# Managing hard-to-control weeds along Australian roadsides

## GUIDELINES FOR MANAGERS

- Hard-to control weeds, including those that are herbicide resistant, are becoming more common on roadsides and present major challenges for road managers.
- Identification and mapping of hard-to-control weeds is the first step to improved management.
- A shift away from reliance on a glyphosate-based management system will require a commitment to retrain staff and re-evaluate work procedures and budgets.
- When herbicides are used on roadsides they must be applied through well calibrated equipment at sufficiently high rates and application volumes for the type of herbicide being used.
- When using herbicides it is critical that all spray drift and environmental constraints are followed.

Australia has more than 874,000 kilometres of roads. This means up to 1.75 million km of roadside vegetation that must be managed and can potentially act as a reservoir for weeds that impact both natural and agricultural systems.

*On major roads in Western Australia the average width managed from edge of the tar is 4m. AGRONOMO*

### Managing roadside vegetation is complex

Managing roadside vegetation can be complex due to:

- prioritisation of road-user safety
- maintaining road structure
- fire management
- conservation of rare and endangered vegetation
- the need to follow environmental constraints
- the requirement to only control declared weeds

The management of roads and roadside vegetation is further complicated because they are managed by a range of organisations often using contractors and are required to adhere to a budgetary framework.

Add to this, the number of landowners adjacent to these linear reserves that have different motivations for management.

### Road-user safety

Public safety is the primary driver for roadside vegetation management. An extended line of sight, unimpeded vision of roadside furniture and the ability for a vehicle get off the 'seal' without any damage to person or vehicle are important goals. Roadside vegetation often has a maximum 30 centimetre height before treatment, which allows road users to see roadside posts and reflectors without obstruction.


*States have different signs to alert weed managers to important weed infestations, for example a Tasmanian Priority Weed Program sign warning of a Chilean Needle grass infestation. State Roads Tasmania.*

## Maintaining road structure

The management of infrastructure is also an important driver of roadside vegetation management. It is essential that water freely flows from the sealed surface and off the road shoulder. Ponding of water near the edge of the seal caused by weed growth allows water to enter the road base, which in turn destabilises the underlying road structure. Keeping signs, posts and roadside structures free of plant growth also helps protect it from corrosion and potential fire damage.

## Fire management

Fire management can play a significant role in how roadside vegetation is managed. Roadsides are a point of ignition, provide containment and firebreak, and are a route of escape in the event of an evacuation. Roads can be used as fire breaks, with the road corridor tending to be wider such as in Western Australia, where major roads have a four to 10m vegetation management buffer from the edge of the bitumen.

## Conservation of rare and endangered vegetation or habitats

Areas of vegetation between the roadside and freehold land often contain rare habitats or rare and endangered plant and animal species, which rely on these areas for their survival. In many regions, due to significant clearing, roadside verges are the last relatively untouched stands of native vegetation. These areas can be signposted and have specific protocols in place to minimise disturbance and further loss. For example, in New South Wales demarcation of these areas is with 'Significant Roadside Environment Area' signs, while Tasmania has yellow 'L' shaped markers on the fence. The remnant vegetation along roadsides also provides connectivity between larger patches of native vegetation, particularly in areas that have been heavily cleared for cropping or grazing and are used as movement corridors for birds and animals.

## Control of weeds on roadsides

Weeds on roadsides are divided into legally controllable or 'declared' weeds and 'other' weeds. 'Other' weeds have no legal requirement for control and are generally seen as a low priority for roadside vegetation managers. Weeds that impact agricultural productivity fit into the 'other' weed category, and when they occur on roadsides are low priority for management unless they impact road user safety (line-of-sight) or are on a locally important weed list developed by a local natural resource management group or council.

Therefore, control of declared weeds along roadsides is the priority for roadside vegetation managers. Each state has slightly different systems for declaring specific weeds that must be controlled or contained.

For example, NSW has the Biosecurity Act 2015 from which 11 strategic weed management plans have been developed that articulate how 'road authorities' will conduct management of declared weeds on roadsides.

Some states and local government areas now map declared weeds to ensure effective ongoing management. In NSW, the 'Red Guidepost' program aims to increase awareness of declared weeds on roadsides by both the public and road managers. Red posts are located at the beginning and end of a declared weed infestation. Tasmania has a "Priority Weed Program" where the infestations of certain species are clearly identified by signage and therefore need different management.

