Weeds of National Significance

Gorse

National Best Practice Manual

Australian Government

National Gorse TASKFORCE

Tasmania
Explore the possibilities

Gorse

National Best Practice Manual

Managing gorse (*Ulex europaeus* L.) in Australia

Australian Government

National Gorse TASKFORCE

Tasmania

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Foreword

Gorse is one of the most invasive and costly weeds in southern Australia. It is like a green cancer, invading and infesting pasture, cropping land, plantations, roadsides, urban blocks, river banks, native vegetation and degraded sites. Currently gorse invades over five states of Australia, covering and making unusable up to 1 million hectares of land. It has a potential range of over 87 million hectares of Australia.

Gorse imposes an enormous financial burden on land managers. It reduces the carrying capacity of pasture, is a serious fire hazard, harbours feral animals, degrades native vegetation, carries significant control costs and has a negative effect on land values. These are just some of the gorse-imposed costs with which land managers have to cope, and for which the general community ultimately pays.

This is the 2nd edition of the Gorse National Best Practice Manual. It is a fully integrated best practice document which includes comprehensive instructions for mapping gorse, planning a control program, undertaking the work and following-up. It is the definitive guide for land managers to inform themselves about how to plan gorse control and ultimately eradicate gorse from their properties and the Australian landscape. The manual describes the latest trailed best practice gorse management, with enough detail in easy-to-understand language to allow land managers to confidently take on eradicating gorse and win.

We are all used to hearing people saying "gorse cannot be eradicated" and using its persistence (gorse seed is viable for at least 25 years, there can be up to 400 million seeds per hectare in the soil) as an excuse to do nothing or concentrate on control.

Land managers know it is hard to eradicate gorse, but nonetheless, we also know successful gorse control and eradication has been demonstrated and is possible. Over the last 3 years many land mangers have used the best practice manual to not only plan treatment but have started to eradicate Gorse from their lands.

Since the launch of the first Best Practice Manual, Gorse is now being eradicated from Northern NSW South Eastern South Australia and a major project to eradicate all the Gorse in Western Australia has started. Significant in-roads have been made into core infestations and road side infestations in Southern NSW, the Mt Lofty Ranges in SA Tasmania and in Victoria. Many land managers are using best practice methods and following up with programmed maintenance of the treated sites that are documented in the best practice manual.

The Gorse National Best Practice Manual contains descriptions of gorse, plus clear instructions for management methods and their costs, guidelines for preventing the spread of gorse and for undertaking integrated control on established infestations.

We have included tailored decision support tools so that land managers can make informed decisions for their own individual situation. There are also 13 gorse control case studies from across Australia. These real life case studies showcase effective primary control and follow-up methods for successful integrated gorse control. They demonstrate that gorse control is feasible on commercial grazing properties and in remnant native vegetation.

The development of the Gorse National Best Practice Manual would not have been possible without funding by the Australian Government's Defeating the Weed Menace program.

Accurate mapping of gorse distribution is a vital part of nationally strategic best practice management. To facilitate this, we have included the Bureau of Rural Sciences' new A field guide for surveying and mapping nationally significant weeds as a CD attachment in the back of the Gorse National Best Practice Manual. This is an Australian first for Weeds of National Significance manuals, and will give government and community land managers in all states the tools they need to map gorse consistently.

The responsibility for gorse control lies with managers on both public and private land. Good planning, cooperation, primary control and follow-up by these managers over the long term is crucial for success against this invasive weed. This manual will help anyone who manages gorse-infested land to achieve success. It is the most valuable resource for gorse control at present; I recommend the manual to all land managers who need to control their gorse.

Ian Sauer
Chairman
National Gorse Taskforce

Contents

Introduction

Gorse – a Weed of National Significance
Gorse (*Ulex europaeus* L.) is an exotic plant from Europe. It has been identified in Australia as a Weed of National Significance (WoNS) due to its invasiveness, impacts, potential for spread and effects on socioeconomic and environmental values.

Who is affected by gorse? Who can use this manual?
- Farmers and graziers
- Local and regional weed officers
- Bushcare and Landcare groups
- Rural-residential land owners
- Infrastructure/utility managers
- Other community groups
- Native vegetation managers
- Weed control operators.

The gorse problem originated in the early 1800s when gorse was planted for hedges, used as an ornamental plant, and used as fodder; ornamental planting of gorse continued until the 1980s.

Today, gorse ranges across 23 million hectares of the continent, and infests up to 1 million hectares. Its potential range is 87 million hectares.

Impacts on agriculture include reduced carrying capacity, restricted stock and human access, harbouring of feral animals and reduced land value. In forestry, gorse interferes with access, seedling establishment and harvesting. The impact of gorse on these sectors alone was valued at $7 million in 2000. In native vegetation, gorse forms dense monocultural stands. It poses a fire hazard and detracts from landscape values across all land types. Gorse threatens the integrity of riparian zones, impacts on biodiversity in native vegetation and on threatened species.

In response to the threat posed by gorse, a national strategy for its management was produced in 2003. This was overseen by the Tasmanian Department of Primary Industries and Water, with full cooperation of all states, territories and the Australian Government. The strategy establishes five desired outcomes for gorse control in Australia:

1. Best practice management of established infestations implemented across Australia
2. Prevention of spread from established infestations
3. Eradication of isolated and scattered infestations
4. Management of at-risk areas to maintain them free of gorse
5. The strategy for gorse control is effectively managed at the national level.

Implementation of the strategy is led by the National Gorse Taskforce. This group was formed in November 2004 and is an Australia-wide body representing production, conservation, government and community organisations. The Taskforce has identified national eradication and containment zones for gorse. Each year progress against the National Gorse Strategic Plan is documented at www. weeds.org.au/WoNS/gorse.

Nationally strategic isolated and scattered infestations with the potential to be eradicated are in Western Australia; the ACT; all of South Australia (other than Barossa, Mt Lofty and Fleurieu areas); the majority of NSW including New England, the south coast and Southern Tablelands; East Gippsland and Wimmera Catchment Management Areas in Victoria; Waratah, Wynyard, Devonport, Dorset, Flinders, Kentish, King Island, Sorell and Tasman Council areas in Tasmania.

Using this manual

Biology, distribution & impacts of gorse

(Tim Rudman)

CHAPTER 1

Chapter 1
Biology, distribution & impacts of gorse

1.1 Name and origin

Gorse is a member of the Fabaceae, or legume (pea) family. Other common names for gorse are "furze" and "whin". Its scientific name is *Ulex europaeus* L.: Ulex, the Latin name for a spiny shrub; *europaeus*, for its European origin; and "L", after Swedish botanist Linnaeus, who gave the weed its name.

Gorse originates in Portugal, Spain, France and Britain.[1,2] In its natural range gorse grows as scrub and heath, in which frequent fire promotes its growth and prevents the development of forest or other vegetation.[3,4,5,6,7]

1.2 Description

Gorse is a dense, extremely spiny shrub up to 7 m tall, but more commonly 1 to 2.5 m tall.[1,8,9] Many stems grow from ground level. The stems are soft, grey-green and hairy when young, hardening with age. Bark on mature stems is rough, with diagonal and lengthways pale brown and grey ridges.

Spines and leaves are grey-green and end in a sharp yellow point

Gorse stems are covered with small branches bearing alternating leaves. All the branches end in a green spine up to 50 mm long, with deep grooves running along its length. Leaves are 6 to 30 mm long by 1.5 mm wide. The leaves resemble spines and are grey-green when young, darkening with age. Spines and leaves have a waxy coating and end in a sharp yellow point. They may be covered with fine hairs. As gorse grows, the lower branches die but remain on the stems, such that older plants can be covered with spiny dead brown branches lower down.

Gorse flowers are 15 to 25 mm long, bright yellow in colour and grow singly from the bases of the leaves.[1] The flowers are shaped like those of peas, beans, or other legumes and they have a distinct coconut-like smell.

Seed pods are 10 to 20 mm long by 6 mm deep, pea-pod shaped and black when mature. The pods are covered with fine, dense hairs. Pods contain 2 to 6 seeds, 3 to 4 mm across, with a very hard green or brown seed coat and a white or yellow appendage.[2,9,10]

Gorse seedlings have soft hairy grey-green "trifoliate", or three-leaflet leaves. These trifoliate leaves are lost as the plants mature, with spines developing on seedling gorse plants from three months of age.[11]

1.3 Distinguishing between gorse and other prickly plants

Gorse can be confused with a number of Australian native plants.[12] The combination of spiny leaves, spiny branches and large yellow pea flowers with a coconut-like smell is unique to gorse in Australia. Native plants that could potentially be confused with gorse are compared in section 5.3.

1.4 Preferred climate and habitat

Gorse originates from regions of the world where the average daily minimum temperature is 2°C in the coldest months and the average daily temperature is 18 to 20°C in the warmest months.[1] Where gorse grows in Australia, winter minima can be cooler (New England and Tasmanian Midlands) and summer maxima can be warmer (South Australia).[13] Mature gorse survives down to -20°C, but seedlings are frost-sensitive.[1] Rainfall at gorse sites in Australia ranges from 450 to 2400 mm per annum.

Gorse grows on most soils other than those rich in calcium.[1] Gorse fixes nitrogen, which allows it to establish on soils with very low nitrogen fertility.[2] It will grow on degraded sites with little soil, such as quarries and gravel pits.[1] Gorse can establish in pasture, plantations, on roadsides, in native vegetation and riparian vegetation. It tolerates a high degree of shade and competition from established plants. One study found that gorse plants had 74% survival in deep shade (3% of full sun).[14]

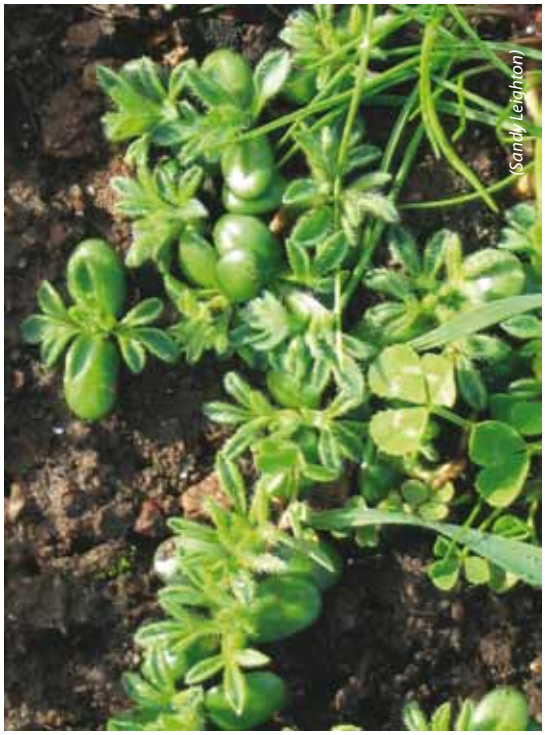
Flowers are shaped like pea, bean or other legume flowers

Pods are covered with fine, dense hairs

Gorse is a dense extremely spiny shrub to 2.5 m tall

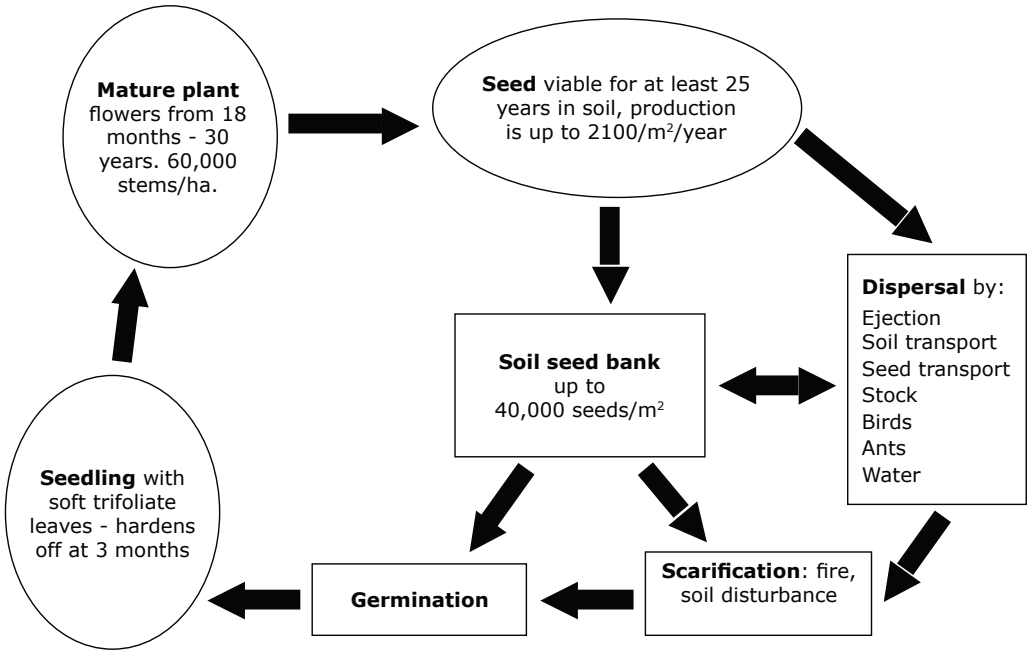
1.5 Life cycle

Gorse plants live for up to 30 years. Reproduction is by seed and plants begin flowering from 18 months to three years of age. Gorse flowers throughout the year. In NSW and Victoria, flowering peaks in March to May, then again in July to October.[15,16] In parts of South Australia gorse flowers only once, in Spring.[17] Pollination is by honey bees and bumble bees.[11,18,19,20] Seed fall occurs in warm weather, when pods split open and eject seed up to 5 m from the plant. Seed falls onto the ground at a rate from 600 seeds/m^2/year[11] to 2120 seeds/m^2/year.[21] This is an annual input to the soil of 6 to 21 million seeds/ha. Gorse seed germinates best between 15 to 19°C.[22,23] New Zealand studies found that peak germination and emergence was in late summer to early autumn and late spring to early summer.[22,24]



Gorse seedlings

The life cycle of gorse is illustrated in this diagram:



Life cycle of gorse (adapted from 11) WHO

1.6 Soil seed bank

Gorse has a very large, long-lived soil seed bank. This is the reason that it takes years or decades to eradicate gorse from a site. There are up to 40,000 gorse seeds/m^2 or 400 million seeds/ha in the soil under a mature gorse bush at any one time.[25,26] Gorse seed is found mainly in the top 2.5 cm of the soil, but occurs down to 15 cm depth.[23,27] Establishment does not occur from greater than 8 cm depth.[23]

Gorse seed is viable in the soil for at least 25 years.[1,28,29] Seed disappears from the soil mainly by germination.[23] In a New Zealand study, soil seed declined to 10% of the original number after 10 years and 1% of the original number after 20 years, without new seed input. Most seed recovered from the soil was viable.[30]Viability of gorse seed in the soil ranges from 10% to nearly 100%.[23,30,31,32,33] Poor viability and high losses of seed from the soil are offset by massive inputs from living plants.

Up to 90% of gorse seed in the soil at any time is "hard".[23,31,32] Hard seed can lie dormant for decades before it germinates. Some damage or "scarification" to the coat of hard seed is needed before it will germinate. In the lab this is achieved by heating to 65 to 100°C, abrasion with sandpaper, or soaking in sulfuric acid.[23,28,31,32] In the natural environment seed is scarified by fire, soil disturbance, insect damage[26], changes in soil moisture[22,25], being abraded in floodwaters or passing through an animal's gut.

1.7 Dispersal

Gorse seed pods split open explosively, ejecting seed up to 5 m, though most seed falls in or near the canopy of mature bushes.[28] Significant long-distance dispersal in Australia occurs when contaminated soil is carried on vehicles and machinery and by transport of contaminated topsoil and fill. Slashing and mulching account for short- and long-distance seed dispersal; seed can be thrown several metres by slashers. Water is an important means of dispersal in NSW, South Australia and Victoria.

Gorse travels long distances on contaminated machinery

There are other more minor gorse seed dispersal mechanisms. Seed can be carried by running water.[28,34] Birds are known to eat gorse seed and might spread the weed.[35,36] Seed is spread by ants in Europe.[37] Sheep from gorse-infested areas carry gorse seeds and pods in their fleece.[26,28] Seed may also be transported in an animal's fur or in soil carried on its feet. Gorse seed alone is too heavy to be blown around, but is dispersed by wind when plant fragments with seed pods are blown about.[28]

Gorse disperses along waterways, Boorolong Creek, NSW

Distribution

1.8 History of spread

Gorse was introduced to Australia during the early 1800s as a hedge and ornamental plant. It had naturalised by 1889.[1] In NSW and the ACT gorse was planted for hedges and as an ornamental until the 1980s.[34,36] It is likely that gorse in South Australia originates from hedges planted in the 1860s.[38]

Gorse spreads at different rates in Australia today depending on management and land use. In the Australian Capital Territory land managers have undertaken primary control measures and the infestations are static in size and are subject to follow-up. Similarly, in Western Australia there is an active program of containment delivered by a partnership between state and local governments and the NRM region. Victoria has implemented significant gorse control measures (especially on roadsides) since 1999, through state government funded programs aimed at reducing the extent of gorse in the Central Highlands by 25%. It is likely that the extent of the weed is contracting there.[39] In South Australia the area of gorse is contracting due to active programs in the Barossa Valley, Mt Lofty Ranges and Fleurieu Peninsula. In Tasmania state and local governments and NRM regions are working together with the community to control gorse. On agricultural land gorse infestations are contracting due to economic incentives for control (e.g. dairy and fat lamb development), whereas gorse on plantation land and in native vegetation is increasing.

1.9 Current and potential distribution in Australia

Gorse is found across temperate Australia. It ranges over 23 million hectares of the land mass.[40]Within this distribution gorse infests between 100,000 and 1 million hectares. Potential distribution based on climate is 87 million hectares.[40]This includes most agricultural land in Victoria and Tasmania, coastal South Australia and much of south-west Western Australia.

In the ACT, where there is an active eradication program, gorse has been recorded from 21 sites. Active control and follow-up prevents re-establishment from the soil seed bank.

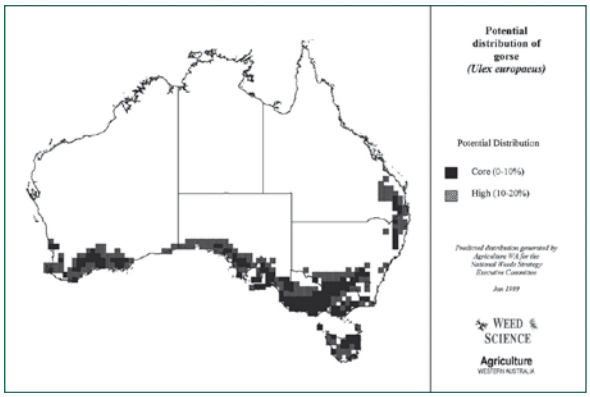
In Western Australia gorse is confined to less than 200 hectares in disturbed areas, on roadsides, in plantations and rural-residential land around Albany on the south coast.[27]

In South Australia gorse occurs on Kangaroo Island, Eyre, Fleurieu and Yorke Peninsulas, Mt Lofty Ranges, Barossa and Clare Valleys, the south-east, Burra, Jamestown and Port Wakefield. The total area infested is a few thousand hectares.

Gorse distribution is patchy in NSW and affects around 2000 hectares. Core infestations are in the south-east and Southern Tablelands, Blue Mountains and Lithgow area. Outlying infestations occur in the central west, Hawkesbury/Nepean, Murrumbidgee, New England, Yass Valley and Illawarra district.[41]

In Victoria gorse is distributed throughout the state, except for the Mallee and parts of Gippsland. Heaviest infestations are in the Central Highlands around Ballarat, where there was an estimated 8000 hectares of gorse in 1999.[35] Total area infested is at least 11,000 hectares.

In Tasmania gorse is distributed state wide except for the south-west and some alpine areas. Heavy infestations occur in the Midlands, Fingal and Tamar Valleys, east and west coasts and in the north-west. Actual area infested is between 30,000 and 100,000 hectares.



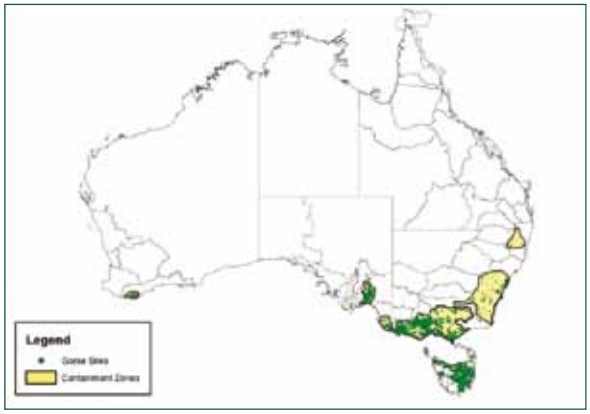
Potential range of gorse across Australia based on climate

1.10 Impacts of gorse

Gorse impacts on a wide range of values in Australia. The annual cost of gorse management to agriculture and forest industries across Australia was estimated at $7 million in 2000.[40] The ongoing financial impact of failure to control gorse in the 800,000-hectare Victorian Central Highlands was estimated at $7 million in tangible and intangible costs over five years in 1999.[35]

Fire hazard

Living gorse is highly flammable, retains dead vegetation in its canopy, contains flammable oils and has a high surface area to volume ratio.[42] Dense gorse patches increase the risk of wildfire and are a particular hazard near buildings, infrastructure, along fence lines and in utility easements.[11,16,35,43,44]



Current gorse distribution across Australia

Gorse is highly flammable and is a hazard near buildings and infrastructure

Community values, recreation and amenities

Gorse restricts recreation opportunities and access to the land.[35,45] It also reduces the natural attraction and value of landscapes and detracts from their natural condition, particularly in wilderness or pastoral areas where it has a "foreign" appearance.[35,45]

Grazing/cropping

Gorse significantly reduces carrying capacity. It is a major agricultural weed in Tasmania, parts of South Australia and Victoria. It invades native, semi-improved and improved pasture and neglected cropping land. Dense infestations exclude all other plants. Gorse blocks access and prevents movement of stock. Further, the weed imposes heavy control costs on land managers.[1,11,16,35,46] The annual economic impact of gorse on agriculture across Australia was valued at $3.6 million in 2000.[40]


(Jonah Gouldthorpe)

Gorse reduces carrying capacity

Heavy gorse covers 30,000 hectares of the Tasmanian Midlands, mainly on sheep pasture, where annual production losses were at least $1 million in 2002.[43] Gorse is unpalatable to cattle and only new growth is palatable to sheep and horses. Mature gorse is eaten by goats.

