlikely	0		
<input type="checkbox"/> don't know	?	<input type="checkbox"/> don't know	?		

This question looks at how well the weed can spread its propagules (seed or vegetative) by natural means, to start new weed outbreaks a long distance from the original outbreak. Weeds which have more means of dispersal tend to spread faster. Consider if a weed is adapted for long-distance dispersal by any of the above means, and how regularly these means of dispersal occur. How often do you see new outbreaks starting at least 100 metres away from an original infestation?

Features favouring long-distance dispersal by flying birds and other wild animals (e.g. foxes, kangaroos, rabbits, emus) are:

- whole fruits are eaten, and viable seeds are then defecated or regurgitated (e.g. olives, sweet briar)
- propagules have hooks, barbs or sticky substances that attach to feathers, hairs or skin (e.g. horehound, brome grass)
- very small seeds which can lodge within feathers, hairs or feet (e.g. nutgrass)

Features favouring long-distance water dispersal are:

- propagules which float (consider wind-assisted movement as water dispersal)
- weeds located in or near to moving water
- frequent floods

Mainly aquatic weeds such as salvinia and seeding willows would be commonly dispersed over 100m by water movement.

Research has shown that seeds of most wind dispersed weeds actually land close to the parent plants. Long-distance dispersal is more likely to be common for tall trees with light seeds (with wings, plumes or hairs) which are subject to frequent strong winds, and for weeds which snap off after fruiting and roll across sparsely-vegetated ground (e.g. wild turnip, serrated tussock).

5. How likely is long-distance dispersal (>100m) by human means?				Total (a+b+c+d)	SCORE
<b>(a) Deliberate spread by people</b>		<b>(b) Accidentally by people and vehicles</b>		6, 7 or 8	3
<input type="checkbox"/> common	2	<input type="checkbox"/> common	2	3, 4 or 5	2
<input type="checkbox"/> occasional	1	<input type="checkbox"/> occasional	1	1 or 2	1
<input type="checkbox"/> unlikely	0	<input type="checkbox"/> unlikely	0	0	0
<input type="checkbox"/> don't know	?	<input type="checkbox"/> don't know	?		?
<b>(c) Contaminated produce</b>		<b>(d) Domestic/farm animals</b>			
<input type="checkbox"/> common	2	<input type="checkbox"/> common	2		
<input type="checkbox"/> occasional	1	<input type="checkbox"/> occasional	1		
<input type="checkbox"/> unlikely	0	<input type="checkbox"/> unlikely	0		
<input type="checkbox"/> don't know	?	<input type="checkbox"/> don't know	?		

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*This question looks at how well the weed can spread its propagules (seed or vegetative) by human-influenced means, to start new weed outbreaks a long distance from the original outbreak. Weeds which have more means of dispersal tend to spread faster. Consider if a weed is adapted for long-distance dispersal by any of the above means, and how regularly these means of dispersal occur. How often do you see new outbreaks starting at least 100 metres away from an original infestation?*

*Deliberate human spread includes weeds which have been planted for use in agriculture, forestry, horticulture, amenity, windbreaks and/or soil protection. Those which are or have been widely planted have greater potential for dispersal due to many introduction points. **Ignore the land use for this question.** Examples include olives, African lovegrass and Aleppo pine. Deliberate human spread also includes weeds with attractive flowers which are picked and then discarded (e.g. Calomba daisy, cape tulip). A weed may be legally restricted from sale, but is it still planted?*

*Features favouring accidental people and vehicle dispersal are:*

- *weeds which grow in heavily trafficked areas, such that transport by footwear, clothing or vehicles (including farm machinery and boats) may occur*
- *weeds which are dragged by farm machinery (e.g. silverleaf nightshade)*
- *propagules have hooks, barbs, or sticky substances to attach to objects (e.g. caltrop)*
- *very small propagules which can lodge in cracks in footwear, clothing or vehicles (e.g. Lincoln weed)*

*For contaminated produce consider crop seed, pasture seed, hay, soil, gravel, fertilisers, manures, and/or mulch. Examples of weeds which may be commonly spread by such means include bifora, salvation Jane, and soursob. Do not consider wool as this relates to the sale of farm animals between properties, which is covered in (d).*

*Features favouring dispersal by domestic/farm animals (e.g. sheep, cattle, horses, dogs) are:*

- *whole fruits are eaten, and viable seeds are then defecated or regurgitated (e.g. cutleaf mignonette, charlock)*
- *propagules have hooks, barbs or sticky substances that attach to feathers, hairs or skin (e.g. horehound, brome grass)*
- *very small seeds which can lodge within feathers, hairs or feet (e.g. nutgrass)*