*Continued reliance on glyphosate has allowed hard-to-control weeds like feathertop Rhodes grass to dominate roadsides. Western Riverina, NSW. AGRONOMO*

*If roadside managers fail to implement a monitoring program for new hard-to-control weed species like this Coolatai grass (Hyparrhenia hirta), these species will dominate roadsides and increase maintenance costs. AGRONOMO*

## Hard-to-control weeds

The management of roadside vegetation is often driven by logistics and not the condition and stage of the vegetation to be managed. Due to the large areas involved, roadsides are often slashed when weeds have already set viable seed or sprayed when plants are stressed from low soil moisture levels or high temperatures. Sometimes plants can be quite mature when they are sprayed, which may mean an insufficient herbicide dose is applied, leading to ineffective control.

Adding to the issues of spraying large and stressed weeds, roadside weed management is now complicated by the presence of weed populations that are either resistant or tolerant to herbicides, in particular, glyphosate. Glyphosate has been a popular herbicide choice due to its activity on both grass and broadleaf weeds, is inexpensive, low odour and easy to use on a range of different weed sizes.

### Herbicide resistance

The continued reliance on glyphosate for roadside vegetation management has led to the development of populations of weeds that are now resistant. Glyphosate resistant weeds found on Australian roadsides include annual ryegrass *(Lolium rigidum*), windmill grass (*Chloris truncata*), feathertop Rhodes grass (*Chloris virgata*), flaxleaf fleabane (*Conyza bonariensis*) and tall fleabane (*Conyza sumatrensis*).

For more information on herbicide resistance - *https://www.agric.wa.gov.au/grains-research-development/herbicide-resistance*

### Herbicide tolerance

Glyphosate tolerant weeds are also becoming an increasing roadside problem. Tolerance to glyphosate is best defined as weed species that were never effectively controlled by that herbicide. Continued use of glyphosate with little other management leads to roadsides being dominated by species that have survived the herbicide treatment. Glyphosate tolerant weeds include the grasses *Hyparrhenia* species (Coolatai/thatch grasses), African lovegrass (*Eragrostis curvula*), windmill grass (*Chloris truncata*) and feathertop Rhodes grass (*Chloris virgata*). In sub-tropical and tropical zones high biomass perennial tussock-forming grasses include various Rhodes grasses (*Chloris* spp.), grader grass (*Themeda quadrivalvis*), giant *Sporobolus* species and Gamba grass (*Andropogon gayanus*). These species create 'line-of-site' (safety) problems and all greatly increase the fire hazard.

Broadleaf species that are glyphosate tolerant include both flaxleaf and tall fleabanes (*Conyza* spp.), primroses (*Oenothera* spp.), crownbeard (*Verbesina encelioides* subsp. *encelioides*), stinkwort (*Dittrichia graveolens*) and dove weed (*Croton setiger*).

Once these species start to dominate the roadside, they can be easily spread by slashers, maintenance machinery and general traffic.

*Road verge cleared width tends to increase in less populated areas. Kimberley, WA. AGRONOMO*

## Management strategies to improve weed control and reduce the risk of herbicide resistant and/or tolerant infestations

The only way to manage difficult roadside weeds (including herbicide resistant populations) is to implement a relatively simple monitoring program and develop a proactive management system, that takes into account the environmental, social and logistical constraints of the area. For many authorities who have already started mapping 'significant' (endangered) roadside vegetation, expanding this to map hard-to-control weeds is a logical and positive step.

To implement a sustainable roadside vegetation management program, contractors, field staff and managers must understand the threats and effects resulting from the development of hard-to-control weeds along roadsides. It is important this acknowledges the impacts to the immediate management program but also to those of neighbouring land managers.

A sustainable roadside vegetation management program should consider the following:

- The climate of the area (especially rainfall distribution and amounts) and the potential impact on vegetation growth
- Mapping of herbicide tolerant and resistant weeds
- Management options tailored to the specific situation including
  - Judicious use of glyphosate on susceptible populations
  - Use of non-glyphosate herbicides
  - Mechanical or other non-chemical control prior to seed set
  - Engineering solutions to minimise vegetation growth
- Emphasis on operational scheduling and machine hygiene to minimise spread
- Additional budgets for training and implementation if shifting away from a glyphosate-based management approach.