Harbour for feral/pest animals

Gorse thickets provide shelter or habitat for rabbits, feral cats, house mice and foxes.[1,11,16,35,43,44]

Land values

In 1999 it was estimated that gorse reduced the value of agricultural land by $220/ha in the Victorian Central Highlands.[35]

Forest management

Infestation by gorse reduces forestry profitability. Gorse interferes with establishment, competes with tree seedlings, restricts operational access, imposes cost for its control and is a major fire hazard.[11,35] In South Australia competition between gorse and seedling trees is the most important impact on plantations.[49] The annual cost of gorse to forest production across Australia was valued at $3.4 million in 2000.[40]

Native vegetation

Gorse invades native vegetation, where it reduces floral diversity and alters fire behaviour.[35] Many native plant communities are vulnerable. In Victoria dry coastal vegetation, heathland and heathy woodland, lowland grassland and grassy woodland, dry and damp sclerophyll forest and riparian and rock outcrop vegetation are vulnerable to infestation.[48] Nine threatened Plant species are affected by gorse in Tasmania: Acacia Axillaris (midlands wattle), Callitris oblonga (South Esk pine), Epacris apsleyensis (Apsley heath), Prasophyllum tunbridgense (Tunbridge leaf orchid), Stonesiella selaginoides (clubmoss bush-pea), Spyridium Lawrencei (small-leaf Spyridium) Hibbertia basaltica, Bertya tasmaniaca and Pterostylis ziegeleri.[49]


(Tim Rudman)

Gorse invades native vegetation, Schouten Island, Tasmania

In Tasmania vegetation ranging from lowland grassland, through dry and wet eucalypt forests, to buttongrass moorland is vulnerable to invasion, particularly after disturbance. In some places gorse excludes all native ground cover under the forest canopy. It also infests wetlands recognised by the Directory of Important Wetlands in Australia and Ramsar (internationally).

Roadsides

Roadside gorse is a particular threat because it:

- displaces threatened native vegetation in roadside remnants
- is a fire hazard and potential ignition point
- reduces visibility for motorists.

The cost of controlling dense roadside gorse infestations in 2006 was around $1250/km.[50]

Environmental/other services

Gorse has value as shelter for stock and it contains stock where fences have not been maintained.[1,11,35] Extracts from gorse seed have widespread use in medical research (e.g. [51,52]). Gorse pollen is important to bees in autumn, late winter and early spring, when little else is flowering.[53,54]

In areas with little native understorey, gorse provides shelter for native animals. In the Tasmanian Midlands gorse understorey maintains bird diversity in forests by preventing invasion by the noisy miner[55,56] and provides ground cover for small mammals including the nationally vulnerable eastern barred bandicoot.[57] (See section 2.7 on how to reduce the impact of gorse control on native animals.) Gorse becomes established in degraded areas and prevents erosion in the absence of other vegetation.[1,11,58]

In most situations, the benefits of controlling gorse far outweigh the costs involved with its removal.

Gorse reduces visibility on roadsides. Before and after roadside grooming, Buninyong, Victoria

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Gorse infestation in pasture Breadalbane Tasmania.

Prospect, Tasmania.

Gorse control

CHAPTER 2

Chapter 2
Gorse control

This chapter will give you information on planning and undertaking gorse control.

Successful gorse control is straightforward. Many farmers, graziers and other land managers have shown that gorse control is a routine part of management. Read the next few pages to get basic information about planning gorse control. Read sections 2.8 to 2.17 for detailed control methods and costs of dealing with gorse.

Spending time on planning gorse control is a good investment and will save you money in the long term. Your program must be cost effective. Good planning will help this.

2.1 Integrating methods for long-term control

You need to combine, or integrate, a number of methods to get a successful long term result against gorse. The methods you use need to suit your situation.

Plan a program, undertake primary control measures, then follow-up on regrowth and/or seedling establishment. A "best practice" gorse program has four parts.

The four parts of a successful gorse control program

1. Prevent spread and protect clean areas
2. Reduce above-ground mass of gorse
3. Kill regrowth
4. Follow-up seedling germination for at least five years and up to 25 years.

Follow-up is critical.
Be realistic about how much time, money and labour is available for follow-up. Don't take on too much at once and don't exhaust yourself or your resources in the first year. Prioritise one patch of gorse for control and follow it up before you start work on new areas.

Land managers who use best practice gorse management say that:

- If you don't follow-up, the money you spent on primary control will be totally wasted.
- The most cost-effective method is the one that works best. Having to repeat treatments that didn't work is very expensive. In the words of Bill Fergusson from "Grindstone Bay"[1]:

There is nothing more expensive than a program that doesn't work – you have spent money but got nowhere … Go for the best option, not the cheapest.

See Chapter 3 for a detailed guide to choosing types of control methods suitable for your situation.

2.2 Regrowth vs seedlings

After you knock down mature gorse, regrowth and seedlings will come up. Follow-up is different for regrowth compared to seedlings.

Regrowth comes from established roots and stems after mature plants have been cleared, burnt or ineffectively sprayed. Regrowth is vigorous, multi-stemmed and spiny.

Seedlings germinate from seeds in the soil. New seedlings are single-stemmed, have three-leaflet leaves and are soft. Even after seedlings grow spines they are spindly and weak-looking compared to regrowth. The huge soil seed bank of gorse means that seedling growth after clearing may be very heavy.

(Sandy Leighton)

Seedlings germinate from seeds in the soil. They are single-stemmed and look weak

2.3 Soil seed bank management

Around 10% of gorse seed in the soil germinates at a given site in a given year. Assuming no new seed input to the soil, it would take 30 years for the typical gorse soil seed bank at a site to decline to 1000 seeds/m^2. This is still far above what is required to start a dense infestation.

If the annual germination rate increased to 50% at the same site, soil seed would reduce to near zero after 10 years. 99% germination of soil seed per year at the same site would eliminate soil seed after only four years.

These figures have implications for management, because some gorse control methods can increase annual germination above the natural 10% level.

Fire may cause 50% germination in soil seed, depleting the soil seed bank and turning seeds into seedlings, which are then vulnerable to follow-up control. Damage by gorse seed weevil may have a similar effect.[2]

Gorse seed in the soil is discussed in detail in the Western Australia gorse seed research case study in section 4.13.

(Jonah Goldthorpe)

Regrowth comes from stumps after fire or clearing. It is vigorous and multi-stemmed

2.4 Developing a gorse control plan

Plan a gorse control program, do the work, follow-up and succeed. Planning helps you to use your gorse control budget most effectively and to work out proper follow-up methods before you start. A suitable structure for a weed control plan is as follows.

1

1. Define problem areas

- Make a property or control area map from aerial photos, existing maps or drawn from eye.
- If you are a community or government land manager, map gorse at WoNS core attribute level (see section 5.11 for WoNS core attributes).
- Identify landmarks, vegetation, assets, and infestations. Indicate size/density/age of gorse.
- Use transparent overlays or GIS to keep the map tidy and superimpose layers.
- Note where gorse performs a service (pollen for bees, habitat for birds, bandicoots).

2

2. Determine priorities

- Work out priorities for each infestation.

Priorities are:

- outliers
- easier areas
- upstream infestations (riparian)
- uphill to downhill (steep slopes).

- Identify: - difficult-to-control areas • What are your legal responsibilities in regard to weed control? (See section 5.1 for details on legal responsibilities for gorse control).
- What are your ethical responsibilities? Is your gorse a threat to neighbours' properties?
- Consider local government, catchment or regional priorities and plans.

Note the priority of each infestation on your map. Plan for at least five years of control.

3

3. Determine integrated management options

- Prevent the spread of gorse (e.g. machinery hygiene) onto/around your property.
- Identify available resources (e.g. labour, machinery, spray equipment, fencing, sheep/goats) for economic management options.
- Do neighbours have assets (e.g. vineyards, fences) which might be affected by some control methods?
- Does legislation affect what you can do
- land clearing, threatened species, works on river banks, agricultural chemicals, fire?
- Do you need a permit to apply herbicides?
- Do you need a permit to burn off gorse or other vegetation?
- Determine management options required for initial treatment, follow-up and monitoring.

Refer to this chapter for detailed control methods and to "Choosing a gorse control program for your situation" (Chapter 3) for site-specific programs. Seek professional advice if you are not confident about control methods (see section 5.10 for contacts in your area).

4

4. Develop a financial plan

- Estimate management costs for each infestation identified. Include running costs and labour.
- Integrate control costs into short-term and long-term budgets.
- Identify availability of financial incentives, low-interest loans or labour programs.
- Account for future follow-up when planning gorse control.

Relate management costs to priorities. Plan for at least five years of control.

Before committing a large amount of money, conduct small-scale trials or seek advice from a professional weeds officer (see section 5.10 for contacts in your area).

5

5. Schedule gorse management over time

Prepare a long term timetable for gorse control to:

- Begin **primary** control on areas small enough to follow-up annually.
- Return to **all** sites **each** year after treatment for at least 5 years to treat survivors and check for new plants.
- Different control methods are effective in different seasons. Balance this against time/ labour availability.
- Be flexible to allow for wet or dry seasons.
- Integrate gorse control with other management e.g. woody weed control, earthworks, pasture improvement/maintenance.

Each site will need an annual control effort for at least 5 years after the primary treatment. The last site started might be 2-5 years after the first which may mean a 10 year program.

6

6. Monitor progress

- Plot progress on your map and record your methods in detail.
- Check treated infestations for regrowth or germination annually.
- Regularly inspect disturbed areas (soil disturbance, heavy grazing, fire, flood) for new outbreaks.
- Document control costs and assess the effectiveness of each method.
- Take photos at the same point over time, to show progress against gorse.

Monitoring is critical to the long-term success of your efforts.

7

7. Follow-up what was started

- Follow-up all treated infestations annually, or as identified through monitoring.
- Use the most suitable follow-up method for your situation.

Follow-up is critical. Germination of soil seed will occur and regrowth from treated plants may occur.

Adapted from Prickly acacia national case studies manual[3] and Tasmanian Bushcare toolkit.[4]

Example of a gorse control plan for a grazing property in southern Australia

Infestation/Priority	Primary Control/Timing	Follow-up/Timing
1 – East/west boundaries (scattered bushes)	Hand gun with Brush-Off + Pulse + marker dye. Spring '06.	Hand gun with Brush-Off + Pulse + marker dye. Spring every 2nd year.
2 – Roadside (scattered bushes)	Phone Shire Weeds Officer – when are they going to do it? Get them to spray for complete coverage this time 'round. Spring '06.	Follow-up phone call. Spring every 2nd year.
3 – Good pasture (dense bushes)	Doze. Spring '07. Use fire fighting unit to wash down straight afterwards.	Turnips spring '07. Cereal autumn '08. Grass pasture autumn '09. Boom spray selective herbicide '09 if needed.
4 – Rough pasture near lake (scattered big bushes)	Burn. Autumn '07. Get volunteer brigade to help arrange permits and do burn.	Hand gun regrowth with Brush-Off + Pulse + marker dye in spring '08 if tall enough, otherwise spring '09. Then spray spring every 2nd year.
5 – Manna gum run (dense, under trees)	Hand gun with Grazon DS + BS1000 + marker dye around edges, as far in as possible.	Let sprayed gorse rot down. Push in a bit further each year and spray a bit more gorse out with Grazon mix.
6 – River banks (line of big bushes)	Cut and paint with Roundup Biactive half-and half with water + some marker dye. Start at upstream end. Talk with Landcare group about getting some volunteer help.	Hand gun/backpack seedlings with Roundup Biactive + Pulse + marker dye. Every 2nd spring.
7 – River cliff (scattered bushes)	Phone Primary Industries Department and find about biological control agents. Try and arrange a release.	Keep fire or other disturbance out.

Problem areas – see photo
Priorities – outliers, easiest bits first.
Responsibilities – keep boundaries clean, observe fire restrictions, follow herbicide labels
Monitor progress – make sure that cleaned-up areas stay clean, follow-up has priority over primary control

2.5 Preventing spread of gorse

(Adapted from [5,6]) Preventing spread is the most cost-effective way to control weeds. In the long run, preventing spread can save $31 for every dollar spent.[7]

Good hygiene practice goes a long way to preventing spread of the weed.

DPIW Tasmania and DPI Victoria have detailed guidelines for hygiene and washdown that can be found at:

- www.dpipwe.tas.gov.au > Weeds, Pests & diseases > Weeds > Managing weeds > Washdown guidelines
- www.dpi.vic.gov.au > Information notes > Factsheets > General farming > Buildings & machinery > Machinery hygiene

In brief:

- Mark out a 10 m buffer around infestations
- Do not disturb soil in this area
- If soil disturbance is unavoidable, work from clean areas towards infested areas
- After work, immediately knock off loose soil or large clods on site
- Washdown close to the infestation, or at the depot if that is not possible.

When to washdown

Washdown after:

- Operating in infested areas
- Transporting soil/quarry materials known to contain gorse seed.

Or before:

- Moving machinery out of a local area of operation
- Moving machinery between properties
- Using machinery along roadsides/river banks
- Transporting soil/quarry materials.

Mobile washdown unit in the field, Zeehan, Tasmania

Where to washdown

Washdown sites are preferably in the field but may be at a depot. In the field:

- Washdown near the infestation
- Don't washdown where runoff can enter a watercourse
- Avoid native vegetation
- Select a site with grass, gravel, bark or timber cording
- Allow enough space to move tracked machinery
- Avoid hazards e.g. powerlines.

How to washdown

General washdown procedure is:

1. Locate a suitable site
2. Park safely and turn off vehicle
3. Examine where soil and plant material is lodged
4. Safely remove guards and covers as necessary
5. Knock off large clods with a crowbar, sweep out cabin
6. Vacuum, blow or brush off loose plant material (e.g. on slasher deck and sills)
7. Clean with high pressure hose and stiff brush (where appropriate)
8. Clean in this order: underside; wheel arches; wheels/tracks; sides; radiator; tray; bumpers; upper body. Move tracked machinery during washdown if necessary
9. Clean associated tools
10. Confirm that there is no loose soil/plant material
11. Rinse off (if in wash bay)
12. Wash effluent away from vehicle. Do not drive through effluent.

How well do you need to washdown?

Good washdown practices are different for each machine. General standard is:

- Remove only cover plates which are quickly and easily removed/replaced
- Remove all clods or loose soil. It is acceptable to leave smeared or firmly lodged inaccessible soil.

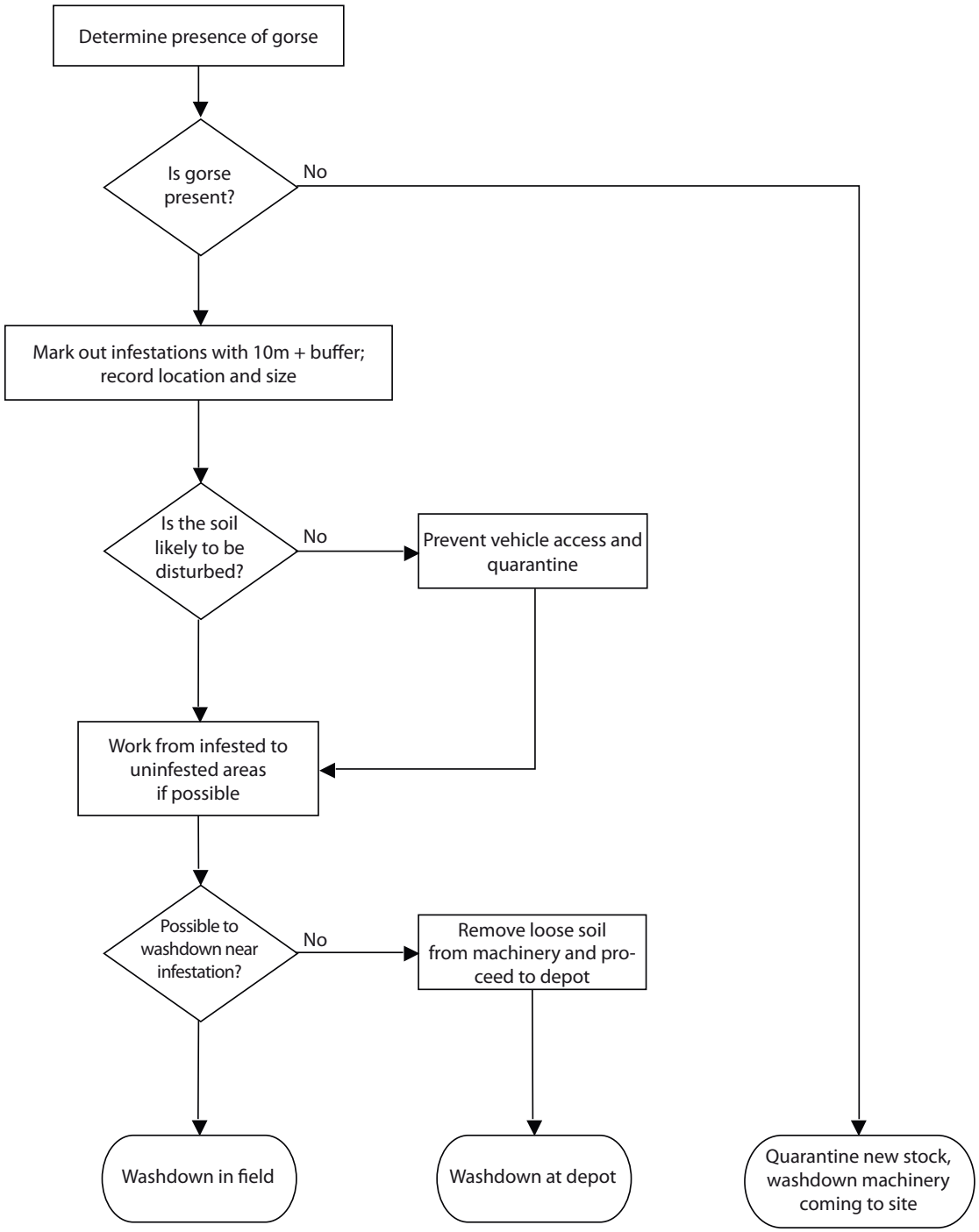
Do sheep spread gorse?

Sheep are known to carry gorse seed in their fleece.[8] Buying sheep off-shears and/or quarantine of new stock on-farm might help prevent the introduction of weeds.[9] Keeping stock out of seeding gorse might contain the spread of the weed.

Clean with a high pressure hose where appropriate

Best practice hygiene for preventing spread of gorse

Adapted from [6]. Where possible, always wash down on site, instead of moving contaminated machinery.



2.6 Roadsides and railways – corridors for the spread of gorse

An important part of gorse management is the prevention of spread and control along roadsides and railways.

Responsibility for roadside gorse control is different from state to state, and from road to road. See section 5.2 for details about roadside gorse responsibility in Australia. Gorse spreads along roadsides easily because:

- slashing throws seed from parent plants and contaminated slashing machinery moves seed between sites
- seed travels long distances in soil on contaminated earthmoving equipment
- seed moves in water along roadside drains
- roadside control is often inadequate
- contaminated soil is hard to identify and is often transported by grading.

Roadside and railway infestations are starting points for the spread of gorse into adjacent land. This is demonstrated by roadside infestations in the Victorian Central Highlands, many of which have spread 10 to 20 metres into adjacent land.

2.7 Protecting habitat during gorse control

Some native animals use gorse as habitat. [10,11,12,13] If you think that gorse is important for birds or mammals at your site, consider the following before taking control measures:

- Survey sites to assess their importance for native fauna
- Retain dead gorse in situ while native understorey re-establishes
- Remove gorse over a number of seasons, and replant or revegetate with native shrubs
- Herbicides offer better habitat protection during gorse control than does mechanical clearing or burning
- Mechanical control/burning is more effective in autumn than spring for habitat protection.

If in doubt, contact your state's environment department for more information.

Roadside infestations are starting points for the spread of gorse into adjacent land, Ballarat, Victoria

Gorse control methods

Each gorse control method discussed in the following sections is described according to these four criteria, which are required for a best practice control program.

Four parts of a successful gorse program

1. Prevent spread and protect clean areas
2. Reduce above-ground mass of gorse
3. Kill regrowth
4. Follow-up seedling germination for at least five years and up to 25 years.

2.8 Mechanical clearing

Approximate cost: $200 to $2900/ha

Use mechanical control to:

- Reduce above-ground mass of gorse
- Kill regrowth (some methods only).

Mechanical clearing is an effective primary control method in some situations, however some gorse grows back from stumps and roots left behind after clearing. Clearing won't reliably kill mature gorse, so you must combine it with other methods to achieve long term gorse control on your property.

The aim of mechanical clearing is to reduce the above-ground mass of gorse before follow-up methods are applied, including spraying with herbicides, restoring pasture, grazing or cultivation. Typically, spraying regrowth after mechanical clearing requires only 20% to 25% of the herbicide needed for spraying uncleared gorse.[14]

A variety of mechanical clearing techniques are proven on gorse. If you clear gorse, remember that:

- the use of heavy machinery can increase the risk of erosion and soil structure degradation
- in NSW, Victoria and parts of South Australia you need a permit to do earthworks on river banks
- larger machines generally work faster and may be more cost effective.

Proven techniques are summarised on the following pages.

Dozing with a bulldozer, tractor with blade, or similar machine. The aim of using a bladed machine is to break the gorse off at soil level. Avoid scalping the surface soil.[15,16]

Windrow gorse after dozing and/or burn on site

Dozing gorse

Grubbing with an excavator, tractor with bucket, front-end loader, bobcat or similar machine. The aim is to break the gorse off at soil level. Avoid scalping the soil. This is most effective on old, hard gorse and least effective on young, soft gorse.

Root raking or **stick raking** with an excavator or bulldozer fitted with a root rake or stick rake. The aim is to pull bushes and larger roots out of the ground. This method results in less regrowth than dozing, but creates more soil disturbance and buries seed.

Mulching or **grooming** with a tractor or excavator-mounted mulcher, hammer mill, groomer, or similar. This method cuts bushes off at ground level and processes them to a fine mulch. The mulch provides some suppression of seedlings. This method is popular on mainland Australia and leaves a "cleaner" site after control than some other mechanical methods. Excavator-mounted groomers can be used to access creek banks and steep sites, but must be kept out of the streambed proper.

Root raking gorse with an excavator, Zeehan, Tasmania

Groomer head on an excavator, Delamere, South Australia

Tractor-mounted mulcher, Avoca, Tasmania

Crushing with a tractor-mounted "Meri Crusher" or similar. This method breaks bushes, including the root crown, into pieces and incorporates broken material with the top 10 cm of the soil profile. This is claimed to result in less regrowth than other mechanical methods because the leaves and green stems are buried.