## IMPACTS

This section indicates the **potential impacts** the weed has. Each question is answered with a land use in mind. Assume that the **weed has spread** across a whole paddock, orchard, plantation, nature reserve or water body, and that **commonly-used weed management practices have not been changed to specifically target the weed**. If the weed is well-controlled by these common practices then it will occur at a low density and will have minimal impacts. Alternatively, if the weed is poorly controlled by these common practices then it may get to a high density and have substantial impacts. If the weed has an effective biocontrol agent established which substantially reduces its growth then the weed's impacts will be reduced. **Decide if the weed is likely to reach a low, medium or high density in the land use.**

1. Does the weed reduce the establishment of desired plants?		SCORE
<input type="checkbox"/> >50% reduction	The weed stops the establishment of more than 50% of desired plants (e.g. regenerating pasture, sown crops, planted trees, regenerating native vegetation), by preventing germination and/or killing seedlings.	3
<input type="checkbox"/> 10-50% reduction	The weed stops the establishment of between 10% and 50% of desired plants.	2
<input type="checkbox"/> <10% reduction	The weed stops the establishment of less than 10% of desired plants.	1
<input type="checkbox"/> none	The weed does not affect the germination and seedling survival of desired plants.	0
<input type="checkbox"/> don't know		?

*This question looks at whether the weed prevents the establishment of desired plants, so the density of these plants is reduced. The weed may prevent germination by dense shading, or by forming physical barriers to water movement into the soil. The weed may kill seedlings by denying them access to soil moisture, sunlight and nutrients.*

*Note that the desired plants may mainly establish after a major disturbance (e.g. cultivation prior to planting, bushfire), so the weed itself may also be establishing. In these cases does the weed actually have a major effect?*

*Weeds which are likely to cause over 50% reductions in establishment are gorse and early-germinating (and unsprayed) salvation Jane in pastures, and phlaris and watsonia in native vegetation.*

2. Does the weed reduce the yield or amount of desired vegetation?		SCORE
<input type="checkbox"/> >50% reduction	The weed reduces crop, pasture or forestry yield, or the amount of mature native vegetation by over 50%.	4
<input type="checkbox"/> 25-50% reduction	The weed reduces yield or amount of desired vegetation by between 25% and 50%.	3
<input type="checkbox"/> 10-25% reduction	The weed reduces yield or amount of desired vegetation by between 10% and 25%.	2
<input type="checkbox"/> <10% reduction	The weed reduces yield or amount of desired vegetation by up to 10%.	1
<input type="checkbox"/> none	The weed has no effect on growth of the desired vegetation. Or the weed may become desirable vegetation at certain times of year (e.g. providing useful summer feed), which balances out its reduction in the growth of other desirable plants.	0
<input type="checkbox"/> don't know		?

*This question looks at the degree of yield loss (in crops, pastures, forestry) or suppression (in mature native vegetation) caused by the weed. It follows on from question 1, and looks at the growth achieved by plants which did establish despite the weed. The question is answered on a per hectare basis, in comparison to similar vegetation which is free of the weed. For native vegetation it may be useful to think in terms of percentage cover.*

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Weeds will reduce growth of other plants by competing for sunlight, water and nutrients. Competition is greater where a weed is larger (e.g. tall with a dense leaf canopy and an extensive root system) and grows at the same time as the desirable plants. Some weeds also compete by forming physical barriers which stop plants growing to reach light, water and/or nutrients (e.g. tuber mat of bridal creeper). A special case are parasitic weeds which directly attack other plants. Weeds which could cause >50% reductions in the yield/amount of desired vegetation would include Aleppo pines, serrated tussock and branched broomrape.

Some weeds may increase the amount of useful vegetation in a land use. For example, does a perennial weed of grazing land provide nutritious summer feed, thus increasing total pasture available throughout the year?

3. Does the weed reduce the quality of products or services obtained from the land use?		SCORE
<input type="checkbox"/> <b>high</b>	The weed severely reduces product quality such that it cannot be sold. This may be due to severe contamination, toxicity, tainting and/or abnormalities (chemical and/or physical). For <b>native vegetation</b> , the weed severely reduces biodiversity (plants and animals) such that it is not suitable for nature conservation and/or nature-based tourism. For <b>urban</b> areas, the weed causes severe structural damage to physical infrastructure such as buildings, roads and footpaths.	3
<input type="checkbox"/> <b>medium</b>	The weed substantially reduces product quality such that it is sold at a much lower price for a low grade use. For <b>native vegetation</b> , the weed substantially reduces biodiversity such that it is given lower priority for nature conservation and/or nature-based tourism. For <b>urban</b> areas, the weed causes some structural damage to physical infrastructure such as buildings, roads and footpaths.	2
<input type="checkbox"/> <b>low</b>	The weed slightly reduces product quality, lowering its price but still passing as first grade product. For <b>native vegetation</b> , the weed has only marginal effects on biodiversity but is visually obvious and degrades the natural appearance of the landscape. For <b>urban</b> areas, the weed causes negligible structural damage, but reduces the aesthetics of an area through untidy visual appearance and/or unpleasant odour.	1
<input type="checkbox"/> <b>none</b>	The weed does not effect the quality of products or services.	0
<input type="checkbox"/> <b>don't know</b>		?