The move from reactive to planned weed management has the following benefits:

- Cheaper overall weed management – monitoring and mapping of problem weeds allows site-specific programs to be used, rather that treat all roadsides with more expensive strategies.
- Better relationships with stakeholders. Spread of glyphosate resistant or tolerant weeds into high conservation value vegetation and landholders' paddocks can create unnecessary conflict.
- Well trained and involved staff and contractors will be happier and work more effectively.

The components of a management plan must fit the local conditions and institutional responsibilities.

## Environmental impacts

Temperature and rainfall influence plant growth so wetter warmer conditions like that found in coastal areas require more spraying and slashing, additional engineering solutions or the judicious use of residual herbicides. This in turn increases costs, the level of management complexity and risk. Timing of operations are crucial in effectively managing hard-to-control weeds. Many non-glyphosate options work best on small plants, so allowing weeds to get large will likely result in multiple control attempts. Stopping annual weeds from setting seed is a useful long-term management practice that reduces troublesome weed populations over time.

## Community expectation

Community expectations will be reflected through local government which determines what are acceptable practices. For example, some roadside managers have made the decision to reduce/eliminate glyphosate use which leads to either a shift to other herbicide modes of action and/or the use of more mechanical weed control. As mechanical weed control treats fewer kilometres of road per day, more equipment and operators are required to effectively manage the same area.

*To maintain the integrity of the road base from ingress of water it is important to keep weeds from the edge of the tar. Perennial grasses are a problem because they are hard to control and thrive on the water harvested from the road surface. Grasspatch, WA. AGRONOMO*

## Hygiene

Machinery hygiene is an underestimated and often overlooked part of a weed management plan.

Simple techniques such as slashing from clean to infested areas and not slashing weeds with viable seed make roadside weed management much easier, and cheaper.

Using better designed equipment (for example *https://www.slasherteck.com.au/products/vegetation-management/equipment*) increases the likelihood that operators will clean down machinery before moving to a new operational area. The commonly used flatbed slasher by comparison accumulates debris and seeds on the deck.

Additional costs for dealing with hard-to-control weeds, such as the use of more expensive herbicides or additional treatment must be included in weed management contracts.

## Use of herbicides on roadsides

Using herbicides to manage roadside vegetation introduces complications such as spraying near sensitive areas. Sensitive areas include aquatic and wetland areas, surface streams and rivers, organic farms, human habitation, urban areas, schools and hospitals, which all need special consideration and management. Herbicide use in these situations must be consistent with all of the relevant label statements such as withholding periods (WHPs), environmental protections and buffer zones.

Continued use of herbicides on roadsides and other areas is determined by the social license to operate. The social license to operate is the general public's ongoing acceptance of roadside management practices which include herbicides. This is reliant on trust within the community. Road managers must conduct environmentally safe herbicide usage and be seen to be doing so.

The range of available herbicides being used on roadsides is reducing due to potential off-target damage, occupational health and safety implications and concerns from the public.

## Which herbicides can be used on roadsides?

Chemical usage in Australia is tightly regulated to ensure safety for the operator, public and environment, and as such herbicides must only be used where they are registered or permitted to do so. While very few herbicides have 'roads' and 'roadsides' in their 'Situation for use' the Australian Pesticides and Veterinary Medicines Authority (APVMA) consider it reasonable to interpret non-crop areas and rights of way to include roadsides. Their guidance for what is a major or minor crop/situation lays out the definition of a non-crop area which includes roadsides.

### Non-food situations

- agricultural non-crop areas (includes land associated with farmland but not used for regular cultivation and/or grazing)
- non-crop areas (includes areas of lands not being used or intended to be used for cropping or grazing).

These areas include industrial sites, timber yards, areas around farm buildings, along fences and roadsides, rights-of-way, storage areas, wastelands, vacant lots, cemeteries, etc.

*https://apvma.gov.au/node/10931*

While the definition of 'non-crop areas' legalises a number of herbicides, the actual number of herbicides which can be used practically is much smaller.

Some road management authorities such as NSW Roads & Maritime Services have approved herbicide lists, which include the products they deem as suitable for their area of management responsibility.