Meri Crusher, Zeehan, Tasmania

Slashing with roadside or grass slashing equipment can be used to reduce the height of gorse.[16] Slashing will not kill gorse, and gorse subject to repeated slashing will flower and set seed at a height of only 10 to 15 cm. It may also develop an extensive root system. The reduced stem and leaf growth means that there is not enough surface area to absorb sufficient herbicide for effective follow-up spraying. The deep trash layer left after slashing gorse limits effective herbicide coverage when spraying regrowth or seedlings.

Pulling with a tractor and chain or other tools is effective at reducing above-ground mass.[17] Pulling should not be used where soil disturbance is unacceptable, especially in riparian zones.

2.9 Cultivation

Approximate cost: $97+/ha (variable)

Use cultivation to:

- Kill regrowth
- Follow-up seedling germination.

Cultivation with disc or mouldboard ploughs is useful for breaking established roots and for follow-up treatment of seedlings and small regrowth.[17] Some equipment may be strong enough to clean up burnt canes after fire.

Ploughing living gorse is not practical. Trying to cultivate standing bushes will create a mess and might damage equipment.

Cultivation as part of a cropping regime or for pasture maintenance is very effective at killing gorse seedlings, burying seed below viable depth or promoting germination prior to other follow-up methods. Many land managers [19,38,39,40,41] believe that three to four years of cultivation and cropping will control gorse effectively on arable land.

A period of cultivation and cropping will control gorse on arable land

2.10 Herbicides

2.10.1 Chemical certification

Certification required for herbicide users in Victoria and NSW

Certification or training is required for operators using some herbicides in Victoria and NSW. It is your responsibility to comply with relevant rules and legislation. See section 5.6 for information on chemical certification/training.

2.10.2 Foliar spraying of herbicides

Approximate cost in 2009: $300 to $1660/ha (highly variable)

Use herbicides to:

- Reduce above-ground mass of gorse
- Kill regrowth
- Follow-up seedlings germination

Spraying, including aerial spraying, with registered herbicides is effective on gorse. See section 5.4 for a full list of herbicides registered for use on gorse

Safe herbicide use is your responsibility

All herbicides come with a label, which is a legal document. You must read the label. You are breaking the law by using a herbicide in a manner other than that stated on the label. The label tells you how to use the herbicide:

- safely
- effectively
- in a way which reduces the risk of off-target impacts on your property or other properties.

"Off-label" or "minor use" permits for some herbicides have been issued in some states. Links to these permits are given in section 5.5.

Spraying from the ground is economical where there are large isolated bushes, clumps of bushes less than 10 m x 10 m, or where there is open regrowth. If you can't walk through the infestation then it is probably not economical to spray from the ground because of labour and herbicide costs.

Aerial spraying is economical on large, dense infestations.

Clear or burn dense tall infestations to reduce above-ground gorse, then spray regrowth (see the relevant parts of this chapter for details about these options). This can cut 75% to 80% off the herbicide bill[14,18] and result in big time and cost savings. Alternatively, clear swathes through the gorse, at intervals that will give you access and complete coverage on all bushes when spraying.

Scattered bushes or low regrowth are economical to spray from the ground

Isolated large bushes are economical to spray from the ground

Dense tall gorse is not economical to spray from the ground. Clear or burn first, then spray regrowth, or aerial spray

2.10.3 Getting the best results from foliar spraying

Remember these points when spraying herbicides on gorse to get the best result:

1. Follow the label and read the critical comments section.
2. Complete coverage of bushes is essential.
3. Always use a wetting agent/penetrant/adjuvant/surfactant as directed by the label.
4. Only spray actively growing gorse.
5. Regrowth must be at least 40 cm tall before spraying.
6. Leave sprayed gorse undisturbed for at least 12 months after treatment.
7. Use clean water. "If you wouldn't drink it, don't use it". Water quality can mean the difference between a poor result and a total kill. Trucking clean water to a site could actually save money.[18]
8. Don't spray stressed gorse (during extremes of heat, cold and drought).
9. Calibrate spraying equipment and replace nozzles/jets regularly. Worn nozzles or poor calibration can deliver four to 20 times the required amount of herbicide. This increases herbicide costs and increases the chances of off-target damage.[17]
10. Spray in suitable weather. Labels give guidance. Avoid wet weather, very cold or very hot weather, dead-calm weather or windy weather. Spraying in these conditions reduces effectiveness and/or increases off-target damage.[14] See section 5.7 for information on weather and spraying.
11. Spray between late morning and early afternoon for best results.[14,18,19]
12. Use dye to indicate coverage. This makes the work easier and saves time and money.[1,20]

Half-sprayed bushes will not be killed

2.10.4 Choosing a herbicide for foliar spraying

Prices below ae a comparative guide only and were calculated in 2009

Be safe – read the label and MSDS
Read the label and the MSDS (material safety data sheet), which come with the herbicide.

Choose the right herbicide for spraying gorse based on your situation. Seek professional advice from local or regional weed officers, agronomists or representatives from herbicide companies.

This section looks at the herbicides widely used on gorse, listed by their active constituent(s). The mode of action is briefly described. Some comments are given on their use by land managers with extensive experience. All these herbicides will kill clover in pasture.

Registered herbicides are listed in section 5.4.

Glyphosate e.g. Roundup®

$5.45-$7.60 for glyphosate + $12 for Pulse /100 L of spray mix (approx. cost) in 2009.

Glyphosate is a non-selective (kills grasses and broad-leaved plants) herbicide which is absorbed through leaves and green stems. It moves rapidly throughout the plant and interferes with the formation of amino acids. It is deactivated on contact with the soil.[21]

Special formulations of glyphosate herbicides for use in aquatic situations are the only option for spraying gorse growing in or over water.
To kill mature or regrowth gorse, glyphosate should be used with an organosilicone penetrant such as Pulse®.[22,23,24,25,26,27,28]

Glyphosate herbicides are scheduled 5 on the poisons schedule = CAUTION.

Metsulfuron-methyl e.g. Brush-Off®

$4.10/100 L of spray mix (approx. cost) in 2006

Metsulfuron-methyl is a selective (kills only broad-leaved plants) herbicide which is absorbed through both roots and leaves. It moves rapidly through the plant and prevents cell division.[21]

This herbicide is widely used but can be slow-acting. On the label it is recommended for Gorse less than 2m tall but it is generally effective on larger bushes.

Use an organosilicone penetrant such as Pulse® as directed by the label.[22,29,30,31,32,33]

Use a penetrant/surfactant as directed by the label.[22,29,30,31,32,33]

Metsulfuron-methyl is not a scheduled poison.

Triclopyr e.g. Garlon 600

$4.40 to $8.80 for triclopyr + a non ionic wetting agent or $12 for Pulse /100 L of spray mix (approx. cost) in 2009.

Triclopyr is a selective herbicide which is taken up by the leaves and roots and moves throughout the plant. It works by creating an auxin-type response (interferes with normal growth).[21]

Two rounds of spraying may be needed to achieve complete kill. The triclopyr labels generally recommend a non-ionic surfactant however organosilicone surfactants such as Pulse® generally give higher levels of control (Zabkiewwicz et al, 1992)

Triclopyr herbicides are scheduled 6 on the poisons schedule = POISON.

Picloram/triclopyr e.g. Grazon DS

$9.00 to $18.00 for triclopyr/picloram + $12 for Pulse® /100 L of spray mix (approx. cost) in 2009
Grazon Extra is similar to the triclopyr/picloram mixes above but also contains aminopyralid and costs about 25c/100 L more.

Picloram is a selective herbicide which is absorbed by leaves and roots and moves throughout the plant. It is concentrated in new growth where it affects the synthesis of proteins.[21]

In the field, picloram has residual properties in the soil which suppress seedlings for some time after treatment.[1,19]

Picloram/triclopyr herbicides are widely used in Tasmania, Victoria and NSW. Amitrole and 2,4-D+picloram mixes are also registered for gorse control but more expensive at $30.00/100 L and $13.00/100 L of spray mix respectively and generally less effective than the herbicides above. Mixtures of glyphosate + metsulfuron (e.g. Trounce® or Cut-Out®) and metsulfuron + picloram (e.g. Crossbow®) are also available.[71]

Picloram/triclopyr herbicides are scheduled 6 on the poisons schedule = POISON.

Penetrants, surfactants, adjuvants e.g. Nufarm PULSE Penetrant, BS 1000

Without these products, foliar herbicide sprays are less effective against gorse. These products help herbicides to "stick" to gorse and break through its waxy surface coating. Claimed benefits of these products are:

- improved wetting
- improved spray coverage
- improved absorption into gorse leaves, spines and branches.

Add these products to the tank at the time of mixing herbicide, in accordance with label instructions. Herbicide labels recommend compatible products and rates.

2.10.5 Methods of foliar spraying

See sections 5.7 to 5.9 for more information on herbicide application.

Backpacks are useful for spraying isolated bushes or scattered regrowth/seedlings, Delamere, South Australia

Trailer or truck-mounted spray units with hoses and hand guns are widely used on gorse, Black River, Tasmania

Boom spraying is permitted for some herbicides in some states. It offers fast, cost-effective coverage of regrowth, Delamere, South Australia

Aerial spraying is permitted for some herbicides in some states. It offers fast, cost-effective coverage of large infestations, Avoca, Tasmania

2.10.6 "Cut and paint", or "cut stump"

Approximate cost: $50+/ha using voluntary labour (highly variable)

Use cut and paint to:

- Reduce above-ground mass of gorse
- Kill regrowth.

Use cut and paint on gorse in native vegetation, on hard-to-access sites and where machinery, spraying or fire are undesirable.

Cut and paint is suited to infestations of less than 10 m x 10 m (0.01 ha), or where there is abundant labour, or where other methods are unacceptable.

There are two stages to cut and paint:

1. Cut gorse stems level/horizontal and close to the ground
2. Completely wet the cut surface of all stems with herbicide within 20 seconds of cutting.

- Use a permitted/registered herbicide at recommended rates. Use dye with the herbicide to indicate coverage.
- Wear appropriate safety equipment when doing cut and paint, including safety glasses, and gloves to protect your hands from herbicide.

Use the following tools for cutting:

- Secateurs
- Loppers
- Bow saw/pruning saw
- Chainsaw/brush cutter.

The cut made on gorse stem(s) should be low (to reduce hazard) and level (to prevent herbicide runoff). Some managers split or scrape the stump to increase the area over which herbicide is absorbed.[10,34]

Use the following tools for painting:

- Paint brush
- Foam shoe-polish applicator
- Sauce/product bottle
- Trigger spray bottle
- Pump spray bottle
- Backpack.

(Joseph Gouldthorpe)

1. Cut the stump low and level

(Tom Sloane)

2. Completely wet the cut surface with herbicide within 20 seconds of cutting

Brushes and foam applicators quickly become clogged with debris. Sauce bottles spill when dropped or inverted. Backpacks are heavy. Spray bottles don't get clogged, are a good weight to carry and are less prone to spillage. They should have an adjustable nozzle so spray can be directed only onto the cut stump.

Glyphosate 360 g/L herbicides used either undiluted or diluted up to 1:5 in water are economical and effective in states where their use is permitted. Two picloram herbicides, Vigilant® and Tordon Gel Herbicide®, are also registered for cut and paint on gorse.

Using one operator with a brush cutter, a second with a rake to clear debris and a third with

a backpack to treat stumps has been a cost effective method of cut and paint in Tasmania and Victoria.[35,36]

Deal with the cut material in one of the following ways:

- Bag seeding plants on site then remove for disposal by deep burial
- Lay cut plants on top of stumps as mulch to suppress gorse seedlings – a good resource.

An experienced cut and painter's approach

Greg Taylor, from the Cradle Coast NRM in north-west Tasmania, has overseen more than 5000 hours of gorse control on The Nut, at Stanley.

Greg has developed a highly efficient cut and paint method based on this experience. He cuts with secateurs and a bow saw. He says that chainsaws and brush cutters are uncomfortable to work around (noisy), hazardous and exhausting to carry on difficult terrain.[37] In practice, a bow saw is faster than an expert-operated chainsaw over large areas. Secateurs deal with stems too small for the saw, so loppers aren't needed.

Cut and paint gear at The Nut, north-west Tasmania

Greg paints with a 450 ml "Plaspak Selectaspray" trigger spray bottle. The bottle is reliable, doesn't leak and holds the right amount of herbicide to use in a session between breaks. The herbicide used is a glyphosate 360 g/L product mixed at 1:1 with water, with red dye added. Greg stresses the importance of wearing safety glasses. He uses two pairs of "Nitrilite" gloves, which offer protection against spines and herbicide.

Greg has trialled different ways of getting rid of the cut plants. He said that burning off the trash was possibly the biggest mistake he made in trying to control gorse on The Nut. The fire promoted massive seed germination, which required a second round of treatment. Greg now deals with cut plants by piling them back on their stumps, where they form a mulch which suppresses new gorse seedlings.

Greg observes that fire is a risky tool to use on cut gorse. Choosing to burn cut gorse makes site management more complex, involves more work and generates emissions.

Using fire to remove cut and paint trash from native vegetation generated smoke, triggered massive seed germination and necessitated a second round of treatment

2.11 Hand-pulling

Approximate cost: variable

Use hand-pulling to:

- Follow-up seedling germination.

Hand-pulling is a useful method to follow-up seedlings after cut and paint. Pull seedlings before they "harden off". If you can't pull a seedling easily without it breaking off, then cut and paint or spray the seedling.

2.12 Fire

Approximate cost: low

The burning of any gorse where no useful purpose is served and where it is not intended to pursue the eradication process further is foolish …
Every time mature gorse is fired, more gorse is brought to life …[42]

Use fire to:

- Reduce above-ground mass of gorse.

The key points for burning gorse are:

1. Exercise extreme caution when using fire – consult your fire authority before burning gorse and comply with permit requirements, fire bans etc.
2. Fire won't kill gorse. You must use fire in combination with other control options
3. Burning gorse without following-up will make the infestation worse
4. Don't burn for at least 12 months after spraying gorse with a herbicide
5. Don't burn gorse in or near native vegetation or riparian bush
6. Establish competitive pasture after fire
7. Burn in autumn to reduce impacts on wildlife.

Risks of burning gorse

Avoid burning living gorse if possible. Fire alone will not control gorse and must be combined with other management options.

Burning living gorse makes infestations denser by promoting germination of seed from the soil and vigorous regrowth from roots. In Tasmania, heavy gorse infestations recover completely within four to five years after fire.[43] Gorse will not carry fire until it is mature[43], so continuous burning establishes a cycle of germination and regrowth, maturity and seeding.

Gorse burns vigorously. Burning living gorse threatens human safety and assets and risks causing wildfire. Particularly at risk are fences, houses, bush and powerlinesand so should not be burnt if under power lines..

Using fire to clear dead gorse after spraying, Adelaide & Mt Lofty Ranges NRM Board

Burning living gorse leaves behind a mass of charred canes. Charcoal from these canes contaminates fleece. The canes block access for stock and cause punctures in tyres (including tractor tyres). Burning living gorse kills competitive pasture and native plants. Burnt canes may need to be removed with a dozer, excavator, front-end loader or similar to gain access prior to spraying regrowth.

Cool fires in green gorse only burn off leaves and spines

The value of gorse as habitat for native animals is destroyed by fire. Autumn burning will have less impact on native animals relying on gorse compared to spring burning.

Don't burn gorse, dead or alive, in native vegetation. Burning living gorse in native vegetation will entrench the problem.[44]

Gains from burning gorse

Fire is an effective way to remove *dead* gorse after clearing or herbicide treatment. Burning dead gorse creates a hot fire, kills some of the soil seed bank and leaves a tidy site.

Fire may be the only viable option for reducing the above-ground mass of gorse in pasture, particularly on steep banks.

Burning dead gorse leaves a clean site, Scarsdale, Victoria

Fire can reduce the soil seed bank. A hot fire can reduce soil seed by 50% by killing seed or causing it to germinate. Theoretically, fire could be used on an annual basis to reduce soil seed to near zero levels within 10 years[2] but in practice, there is never enough fuel to get a hot burn in young gorse.

Cool or running fires in gorse only burn off leaves and spines, and tend not to damage much seed in the soil. By comparison, hot fires such as those produced by burning dead or windrowed gorse produce enough heat to kill soil seed and prevent mass germination on the burnt site following fire.[2,37,45]

Hotter burns can be achieved by rolling, breaking or spraying gorse prior to burning. Run over gorse with a bladed tractor, tracked machinery or similar to break it off prior to a burn.

Because burning live gorse destroys competitive cover and promotes regrowth and germination, it must be followed-up with spraying, establishment/maintenance of pasture and grazing. Burning living infestations will also germinate seed. Seeds germinated by fire can then be controlled by herbicides or heavy grazing.

2.13 Grazing

Approximate cost: variable

Use grazing to:

- Reduce above-ground mass of gorse
- Kill regrowth
- Follow-up seedling germination.

Grazing with sheep and goats is a proven technique for controlling gorse in Tasmania and New Zealand. There is a gap in knowledge about integrating sheep with gorse control in Australia and most information about grazing for gorse control comes from New Zealand. Trial work could help fill this gap.

Sheep are effective on seedlings, but not tall growth once it gets over their head height. Goats are effective on regrowth and mature bushes and will provide better than 90% gorse control in four to five years.[46,47,48 49] Historically, horses were also fed gorse.[50] Stock availability, adequate fencing and the establishment of strong pasture grasses are the keys to grazing for gorse control.[51]

Set stocking with sheep and goats for 15 years on this slope has reduced a dense 3 m tall infestation to scattered knee-high bushes, Woodbury, Tasmania

Sheep can be integrated in gorse control , Campbell Town, Tasmania

When using goats, fencing is the top priority. In Tasmania the use of goats on grazing country does not affect carrying capacity for sheep.[49,52] Goats can be used to open up gorse infested pasture for sheep and suppress regrowth.

Stock are also useful for trampling grass seed into burnt gorse and trampling gorse seedlings. In practice this involves circling a mob of sheep over a patch of seedlings for five to 30 minutes or stocking heavily and briefly just after sowing.

Where gorse control is the main aim of grazing with sheep, there will be loss in animal production. Use wethers or dry ewes, preferably older animals. Goats, including does with kids at foot, can perform satisfactorily on gorse infested pasture year round in Tasmania.[49,52]

The key points for grazing gorse are:

1. Reduce above-ground mass using mechanical control or fire, or both
2. Top-dressing with fertiliser significantly improves attractiveness of gorse to stock, and competitiveness of grass against gorse
3. Sowing pasture grasses significantly improves the chance of long-term success
4. With sheep, hard grazing is needed. Stocking rates must be heavy enough to eliminate selective grazing [53]
5. Better results on gorse are achieved with rotational grazing compared to set stocking
6. Older/experienced animals are better at eating gorse [54,55]
7. Spraying of regrowth is required.

Costs involved with grazing for gorse control may arise from (adapted from [51]):

1. Capital cost of stock
2. Fencing, water and care
3. Loss of condition/live weight
4. Damage to fleece/skins
5. Off-target damage
6. Damage to soil structure
7. Treading damage to pasture
8. Damage to other assets by escaped stock.[51]

Stocking rates for gorse control will vary depending on a number of factors. The following table summarises stocking rates from a number of trials and programs.

Published stocking rates for gorse control

Author	Stock	Rate/ha	Set/rotational	Duration
42, 49, 56	goats	10 to 33	set	NA
42, 56	goats + sheep	5 + 4 to 16 + 8	set	NA
57	goats	80 to 140	rotational	1 week on, 3 weeks off
57	goats + sheep	70 + 35	rotational	1 week on, 3 weeks off
57	sheep	40 to 70	rotational	1 week on, 3 weeks off
58	sheep	200	rotational	3 days on, 27 days off
56, 59	sheep	10 to 34	set	NA
59	sheep	68	rotational	3 weeks
60	sheep	500	rotational	2-3 days

Extensive work has been done in New Zealand to integrate grazing with gorse control. A typical New Zealand program[56,57,58,59,60,61] on un-ploughable country has been:

1. Crush or roll mature gorse then burn in Autumn
2. Divide infested land into small paddocks
3. Broadcast 25 to 40 kg/ha pasture seed mix and spread 250 kg/ha superphosphate + 2.5 t/ha lime
4. Introduce dry ewes/wethers or goats as soon as possible, to trample seed into soil and break canes
5. Remove stock and allow pasture to establish before restocking[62]
6. Alternatively, rotate 200 to 500 sheep/ha. Three to four weeks rest appears ideal
7. Spray regrowth.

2.14 Pasture management

Approximate cost: variable

New Zealand gorse control from the 1950s to the 1980s highlighted the importance of integrating pasture maintenance and/or improvement with gorse control. This is important because:

- Gorse seedlings compete poorly with grasses. Well-managed pasture reduces recruitment of new gorse seedlings
- Gorse which has been fertilised, especially with nitrogen, is more attractive to sheep[18,50,63]
- Lime suppresses gorse seedlings.[50,63]

New Zealand practice involved sowing down heavy grass/clover mixes. In Australia land managers advocate sowing grass only, which keeps open the option of spraying with selective herbicides for follow-up.
Some grasses are more competitive against gorse than others. In New Zealand perennial ryegrass was found to be the least effective grass at controlling gorse seedlings.

In Australia it is unusual for farmers to sow pasture grasses down after gorse control, let alone to fertilise or apply lime. Most farmers who have oversown cleared gorse have broadcast seed opportunistically after clearing, mulching or crushing, when the soil has been disturbed.

2.15 Revegetation

Approximate cost: variable

Use revegetation to:

- Follow-up seedling germination.

Planting a control site with native plants increases competition against gorse seedlings. Revegetation with native plants is essential after removing gorse which is habitat for native animals.

Planting with native stock increases competition against gorse seedlings, Buninyong, Victoria

Working other follow-up methods around newly planted natives can be difficult. For example, off-target damage to newly planted shrubs and trees is likely when spraying adjacent gorse regrowth. For this reason, delay planting until at least two years after follow-up methods have been used at a gorse control site.

Using native grasses to replant control sites gets around the problem of off-target herbicide damage if a selective herbicide has been used. Grasses also offer better competition against gorse seedlings than do broad-leaved plants.

Remember these points when replanting after gorse control:

- Wait at least two years after primary control before revegetating
- Grasses are more competitive against gorse than broad-leaved plants
- Grasses can be sprayed with selective herbicides during follow-up
- Some grasses (e.g. silver tussock – *Poa labillardieri*) don't need to be guarded
- Use "local provenance" plants.