*This question looks at whether the weed effects the quality of products or services obtained from a land use. Products affected by the weed may include meat, grain/seed, milk, wool, timber, fruit, hay, and/or water. For native vegetation, consider services such as nature conservation and tourism. An example of a high effect on quality is dodder preventing the sale of seed crops. Reduction in stock condition/liveweight should not be considered here - this is due to either a reduction in available feed (question 2) or animal health effects caused by eating the weed (question 5).*

*For this question, ignore a weed's proclamation status with regard to moving contaminated produce in South Australia, but do consider noxious weed lists and seed quality standards of other states or countries. This prevents bias against non-proclaimed weeds when comparing them to existing proclaimed plants.*

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<b>4. Does the weed restrict the physical movement of people, animals, vehicles, machinery and/or water?</b>		<i>SCORE</i>
<input type="checkbox"/> <b>high</b>	Weed infestations are impenetrable throughout the year, preventing the physical movement of people, animals, vehicles, machinery and/or water.	3
<input type="checkbox"/> <b>medium</b>	Weed infestations are rarely impenetrable, but do significantly slow the physical movement of people, animals, vehicles, machinery and/or water throughout the year.	2
<input type="checkbox"/> <b>low</b>	Weed infestations are never impenetrable, but do significantly slow the physical movement of people, animals, vehicles, machinery and/or water at certain times of the year <b>or</b> provide a minor obstruction throughout the year.	1
<input type="checkbox"/> <b>none</b>	The weed has no effect on physical movement.	0
<input type="checkbox"/> <b>don't know</b>		?

*This question looks at the degree to which a dense infestation of the weed physically restricts movement. Weeds may restrict movement by being tall, thorny, tangled and/or dense. For this question, ignore any deliberate restrictions on movement aimed solely at limiting the spread of weed propagules.*

*Examples of weed limits on movement include:*

- *slowing of stock mustering*
- *blockages of farm machinery at crop sowing and/or harvesting*
- *tyre punctures*
- *slowing of water flow in irrigation systems*
- *interference with boat access*
- *interference with thinning operations in forestry*
- *preventing stock access to pasture and/or water*
- *preventing animal access to nesting sites*

*Weeds which would score highly include blackberry and gorse at high densities, forming impenetrable thickets.*

<b>5. Does the weed affect the health of animals and/or people?</b>		<i>SCORE</i>
<input type="checkbox"/> <b>high</b>	The weed is highly toxic and frequently causes death and/or severe illness in people, stock, and/or native animals.	3
<input type="checkbox"/> <b>medium</b>	The weed occasionally causes significant physical injuries (due to spines or barbs) and/or significant illness (chronic poisoning, strong allergies) in people, stock, and/or native animals, occasionally resulting in death.	2
<input type="checkbox"/> <b>low</b>	The weed can cause slight physical injuries or mild illness in people, stock, and/or native animals, with no lasting effects.	1
<input type="checkbox"/> <b>none</b>	The weed does not affect the health of animals or people.	0
<input type="checkbox"/> <b>don't know</b>		?

*This question looks at how the weed affects the health of animals (domestic stock and native) and people. Note that if a weed is toxic but is not palatable then it may not actually be grazed. Ignore any starvation effects from reduced growth of pasture or reduced access to pasture, as these have been covered in questions 2 and 4. A weed with high effects on health would be poison ivy.*

6. Does the weed have major, positive or negative effects on environmental health?				
	<input type="checkbox"/> major positive effect	<input type="checkbox"/> major negative effect	<input type="checkbox"/> minor or no effect	<input type="checkbox"/> don't know
scoring for (a) - (f):	-1	1	0	?
(a) food/shelter ?	<i>Examples of negative effects are blackberry harbouring rabbits and grass weeds hosting wheat root diseases. An example positive effect is boxthorn providing stock shelter. Ignore pasture for livestock as this was covered in question 2.</i>			
(b) fire regime?	<i>This includes changes to the normal frequency, intensity, and/or timing of fires. Examples of weeds having major effects include exotic grasses invading shrubby native vegetation.</i>			
(c) increase nutrient levels?	<i>For example, legumes can increase soil nitrogen. This may make native vegetation more prone to invasion by other weeds, but would be beneficial in agriculture. Ignore competition for nutrients (decreased nutrient levels) as this was covered indirectly in question 2.</i>			
(d) soil salinity?	<i>Are the leaves of the weed high in salt? Leaf decomposition may increase salinity at the soil surface. Example plants are iceplant and tamarix.</i>			
(e) soil stability?	<i>Does the weed increase soil erosion, or silting of waterways?</i>			
(f) soil water table?	<i>Does the weed substantially raise or lower the soil water table compared to other plants present? Is this positive or negative? Ignore competition for water as this was covered in question 2.</i>			
Total (a + b + c + d + e + f)	>3	2 or 3	1	0 or less
SCORE FOR 6.	3	2	1	0