*A typical minor bitumen road in cropping areas in Western Australia. AGRONOMO*

*In some jurisdictions a residual herbicide such as simazine is added to the knockdown herbicide to give extended weed control on the road shoulder. AGRONOMO*

## Herbicides with an acceptable risk profile for roadsides

For many years, glyphosate has been the mainstay of roadside chemical weed control due to its effectiveness in controlling a wide range of species and at different development stages. However, with the development of glyphosate resistant and/or tolerant weed populations and growing public concern over the product, land managers are looking to utilise other herbicide options.

This shift from a glyphosate-based program will potentially complicate chemical control, as a land manager will need to understand

- What herbicides are registered and provide activity on the range and size of weeds present (which also requires accurate weed identification)
- How the herbicides work and if they can be mixed (physical and in-plant compatibilities)
- What sprayer set up is required (water rates, droplet size, coverage)

For detailed spray application information see the GRDC Spray Application manual

*https://grdc.com.au/resources-and-publications/grownotes/technical-manuals/spray-application-manual*

However, armed with this knowledge, weed management programs incorporating a range of herbicides will continue to be viable options for land managers.

For more detailed information refer to:

NSW Weed Control Handbook - A guide to weed control in non-crop, aquatic and bushland situations *https://www.dpi.nsw.gov.au/biosecurity/weeds/weed-control/management-guides/noxious-enviro-weed-control*

Weed Control Handbook for Declared Plants in South Australia July 2018 Ed. *https://www.pir.sa.gov.au/__data/assets/pdf_file/0020/232382/WEB_8867_PIRSA_Weed_Control_Handbook_2018.pdf*

## Non-glyphosate knockdown herbicides

**Paraquat** – poorly translocated so needs excellent coverage. Suited to controlling seedlings. No residual.

**Amitrole** – a broad-spectrum herbicide that is translocated. It is strongest on broadleaf and sedge weed species and less effective on grasses. Slow acting when compared with glyphosate and weed brown-out may not occur for 4-6 weeks.

**A mix of amitrole + paraquat** – is increasingly used on roadsides as it introduces two different modes of action to control glyphosate resistant weeds.

**Glufosinate** – translocated. Best results in warm and humid conditions. Better control of broadleaf weeds and pines than grasses.

**Pine oil, vinegar, nonanoic acid** – Various plant oils, such as pine oil, and acids, such as vinegar and nonanoic acid. These are not translocated and can be used for control of small weed seedlings. Larger annual weeds need multiple applications. Control of established perennial weeds is unlikely.

## Soil active/residual herbicides

There are multiple residual herbicides with registrations for use on roadsides. They predominantly include simazine, sulfometuron-methyl, terbacil (+ sulfometuron), flupropanate and others in mixtures. These are often used for specific weed problems. Residual herbicides have the advantage that they will control weeds for an extended period of time depending on rate and amount of rainfall; however, for some herbicides there is a risk that they will move off site and damage non-target shrubs and trees or contaminate waterways.

*Slashing roadside vegetation is widely used but without effective clean-down procedures, it readily spreads weeds. AGRONOMO*

## Post emergent selective herbicides

These herbicides are usually applied to emerged weeds and absorbed via the leaves. Some have additional soil activity such as 2,2-DPA. They will often only control a certain group of weeds such as broadleaf only or grass only. Some will do both.

**2,2-DPA** – shoot & root uptake. Controls annual and perennial grasses plus monocots such as *Watsonia* spp.

A range of herbicides including **MCPA, fluroxypyr, triclopyr, aminopyralid (+ fluroxypyr)** and **picloram.** These herbicides are well translocated and target a range of broadleaf weeds, including woody weeds.

**Bromoxynil** – no translocation – controls small broadleaf seedlings only.

**Metsulfuron-methyl** – well translocated. Broadleaf species including woody weeds and Bahia grass (*Paspalum notatum*) (Permit).

The grass selective herbicides **fluazifop-p-butyl, haloxyfop-p-methyl and quizalofop-p-ethyl** are poorly translocated so good spray coverage is essential.

## Precision optical spot sprayers

Precision optical sprayers like Weedseeker® and WEED-it® identify green plants against a soil background for targeting with herbicides. This reduces the area where herbicides are applied, reducing potential risks to the environment. It also allows higher cost products to be used for targeted applications.