"Local provenance" refers to native plants which are genetically adapted to your area. Source seed for local provenance plants at the nearest site where those plants grow naturally, if this can be done in a sustainable way.[64]

2.16 Biological control

John Ireson, Tasmanian Institute of Agricultural Research

Approximate cost: not applicable to land managers

Introduction

Biological control agents should be released in gorse infestations where access is difficult and the opportunity for other control methods is limited. With regard to weeds, "biological control" is the use of a living species, usually an insect, mite or pathogen, to control the growth and/or spread of an undesirable plant species. Although there are several techniques that can be employed, the most commonly used is classical biological control.

This involves the introduction of natural enemies from their native range into an exotic range where the host plant has become a weed. Strict protocols ensure that biological control agents are selected very carefully to minimise any risk of introduced agents attacking desirable plants.

Biological control will not eradicate a weed, because the agents always need some surviving plants to complete their life cycle. Successful biological control helps to reduce the vigour, abundance and therefore the economic impact of a weed to a lower level, usually in conjunction with traditional control methods as part of an overall integrated weed management program.

Control agents established on gorse

Exapion ulicis (gorse seed weevil)

Since its release in 1939 gorse seed weevil has become common on gorse throughout Tasmania, Victoria and South Australia and is also present in NSW, but its impact on seed production is not high enough to reduce plant densities. The flowering period of gorse varies considerably, not only between sites, but also on individual bushes within sites. At some sites most gorse bushes flower during spring and at other sites flowering occurs in autumn and winter as well as in spring. The weevil larvae only feed on seeds produced in spring and summer and are not present during the autumn/winter period. As a result a significant proportion of the annual seed crop is undamaged.[65]

Gorse seed weevil, Exapion ulicis. Inset shows seed damaged by larvae compared to undamaged seed

Tetranychus lintearius (gorse spider mite)
This control agent was first released in Tasmania and Victoria in 1998. It is now widespread throughout Tasmania and parts of Victoria and is established in NSW, South Australia and Western Australia. The mite builds large colonies that can feed on old and new growth. Field studies in Tasmania have shown that the presence of mite colonies on gorse bushes over a period of 2.5 years from the time of release reduced foliage dry weight by approximately 37%.[66] However, predation is significantly restricting the usefulness of gorse spider mite as a biological control agent.[67]

Colony of gorse spider mite, Tetranychus lintearius, on gorse

Webbing on gorse by gorse spider mite, Tetranychus lintearius, at Stonehenge, Tasmania

Sericothrips staphylinus (gorse thrips)
Thrips were first released in Tasmania and Victoria in 2001. Thrips feed on the new growth produced in spring and on seedlings. A glasshouse study on the efficacy of gorse thrips showed that a combination of the thrips, ryegrass competition and simulated grazing resulted in a gorse seedling mortality of 93%. This demonstrated the potential of gorse thrips in an integrated control program if field populations are eventually able to increase to sufficient levels.[68] Gorse thrips have been recovered at 86% of the release sites, however, they have not yet been recorded in high densities. They are initially very slow to disperse, and current densities may be too low to enable reliable detection. It is common for biological control agents to exist at low levels for several generations after which populations start to increase exponentially to high densities and start to disperse. Mass rearing followed by field release of gorse thrips is continuing in order to increase establishment and spread.

Gorse thrips, Sericothrips staphylinus

Agonopterix "umbellana" (gorse soft shoot moth) The moth was first released in Tasmania and Victoria in 2007, however, establishment is yet to be confirmed and additional releases are planned. Moth larvae feed on the tips of the shoots and on developing green spines in spring and early summer and have potential to cause significant foliar damage.

The foliage feeding larva of theGorse Soft Shoot Moth

Future prospects for biological control
If successful establishment of the gorse soft shoot moth is achieved, the guild of agents for biological control of gorse in Australia will consist of one seed feeder and three foliage feeding agents. The level of impact that this combination of agents will have on gorse in the long term will be determined only by future research. However, the results to date suggest that additional agents will be required to increase the importance of biological control as a component of long-term integrated management strategies.

Surveys for possible fungal pathogens in Western Europe were conducted in 2006-07 and the results are now being assessed. If potential agents can be found, further research will be necessary to determine whether they are suitably host specific to enable their introduction to Australia.

Management of gorse biological control agents
Initially, biological control agents should be released in gorse infestations where access is difficult and the opportunity for other control methods is limited. This will provide the opportunity for populations to increase and disperse to adjacent infestations and enable a site to be used for the collection and transfer of the agent to other sites. This is particularly important for agents such as the gorse thrips, which is initially slow to increase and disperse. However, if gorse is to be cleared or controlled in areas where the widely established gorse spider mite and gorse seed weevil are present, traditional control measures can proceed. This is because both agents have good dispersal abilities and can reinfest gorse if it is cleared from an area and starts to grow back.

2.17 Costs of control

Indicative costs per hectare for different stages of gorse control are given in the following table (adapted from [69]).

The cost of spraying gorse is highly variable depending on which herbicide is used and how dense the gorse is. Prices for all methods assume that work is contracted, not owner-operated. Owner-operators often achieve much cheaper gorse control.

Primary Control Only

Approximate costs per hectare for gorse control methods (current at April 2006)

Method	Most suited to…	Based on hourly rate of… ($)	Approx cost ($/hectare)	Principle variables in cost
Herbicide				
Cut and paint	Native bush, riparian zones, infestations <0.01 ha, inaccessible areas	0: voluntary labour 35: paid labour	50+ 12,000 to 30,000	Density of gorse, slope, presence of other weeds. Herbicide costs start at $50/ha
Foliar spraying (backpack)	As above, seedlings, scattered plants and regrowth	35	Variable	Accessibility, slope, water supply, density and height of gorse, herbicide choice
Foliar spraying (Quik Spray etc.)	Roadsides, native vegetation, regrowth or scattered gorse in pasture	55 to 75 (Quik Spray, 1 operator) 80 to 87 (Quik Spray, 2 operators)	Highly variable* $200-2000	Accessibility, slope, water supply, density and height of gorse, herbicide choice
Aerial spraying by helicopter	Large infestations in pasture	NA	555	Herbicide choice
Mechanical				
Dozing (22 t excavator with thumbs)	Old gorse in pasture	170 (D7 or equivalent)	500 to 1000 plus transport @155/hr	Transport, accessibility, slope, presence of native vegetation, age of gorse, operator ability
Grubbing	Old gorse in pasture	115 (22 t with thumbs)	300 plus transport @115/hr	Transport, accessibility, slope, presence of native vegetation, age of gorse, operator ability
Root raking	Old gorse in pasture	170 (D7) 115 (20 t excavator)	300 to 1000	Transport, accessibility, slope, presence of native vegetation, age of gorse, operator ability
Mulching (tractor)	Pasture with few rocks and slopes <25°	200 to 400	700 to 2900	Transport, density and height of gorse, surface rocks
Mulching or grooming (excavator)	Pasture with few rocks and slopes <25°, riparian zones	160	1000+	Transport, density and height of gorse, surface rocks
Meri Crusher	Pasture with few rocks and slopes <25°	220	700-1000	Transport, stony/sandy soil (slower)
Cultivation	Pasture	NA	97	Assumes arable land
Other				
Burning	Pasture	NA	Negligible	Fire management and safety
Grazing	Pasture	NA	Variable	Cost of stock, fencing, water and care
Biological control**	Most situations	NA	$1200 to 1500	Availability of agents

*Height and density of infestation and herbicide choice affects the cost of ground spraying. Scattered bushes or light regrowth could cost $160/ha in labour and $140 to $255 in chemicals (at 750 l/ha) to spray (total cost = $300 to $415). Tall dense gorse could cost four times this much to spray (assuming 3000 l/ha) (total cost = $1200 to $1660).[70]
**Cost per release usually borne by Australian Government.

Note: hourly and hectare costs are based on going commercial rates quoted by Tasmanian and Victorian contractors as at April 2006, and on land manager experience with different control methods.

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Example of a gorse control plan for a grazing property in southern Australia

Choosing a gorse control program for your situation

CHAPTER 3

Chapter 3
Choosing a gorse control program for your situation

Develop a gorse control program based on the type of land or infestation you need to treat and the options you have available to you. This chapter has been divided into sections detailing your choices of gorse control programs for different situations.

Before you follow any of these programs it is important that you:

1. Develop a five year gorse control plan (refer to section 2.4 for detailed instructions)
2. Work out your primary control and follow-up methods
3. Prevent further seed spread (refer to section 2.5).

3.1 Steep or stony pasture

Use the flowchart for steep or stony pasture to work out a gorse control program. Follow the steps in the flowchart in the sequence that they are written down. Remember these key points when controlling gorse on steep or stony pasture:

- Prevent further seed spread
- Wait at least 12 months before burning sprayed gorse
- Heavy stocking will improve results
- Sowing pasture and fertilising improves results
- Use local/expert knowledge when establishing pasture
- Follow-up treatment of gorse regrowth and seedlings is essential.

Refer to the case study in section 4.3 where a gorse infestation on stony pasture was effectively dealt with.

3.2 Arable pasture

If you plan to control gorse in arable pasture, use the arable pasture flowchart to work out a gorse control program for your site. Follow the steps in the flowchart in the sequence that they are written down. Observe these key points when controlling gorse in arable pasture:

- Prevent further seed spread
- Wait at least 12 months before burning sprayed gorse
- Heavy stocking will improve results
- Sowing pasture and fertilising improves results
- Use local/expert knowledge when establishing pasture
- Follow-up treatment of gorse regrowth and seedlings is essential.

Refer to case studies that effectively dealt with gorse infestations in these conditions: sections 4.1, 4.2 and 4.4.

3.3 Native vegetation

The flowchart for native vegetation outlines some gorse control programs for infested bush. Follow the steps in the flowchart in the sequence that they are written down. Key points for controlling gorse in native vegetation are:

- Prevent further seed spread
- Exclude fire from the area
- Avoid all soil disturbance
- Be careful when using herbicides around stringy bark/messmate – these plants are very sensitive to herbicides
- Follow-up treatment of gorse regrowth and seedlings is essential.

Refer to case studies that effectively dealt with gorse infestation in these conditions: section 4.6 and 4.7.

3.4 Riparian zones

If you plan to control gorse on stream banks, use the riparian zone flowchart to work out a gorse control program suited to your site. Follow the steps in the flowchart in the sequence that they are written down. Observe these key points when controlling gorse in riparian zones:

- Seek expert advice - (Primary Industry staff and Riparian Habitat Management Guide, availablefrom http://www.weedscrc.org.au/documents/hmg_riparian.pdf.
- Prevent further seed spread
- Check if your state or region requires you to have a permit before working on stream banks (see Section 5.9)
- Maintain good vegetative cover. Erosion is much harder to control than gorse
- Only use herbicides registered for use around waterways
- Work from upstream to downstream[1]
- Work on a manageable section at a time, not on large continuous sections[1]
- Avoid spring or summer works to protect habitat
- See section 5.8 for guidelines for using herbicides in riparian zones
- Follow-up treatment of gorse regrowth and seedlings is essential.

Refer to case studies that effectively dealt with gorse infestation in these conditions: Section 4.8 and 4.9.

Don't take on more than you can follow-up. Break the work into manageable sections

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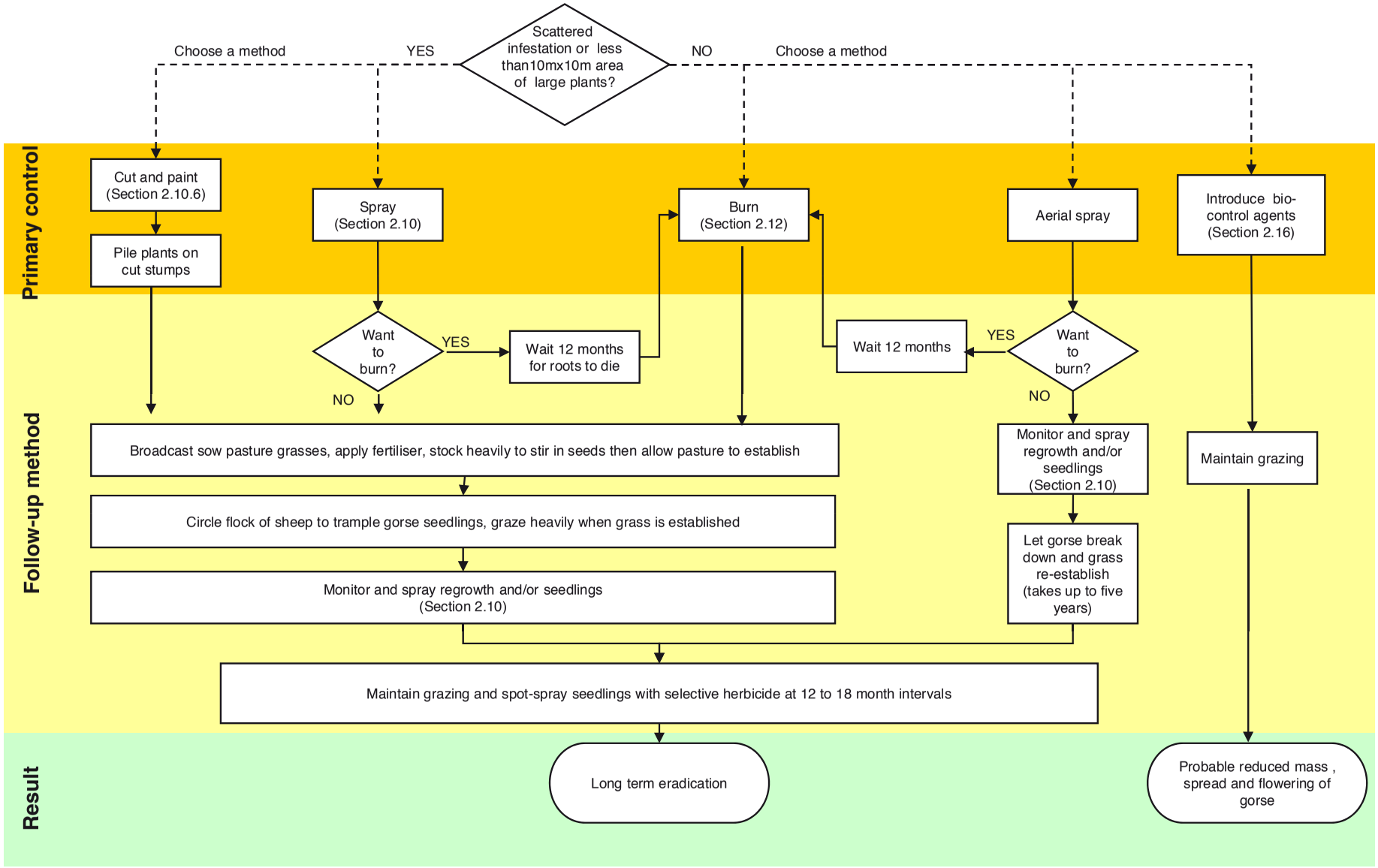
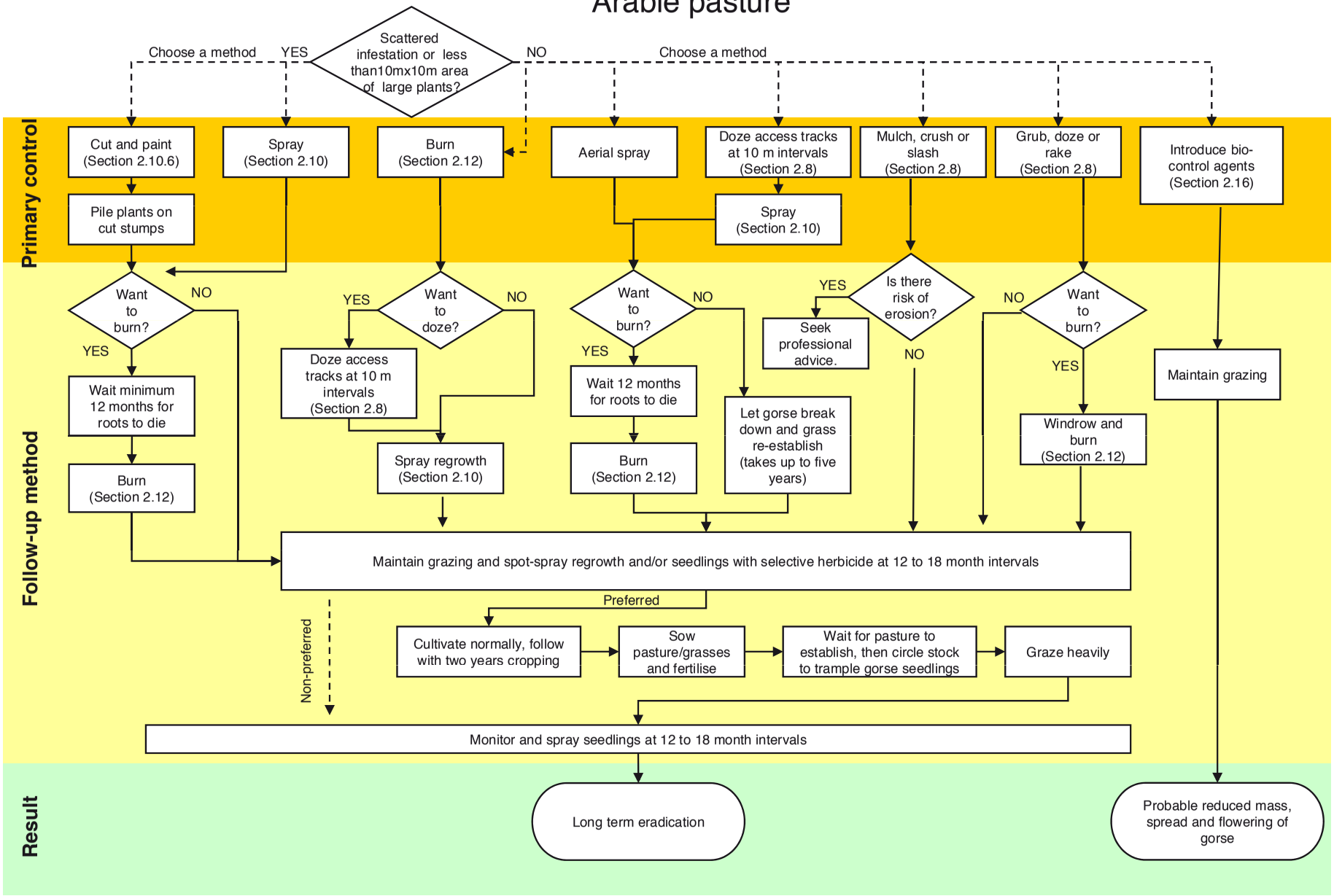
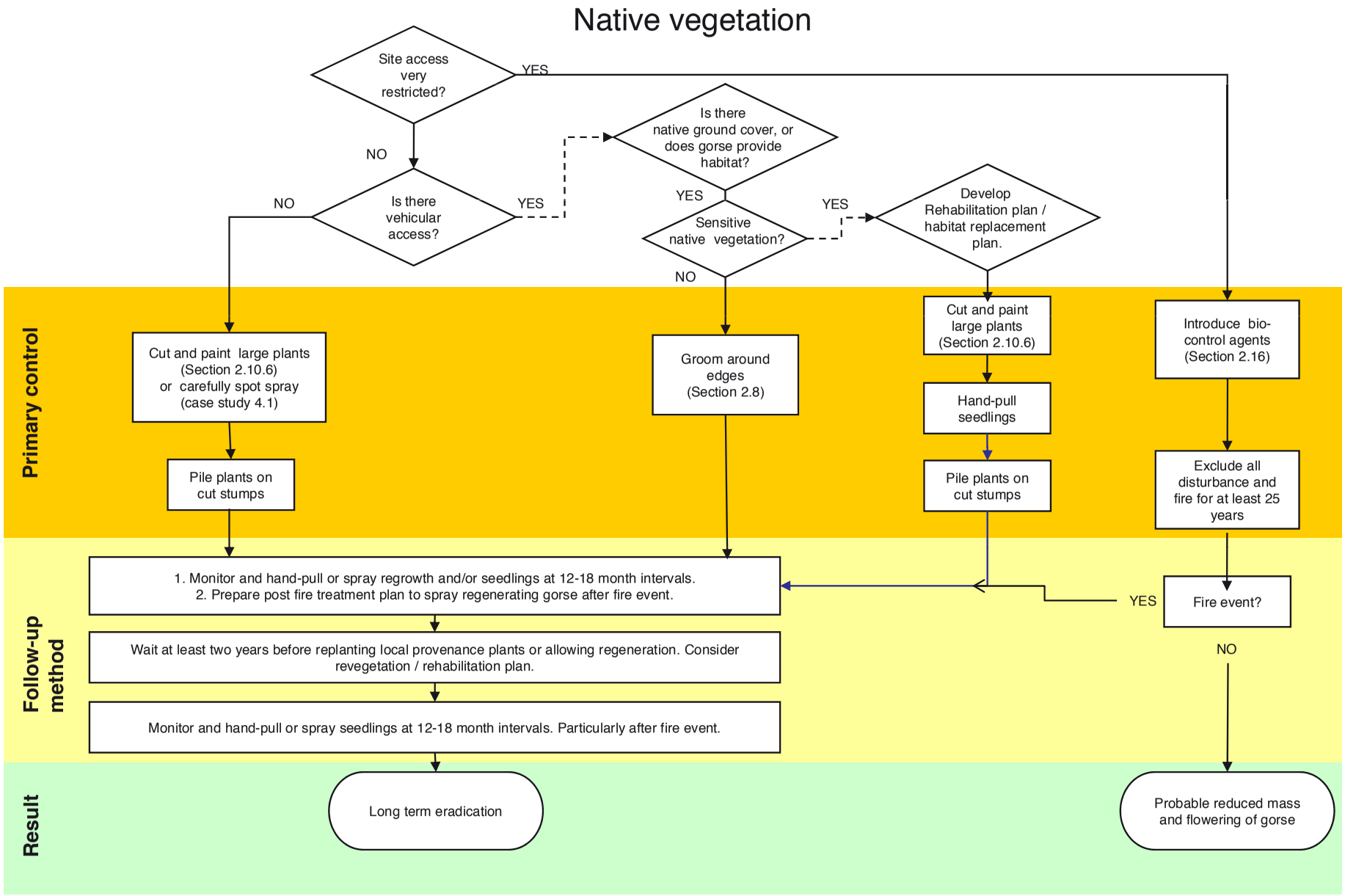
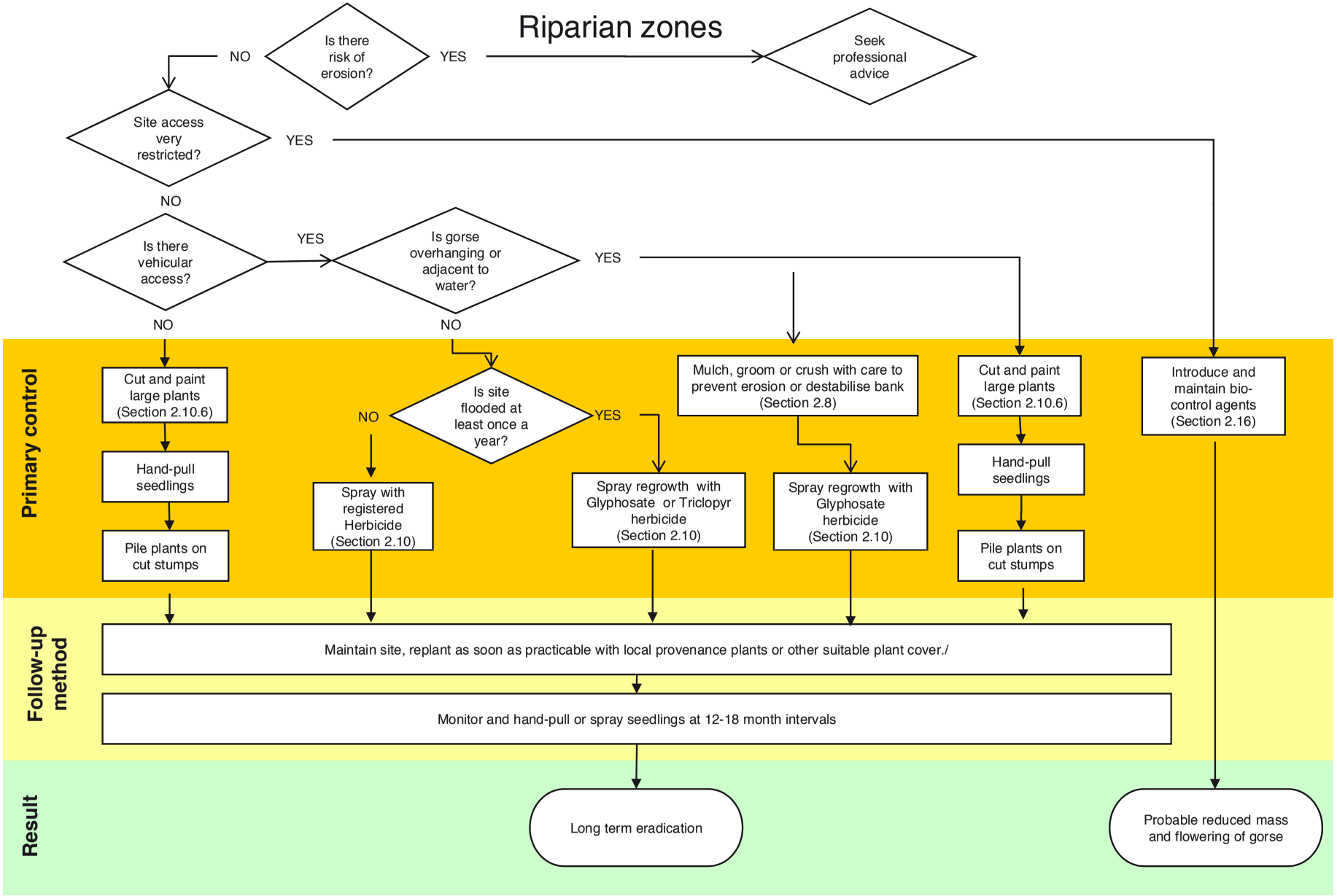
Steep or stony pasture