*This question looks at whether the weed has major, long-term effects on a land use's environment. These effects may be beneficial or detrimental. Effects are more likely where the weed substantially changes the vegetation structure, such as woody weed invasion of grassland. Decisions on major effects should be well-known (e.g. backed up by scientific studies or expert opinion).*

## POTENTIAL DISTRIBUTION

This section looks at what proportion of a land use is at risk from the weed in question. This will depend on the **climate and soil preferences of the weed**. For example, some weeds may only be suited to higher rainfall areas of a Board, or only be a problem on alkaline soils. **Differences within the land use also need to be considered**. For example in the perennial horticulture land use, a weed may be a problem in citrus but not occur in vineyards. This score should also be based on where the weed will grow at the density you assumed in scoring Impacts. That is, if you assumed a high density in scoring impacts then ignore areas where the weed would only persist at a low density when determining potential distribution

This question is best answered with topographic, land use and soil maps for the Board area. These can be analysed electronically using a GIS system such as ArcView, or done on paper maps. Data and maps can be obtained from PIRSA. If using maps the following steps will help in estimating the percentage area of a land use that is suitable for the weed:

1. Map the land use in your Board. If you do not have a land use map, you could shade areas on clear plastic laid over topographic maps.

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2. Consider the climatic and soil preferences of the weed, and the vegetation/crop/pasture types within the land use to which the weed is suited. Lay a sheet of plastic over the land use map, and shade the areas of the land use which are suitable for the weed.
3. Compare the weed's map to the land use map to estimate the percentage of the land use which is suitable for the weed. Answer as follows:

<b>In the Board, what percentage area of the land use is suitable for the weed?</b>		<i>SCORE</i>
<input type="checkbox"/> <b>&gt; 80% of land use</b>	The weed has a potential to spread to more than 80% of the land use in the Board.	<i>10</i>
<input type="checkbox"/> <b>60-80% of land use</b>	The weed has a potential to spread to between 60% and 80% of the land use in the Board.	<i>8</i>
<input type="checkbox"/> <b>40-60% of land use</b>	The weed has a potential to spread to between 40% and 60% of the land use in the Board.	<i>6</i>
<input type="checkbox"/> <b>20-40% of land use</b>	The weed has a potential to spread to between 20% and 40% of the land use in the Board.	<i>4</i>
<input type="checkbox"/> <b>10-20% of land use</b>	The weed has a potential to spread to between 10% and 20% of the land use in the Board.	<i>2</i>
<input type="checkbox"/> <b>5-10% of land use</b>	The weed has a potential to spread to between 5% and 10% of the land use in the Board.	<i>1</i>
<input type="checkbox"/> <b>1-5% of land use</b>	The weed has a potential to spread to between 1% and 5% of the land use in the Board.	<i>0.5</i>
<input type="checkbox"/> <b>unsuited to land use</b>	The weed is not suited to growing in any part of the land use in the Board.	<i>0</i>
<input type="checkbox"/> <b>don't know</b>		<i>?</i>

## COMPARATIVE WEED RISK SCORE

The score for weed risk is calculated by adjusting the invasiveness, impacts and potential distribution scores to range from 0 to 10, and then multiplying these. Weed risk will have a maximum of 1000, and a minimum of 0. The spreadsheet does this for you.

**To calculate manually, adjust the raw scores as follows:**

Invasiveness: Divide by 15 and multiply by 10. Round off to one decimal place.

Impacts: Divide by 19, and multiply by 10. Round off to one decimal place.

Potential distribution: Leave unchanged.

**Comparative Weed Risk = Invasiveness × Impacts × Potential distribution**

Splitting up these possible scores into bands of 20% gives cutoffs for classes of weed risk:

<b>Frequency Band</b>	<b>Weed Risk Score</b>	<b>Weed Risk</b>
80 - 100% (top 20% of possible scores)	192+	<i>Very high</i>
60 - 80%	< 192	<i>High</i>
40 - 60%	< 101	<i>Medium</i>
20 - 40%	< 39	<i>Low</i>
0 - 20% (bottom 20% of possible scores)	< 13	<i>Negligible</i>

**Do not compare scores between land uses.** Land uses differ in their value and this is hard to measure. Also, average weed risk scores may be lower in agricultural land uses compared to other land uses. This is simply because of the greater level of weed management in agriculture. It does not mean that agricultural weeds are less important.