While this technology is widely used in broadacre cropping situations, its application on roadsides is undeveloped. It does have potential for follow-up control of weeds on road shoulders that have survived the initial treatment.

## Non-herbicide options

### Slashing

Slashing is relatively slow and often requires multiple staff members to alert motorists to the tractor-slasher ahead. In wet years and higher rainfall areas, such as the coast, it can be difficult to keep vegetation at the allowable height and most slashers are also incapable of getting close to roadside furniture. Using 'flat-deck' slashers makes it difficult to prevent weed seed spread without significant down-time for cleaning. However, well planned work scheduling (working from 'clean' to 'dirty' areas) will minimise weed spread and regular slashing prior to seed-set can be very effective in reducing the impact of annual weeds.

The use of articulated slashers has become more common. These machines have the advantage of reaching difficult to access spots such as steep embankments. On the negative side they are often used to 'prune' remnant native shrubs and trees creating long term damage.

### Electrical discharge

There are several commercially available weed electrocution systems being used in the Americas and Europe on roadsides and urban areas and have potential for the control of hard-to-kill species.

The tractor drives a PTO-driven generator in a rear-mounted box which in-turn powers high-frequency, high-voltage transformers. Power is then transferred to an applicator on the front linkage via high voltage cables and connectors and a positive charge is channelled through two rows of offset paddles. These make contact with the ground across the width of the machine. Machines typically travel at 4-6kph.

*Articulated slashers have become a very common tool to manage roadside vegetation. They need to be used with a significant degree of restraint and clear outcomes in the mind of the plant operator. AGRONOMO*

**Propane flaming**

Propane flaming has been used in North America and parts of Europe with varying success to control weeds in establishing crops such as maize. However, species with protected growing points will not be controlled at any growth stage or propane volume.

Broadleaf weeds more susceptible to flaming than grasses due to their unprotected growing points and often thinner leaves however within broadleaf species there is considerable variability in control. For example, fat hen (*Chenopodium album*) is more susceptible than Shepherd's purse (*Capsella bursa-pastoris*).

Effective ground speeds for propane flaming are low and often around 2kph.

Flaming also introduces a range of other issues such as operator and public safety as well as increased fire risk.

**Steam**

Steaming for weed control has the same limitations as flaming in that species with protected growing points will not be controlled. Control is achieved by heating the plant tissue to a temperature where the structure is destroyed. Steam is most effective on small annual weeds and has poor efficacy on larger or perennial weeds.

Steam is a high cost option (generating steam with fossil fuel) and uses large volumes of water. There are also issues with user safety and traffic hazards in winter from clouds of vapour impeding road-user vision.

**Roadside engineering options**

Engineering solutions include increasing the width of the sealed road surface. By sealing what would normally be the gravel 'shoulder' there is less disturbance at the edge of the seal, which reduces weed germinations.

When designing the road ensure road shoulders have batters of a sufficiently low angle to allow management vehicles such as tractors with slashers to operate safely.

## Acknowledgments

The 'Area Wide Management for cropping systems weeds: investigating the weed management, social and economic opportunity' project aims to take a new approach to weed control. The traditional approach to tackling weeds has been to focus on paddock or farm scale management. Instead this project aims to take an area-wide approach to weed management. The theory being that if the number of weeds over the entire landscape can be reduced, everyone in that area should benefit, especially when dealing with weeds with mobile seed and pollen. This includes considering potential benefits across different land uses such as dryland, irrigated land and public areas like roadsides. This project is supported through funding from the Australian Government Department of Agriculture as part of its Rural R&D for Profit program and the Grains Research and Development Corporation and the Cotton Research and Development Corporation.

See *Area wide management of weeds* for more information.

## Useful Links

*GRDC Spray Application manual*
*GRDC Herbicide Use Grownotes™ Technical Manual*
*Soil behaviour of pre-emergent herbicides in Australian farming systems: a reference manual for agronomic advisers*
*Understanding post-emergent herbicide weed control in Australian farming systems*

## Other links

*NSW Weed Control Handbook - A guide to weed control in non-crop, aquatic and bushland situations*
*Weed Control Handbook for Declared Plants in South Australia July 2018 Ed.*

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