Arable pasture




Native vegetation
Site access very restricted?
YES
NO
Is there vehicular access?
NO
YES
Is there native ground cover, or does gorse provide habitat?
YES
Sensitive native vegetation?
YES
NO
Develop Rehabilitation plan / habitat replacement plan.
Primary control
Cut and paint large plants (Section 2.10.6) or carefully spot spray (case study 4.1)
Pile plants on cut stumps
Groom around edges (Section 2.8)
Cut and paint large plants (Section 2.10.6)
Hand-pull seedlings
Pile plants on cut stumps
Introduce bio-control agents (Section 2.16)
Exclude all disturbance and fire for at least 25 years
Follow-up method
1. Monitor and hand-pull or spray regrowth and/or seedlings at 12-18 month intervals.
2. Prepare post fire treatment plan to spray regenerating gorse after fire event.
Wait at least two years before replanting local provenance plants or allowing regeneration. Consider revegetation / rehabilitation plan.
Monitor and hand-pull or spray seedlings at 12-18 month intervals. Particularly after fire event.
YES
Fire event?
NO
Result
Long term eradication
Probable reduced mass and flowering of gorse


Riparian zones
Is there risk of erosion?
NO
YES
Seek professional advice
Site access very restricted?
YES
NO
Is there vehicular access?
YES
Is gorse overhanging or adjacent to water?
YES
NO
NO
Primary control
Cut and paint large plants (Section 2.10.6)
Hand-pull seedlings
Pile plants on cut stumps
NO
Is site flooded at least once a year?
YES
Spray with registered Herbicide (Section 2.10)
Spray regrowth with Glyphosate or Triclopyr herbicide (Section 2.10)
Mulch, groom or crush with care to prevent erosion or destabilise bank (Section 2.8)
Spray regrowth with Glyphosate herbicide (Section 2.10)
Cut and paint large plants (Section 2.10.6)
Hand-pull seedlings
Pile plants on cut stumps
Introduce and maintain bio-control agents (Section 2.16)
Follow-up method
Maintain site, replant as soon as practicable with local provenance plants or other suitable plant cover./
Monitor and hand-pull or spray seedlings at 12-18 month intervals
Result
Long term eradication
Probable reduced mass and flowering of gorse

Gorse biological control research

Case studies

(Alan Lane)

CHAPTER 4

Chapter 4
Case studies

Productive land

4.1 Gorse management on productive agricultural land

Martin Dumaresq (Mt Ireh Estate) and Jonah Gouldthorpe

Tasmanian Northern Midlands, 790 mm rainfall

A three to four-metre-tall gorse infestation has been transformed into irrigated crops and improved pasture on a farm in Tasmania's Northern Midlands.

This hillside was covered by three to four-metre-tall gorse

"Mt Ireh Estate", near Longford, is a 1000 hectare property producing prime lambs, cattle and irrigated crops. The farm also has significant black peppermint forest. It has been in the Dumaresq family since the 1830s, when gorse was planted for hedges. Eradicating the weed from Mt Ireh Estate has been a "lifetime project" for Martin Dumaresq, following on from work started by his father in the 1950s. Gorse control on Mt Ireh Estate shows how machinery and herbicides can be integrated to eradicate the weed from pasture and native vegetation.

The Dumaresqs have had to deal with gorse in two very different situations. In the understorey of black peppermint forest it had spread slowly to form a head-high scrub covering 30% of the ground in all remnants. In pasture, gorse had spread quickly, with infestations ranging from short, sheep-eaten bushes to four-metre-high walls of gorse.

Martin tackled gorse in bushland by spraying with 2,4,5-T initially, then Grazon DS Herbicide later on. He overcame the problem of access by towing the spray rig behind a tractor with a bucket, which he used to push through the gorse. Standing on the tank of the rig and spraying downwards prevented herbicide contacting the leaves or green bark of the peppermint canopy. Spraying only in settled weather was also important for avoiding off-target damage. Sprayed gorse was left to break down and remnant bush is now open enough to drive through and spot-spray annually for follow-up.

In 2001 Martin Dumaresq began a program to eradicate a 30 hectare patch of gorse from a fertile hill which was potentially productive, but so dense with three to four-metre-tall gorse and black wattle that, "you couldn't run anything through it." The first step was to reduce the above-ground mass of gorse, which was done by bulldozing the thickest part of the infestation and grubbing plants around the edges with an excavator. The debris was windrowed and burned, and then Martin cleaned up floating rocks, using a front-end loader.

"Doing nothing is not an option. We would eventually lose the farm."

Martin Dumaresq cleaned up rocks to allow access for boom spraying

Aerial spraying of gorse with Grazon DS Herbicide in an adjacent pasture took place around the same time. The rougher ground, which had been stirred up by the earthmovers, was broadcast sown to cocksfoot and rye in autumn, while the cleaner ground was put into an irrigated cropping cycle under a centre-pivot. Follow-up has involved boom spraying dense regrowth/seedlings and spot spraying sparse plants in spring every one to two years using Grazon DS Herbicide.

Martin believes that the timing of spraying has been critical – spring or early summer spraying gives a good kill, compared to autumn spraying which results in regrowth two to three years later. He also thinks that cocksfoot offers the best competition for gorse seedlings: "Once you get this dense grass cover the gorse competes poorly"; but cocksfoot is poor feed when rank and can't be relied on in the autumn grazing part of his enterprise. Early experiences with burning gorse at Mt Ireh Estate have shown that it comes back vigorously after fire and may even be harder to treat with herbicides after burning; the burning of gorse on the farm is now restricted to cleaning up debris.

On current values, the Dumaresqs have spent $2000 to $5000 every year on chemicals for spraying gorse. All work has been done "in-house", with about 0.25 full-time equivalent of labour dedicated to ongoing gorse control. $5000 was spent on the bulldozer and $2000 on the excavator while clearing gorse on the fertile hill site. An unknown amount was spent on aerial spraying. The cost of controlling gorse has been significant, but Martin is emphatic: "Doing nothing is not an option. We would eventually lose the farm."

Aerial photo showing two major infestations on Mt Ireh Estate in 1994

The same area in 2005, now under irrigated crops and pasture

The Dumaresqs expect to spend at least another five years on gorse before it is fully controlled. Spot spraying and boom spraying will continue in both bush and pasture. Martin also has plans for a steeper gorse-infested bank, which he intends to treat New Zealand-style. This will involve aerial spraying with Roundup®/penetrant, burning 12 months later, sowing grasses into the ash bed, grazing, and treating regrowth/seedlings with a selective herbicide. Martin points out that, "It's the constant follow-up that's such a problem with gorse." But persistent follow-up is also the key to the Dumaresq's success against gorse on Mt Ireh Estate.

The Dumaresqs plan to do more aerial spraying of gorse

4.2 Gorse control on a beef cattle property

Leigh and Meg Hansson (Winter Run) and Jonah Gouldthorpe

Bruny Island, Tasmania, 860 mm rainfall

Leigh and Meg Hansson have successfully cleared hectares of tall gorse from pasture on their Bruny Island farm.

The Hanssons have spent the last 15 years developing "Winter Run", a 120 hectare beef cattle property on the south of Bruny Island. When they first took on Winter Run, there were two main patches of gorse, of around two hectares and 0.5 hectares respectively. Scattered gorse bushes were also spreading onto other parts of the property.

The Hanssons took advantage of a financial incentive to control their infestations and prevent the weed from spreading further into productive pasture.

The Hanssons run beef cattle

Leigh Hansson explained that the big infestations were 2 to 2.5 metres tall: "The bushes were too big to get a really good coverage." Mechanical clearing was needed before they could be sprayed. Leigh pushed the gorse out with a front-end loader in August and September, then piled it up. The piles were burnt 10 weeks after clearing.

Dense gorse-infested hectares of pasture on Winter Run

"The key is getting it under control so it's not a huge job every year."

The Hanssons followed-up the main infestation by cultivating and sowing to turnips in the first year, then cultivating and sowing to pasture in the second year. Meg followed-up regrowth and seedlings from 30 cm tall by spraying with Grazon DS Herbicide plus a penetrant. The Hanssons have also conducted follow-up spraying on scattered gorse bushes across the farm. Leigh says that whenever he finds a new bush he makes a note of where it is, then periodically spends a day "touching up" these outliers with Grazon DS Herbicide. Gorse spider mite was introduced to the property and established well initially, but ultimately disappeared.

Leigh Hansson pushed out gorse with a front-end loader

Herbicide costs on Winter Run and other properties in the area were covered by an Australian Government grant in 2004. The Hanssons cleared and sprayed gorse themselves, using their own equipment.

The hard work of primary control is finished, but the threat of re-infestation from dormant seed, neighbouring properties and roadsides means that follow-up will be a long term program on Winter Run. Leigh sums it up:

> ***"Weed control is a big activity for Winter Run so we will be making sure we stay on top of it, monitoring the paddocks all the time and keeping track of where we need to spot spray. The key is getting it under control so it's not a huge job every year."***

4.3 My goal is to eradicate it – gorse control and wool production

Bill Fergusson (Grindstone Bay) and Jonah Gouldthorpe

Triabunna, Tasmania, 480 mm rainfall

Bill Fergusson is about to win an 18-year battle with gorse on his family's 2200 hectare grazing property.

"Grindstone Bay" has been in the Fergusson family for the last 50 years. The east coast Tasmanian property has a mix of wool and beef cattle enterprises. Gorse was extensive on the farm until the 1980s. Bill said, "There was not a paddock on the place that didn't have gorse in it." He began a thorough program of burning, clearing and spraying gorse and today has less than 10 hectares of infestation left to control. Bill Fergusson's story shows how combining different control methods in a long-term program can defeat gorse on low rainfall grazing properties.

Pasture at Grindstone Bay is now 90% free of gorse

Bill Fergusson started on the most scattered areas and worked towards the dense infestations. He is realistic about how long it will take to bring any infestation under control and plans a 10 to 15-year program for any patch of gorse he tackles.

Bill started by reducing the mass of gorse, either by burning or dozing with a D7 machine, depending on which method was suitable for the site. After dozing, Bill waited two months for the gorse to dry off before burning. Bill emphasised that the aim with dozing is to break the bushes off at ground level so as to get a hotter burn, not to scalp the soil. He found that where standing gorse had been burnt, there was a mass of charred canes which tangled the hose on the spray rig and made follow-up spraying difficult. He now uses the dozer or a front-end loader to push access tracks into the burnt gorse before spraying.

Bill Fergusson dozed gorse where appropriate

Burnt gorse ready for spraying. Bill has cleared access tracks into the canes with a front-end loader

Follow-up at Grindstone Bay is by foliar spraying with hand guns off a home-built rig. This was originally with glyphosate, but Bill switched to Grazon DS Herbicide. He uses a surfactant and marker dye, and said that using marker dye lets him see when the spray is reaching the point of run-off and makes for much more efficient herbicide use: "I can do half as much again with it." It takes one to three years, depending on rainfall, for regrowth to reach 30 to 40 cm high and for a reasonable number of seedlings to germinate. At this stage Bill sprays the regrowth and seedlings. Follow-up of seedlings is an ongoing process, which typically lasts for 10 years after primary control.

Bill Fergusson sprays regrowth with Grazon DS Herbicide, surfactant and marker dye, using a home-built rig

Bill has found that heavy germination from the soil seed bank has occurred three, four and five years after primary control. This germination, and the amount of follow-up spraying needed to keep on top of it seems to tail off after five years.

Bill guesses that gorse control on Grindstone Bay has cost at least $70,000 to date, including labour, herbicide and machinery time. He spends at least 250 hours per year on gorse control, of which one-third goes into primary control and two-thirds into follow-up.

Gorse control on "Grindstone Bay" is 90% complete, with just 10 hectares of infestations remaining. Bill is committed to getting rid of it all.

He said, "My goal is to eradicate it from the place." Bill explains his determination to control gorse despite the high cost:

> ***"Every clump that is around is growing every year and infesting land which is clean. You can't compare the cost of working on gorse with buying clean land, because clean land will be infested in 10 years".***

4.4 Gorse management program on a dairy and beef property

John Korpershoek (farm manager) and Jonah Gouldthorpe

Stanley, Tasmania, 940 mm rainfall

Harry and John Korpershoek have systematically eliminated gorse from their property over a 20-year period.

The Korpershoek brothers crop vegetables, milk 420 cows and produce beef cattle on over 400 hectares of owned and leased land in Tasmania's north-west. In the early 1980s Harry and John bought a 72 hectare block near Stanley, which was overrun with gorse. They systematically cleared the block of gorse, paddock by paddock. Today it is largely confined to fence lines and the Korpershoeks run beef cattle, cut hay and over-winter dry cows from their dairy farm across the entire block. Their story shows how even huge infestations can be overcome by breaking the job into manageable sections and being vigilant with follow-up.

The Stanley block was overrun with gorse

When Harry and John bought the Stanley block it had been cultivated but not sown down, and was thick with gorse. They divided the property into 15 hectare paddocks and began work on the gorse by tackling the worst patches on dry banks with a slasher. They continued slashing only for the first few years, but John said, "We weren't getting anywhere like that." The brothers changed tactics and now have a proven method for getting rid of gorse.

Dry cows are over-wintered on pasture which was heavily infested with gorse 20 years ago

"Maintain it. You just can't let off".

Harry and John now tackle gorse paddock by paddock. Once an area has had primary control, they move on, but maintain follow-up spraying to secure the work done already. The Korpershoeks slash gorse where possible, or burn, then slash very tall bushes. They then wait until there is at least 30 cm of regrowth before spraying, preferably in late spring or summer. Spraying is done with a hand gun on a 400 L tractor-mounted spray rig. The sprayed bushes are left to rot down.

Originally Harry and John used 2,4,5-T, then switched to Grazon DS Herbicide. Now their preference is for metsulfuron-methyl (e.g. Brush-Off® brush controller) plus penetrant.

Follow-up on the Korpershoek's Stanley block is by hand gun spraying with metsulfuron-methyl herbicide. All the paddocks have had at least two rounds of spraying, but seedlings are still coming up 20 years after primary control. John also maintains spraying along fence lines. He believes that stock have a role in controlling gorse by trampling and browsing; once primary control is complete, then "it's got to be grazed".

John said that it is hard to put a cost on the work they have done. Early in their program it was common to spend a week of four to five hour days slashing a paddock out then spraying the regrowth. Now, John says that, "We've got it pretty well covered in the paddocks", and he can spray out the remaining fence lines in less than a day. A $3000 grant from the Australian Government in 2003 helped to cover herbicide costs for ongoing work.

Future gorse control on the Korpershoek's property will involve slashing the few remaining patches of extensive gorse, spraying out regrowth and maintaining a spray program along fence lines. John sums up his attitude towards gorse control and follow-up simply: "Maintain it. You just can't let off."

John can now spray out his fence lines in less than a day

John slashes dense infestations then sprays regrowth when it reaches 30 cm in height

Regional eradication

4.5 Seek and eradicate

Geoff Price (Resource Protection Officer,Weeds, Environment ACT) and Jonah Gouldthorpe

ACT gorse infestation, Majura Road Majura

Canberra, ACT, 620 mm rainfall

Gorse has been virtually eradicated from the 2400 km^2 area of the ACT and the annual follow-up bill is less than $2000.

This has been possible because of a vigilant attitude, prompt and effective treatment of infestations and good mapping. A properly funded long term follow-up program backs up primary control. The ACT story demonstrates how easy and cost-effective early intervention can be, and is a potential model for weed authorities in regions where gorse is confined to small infestations.

Gorse in the ACT probably comes from 20 to 30-year-old garden escapes in Canberra, and from across the NSW border. The occasional bush is found in suburban gardens or on nature strips, but infestations are mainly on roadsides. A typical infestation has less than 100 plants and the plants are less than one metre tall. Machinery, livestock and birds are the likely means of spreading gorse in the ACT.

A strategic plan for gorse control on public lands is established every year in the ACT Weed Control Program. The program is prepared by the ACT Government, the Australian Government and community groups, and outlines gorse control measures for the upcoming year. The Program for 2005–06[1] establishes that:

- responsibility for gorse control sits with all public land mangers
- all mature plants will be removed
- all treated infestations will be mapped
- all treated sites will be monitored and re-treated annually for 10 years after primary control, then biennially for 10 years.

Anticipated expenditure on gorse in 2005–06 is $2000, funded from an operational budget.

Control of gorse on public lands in the ACT is conducted by Environment ACT operational staff. Cut and paint with glyphosate is used on individual plants and foliar spraying with Grazon DS Herbicide is used on larger infestations. Staff have a "seek and destroy" approach and always have equipment for treating gorse on hand so that new infestations are dealt with promptly.

Cut and paint equipment is always on hand

Large-scale works are contracted out to trained weed control operators. Machinery hygiene is taken seriously; there is a full washdown facility at the Environment ACT Mitchell depot and portable cleaning equipment is taken into the field.

Gorse on private land is targeted with an education and awareness campaign.
The Australian Native Plants Society, in partnership with Environment ACT and the Australian Government, conducts "Weed Swap" twice a year. These are events where members of the public can remove weeds from their gardens and exchange them for suitable native plants at no cost.

Follow-up on treated infestations involves revisiting sites and spot spraying or cutting and painting as necessary. This occurs on an annual basis for 10 years after primary control, then every second year for another 10 years. A recurrent works program identifies the locations of infestations, and staff prioritise follow-up procedures for the year. Good mapping underpins this work.

Suburban blocks are problematic for gorse eradication measures in the ACT because the ACT Weed Control Program is restricted to public lands.

Keeping the public aware of the threat posed by woody weeds means that land owners are more likely to recognise and report significant weeds in their own, or neighbours' gardens.

There are very good reasons for maintaining an eradication program for gorse in the ACT. The benefit to cost ratio for early intervention in weed control is 16:1[7], treatment of minor infestations is inexpensive, and the neighbouring Yass Valley in NSW illustrates the potential gorse has to invade kilometres of roadsides and river banks in the region.

Machinery hygiene in the ACT. The blower is carried on the slasher deck for cleaning in the field

4.6 Managing gorse in native vegetation at Deep Creek Conservation Park

Volker Scholz (Senior Ranger, Department of Environment and Heritage, SA) and Jonah Gouldthorpe

Delemere, South Australia, 540 mm rainfall

Volker Scholz, Senior Ranger in charge of Deep Creek Conservation Park, bulldozed 40 hectares of gorse-infested native bush to get at the weed.

The 4300 hectare Deep Creek park protects the biggest block of coastal bushland on the Fleurieu Peninsula. When Volker Scholz first started working there in 1984, gorse had overrun 400 hectares of regenerating bush and threatened important flora, fauna and recreation values. A 40 hectare patch on the "Tapanappa" block of the park was particularly dense. Park staff began a very large works program, and after two decades of great successes and some setbacks, have the gorse under control. The Deep Creek story illustrates how good documentation and dogged follow-up can defeat hundreds of hectares of gorse in native vegetation.

Gorse took off in the park after fire swept through in 1980. For the next four years the weed spread unchecked through regenerating bush and pasture and by the time park and NRM Board staff tried to control it in 1984, the worst gorse was too dense to spot spray. Something drastic had to be done just to get access to the area. After much consideration, park staff chain-pulled 40 hectares of the most heavily infested regenerating bush, then windrowed and burned the dry debris.