**Why multiply the invasiveness, impacts and potential distribution scores?**

- Multiplying gives a greater spread in the scores than adding (i.e. range from 0-1000 compared to 0-30).
- Multiplying is logical, as it recognises the interactions between the criteria. Say the impacts of a weed can be measured in dollars per hectare per year, the potential distribution is known in hectares, and the invasiveness (i.e. rate of spread) is measured in terms of the increase in hectares compared to the previous year:

$$\begin{array}{ccccc} \text{Impact} & \times & \text{Potential Distribution} & \times & \text{Invasiveness} \\ \$ / \text{hectares} / \text{year} & & \text{hectares} & & \text{hectares}(\text{current year}) / \text{hectares} (\text{previous year}) \end{array}$$

*When multiplying, all of the hectares units cancel so that weed importance is measured in total dollars per year. In multiplying the invasiveness, impacts and potential distribution criteria scores, we are mimicking the above calculation, without having the actual dollar and hectare figures.*

## 2) FEASIBILITY OF CONTAINMENT

The feasibility of containment questions are divided into three main criteria; control costs, current distribution and persistence. **Control costs** considers the weed management costs of detection, on-ground control and enforcement/education needs. **Current distribution** considers how widespread the weed is. **Persistence** refers to the expected duration of control works. Scores for each of these criteria are multiplied (each ranging between 0 and 10), to give a feasibility score out of 1000.

Assess feasibility for the **land use at risk**, so that its score can be directly compared to the weed risk score from the same land use to set control priorities.

In the following questions higher scores indicate lower feasibility of containment.

### CONTROL COSTS

This section indicates the control cost per hectare in the **first year of targeted control**, for an infestation of the weed that has reached its **maximum density in the land use at risk**. The four main cost factors associated with coordinated control programs are searching for the weed, accessing and treating infestations, and achieving landholder commitment.

1. How detectable is the weed?		Total (a+b+c+d)	SCORE
<b>(a) Height at maturity</b>		7 or 8	3
<input type="checkbox"/> <0.5 m	2	5 or 6	2
<input type="checkbox"/> 0.5-2 m	1	3 or 4	1
<input type="checkbox"/> >2 m	0	0, 1 or 2	0
<input type="checkbox"/> don't know	?		?
<b>(b) Shoot growth present</b>			
<input type="checkbox"/> <4 months	2		
<input type="checkbox"/> 4-8 months	1		
<input type="checkbox"/> >8 months	0		
<input type="checkbox"/> don't know	?		
<b>(c) Distinguishing features</b>			
<input type="checkbox"/> non-descript	2		
<input type="checkbox"/> sometimes distinct	1		
<input type="checkbox"/> always distinct	0		
<input type="checkbox"/> don't know	?		
<b>(d) Pre-reproductive height in relation to other vegetation</b>			
<input type="checkbox"/> below canopy	2		
<input type="checkbox"/> similar height	1		
<input type="checkbox"/> above canopy	0		
<input type="checkbox"/> don't know	?		

*This question indicates the cost of finding infestations of the weed. Parts (a), (b) and (c) relate to finding new infestations. Part (d) relates to finding and treating plants prior to reproduction.*

*(a) Taller plants can be spotted from greater distances.*

*(b) Shoot growth considers when shoots are visible (live or dead). Annuals and some perennials (e.g., bridal creeper, bulbil watsonia) have shoots present for a limited period of the year.*

*(c) Distinguishing features include appearance and smell of foliage, flowers and fruits. This indicates how conspicuous the weed is amongst other vegetation. For example, the shape and foliage of a pine tree is quite obvious amongst native vegetation.*

*(d) Pre-reproductive height refers to locating the weed for control prior to seed set or bulb formation. Control must occur before reproduction if local eradication is to occur. The pre-reproductive height will mostly be less than at maturity and the weed will also probably be growing amongst other vegetation. Hence the weed's height is described relative to the canopy height of this other vegetation. For example, if considering a weed of the Crop/Pasture Rotation land use then the canopy will be the height of the crop.*

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<b>2. What is general accessibility of known infestations?</b>		<b>SCORE</b>
<input type="checkbox"/> <b>low</b>	Most infestation sites difficult to access	2
<input type="checkbox"/> <b>medium</b>	Most infestation sites readily accessible	1
<input type="checkbox"/> <b>high</b>	All infestation sites readily accessible	0
<input type="checkbox"/> <b>not present</b>	Not known to be present in Board	0
<input type="checkbox"/> <b>don't know</b>		?

*Sites may be difficult to traverse due to slope, rockiness, dense vegetation and/or surface water. This will slow down searching and control activities. There may be seasonal differences in accessibility (e.g. winter waterlogging), but answer in terms of the optimal search and control times for the weed.*

<b>3. How expensive is control of the weed, using techniques which both maximise efficacy and minimise off-target damage?</b>			<b>SCORE</b>
<b>(a) Chemicals, fuel and equipment operating costs</b>	<b>(b) Labour costs</b>	Total (a+b)	Range between 0 and 8
<input type="checkbox"/> <b>very high</b> 4	<input type="checkbox"/> <b>very high</b> 4		
<input type="checkbox"/> <b>high</b> 3	<input type="checkbox"/> <b>high</b> 3	<input type="checkbox"/> <b>don't know</b>	?
<input type="checkbox"/> <b>medium</b> 2	<input type="checkbox"/> <b>medium</b> 2		
<input type="checkbox"/> <b>low</b> 1	<input type="checkbox"/> <b>low</b> 1		
<input type="checkbox"/> <b>not applicable</b> 0	<input type="checkbox"/> <b>not applicable</b> 0		
<input type="checkbox"/> <b>don't know</b> ?	<input type="checkbox"/> <b>don't know</b> ?		

**Select a cost category (A, B or C) for the land use being considered. This allows for more realistic control cost estimates.**

	<b>Cost Categories</b>			<b>SCORE</b>
	<b>A</b>	<b>B</b>	<b>C</b>	
<b>Very high</b>	>\$1000/ha	>\$500/ha	>\$100/ha	4
<b>High</b>	\$500-1000/ha	\$250-500/ha	\$50-100/ha	3
<b>Medium</b>	\$250-500/ha	\$100-250/ha	\$25-50/ha	2
<b>Low</b>	<\$250/ha	<\$100/ha	<\$25/ha	1

*Herbicides are the main means by which weeds are controlled. Physical control methods may be cultivation, cutting/slashing stems or extraction (e.g., boxthorn plucker). Do not consider capital costs for purchasing application equipment in this question.*

<b>4. What is the likely level of cooperation from landholders within the land use at risk?</b>		<b>SCORE</b>
<input type="checkbox"/> <b>low</b>	Weed control is rarely undertaken in the land use. Cost of control is beyond the financial and technical capacity of landholders.	2
<input type="checkbox"/> <b>medium</b>	Control of the weed will require a significant change in existing weed management practices, but this will be within the financial and technical capacity of landholders.	1
<input type="checkbox"/> <b>high</b>	Control of the weed will require minimal change in existing weed management practices.	0
<input type="checkbox"/> <b>don't know</b>		?

*Aside from the “on-ground” costs of searching and control, a coordinated control program will have overarching costs of extension/education, enforcement, project management and administration. The ease of motivating and coordinating landholders in an ongoing program will vary between land uses, particularly in relation to their financial capacity to support a control program.*

## CURRENT DISTRIBUTION

This section indicates how widespread the weed currently is within the land use. It considers the proportion of the land use infested, and the overall pattern of infestations.

1. What percentage area of the <u>land use</u> is currently infested by the weed?		SCORE
<input type="checkbox"/> >80% of land use	The weed infests more than 80% of the land use in the Board.	10
<input type="checkbox"/> 60-80% of land use	The weed infests between 60% and 80% of the land use.	8
<input type="checkbox"/> 40-60% of land use	The weed infests between 40% and 60% of the land use.	6
<input type="checkbox"/> 20-40% of land use	The weed infests between 20% and 40% of the land use.	4
<input type="checkbox"/> 10-20% of land use	The weed infests between 10% and 20% of the land use.	2
<input type="checkbox"/> 5-10% of land use	The weed infests between 5% and 10% of the land use.	1
<input type="checkbox"/> 1-5% of land use	The weed infests between 1% and 5% of the land use.	0.5
<input type="checkbox"/> <1% of land use	The weed is present in the land use but infests less than 1%.	0.1
<input type="checkbox"/> 0% of land use but in 20-40% of Board	The weed is not known to be present in the land use but does infest between 20% and 40% of the Board area.	2
<input type="checkbox"/> 0% of land use but in 10-20% of Board	The weed is not known to be present in the land use but does infest between 10% and 20% of the Board area.	1
<input type="checkbox"/> 0% of land use but in 5-10% Board	The weed is not known to be present in the land use, but does infest between 5% and 10% of the Board.	0.5
<input type="checkbox"/> 0% of land use but in 1-5% Board	The weed is not known to be present in the land use, but does infest 1-5% of Board.	0.1
<input type="checkbox"/> 0% of land use but <1% of Board	The weed is not known to be present in the land use, but does infest <1% of Board. Or the species is not naturalised in the Board but is cultivated (e.g. olives).	0.05
<input type="checkbox"/> 0% of Board	The species is not known to be present in the Board.	0
<input type="checkbox"/> don't know		?

*The aim of containment is to prevent weed spread to a susceptible land use. The greater the area of land use that is already occupied, then the less feasible is containment. In the above table it is assumed to be highly unlikely that a weed could infest >40% of the Board area and not also be present in the land use.*

2. What is the pattern of the weed's distribution across the Board area?		SCORE
<input type="checkbox"/> widespread	The weed occurs in large and small infestations across most of the Board area.	2
<input type="checkbox"/> evenly scattered	The weed occurs as discrete, mainly small infestations across much of the Board area.	1
<input type="checkbox"/> restricted	The weed is localised to 1-2 hundreds of the Board area. Or the weed is not known to be naturalised in the Board area.	0
<input type="checkbox"/> not present	The species is not known to be present in the Board.	0
<input type="checkbox"/> don't know		?