Chained and windrowed infestation at Deep Creek

Gorse in pasture gullies on a leased part of the park was dozed, windrowed and burnt immediately, using the dozer to open up burning piles to achieve a hot, clean fire.

The first follow-up undertaken on the big infestation was to clean up gorse and scrub regrowth with a mulcher and slasher. This opened the area up enough to enable easy spot spraying of subsequent gorse regrowth. In the early days 2,4,5-T was used, but it was later replaced by triclopyr and metsulfuron-methyl herbicides. Cleaning up the site also meant that park staff could boom spray for salvation jane (*Echium plantagineum,* also known as Paterson's curse) using metsulfuron-methyl, with the bonus that gorse regrowth was efficiently killed at the same time.

Boom spraying was used as part of follow-up

Spot spraying of gorse in other bush areas in the park continued, using hand guns and backpacks. Marker dye was added to the herbicide mix to avoid double-spraying and missing patches, which saved time and money. Fire was used twice to burn out isolated stands of gorse, with great success in a previously sprayed patch, but with poor results in living gorse.

Use of dye makes spraying more efficient

Over the last five years park staff have re-mapped and revisited all infestations. Follow-up is conducted on a two-year cycle (this prevents gorse reaching maturity) by spot-spraying with backpacks, hand gun and a spray unit mounted on a quad bike. Every time a new employee comes to the park, they are encouraged to map the gorse, to familiarise themselves with its extent.

There were some problems along the way. Spraying in warm, dead-calm conditions using triclopyr resulted in the death of a stand of messmate stringybark (*Eucalyptus obliqua)*. Off-target damage to native plants also occurred using metsulfuron-methyl. In response to this, both selective herbicides were restricted to gorse in open areas and glyphosate (which is not volatile or residual) is now used instead under native canopy. Winter spraying did not achieve good results, and now all work is done in September to December. Near escapes with two gorse fires demonstrated that although burning can be a useful management tool, it should be avoided in native vegetation.

Death of messmate stringybark from spraying triclopyr in dead-calm conditions

Gorse control measures at Deep Creek have been documented with a high level of detail, including herbicides used, time of application and effectiveness. Volker Scholz also developed gorse mapping and established photo points early in the program. By doing this, he has been able to clearly identify what works and what doesn't, and to continuously improve control practices. Documenting control costs and effectiveness makes it easier to develop, justify and negotiate budgets for future works and gives the program continuity. Finally, good record keeping and accountability strengthens community support for the excellent work being done against gorse in the park.

Dense infestation in 1984

"When you have a park of this size and you look at the reasons it came into being, we have to keep at it …

Same point in 1991

… and in 2006

Gorse control at Deep Creek hasn't come cheaply. An employee is dedicated to weed control in the park for 12 weeks a year (0.25 FTE) at a cost of around $11,000. On top of this is an annual chemical budget of $6000 to $7000. Keeping operator time and equipment in-house makes the work around 50% cheaper.

Gorse infestations are now in a "holding pattern" in the park. Following-up small infestations in native bush is the highest priority. Large infestations are contained in pasture, but Volker Scholz wants to consolidate work done already before tackling new areas. In common with gorse eradication everywhere, primary control is wasted without follow-up. In Volker's words: "When you have a park of this size and you look at the reasons it came into being, we have to keep at it … Deep Creek is the largest remnant of native vegetation on the Fleurieu Peninsula, and it must be protected."

4.7 Gorse management in the Blue Mountains

Ian Lett (Green Team Leader, Blue Mountains City Council), Vanessa Richardson (Ranger, NSW National Parks and Wildlife Service) and Jonah Gouldthorpe

Blackheath, NSW, 1400 mm rainfall

The community of the Blue Mountains has been working beside NSW National Parks and Wildlife Service (NPWS) and Blue Mountains City Council to control gorse in rugged bush since 1993. Ian Lett, Green Team Coordinator from Blue Mountains City Council, explained that until 1996 gorse infestations between Katoomba and Blackheath mostly came from movement of contaminated aggregate for roadworks from a site in Blackheath. The weed spread down creek lines, ultimately reaching the Grose, Coxs and Jamiesons Rivers. Many hectares of river bank and swampy areas were infested, including "Temperate Highland Peat Swamps on Sandstone", which are an endangered community under the *EPBC Act 1999*. The extent of the weed was discovered in 1993 and ranger Cath Ireland organised the inaugural "Great Grose Gorse Walk", which coordinated volunteers to map gorse and treat isolated plants along 50 km of the Grose. The Walk has been repeated every year since, and showcases the power of well organised community groups to deal with extensive gorse in bush.

Gorse infests river banks in the Blue Mountains

Careful planning is needed when using volunteers to help control weeds. Vanessa Richardson is a ranger with NSW NPWS in Blackheath, and coordinates the Walk. Vanessa details the preparatory work involved with bringing the Great Grose Gorse Walk together each year. The Walk is promoted through local radio, the *Blue Mountains Gazette*, fliers in shops, online and by word-of-mouth. All events in the Walk are subject to a job safety analysis and volunteers are covered by insurance arranged through the NSW NPWS. Vanessa has found that the most productive and manageable volunteer group size is eight people. Volunteers are supervised by NPWS staff, or by hired weed control operators.

During the first two years of the Great Grose Gorse Walk volunteers mapped gorse and broom infestations in five stages along remote reaches of the Grose River. Mapped infestations were controlled in subsequent years. Since 1993 the Walk has evolved to target a range of woody weeds and has had a name change, as the follow-up time required for gorse diminished.

Vanessa says that now the Walk involves 20 to 40 volunteers working over a two month program of events. Volunteers walk to mapped sites to cut and paint gorse and other weeds using undiluted or 1:1 glyphosate herbicide with marker dye, then bag seeding plants for removal.

Follow-up of primary control measures has been ongoing and has involved cutting and painting large plants and hand-pulling seedlings. Vanessa schedules events in the Walk with the aim of following-up infestations every three years in wilderness, and every two years in accessible spots.

A 10-year program for gorse control has also been running in the Blue Mountains at Braeside, adjoining the Blackheath golf course. The site was originally infested with several hectares of head-high gorse. Primary control was conducted by NSW NPWS, who sprayed and used the cut and paint technique with a range of herbicides over a five-year period. Unacceptable off-target damage, especially by metsulfuron-methyl herbicides, prompted a switch to cut and paint. Soil disturbance, even by foot traffic, was kept to a minimum at all times to reduce opportunities for gorse seed germination and erosion. Effective follow-up over the decade following spraying has reduced the infestation to sparse 30 cm seedlings and regrowth.

Follow-up at Braeside is based on total catchment management principles. These principles involve: hiring contractors to spray and cut and paint; monthly visits by Bushcare volunteers to hand-pull and cut and paint gorse; and revegetation. Ian Lett coordinated widespread planting of *Blechnum* fern, which was chosen for its ability to form dense ground cover after 18 months and shade-out gorse seedlings. Regular fuel reduction burns downwind of Braeside not only serve to protect houses, but also keep wildfire out of the treated infestation, which reduces germination of soil seed. Vanessa says: "I don't want it burnt, because we don't have the resources to deal with it."

"If you don't have community support, you're not going to win the war."

Blechnum fern was planted to compete with gorse seedlings

Defining tenure and park boundaries in the bush of the Blue Mountains is often difficult, so across-boundary cooperation has been essential to overcoming the gorse problem. Blue Mountains City Council and the NSW National Parks and Wildlife Service have excelled in working together on gorse. Community involvement has also been critical for controlling gorse on the ground, building political pressure for funding of gorse control, and maintaining continuity of control programs beyond the tenure of experienced NPWS and Council employees.

It is difficult to put a dollar value on gorse control in the Blue Mountains. Vanessa estimates that to pay for contractors to do the work of the Great Grose Weed Walk and Braeside would have cost at least $1 million. As it stands, the Walk receives $5000 annually from an operational budget, which is spent on herbicide, food and drinks for volunteers and some contracted weed control operators. The Blue Mountains City Council has sourced funding for gorse control through its operational budget, an environmental levy, state government noxious weed grants and a one-off program for protecting urban runoff quality.

Both Ian Lett and Vanessa Richardson stress that factors underpinning successful gorse control include: the ability to work across property boundaries, support from the community and access to voluntary labour. Ian says: "If you don't have community support, you're not going to win the war." Primary control of gorse has been completed for all Blue Mountains infestations. Vigilant follow-up by government organisations and the community will protect the Blue Mountains National Park and the Greater Blue Mountains World Heritage Area into the future.

Riparian zones

4.8 Managing gorse in riparian vegetation, Inman River, Fleurieu Peninsula

Gunter Bertram, Monika Bertram, Ron Taylor and Jonah Gouldthorpe

Victor Harbour, South Australia, 540 mm rainfall

Gorse control has been combined with fencing and revegetation to restore a 1.1 km stretch of gorse-infested riparian woodland on the Inman River, South Australia.

The Fleurieu Animal and Plant Control Board (APCB) issued land owners Gunter and Monika Bertram with a letter in 2002, ordering that they control gorse and blackberry along their stretch of the Inman River. The Bertrams lived overseas at the time, and local volunteer land manager Ron Taylor organised a weed control program for them. Ron drew up a plan which broke the infestation into three manageable sections. Gorse was controlled with fire, mechanical clearing, cut and paint and spot spraying, then infested areas were replanted using local provenance stock. The Bertram's story shows that good planning, integrated control and consistent follow-up will defeat even major gorse infestations.

Ron Taylor used an aerial photo and title plan to map the Bertram's gorse infestation and divide it into 400 m sections.

Aerial photo of the property with zones for gorse control

Breaking the program into three sections was significant because it made the job seem more achievable and allowed for native plants to grow before the last gorse was removed, protecting against habitat loss and erosion. Gorse provides important nesting sites for small birds such as fairy wrens. The plan combined gorse control, other woody weed control (blackberry and dog rose), fencing and revegetation. Integrating a gorse control program with other property management activities allowed the Bertrams to save money.

Work began in May 2002. The Inman River Catchment Group sponsored grooming of woody weeds using an "Envirotrim" machine on accessible areas.

Groomer in zone 1, 2002

The control area was then fenced off from stock, to minimise soil disturbance, germination of weed seeds and damage to future revegetation. The Fleurieu APCB sprayed dense gorse using metsulfuron-methyl in the less accessible parts of zones 1 and 2. Cut and paint was used on lone bushes, or where spraying presented off-target risks. Ron also took the opportunity to collect seed from local plants on the site for future revegetation work.

Cutting and painting in zone 1, 2002

Same site in 2006

Dense gorse still stood in parts of the river bank where the machine and spray operators couldn't reach. In June 2003 Ron arranged for the Bertrams to put on a barbecue and a few drinks as an incentive for Country Fire Service volunteers to burn off the remaining gorse in zone 1 as a training exercise. Fire was also used in zone 2 in 2004 to control inaccessible gorse.

Revegetation in zone 1 was scheduled for the winter of 2003. Friends of Newland Head (a local conservation group) planted out and guarded 2000 seedlings of local provenance plants in zone 1. Revegetation continued through zones 2 and 3 into October 2004, when the Bertrams planted out and guarded more seedlings.

Their aim is to plant 3000 seedlings in total to replace gorse and blackberry. Ron has designed a revegetation program which uses local species, has the same range of groundcover, shrubs and trees as local bush and looks "real". The program uses revegetation, particularly with native grasses, as follow-up gorse control.

Regrowth following grooming/burning was spot sprayed at 40 cm height in the spring using a backpack with Roundup® Biactive™ plus penetrant, or Quik Spray units and metsulfuron-methyl herbicide. Seedling gorse has germinated vigorously after rain and has been controlled from 20 cm height upwards by hand pulling or spot spraying with Roundup® Biactive™. Zones 1 and 2 have now had five rounds of follow-up spraying. All regrowth has been killed, and very few new seedlings are emerging.

Ron says that spot spraying with a backpack was the most efficient method for following-up seedlings. Glyphosate herbicide plus penetrant was very successful except in February 2004, when conditions were too dry and only 50% of sprayed seedlings were killed. Ron also has a tip for cutting and painting: stumps which are split with a tomahawk after cutting have a bigger surface area for herbicide uptake, which results in a better kill rate.

Gorse work on the Bertram's property has cost around $10,000 for herbicide, equipment and consumables, not including work done by the groomer. Labour input had all been in-kind, and this has cut costs dramatically. Assistance with exclusion fencing and revegetation was also provided by the Inman River Catchment Group.

The Bertrams have a busy schedule and time for follow-up is limited. They visit the site for a few hours once a week to cut and paint, and hand-pull seedlings. Zone 3 has not had any extensive work on the gorse since grooming in 2003, and will be a target in the future when resources allow for more large-scale work. Zones 1 and 2 are now free of gorse other than the occasional seedling, and pay testament to the hard work done by the Bertrams and Ron Taylor along their stretch of the Inman River.

4.9 Gorse in riparian vegetation in the Yarrowee-Leigh catchment

Jenny Sedgwick (Landcare coordinator, Leigh Catchment Group) and Jonah Gouldthorpe

Buninyong, Victoria, 700 mm rainfall

The Leigh Catchment Group has successfully integrated gorse control, revegetation and river works over 10 years at two degraded sites on the Yarrowee River.

The Yarrowee River begins near Ballarat in the Victorian Central Highlands, becoming the Leigh River as it tracks south towards Geelong. Sediment from gold mining around Ballarat built up deep deposits on the Yarrowee's banks, which became infested with dense two to three-metre-tall gorse bushes for many kilometres along the river.

Landcare and environment groups operating under the umbrella of the Leigh Catchment Group have conducted major control work on this gorse, including programs at Garibaldi Bridge and South Durham Road Bridge, by the Garibaldi Environment Group. Their stories demonstrate how to integrate mechanical, herbicide and fire control of gorse, and successfully include revegetation in follow-up.

Jenny Sedgwick, Landcare Coordinator with the Leigh Catchment Group, explained that the Group

targeted prominent sites at road crossings to get maximum exposure of their rehabilitation work. This has been a way of drawing in neighbours to volunteer on site and promoting gorse control to surrounding land owners.

The Grenville Landcare and Garibaldi Environment Groups started with a much degraded site at Garibaldi Bridge, which was "all weeds" and had an erosion problem.

The Garibaldi Environment Group plans gorse control

The Groups coordinated major earthworks to re-align and batter the eroding bank. Bare soil was planted with ryecorn. The Groups controlled gorse on the northern side of the river by cut and paint. On the southern bank the local Country Fire Authority Brigade burnt a larger infestation to reduce its mass.

Cutting and painting gorse at Garibaldi Bridge in 1997

Rehabilitated Garibaldi Bridge site after weed control, revegetation and earthworks

Follow-up work at Garibaldi Bridge has taken nearly 10 years. Volunteers put local provenance plants into "clean" sites early on, but resisted planting in gorse-infested soil until follow-up work was well underway. Jenny said that, "We don't want to create a problem with revegetation and gorse in together." Follow-up after cut and paint has included spraying with Grazon DS Herbicide or Roundup® Biactive™, depending on the area's proximity to the water. Spraying small regrowth and seedlings has been much quicker than cutting and painting. On the site that was burnt, the Group used a grader to knock down the burnt canes to get access for follow-up spraying with Grazon DS Herbicide, or Roundup® Biactive™ next to the river.

At the South Durham Road site the Leigh Catchment Group faced an impenetrable wall of gorse. They tackled this infestation with a groomer in January 2003, which cleared a lot of ground. Jenny said that, "Grooming opened up the whole area, and we could see the potential of what we were working with. It wasn't so overwhelming as coming up to this absolute hedge that was blocking us." Gorse along an old fence line which was inaccessible to the groomer was sprayed.

Regrowth and seedlings have been slow to emerge from the groomed areas and have been sprayed only twice in three years, with Grazon DS or Roundup® Biactive™, depending on their proximity to the water. The grooming revealed some clean patches of ground which

were replanted with local provenance stock immediately – 32 neighbours turned up for a field day, barbecue and planting session.

Clean areas have already been replanted with local provenance stock

The Group has avoided planting previously infested areas, as the local rule of thumb is to wait at least three years after primary control before replanting with local provenance stock. However, Jenny explained that *Poa labillardieri* (silver tussock) can be planted immediately after primary control because it competes well with gorse seedlings, can be sprayed over with selective herbicides and doesn't have to be guarded.

Jenny said that the Leigh Catchment Group has had some off-target damage to remnant trees when foliar spraying with picloram herbicide. This constituent is soil active and residual and can be taken up from the ground by trees' roots. Changing to triclopyr-only herbicides has solved this problem. Jenny also said that the Group's ability to use fire as primary control for gorse has been limited by safety issues. Despite minor problems, the Group's experience with gorse control has been very positive, and the program has acted as a great community builder, particularly where works being done on Crown land complement programs undertaken on private land.

Control costs have been shared along the Yarrowee River by land owners, lessees and the Victorian Government. Funding for gorse control on Crown land at both the Garibaldi Bridge and South Durham Road sites was through the "Good Neighbour Weed Control Program". Facilitation of gorse control on adjacent private land by the Victorian Department of Primary Industries complements the Leigh Catchment Group's work.

Future works at the Garibaldi Bridge and South Durham Road sites will involve follow-up spraying of seedlings and untreated mature gorse, blackberry and paterson's curse. There is also a lot of ground which remains to be planted with local species. The Leigh Catchment Group's ultimate aim is to connect the two sites with a four-kilometre walking track along the river, showcasing gorse-free regenerating native bush.

Cooperative gorse control

4.10 West Coast Weed and Fire Management Group

Andrew Laird (Coordinator, West Coast Weed and Fire Management Strategy, West Coast Council)

Zeehan, Tasmania, 2440 mm rainfall

Tasmania's West Coast Weed and Fire Management Group (WCWFMG) has united business, community and government representatives. It has transformed gorse control into a coordinated, inter-agency program that is implementing best practice methods.

West Coast Weed and Fire Management Group gorse control

WCWFMG has representatives from West Coast Council, Forestry Tasmania, Tasmania Parks and Wildlife Service, Department of Infrastructure Energy and Resources (Roads Department and Mineral Resources Tasmania), Department of Primary Industries and Water, Cradle Coast Natural Resource Management, Hydro Tasmania, Aurora Energy, Transend Networks, Verdanta – Copper Mines of Tasmania, Zinifex Rosebery Mine, Bluestone Mines, Henty Gold, Zeehan Landcare Group, Friends of the Wild West Coast, King River Action Group and Trial Harbour Progress Association. The Group's project officer, Andrew Laird, is hosted by the West Coast Council and works are guided by the *West Coast Weed and Fire Management Strategy.*[1] The plan was developed in consultation with stakeholders and clearly states the targets of WCWFMG and the actions necessary to achieve those targets.

Gorse control undertaken by the WCWFMG demonstrates how different organisations can share equipment, expertise and costs, and implement best practice management for excellent results against gorse.

The WCWFMG achieves best practice management of gorse by sticking to some key principles:

- Follow-up has priority over primary control
- Cooperative funding of priority projects irrespective of land tenure
- Weed mapping is regularly updated
- Contractors (or internal operators) to own or access mobile washdown units to enable cleaning of machinery and vehicles on site.

Integrated gorse control on the West Coast combines mechanical clearing, herbicides, biological control and fire. The group selects an appropriate herbicide based on site constraints. Grazon DS Herbicide can be used in areas that remain dry year round, whereas Garlon 600 is used in areas with seasonally wet ground. Roundup® Biactive™ is sprayed where there is standing water, and adjacent to streams.

David Lane, the President of Zeehan Landcare, explains that recently a tractor-mounted mulcher was hired to knock down a 4.5 hectare infestation. Excavators have also been used to grub gorse with a modified root-rake (locally known as "the claw"), or to break bushes down with the back of the bucket to avoid soil disturbance. Cut and paint is preferred along fence lines, inaccessible sites and in suburbia, using hand tools and 1:1 glyphosate in water.

A modified root rake on an excavator ("the claw") was used to grub gorse

"The take-home message is that you can defeat the weed menace confronting you if you have a clear plan, ongoing sources of funding and are prepared to follow-up, follow-up, follow-up."

David believes that on extensive infestations, foliar spraying is only really efficient for bushes or regrowth less than one metre tall. The group follows-up after clearing or cut and paint by spraying regrowth and hand-pulling or spraying seedlings. David's key points are:

- Early treatment of small infestations and follow-up of primary control are top priorities
- Once you start treating an area, NEVER, EVER stop
- Delay replanting natives until after two rounds of follow-up
- Delay replanting natives for two years after using picloram herbicides.

The Queensberry Track, in the wilderness south of Zeehan, is another West Coast gorse success story. Benjamin Hill from the Tasmania Parks and Wildlife Service (PWS) says that gorse was introduced to the track on mining equipment in the 1980s, but not controlled until 2000. Initially the gorse was sprayed with Grazon DS Herbicide, but PWS switched to cut and paint with Roundup® Biactive™ due to the proximity of the control site to Lode Creek. The first objective was to remove mature bushes along the creek to prevent seed spread, then work back along the track towards the main (Henty) road. Follow-up has been by hand-pulling and spraying seedlings. PWS plans to monitor the site until 2009 and follow-up seedlings on a regular schedule.


(Benjamin Hill)

Cut and paint was used around Lode Creek

The most spectacular campaign against gorse on the West Coast has been on the Henty Road, where there was a continuous 25 kilometre-long infestation, spreading up to 500 metres from the road. Fifteen kilometres of the infestation was mulched in the summer of 2001–02 as a primary control method, with funding provided by the Australian Goverment. Since 2002 the work has been followed-up by annual spraying. Some untreated bushes have also been sprayed. Off-target impacts in native vegetation are avoided by spraying carefully, in suitable weather conditions; good contractors are essential for this. Areas previously infested by gorse are now returning to native vegetation.

The WCWFMG has achieved its success against gorse because it plans work carefully, cooperates on priority jobs and has follow-up as its top activity. By pooling resources on priority jobs, the Group ensures that bad infestations don't miss out on control because of unclear land tenure, unclear responsibility or lack of funds. Andrew sums up the Group's philosophy like this:

"The take-home message is that you can defeat the weed menace confronting you if you have a clear plan, ongoing sources of funding and are prepared to follow-up, follow-up, follow-up."


(Andrew Laird)

David Lane demonstrates his cutting technique

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4.11 Gorse control in suburban landscapes

Ashley Hall (Land Management Officer, Golden Plains/Moorabool Shires) and Jonah Gouldthorpe

Bannockburn, Victoria, 700 mm rainfall

Ash Hall meets one-to-one with suburban land owners and tailors low cost control plans to get them into an "eradication cycle".

Suburban gorse in Golden Plains Shire

Ash works as a Land Management Officer with Golden Plains and Moorabool Shires. He promotes gorse control to residents of suburban and rural residential blocks focused around the towns of Haddon, Linton, Scarsdale and Snake Valley, south-west of Ballarat. Infestations range from lone roadside bushes to dense head-high infestations covering hectares of pasture and mullock heaps. Ash aims to deliver control programs which are suited to the individual land owner, are inexpensive and have a strong emphasis on follow-up.

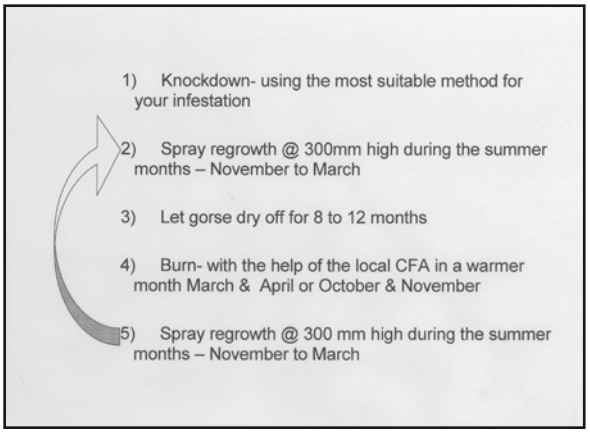
Infestations are mapped on a presence/absence basis, which is adequate for small properties. After infested properties have been identified Ash sends letters to all residents in the town (typically 200 households) informing them about the upcoming gorse program. Next, occupants of infested blocks are contacted by phone (around 20 in a town) and Ash arranges a face-to-face visit to develop a gorse control program with them.

Ash maps gorse on a presence/absence basis for small blocks

Ash encourages spraying or cut and paint of small infestations and grooming or mulching of extensive gorse. Where land owners can not afford this type of control, they are encouraged to cut their gorse and mow regrowth, which prevents flowering, until they can afford more effective treatment. Burning of green gorse is not encouraged. When a property owner is physically incapable of doing the work alone, Ash tries to involve neighbours or relatives. In all cases, he encourages people to treat outlying bushes or infestations first, then work towards the core infestation.

"Gorse is all about follow-up, and I couldn't say that enough."

Ash Hall recommends grooming of large infestations – Golden Plains gorse infestation prior to grooming



Ash Hall's "eradication cycle", which he promotes to residents – follow-up is a key part of the cycle

Same infestation after grooming

Follow-up spraying of 30 cm-tall regrowth and seedlings is done from November to March. Sprayed gorse is burnt after eight to12 months, while cut and painted gorse is piled back onto its stumps along with sticks and garden refuse to fuel a hot burn at least 12 months after primary control. Where land owners don't feel confident about burning dead gorse they can involve the local Country Fire Authority. According to Ash, native plants should not be used in follow-up revegetation for at least three years after primary control, so that the option of using selective herbicides on gorse regrowth is there for a little longer.

There are some significant constraints on promoting gorse control within town boundaries. Very few suburban residents have an Agricultural Chemical User's Permit (ACUP), so they don't have the option of using herbicides with a triclopyr component. Identifying the owners of some blocks can be difficult, as tenure is often complex in rural towns. The uncertainty about roadside weed responsibility on some Victorian roads can also make it hard to decide who has to clean up an infestation.

The work done promoting gorse control to residents in Golden Plains and Moorabool Shires has resulted in good primary control. Now, land owners need to follow up on regrowth and seedlings to consolidate that good work. As Ash said, "Gorse is all about follow-up, and I couldn't say that enough."

4.12 Leading the community in gorse control - Victorian Gorse Task Force

Sharyn Williams and Hamish Hurley (both Department of Primary Industries, Victoria)

This case study is adapted from a paper presented at the 15th Australian Weeds Conference, Adelaide, **September 2006.**

Victorian Central Highlands, 700 mm rainfall

The Victorian Government and the community have developed the "Community Weed Model", an innovative approach to weed management as the preferred approach for addressing weed management challenges.

The role of the Community Weed Model is to act as a catalyst and create enthusiasm for change. It's about participation, responsibility, cooperation, environmental care; and it's about doing something. The Community Weed Model is designed to draw the community and government agencies together to tackle a common weed problem and take advantage of a shared opportunity.

The Victorian Gorse Task Force (VGT) is a working example of the Community Weed Model, which provides a framework to engage key stakeholders in long-term gorse control programs.

The VGT was formed in 1999 as a result of community action for gorse control, driven primarily by the municipalities of the Central Highlands region and a number of local Landcare groups. The VGT membership consists of representatives from community groups, catchment management authorities (CMA), local municipalities, the Department of Primary Industries, and the Department of Sustainability and Environment.

The formation of the VGT prompted the development of the Gorse Control Strategy (GCS), which was officially launched in September 1999, after consultation with a wide cross section of the community.

The two principal goals of the strategy were to:

1. Reduce the overall extent of gorse within the GTF Area by 25% within five years
2. Reduce the extent of gorse by 15% within five years on all roadsides and waterways

These goals provided the dual objectives of reducing the overall infestation of gorse within the VGT area as well as reducing infestations in avenues of greatest spread, i.e. waterways and roadsides. The GCS comprises 10 strategies that relate to the mechanisms of changing people's attitudes towards gorse and their responsibilities for its control. They also aim towards increasing the adoption of improved land management techniques for long-term control of gorse. Further, the GCS addresses priorities established at the local level while being consistent with the regional NRM strategies and state and federal weed strategies.

The VGT's primary role is coordinating the implementation of the GCS, which has been made possible through the state and Australian Government funding sources.

The six key aspects of implementing the GCS are examples of how engagement with Community Groups, Municipal Councils and state government on a state-wide level can build partnerships, community capacity and improve overall environmental values.

They also highlight the success of integrating weed projects within other NRM programs to become precursors to landuse change.

The six key aspects to implementing the GCS are:

1. Facilitation and extension

Facilitators are employed by the VGT to provide awareness and extension activities, primarily individual property inspections with one-on-one contact. Facilitator support for community groups and landholders has been directed towards groups actively controlling gorse within specific target areas with demonstrated public benefit.

These areas are defined after planning sessions are conducted with community groups. From these sessions Gorse Control Action Plans are developed, ensuring that projects are aligned with the gorse control strategy.

Information and assistance with defining management responsibilities and preferred control techniques are provided to landholders within these target areas. Facilitators then negotiate Work Plan Agreements (WPAs) with individual landholders to ensure gorse control targets are achieved. Services are still provided to landholders outside these targeted areas but they are not as comprehensive. Information was also disseminated to the wider community through media articles, field days, information presentations and distribution of the gorse control brochure.

2. Community group incentives

The GCS highlights the need for supporting community groups and landholders who are actively controlling gorse. Grants are issued to community groups for on-ground works targeted towards roadsides and waterways with up to a 50: 50 cost share with the landholder for long term control measures such as chemical treatment or mechanical removal. The landholders must contribute at least 50% of the control costs, excluding in-kind labour.

3. Local government (Co-operative Roadside Program)

The GCS identifies gorse control on roadsides as a high priority (approximately 40% of gorse in the Ballarat region occurs on roadsides). Roadsides often contain remnant vegetation with high biodiversity values, which are threatened by invasion of gorse. The potential for long distance spread from these areas through transport on road-making and other machinery is also high. Consequently the VGT has made funding available for implementation of cooperative partnerships between the VGT, DPI, local municipalities, and individual land managers for the control of gorse on undeclared roadsides. Since the program commenced in 1999 the six municipalities within the VGT area (Ballarat City, Ararat Rural City, Golden Plains, Pyrenees, Moorabool and Hepburn Shires) have participated in the program with grants by the VGT to each municipality. A number of municipalities have also provided further financial resources from their own budgets to match the grant funding for on-ground incentives. If the municipality matches the funding for on-ground works then the original figure is doubled. Offers are made to assist landholder control gorse on their roadside on a 50:50 cost sharing basis, hence the funding is doubled again. In essence, for every dollar the VGT gives to this program there is the potential of four dollars of on-ground control works carried out.

4. Compliance

Under Victorian legalisation, land managers must take all responsible steps to prevent the spread and growth of noxious weeds on their property. Effective control of gorse through extension is only possible where there is a desire on the part of the landowner to control gorse. Unfortunately, some landowners are not willing to accept their responsibility and comply with the *Catchment and Land Protection Act 1994* (CaLP Act 1994).

The Department of Sustainability and Environment - Enhanced Enforcement Program (EEP) funding is provided to DPI to support

the extension activities conducted by the VGT facilitators. EEP resources are used for the employment of authorised officers to support community action in identified community target areas. These officers are engaged at the end of the compliance process when it is clear that education and extension activities have not succeeded. This enforcement support ensures that recalcitrant landholders don't affect the overall success of the projects. However, the low numbers of land management notices issued compared to the number of properties visited is an indication that extension activities are working and the vast majority of landholders are willing to accept their responsibilities for the control of gorse.

5. Increased public land works

An increase in community action directed towards gorse control has flowed on to public land managers. Funding sources such as the Victorian Government Good Neighbour Program (GNP) have enabled the public land management businesses i.e. Land Victoria, Forest Management and Park Victoria to significantly increase their level of gorse control works. Strategic direction provided by the VGT and facilitators has enabled improved coordination between the public and private interface, in targeted community priority areas.

6. Multiple outcome projects

Over the duration of the gorse program the VGT has been very successful in developing collaborative shared investment partnerships to deliver integrated multiple outcome projects that add value to other priority NRM projects. These projects have primarily been directed towards priority waterway rehabilitation projects and have been developed in partnership with community groups and CMA waterway offices. Together the partners have addressed weed issues as a precursor to waterway fencing and revegetation. Through the use of extension and enforcement measures (where required), the VGT and DPI have achieved 100% landholder weed control compliance along a contiguous length of waterway. This has significantly increased the capacity for private landholders to implement best practice land use change and has reduced the potential for further weed spread and invasion of clean properties in lower catchment areas.

Subsequent to the development of this case study a revised edition of the 1999 Gorse Control Strategy ws released in 2008 and is available at www.vicgorsetaskforce.com.au.

Soil seed bank research

4.13 Controlling gorse seed banks

John Moore, Libby Sandiford, Liz Austen and Grey Poulish.

Albany, Western Australia, 930 mm rainfall

Summary

Gorse has a persistent seed bank. Techniques to either kill or germinate seed were investigated. Scarification of the seed coat resulted in almost complete germination. Smoked water had little effect on intact seed and high concentrations killed scarified seed. Gorse seed tolerated soaking in many organic compounds, however two bipyridyl herbicides at approximately 100 to 125 kg a.i/ha killed seed. Low levels of microwave radiation increased germination and high levels killed seed. Solarisation did not give adequate control. Gorse seed germinated over a range of temperatures from 14 to 24°C and appeared to have a bimodal optimum.

Nearly all the seed is in the top 20 cm of soil and occurs within a few metres of the parent plant. Seed will not establish from more than 10 cm deep, so burial of isolated patches is a possible control technique.

Methods

Gorse seed was collected from mature pods around Albany, Western Australia, removed from pods and treated. After treatment, seed was placed in the dark in a germination cabinet at 15 to 19°C. Treatments are summarised in Table 1.

Table 1. Treatment methods

Treatment	Method
Smoked water	Seeds soaked in six different smoked water solutions.
Hydrocarbons	Seeds wetted with a 5% solution of 53 different products.
Temperature	Seeds placed on a temperature plate with gradient from 13 to 26^0C.
Microwave radiation	Seeds were either soaked in water or left dry then microwaved in an 800W oven
Solarisation	Seeds mixed with soil, covered with polythene sheeting and exposed to sunlight.
Scarification	Part of the seed coat was removed with a scalpel.
Seed bank depth	Soil cores were layered off at 1, 2 or 5 cm intervals then sorted by hand.
Seed bank spread	Soil samples taken from 0 to 20 m from the canopy edge then sorted by hand.
Germination depth	Scarified seed sown at 0, 1, 2, 5, 8 and 10 cm depths in 11.5 cm-deep pots.

Results from the experiments are summarised in Table 2.

Table 2. Treatment results

Treatment	Results
Smoked water	No effect on intact seed
Hydrocarbons	Reglone® (diquat 200 g L^{-1}) and Spray.Seed® (diquat 200 g L^{-1} plus paraquat 135 g L^{-1}) killed all seed treated with a 5% solution. Five compounds reduced viability by more than 60%
Temperature	Peak germination at 15.9 and 19.3°C.
Microwave radiation	High doses killed seed. Low levels killed scarified and soaked seed only.
Solarisation	Surface temperatures up to 20°C higher than on uncovered soil achieved. At least 100°C required to sterilise seed.
Scarification	Over 80% germination of scarified seed compared to 20% germination of intact seed.
Seed bank depth	78% of seed in top 2 cm of soil on unburnt sites. Seed found up to 20 cm below soil surface.
Seed bank spread	Most seed found under canopy. 99% of seed less than 3 m from canopy edge. No seed further than 7 m from canopy edge.
Germination depth	Maximum recruitment from 1 cm depth. No recruitment from below 5 cm depth.

Conclusions

Gorse seed is proving to be very resilient against a range of control techniques applied by us and others around the world. Scarification of the seed coat is effective for stimulating germination and further research into practical methods of achieving effective scarification by mechanical, chemical or biological methods is warranted. The occurrence of gorse in difficult geographic locations makes the use of biological and chemical methods particularly attractive. The effects of bipyridyl herbicides provide the most promise of a new solution.

Further research is required to determine if effective seed control techniques can be developed because it will be difficult to deliver the herbicide to the site of the seed in the field.

Investigation of biological agents including micro-organisms that attack the seed coat, especially in soil-borne seed, is warranted. Burial of seed should be useful in some situations and could be incorporated into best practice procedures for councils and contractors that are required to conduct earthworks in infested areas. The top 20 cm of soil could be stockpiled, then the relevant works conducted and the top soil returned to positions where it would be covered by at least 10 cm of clean soil. Field trials are underway to determine the practicality of these measures. Solarisation and microwave treatments would appear to be less likely contenders for successful techniques. Smoked water and many other organic compounds appear to be limited in their usefulness, probably because the impermeable seed coat provides robust protection from outside agents in natural as well as artificial environments.

Acknowledgments

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This case study is adapted from a paper presented at the 15th Australian Weeds Conference, Adelaide, 25 to 28 September 2006.

Further information

CHAPTER 5

Chapter 5
Further information

5.1 Legal status and responsibilities

Western Australia
Gorse is a declared plant under the *Agricultural and Related Resource Protection Act 1976*. It is declared P1 for the entire state (sale or movement prohibited), P2 for most districts (destroy all plants, prevent spread) and P3 for Albany, Cranbrook, Denmark and Plantagenet (destroy all infestations of <10 plants or <2 ha).

South Australia
Gorse is a declared plant under the *Natural Resources Management Act 2004,* and must be controlled throughout the state.

Victoria
Gorse is declared under the *Catchment and Land Protection Act 1994* as a "Regionally Prohibited Weed" in West Gippsland and East Gippsland. Land owners, including public authorities responsible for Crown land management, must eradicate or control gorse on their lands. Private landholders are responsible for control on private land but not on roadsides adjoining their property, which are the responsibility of VicRoads, municipalities or the Department of Sustainability and Environment (DSE), depending on the class of the road. Gorse is declared as a "Regionally Controlled Weed" in all other regions except for Mallee. Landowners have the responsibility to take all reasonable steps to control and prevent its spread and growth on their land and the roadsides that adjoin their land. Certain roadsides are exempt. Contact a local DSE or DPI office for further advice.

ACT
Gorse is a declared pest plant under the *Pest Plants and Animals Act 2005*; it must be suppressed and its propagation or supply is prohibited.

NSW
Gorse is declared a noxious weed for the purposes of the *Noxious Weeds Act 1993*. Gorse is designated in control class 2 (must be eradicated from the land and land must be kept free of the plant) for Armidale Dumareq, Bega Valley, Eurobodalla, Glen Innes, Guyra, Severn and New England Tablelands, Uralla and Walcha. It is designated control class 3 (must be fully and continuously suppressed and destroyed) for 21 other Local Control Authority areas.

Queensland
Gorse is declared a Class 1 pest under the *Land Protection (Pest and Stock Route Management) Act 2002*. Land managers are required to keep their land free of gorse. It is an offence to introduce, keep or sell Class 1 plants without a permit.

Northern Territory
Gorse is declared a Class A/C weed (to be eradicated/not to be introduced) in all of the Territory.

Tasmania
Gorse is declared under the *Weed Management Act 1999*, which prohibits importation/sale and delineates "Zone A" municipalities (Dorset, Flinders, King Island, Sorell, Tasman and Waratah/Wynyard) for eradication and reporting of new infestations. In "Zone B" (all other municipalities) the requirement is for containment of gorse.

5.2 Responsibility for gorse control on roadsides

This varies from state to state.

Western Australia
Weed control on main roads is a state government responsibility, while control on secondary roads lies with local government.

South Australia
Control of roadside gorse is the responsibility of the relevant Natural Resource Management Board, with adjoining land owners accountable for the costs of control.

Victoria
Responsibility for roadside gorse control varies depending on the type of road. The situation is summarised below.

Responsibility for roadside gorse control in Victoria (from[1])

Category	Regionally prohibited	Regionally controlled
Type of road	**Responsibility**	**Responsibility**
Freeways	VicRoads	VicRoads
Highways	VicRoads	VicRoads
Main roads	Municipality (as VicRoads agent)	Municipality (as VicRoads agent)
Undeclared roads	DSE	Adjoining land-holder*
Unused roads	Adjoining land-holder*	Adjoining land-holder*

* Except where exempt under Section 20 subsection 3 of the Act. The legal interpretation of these exemptions under Section 20 subsection 3 of the CaLP Act is currently being investigated. Please contact DSE or DPI for further advice (phone 13 61 86).

ACT
Territory and Municipal Services. are responsible for gorse control.

NSW
Roadside gorse control is the responsibility of councils on most roads and the RTA manages gorse along freeways and motorways.

Tasmania
Responsibility for gorse control on roadsides resides with the state government (through the Department of Infrastructure, Energy and Resources) on state roads and with local government on other roads.

5.3 Distinguishing between gorse and other prickly plants

(Table adapted from [2])

	Leaves	Spines	Flowers	Pods	Form of plant
Gorse *Ulex europaeus*	Leaves 6 to 30 mm x 1.5 mm; sharp-pointed	Spines to 50 mm long grey-green, hairy; all branches end in a spine	Bright yellow; Pea flower 15 to 25 mm long; "coconut-like" smell	10 to 20 mm long; black or dark brown; covered by dense, fine hairs	Multi-stemmed bush to 7 m
Some wattles *Acacia* species	Leaves 8 to 25 mm x 1 to 3 mm: sharp-pointed	None	Cream, to yellow; cylindrical head, up to 25 mm long or "ball" less than 10 mm across	25 to 90 mm long; green, brown, purple or black; hairless	Low spreading shrubs to small trees
Prickly box *Bursaria spinosa*	Leaves 10 to 50 mm long; not sharp-pointed	Small branches forming grey/ brown spines	White; 10 mm across	Flat pods; 5 to 8 mm long	Upright shrub to small tree
Some bitterpeas *Daviesia* species	Narrow; 6 to 35 mm long; sharp-pointed	Green; all branches end in a spine	Orange and yellow; pea flower 10 mm long	Triangular pod; 10 mm long	Small shrub
Spiky anchorplant *Discaria pubescens*	10 mm long; not sharp-pointed	In opposite pairs along the branches	White; 5 mm long	3-lobed capsule; 5 mm long	Small shrub
Some needlebushes *Hakea* species	To 60 mm long; sharp-pointed	None	Tubular; cream/ white; 10 to 20 mm long	heavy woody pod capsule; winged seeds	Small to medium shrub
Spiky violetbush *Melicytus dentatus*	Leaves 6 to 30 mm long; not sharp-pointed	Brown or grey spines	Pale yellow; to 10 mm long	Berry 4 to 5 mm across	Small to medium shrub
Geebung *Persoonia juniperina*	Leaves 10 to 30 mm long; sharp-pointed	None	Bright yellow; 8 to 10 mm long	Green/purple; 10 mm long	Small shrub
Some bushpeas *Pultenea* species	Leaves 8 to 20 mm long; sharp-pointed	None	Orange or yellow with purple/ brown markings; pea flower 5 to 12 mm long	8 to 10 mm long	Small to medium shrub

For photos of these species go to: www.understorey-network.org.au > Plant Database

5.4 Registered herbicides

Herbicides registered for gorse control in Australia[3]

(As at 21 July 2009; herbicides are sorted alphabetically by active constituent(s) then by product name)