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*A weed which is widespread will be more difficult to contain than one which is restricted to a small section of the Board. The former will have more landholders potentially exposed to spread of the weed.*

### PERSISTENCE

This section indicates how long it takes to eradicate the weed. It considers the efficacy of targeted control treatments, reproductive age, seedbank longevity and the likelihood of ongoing dispersal.

1. How effective are targeted control treatments applied to infestations of the weed?		SCORE
<input type="checkbox"/> low	More than 25% of weeds survive annual targeted treatment/s.	3
<input type="checkbox"/> medium	Up to 25% of weeds survive annual targeted treatment/s.	2
<input type="checkbox"/> high	Up to 5% of weeds survive annual targeted treatment/s.	1
<input type="checkbox"/> very high	Up to 1% of weeds survive annual targeted treatment/s.	0
<input type="checkbox"/> don't know		?

*Do the herbicide and physical control treatments costed above kill all plants in an infestation? Efficacy can be reduced due to:*

- *tolerance to or recovery from treatment*
- *incomplete application of a treatment (e.g., some plants receive a sub-lethal dose of herbicide, missed plants)*
- *vegetative regeneration (e.g. silverleaf nightshade)*
- *“out of season” growth (e.g. early or late germination of annuals)*

2. What is the minimum time period for reproduction of sexual or vegetative propagules?		SCORE
<input type="checkbox"/> <1 month	Minimum generation time <1 month.	3
<input type="checkbox"/> <1 year	Minimum generation time 1-12 months.	2
<input type="checkbox"/> <2 years	Minimum generation time 12-24 months.	1
<input type="checkbox"/> >2 years	Minimum generation time >24 months.	0
<input type="checkbox"/> don't know		?

*The shorter the time period to reproduction, the greater the frequency of control treatments required and the greater the chance of plants being missed prior to reproduction. Aquatic plants such as salvinia can have rapid vegetative reproduction.*

3. What is the maximum longevity of sexual or vegetative propagules?		SCORE
<input type="checkbox"/> >5 years	Sexual or vegetative propagules can remain dormant for at least 5 years.	2
<input type="checkbox"/> 2-5 years	Sexual or vegetative propagules can remain dormant for 2-5 years.	1
<input type="checkbox"/> <2 years	Sexual or vegetative propagules remain dormant for less than 2 years.	0
<input type="checkbox"/> don't know		?

*Soil seedbank longevity is the primary determinant of how long an infestation must be treated to achieve eradication.*

4. How likely are new propagules to continue to arrive at control sites, or start new infestations?		Total (a+b)	SCORE
<b>(a) Long-distance dispersal by natural means</b>	<b>(b) Grown</b>		
<input type="checkbox"/> frequent 2	<input type="checkbox"/> commonly planted 2	4	3
<input type="checkbox"/> occasional 1	<input type="checkbox"/> occasionally planted 1	2-3	2
<input type="checkbox"/> rare 0	<input type="checkbox"/> not planted 0	1	1
<input type="checkbox"/> don't know ?	<input type="checkbox"/> don't know ?	0	0
		<input type="checkbox"/> don't know	?

## FEASIBILITY OF CONTAINMENT SCORE

The score for feasibility of containment is calculated by adjusting the control costs, current distribution and persistence scores to range from 0 to 10, and then multiplying these. Feasibility of containment will have a maximum of 1000, and a minimum of 0. The spreadsheet does this for you.

**To calculate manually, adjust the raw scores as follows:**

Control costs: Divide by 15 and multiply by 10. Round off to one decimal place.

Current distribution: Divide by 12, and multiply by 10. Round off to one decimal place.

Persistence: Divide by 11, and multiply by 10. Round off to one decimal place.

$$\text{Feasibility of Containment} = \text{Control Costs} \times \text{Current Distribution} \times \text{Persistence}$$

Splitting up these possible scores into bands of 20% gives cutoffs for classes of feasibility of containment:

Frequency Band	Feasibility Score	Feasibility of Containment
80 - 100% (top 20% of possible scores)	113+	<i>Negligible</i>
60 - 80%	< 113	<i>Low</i>
40 - 60%	< 56	<i>Medium</i>
20 - 40%	< 31	<i>High</i>
0 - 20% (bottom 20% of possible scores)	< 14	<i>Very High</i>

### Why multiply the Control Costs, Current Distribution and Duration of Control scores?

- Multiplying gives a greater spread in the scores than adding (i.e. range from 0-1000 compared to 0-30).
- Multiplying is logical, as it recognises the interactions between the criteria. Say the control costs of a weed can be measured in dollars per hectare per year, the current distribution is known in hectares, and the duration of control is known in years:

$$\begin{array}{rcccl}
 \text{Control Costs} & \times & \text{Current Distribution} & \times & \text{Duration of Control} \\
 \$ / \text{hectares} / \text{year} & & \text{hectares} & & \text{years}
 \end{array}$$

*When multiplying, all of the hectares units cancel so that feasibility of control is measured in total dollars. In multiplying the control costs, current distribution and duration of control criteria scores, we are mimicking the above calculation, without having the actual dollar and hectare figures.*

### 3) DETERMINING PRIORITIES

The following matrix gives guidance on appropriate strategic, weed management actions. Different weed species will appear in different positions on the matrix, based on their risk and feasibility of containment scoring. Each land use will have a separate matrix.

WEED RISK	FEASIBILITY OF CONTAINMENT				
	<i>Negligible</i> >113	<i>Low</i> >56	<i>Medium</i> >31	<i>High</i> >14	<i>Very High</i> <14
<i>Negligible</i> <13	LIMITED ACTION	LIMITED ACTION	LIMITED ACTION	LIMITED ACTION	MONITOR
<i>Low</i> <39	LIMITED ACTION	LIMITED ACTION	LIMITED ACTION	MONITOR	MONITOR
<i>Medium</i> <101	MANAGE SITES	MANAGE SITES	MANAGE SITES	PROTECT SITES	CONTAIN SPREAD
<i>High</i> <192	MANAGE WEED	MANAGE WEED	PROTECT SITES	CONTAIN SPREAD	DESTROY INFESTATIONS
<i>Very High</i> >192	MANAGE WEED	PROTECT SITES & MANAGE WEED	CONTAIN SPREAD	DESTROY INFESTATIONS	ERADICATE

ALERT

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Following are guiding principles for each of the management categories in the matrix. At a landscape scale these principles need to be interpreted in terms of different outcomes per land use for different weeds. For example, a weed may rank as “destroy infestations” in one land use and “limited action” in others. In this case coordinated control may still be required in the latter land uses to enable protection of the former land use.

The term “management area” can be used below to apply to a range of spatial scales (e.g. NRM Board, sub-regional, land use)

### **ALERT**

Species that are not known to be present in the management area and which represent a significant threat. Such species would score “0” in Feasibility of Containment due to their absence.

#### **Aims to prevent the species arriving and establishing in the management area**

- Prevention of entry to management area
- Ongoing surveillance for incursions of the species (e.g. nursery inspections)
- Training and awareness activities for the community to enable early detection

### **ERADICATE**

#### **Aims to remove the weed species from the management area**

- Detailed surveillance and mapping to locate all infestations
- Destruction of all infestations including seedbanks
- Prevention of entry to management area and movement and sale within
- Must not grow and all cultivated plants to be removed
- Monitor progress towards eradication

### **DESTROY INFESTATIONS**

#### **Aims to significantly reduce the extent of the weed species in the management area**

- Detailed surveillance and mapping to locate all infestations
- Destruction of all infestations, aiming for local eradication at feasible sites
- Prevention of entry to management area and movement and sale within
- Must not grow
- Monitor progress towards reduction

### **CONTAIN SPREAD**

#### **Aims to prevent the ongoing spread of the weed species in the management area**

- Surveillance and mapping to locate all infested properties
- Control of all infestations, aiming for a significant reduction in weed density
- Prevention of entry to management area and movement and sale within
- Must not allow to spread from cultivated plants (if grown)
- Monitor change in current distribution

### **PROTECT SITES**

#### **Aims to prevent spread of the weed species to key sites/assets of high economic, environmental and/or social value**

- Weed may be of limited current distribution but only threatens limited industries/habitats (lower weed risk). Or the weed may be more widespread but is yet to invade/impact upon many key industries/habitats (higher weed risk).
- Surveillance and mapping to locate all infested areas
- Identification of key sites/assets in the management area
- Control of infestations in close proximity to key sites/assets, aiming for a significant reduction in weed density
- Limits on movement and sale of species within management area

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- Must not allow to spread from cultivated plants (if grown) in close proximity to key sites/assets
- Monitor change in current distribution within and in close proximity to key sites/assets

### **MANAGE WEED**

**Aims to reduce the overall economic, environmental and/or social impacts of the weed species through targeted management**

- Research and develop integrated weed management (IWM) packages for the species, including herbicides and biological control where feasible
- Promote IWM packages to landholders
- Monitor decrease in weed impacts with improved management
- Identify key sites/assets in the management area and ensure adequate resourcing to manage the weed species

### **MANAGE SITES**

**Aims to maintain the overall economic, environmental and/or social value of key sites/assets through improved general weed management**

- Promote general IWM principles to landholders, including the range of control techniques, maintaining competitive vegetation/crops/pastures, hygiene and property management plans.
- Identify key sites/assets in the management area and ensure adequate resourcing to manage these to maintain their values
- Broaden focus beyond weeds to all threatening processes

### **MONITOR**

**Aims to detect any significant changes in the species' weed risk**

- Monitor the spread of the species and review any perceived changes in weediness

### **LIMITED ACTION**

**The weed species would only be targeted for coordinated control in the management area if its local presence makes it likely to spread to land uses where it ranks as a higher priority.**

- Undertake control measures if required for the benefit of other land uses at risk
- Otherwise limited advice to land managers if required