PRODUCT NAME	ACTIVE CONSTITUENTS
ALLFIRE RICOCHET HERBICIDE	2,4-D AS THE TRIISOPROPANOLAMINE SALT / PICLORAM AS THE TRIISOPROPANOLAMINE SALT
AW PULVERISE HERBICIDE	2,4-D AS THE TRIISOPROPANOLAMINE SALT / PICLORAM AS THE TRIISOPROPANOLAMINE SALT
CHEMAG COMMANDER 75-D HERBICIDE	2,4-D AS THE TRIISOPROPANOLAMINE SALT / PICLORAM AS THE TRIISOPROPANOLAMINE SALT
IMTRADE COMMANDER 75-D HERBICIDE	2,4-D AS THE TRIISOPROPANOLAMINE SALT / PICLORAM AS THE TRIISOPROPANOLAMINE SALT
NUFARM TROOPER 75-D HERBICIDE	2,4-D AS THE TRIISOPROPANOLAMINE SALT / PICLORAM AS THE TRIISOPROPANOLAMINE SALT
TORDON 75-D HERBICIDE	2,4-D AS THE TRIISOPROPANOLAMINE SALT / PICLORAM AS THE TRIISOPROPANOLAMINE SALT
TOWELUP 2,4-D HERBICIDE	2,4-D AS THE TRIISOPROPANOLAMINE SALT / PICLORAM AS THE TRIISOPROPANOLAMINE SALT
GRAZON EXTRA HERBICIDE	AMINOPYRALID PRESENT AS HEXYLOXYPROPYLAMINE SALT / PICLORAM PRESENT AS THE HEXYLOXYPROPYLAMINE SALT / TRICLOPYR PRESENT AS THE BUTOXYETHYL ESTER
AW AGGRAV8 HERBICIDE	AMITROLE / AMMONIUM THIOCYANATE
CHEMAG AMITROLE T HERBICIDE	AMITROLE / AMMONIUM THIOCYANATE
CYNDAN WEEDEATH HERBICIDE	AMITROLE / AMMONIUM THIOCYANATE
NUFARM AMITROLE T HERBICIDE	AMITROLE / AMMONIUM THIOCYANATE
GENEREX GLYDRY 700 HERBICIDE	GLYPHOSATE MONO-AMMONIUM SALT
NUFARM CREDIT BROADHECTARE HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE AND MONO-AMMONIUM SALTS
NUFARM CREDIT DUO DUAL SALT TECHNOLOGY HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE AND MONO-AMMONIUM SALTS
NUFARM WEEDMASTER DUO DUAL SALT TECHNOLOGY HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE AND MONO-AMMONIUM SALTS
NUTURF RAZOR HERBICIDE DUAL SALT TECHNOLOGY	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE AND MONO-AMMONIUM SALTS
4FARMERS GLYPHOSATE 360 HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
AGRONICA POLARIS 360 HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
AUS-GOOD CLEANUP 360 GLYPHOSATE HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
BANISH 360 WEED KILLER	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
BAYER GLYPHOSATE 450 HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
BIOCHOICE 360 HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
BIO-SMART 360 HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
BIOTIS GLYPHOSATE 360 HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
CENTURION HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
CONQUEST SQUAREDOWN 360 HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
COUNTRY GLYPHOSATE 360 HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
CROP CARE GLADIATOR HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
ECHEM GLYPHOSATE 360 HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
ECOMAX HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
FARMOZ WIPE OUT 450 NON RESIDUAL HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
FARMOZ WIPE-OUT 360 NON-RESIDUAL HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
FARMOZ WIPE-OUT BIO HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
FARMOZ WIPE-OUT CT ELITE BROADACRE HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
GENEREX GLYPHOSATE 360L	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
GENEREX GLYPHOSATE 450L	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
GENFARM PANZER 360 HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
GLISTER 360 HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
GLYCEL 360 HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
GLYFOS CLASSIC 450 HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
GLYFOS ENVISION HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
GLYPHOKILL 360 HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
GRASS VALLEY GLYPHOSATE 360 HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
GROW GREEN GLYPHOSATE 360 HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
GULLF AG CLEARUP BIO 360 HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
HALLEY GLYPHOSATE 360 HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
HEXTAR GLYPHOSATE 360 HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
KENDON KNOCKOUT 360 HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
KENSO AGCARE KEN-UP AQUATIC 360 HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
KEN-UP HERBICIDE BY KENSO	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
KLIN-UP 360 BIAQUATIC HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT

MACSPRED GLYMAC 360 HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
NIHIL NON SELECTIVE HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
NUFARM GLYPHOSATE 360 HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
OSPRAY GLYPHOSATE 360 HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
OZTEC GLYPHOSATE 360 NON SELECTIVE HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
PESTMASTER AQUA-TECH GLYPHOSATE 360 HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
RICHGRO GLYPHOSATE 360 HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
RIPPER 480 HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
ROUNDUP BIACTIVE HERBICIDE BY MONSANTO	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
ROUNDUP HERBICIDE BY MONSANTO	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
RYGEL CLEARUP BIO 360 HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
SANOS 360 NON SELECTIVE HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
SET-UP BIAQUATIC 360 HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
SHOOT 360 HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
SPALDING GLYPOSATE 360 HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
SUPERWAY GLYPHOSATE 360 HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
SUREFIRE GLYPHOSATE 360 HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
TITAN GLYPHOSATE 360 HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
TITAN GLYPHOSATE 450 HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
TOUCHDOWN 360 HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
TURF CULTURE KERMIT GLYPHOSATE HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
GLISTER 680WG HERBICIDE	GLYPHOSATE PRESENT AS THE MONO-AMMONIUM SALT
GULLF AG CLEARUP 700 BIO-DRI HERBICIDE	GLYPHOSATE PRESENT AS THE MONO-AMMONIUM SALT
KENSO AGCARE KEN-UP DRY 680 WG HERBICIDE	GLYPHOSATE PRESENT AS THE MONO-AMMONIUM SALT
KLIN-UP DRY 680 HERBICIDE	GLYPHOSATE PRESENT AS THE MONO-AMMONIUM SALT
MACPHERSONS GLYPHOSATE 700 DRI-FLO HERBICIDE	GLYPHOSATE PRESENT AS THE MONO-AMMONIUM SALT
MACPHERSONS GLYPHOSATE 700 SOLUBLE GRANULAR HERBICIDE	GLYPHOSATE PRESENT AS THE MONO-AMMONIUM SALT
MACPHERSONS GLYPHOSATE BI-DRI HERBICIDE	GLYPHOSATE PRESENT AS THE MONO-AMMONIUM SALT
MACPHERSONS GLYPHOSATE HI-LIGHT BLUE HERBICIDE	GLYPHOSATE PRESENT AS THE MONO-AMMONIUM SALT
MACSPRED GLYMAC DRI 700 HERBICIDE	GLYPHOSATE PRESENT AS THE MONO-AMMONIUM SALT
MACSPRED GLYPHOSATE BI DRI HERBICIDE	GLYPHOSATE PRESENT AS THE MONO-AMMONIUM SALT
ROUNDUP DRY HERBICIDE BY MONSANTO	GLYPHOSATE PRESENT AS THE MONO-AMMONIUM SALT
ROUNDUP READY HERBICIDE BY MONSANTO	GLYPHOSATE PRESENT AS THE MONO-AMMONIUM SALT
ROUNDUP READY HERBICIDE WITH PLANTSHIELD BY MONSANTO	GLYPHOSATE PRESENT AS THE MONO-AMMONIUM SALT
RYGEL CLEARUP 700 BIO-DRI HERBICIDE	GLYPHOSATE PRESENT AS THE MONO-AMMONIUM SALT
SET-UP DRY 680 HERBICIDE	GLYPHOSATE PRESENT AS THE MONO-AMMONIUM SALT
TITAN GLYPHOSATE 700SG HERBICIDE	GLYPHOSATE PRESENT AS THE MONO-AMMONIUM SALT
WHITESTAR DRI GLYPHOSATE 700 HERBICIDE	GLYPHOSATE PRESENT AS THE MONO-AMMONIUM SALT
DUPONT CUT-OUT BRUSH CONTROLLER	GLYPHOSATE PRESENT AS THE MONO-AMMONIUM SALT / METSULFURON-METHYL
RE-NU BRUSH CONTROL HERBICIDE	GLYPHOSATE PRESENT AS THE MONO-AMMONIUM SALT / METSULFURON-METHYL
TROUNCE BRUSH-PACK HERBICIDE BY MONSANTO	GLYPHOSATE PRESENT AS THE MONO-AMMONIUM SALT / METSULFURON-METHYL
CHEMAG ERADICATOR 510 HERBICIDE	GLYPHOSATE PRESENT AS THE MONOETHANOLAMINE SALT
CHEMAG REBELLION 450 HERBICIDE	GLYPHOSATE PRESENT AS THE MONOETHANOLAMINE SALT
FARMOZ WIPE-OUT PLUS HERBICIDE	GLYPHOSATE PRESENT AS THE MONOETHANOLAMINE SALT
ROUNDUP MAX HERBICIDE BY MONSANTO	GLYPHOSATE PRESENT AS THE MONOETHANOLAMINE SALT
BIOTIS HI-LOAD HERBICIDE	GLYPHOSATE PRESENT AS THE POTASSIUM SALT
COUNTRY GLYPHOSATE 540 HERBICIDE	GLYPHOSATE PRESENT AS THE POTASSIUM SALT
FIREBOLT HERBICIDE	GLYPHOSATE PRESENT AS THE POTASSIUM SALT
GLADIATOR OPTIMAX HERBICIDE	GLYPHOSATE PRESENT AS THE POTASSIUM SALT
IMTRADE TYRANUS 450 HERBICIDE	GLYPHOSATE PRESENT AS THE POTASSIUM SALT
RHODIA GLYPHOSATE POTASSIUM EXPRESS HERBICIDE	GLYPHOSATE PRESENT AS THE POTASSIUM SALT
RHODIA GLYPHOSATE POTASSIUM HIGH LOAD HERBICIDE	GLYPHOSATE PRESENT AS THE POTASSIUM SALT
ROUNDUP POWER MAX HERBICIDE BY MONSANTO	GLYPHOSATE PRESENT AS THE POTASSIUM SALT
RYGEL CLEARUP IMPRESS 540 HERBICIDE	GLYPHOSATE PRESENT AS THE POTASSIUM SALT

TOUCHDOWN HITECH HERBICIDE	GLYPHOSATE PRESENT AS THE POTASSIUM SALT
ACCURATE 600 WG HERBICIDE	METSULFURON-METHYL
AGRICROP BRUSH KING 600 HERBICIDE	METSULFURON-METHYL
APS METSULFURON WATER DISPERSIBLE GRANULE HERBICIDE	METSULFURON-METHYL
ARM METSULFURON HERBICIDE	METSULFURON-METHYL
AW MILITIA 600 WG HERBICIDE	METSULFURON-METHYL
CHEMAG METSULFURON WG HERBICIDE	METSULFURON-METHYL
CHEMFORCE METSULFURON 600WG HERBICIDE	METSULFURON-METHYL
CONQUEST METSULFURON 600 WG HERBICIDE	METSULFURON-METHYL
DUPONT BRUSH-OFF BRUSH CONTROLLER	METSULFURON-METHYL
DUPONT CIMARRON HERBICIDE	METSULFURON-METHYL
DUPONT SAVANNAH HERBICIDE	METSULFURON-METHYL
ECHEM METSULFURON-METHYL WG HERBICIDE	METSULFURON-METHYL
ESTEEM WDG SELECTIVE HERBICIDE	METSULFURON-METHYL
FARMOZ BUSHWACKER BRUSH CONTROL HERBICIDE	METSULFURON-METHYL
FARMOZ BUSHWACKER WG HERBICIDE	METSULFURON-METHYL
FARMOZ LYNX WG HERBICIDE	METSULFURON-METHYL
GENEREX METSULFURON	METSULFURON-METHYL
GENFARM METSULFURON 600 WG HERBICIDE	METSULFURON-METHYL
INNOVA METSULFURON 600 HERBICIDE	METSULFURON-METHYL
KEN-MET 600 WATER DISPERSIBLE GRANULE HERBICIDE	METSULFURON-METHYL
MACSPRED METMAC 600 HERBICIDE	METSULFURON-METHYL
METSUN 600 HERBICIDE	METSULFURON-METHYL
METSY 200 WG HERBICIDE	METSULFURON-METHYL
NUFARM ASSOCIATE HERBICIDE	METSULFURON-METHYL
OSPRAY METSULFURON 600WG HERBICIDE	METSULFURON-METHYL
OZCHEM WOODY WEED SPRAY HERBICIDE	METSULFURON-METHYL
PARTI-SAN 600 HERBICIDE BY SANONDA	METSULFURON-METHYL
RAINBOWGREEN METSULFURON BRUSH CONTROL HERBICIDE	METSULFURON-METHYL
RYGEL BRUSHMASTER HERBICIDE	METSULFURON-METHYL
RYGEL METSULFURON 600 WG HERBICIDE	METSULFURON-METHYL
S U METSULFURON 600 HERBICIDE	METSULFURON-METHYL
SELECTIVE HERBICIDE AIM WDG	METSULFURON-METHYL
SUMMIT SUM-MET DF HERBICIDE	METSULFURON-METHYL
TITAN METSULFURON 600 WG HERBICIDE	METSULFURON-METHYL
TWO-WAY 600 WG HERBICIDE	METSULFURON-METHYL
UNITED FARMERS METSULFURON METHYL 600 HERBICIDE	METSULFURON-METHYL
UNITED FARMERS METSULFURON WG HERBICIDE	METSULFURON-METHYL
WHITESTAR METSULFURON 600WG HERBICIDE	METSULFURON-METHYL
WSD METSULFURON HERBICIDE	METSULFURON-METHYL
TORDON DOUBLE STRENGTH HERBICIDE	PICLORAM AS THE TRIISOPROPANOLAMINE SALT / TRICLOPYR AS THE TRIETHYLAMINE SALT
GENFARM TRICLOPYR/PIC HERBICIDE	PICLORAM HEXYLOXYPROPYLAMINE SALT / TRICLOPYR PRESENT AS THE BUTOXYETHYL ESTER
TORDON GEL HERBICIDE	PICLORAM POTASSIUM SALT
GALLOP HERBICIDE	PICLORAM PRESENT AS THE HEXYLOXYPROPYLAMINE SALT / TRICLOPYR BUTOXYETHYL ESTER
CONQUEST HATCHET HERBICIDE	PICLORAM PRESENT AS THE HEXYLOXYPROPYLAMINE SALT / TRICLOPYR PRESENT AS THE BUTOXYETHANOL ESTER
4FARMERS TRI-PICK HERBICIDE	PICLORAM PRESENT AS THE HEXYLOXYPROPYLAMINE SALT / TRICLOPYR PRESENT AS THE BUTOXYETHYL ESTER
ALLGRAZE SELECTIVE HERBICIDE	PICLORAM PRESENT AS THE HEXYLOXYPROPYLAMINE SALT / TRICLOPYR PRESENT AS THE BUTOXYETHYL ESTER
AW WOODY HERBICIDE	PICLORAM PRESENT AS THE HEXYLOXYPROPYLAMINE SALT / TRICLOPYR PRESENT AS THE BUTOXYETHYL ESTER
COUNTRY PICLORAM/TRICLOPYR HERBICIDE	PICLORAM PRESENT AS THE HEXYLOXYPROPYLAMINE SALT / TRICLOPYR PRESENT AS THE BUTOXYETHYL ESTER
FARMOZ FIGHTBACK HERBICIDE	PICLORAM PRESENT AS THE HEXYLOXYPROPYLAMINE SALT / TRICLOPYR PRESENT AS THE BUTOXYETHYL ESTER

GENEREX TRICHLORAM HERBICIDE	PICLORAM PRESENT AS THE HEXYLOXYPROPYLAMINE SALT / TRICLOPYR PRESENT AS THE BUTOXYETHYL ESTER
GRASS-UP HERBICIDE	PICLORAM PRESENT AS THE HEXYLOXYPROPYLAMINE SALT / TRICLOPYR PRESENT AS THE BUTOXYETHYL ESTER
GRAZON DS HERBICIDE	PICLORAM PRESENT AS THE HEXYLOXYPROPYLAMINE SALT / TRICLOPYR PRESENT AS THE BUTOXYETHYL ESTER
HALLEY TRICLOZON HERBICIDE	PICLORAM PRESENT AS THE HEXYLOXYPROPYLAMINE SALT / TRICLOPYR PRESENT AS THE BUTOXYETHYL ESTER
INNOVA PICLORAM + TRICLOPYR 400 HERBICIDE	PICLORAM PRESENT AS THE HEXYLOXYPROPYLAMINE SALT / TRICLOPYR PRESENT AS THE BUTOXYETHYL ESTER
KENSO AGCARE KEN-ZON HERBICIDE	PICLORAM PRESENT AS THE HEXYLOXYPROPYLAMINE SALT / TRICLOPYR PRESENT AS THE BUTOXYETHYL ESTER
MACSPRED CLEARMAC DS BRUSH HERBICIDE	PICLORAM PRESENT AS THE HEXYLOXYPROPYLAMINE SALT / TRICLOPYR PRESENT AS THE BUTOXYETHYL ESTER
NUFARM CONQUEROR HERBICIDE	PICLORAM PRESENT AS THE HEXYLOXYPROPYLAMINE SALT / TRICLOPYR PRESENT AS THE BUTOXYETHYL ESTER
OSPRAY PICKOUT HERBICIDE	PICLORAM PRESENT AS THE HEXYLOXYPROPYLAMINE SALT / TRICLOPYR PRESENT AS THE BUTOXYETHYL ESTER
PICKER HERBICIDE	PICLORAM PRESENT AS THE HEXYLOXYPROPYLAMINE SALT / TRICLOPYR PRESENT AS THE BUTOXYETHYL ESTER
SUPERWAY TRI-PIC HERBICIDE	PICLORAM PRESENT AS THE HEXYLOXYPROPYLAMINE SALT / TRICLOPYR PRESENT AS THE BUTOXYETHYL ESTER
TITAN PICLORAM + TRICLOPYR 400 HERBICIDE	PICLORAM PRESENT AS THE HEXYLOXYPROPYLAMINE SALT / TRICLOPYR PRESENT AS THE BUTOXYETHYL ESTER
TOKEN HERBICIDE	PICLORAM PRESENT AS THE HEXYLOXYPROPYLAMINE SALT / TRICLOPYR PRESENT AS THE BUTOXYETHYL ESTER
VIGILANT HERBICIDE GEL	PICLORAM PRESENT AS THE POTASSIUM SALT
TRICLON 600 HERBICIDE	TRICLOPYR PRESENT AS THE BUTOXYETHANOL ESTER
4FARMERS TRICLOPYR 600 HERBICIDE	TRICLOPYR PRESENT AS THE BUTOXYETHYL ESTER
AGROREG TRICLOPYR 600 EC HERBICIDE	TRICLOPYR PRESENT AS THE BUTOXYETHYL ESTER
ALLFIRE TRICLOPYR 600 HERBICIDE	TRICLOPYR PRESENT AS THE BUTOXYETHYL ESTER
AMGROW CHEMSPRAY WEED CONTROL TREE & BLACK-BERRY KILLER	TRICLOPYR PRESENT AS THE BUTOXYETHYL ESTER
AW TRICLOPYR 600 HERBICIDE	TRICLOPYR PRESENT AS THE BUTOXYETHYL ESTER
BIOSORB 600 HERBICIDE	TRICLOPYR PRESENT AS THE BUTOXYETHYL ESTER
CHEMFORCE TRICLOPYR 600 HERBICIDE	TRICLOPYR PRESENT AS THE BUTOXYETHYL ESTER
CONQUEST MACA 600 HERBICIDE	TRICLOPYR PRESENT AS THE BUTOXYETHYL ESTER
CROP CARE GRANDO 600 HERBICIDE	TRICLOPYR PRESENT AS THE BUTOXYETHYL ESTER
FARMOZ SAFARI 600EC HERBICIDE	TRICLOPYR PRESENT AS THE BUTOXYETHYL ESTER
GARLON 600 HERBICIDE	TRICLOPYR PRESENT AS THE BUTOXYETHYL ESTER
GENEREX TRICLOPYR 600 HERBICIDE	TRICLOPYR PRESENT AS THE BUTOXYETHYL ESTER
GENFARM TRIDENT 600 HERBICIDE	TRICLOPYR PRESENT AS THE BUTOXYETHYL ESTER
HALLEY TRICLOPYR 600 HERBICIDE	TRICLOPYR PRESENT AS THE BUTOXYETHYL ESTER
HURRICANE 600 HERBICIDE	TRICLOPYR PRESENT AS THE BUTOXYETHYL ESTER
IMTRADE HURRICANE 600 HERBICIDE	TRICLOPYR PRESENT AS THE BUTOXYETHYL ESTER
INNOVA TRICLOPYR 600 HERBICIDE	TRICLOPYR PRESENT AS THE BUTOXYETHYL ESTER
KENSO AGCARE TRICLOPYR 600 HERBICIDE	TRICLOPYR PRESENT AS THE BUTOXYETHYL ESTER
MELON 600 HERBICIDE	TRICLOPYR PRESENT AS THE BUTOXYETHYL ESTER
NUFARM INVADER 600 HERBICIDE	TRICLOPYR PRESENT AS THE BUTOXYETHYL ESTER
OSPRAY TRICLOPYR 600 HERBICIDE	TRICLOPYR PRESENT AS THE BUTOXYETHYL ESTER
REDEEM 600 HERBICIDE	TRICLOPYR PRESENT AS THE BUTOXYETHYL ESTER
RYGEL TRICLOPYR 600 HERBICIDE	TRICLOPYR PRESENT AS THE BUTOXYETHYL ESTER
SMART TRICLOPYR 600 HERBICIDE	TRICLOPYR PRESENT AS THE BUTOXYETHYL ESTER
SUPERWAY TRICLOPYR 600 HERBICIDE	TRICLOPYR PRESENT AS THE BUTOXYETHYL ESTER
TITAN TRICLOPYR 600 HERBICIDE	TRICLOPYR PRESENT AS THE BUTOXYETHYL ESTER
UNI-LON 600 HERBICIDE	TRICLOPYR PRESENT AS THE BUTOXYETHYL ESTER
UNITED FARMERS TRICLOPYR 600 HERBICIDE	TRICLOPYR PRESENT AS THE BUTOXYETHYL ESTER
WEEDPRO TRYCLOPS 600 HERBICIDE	TRICLOPYR PRESENT AS THE BUTOXYETHYL ESTER

5.5 Off-label and minor use permits

Off-label and minor use permits for some herbicides have been issued for some states.

Search for off-label permits through the Australian Pesticides and Veterinary Medicines Authority (APVMA): Website: www.apvma.gov.au > SEARCH for permits

Permit numbers for the states are as follows:

State	Permit number
Western Australia	9655
South Australia	7869
South Australia	8865
Australian Capital Territory	9460
New South Wales	8219
New South Wales	8783
New South Wales	9158
Tasmania	8949

5.6 Chemical certification

Chemical users in NSW , ACT and Tasmania need certification to apply herbicides in a commercial situation. In Victoria, users of chemicals with a triclopyr component need certification to apply those herbicides. For more information about certification in these states, use the following web addresses or phone numbers:

New South Wales Environment Protection Authority:
Website: www.environment.nsw.gov.au > Environmental Issues > Chemicals and pesticides > Training Training Phone: 131 555 and ask to speak to a pesticides officer

Victoria's Department of Primary Industries:
Website: www.dpi.vic.gov.au > Agriculture> General farming > Chemical use > Application Forms Phone: 136 186

Tasmania's Department of Primary Industries and Water:
Website: www.dpiw.tas.gov.au > Food & Agriculture > Agricultural & Veterinary Chemicals > Licences & Certificates
Phone 1300 368 550

5.7 Weather for spraying/avoiding spray drift

Before you spray with herbicides it is important to understand the best weather conditions for spraying and to take steps to avoid spray drift. Useful information can be found through these organisations:

Australian Bureau of Meteorology:
Website: www.bom.gov.au > Learn About Meteorology > search 'P' in the topics list > Pesticide Spraying, Weather for
Phone: (03) 9669 4000

NSW Department of Primary Industries:
Website: www.dpi.nsw.gov.au/agriculture > Farm management > Farm chemicals > Reducing herbicide spray drift Phone: (02) 6391 3100

5.8 Guidelines for using herbicides in riparian zones

It is important to consider the risks associated with the use of herbicides in and around riparian and aquatic zones. Information on this subject is provided by the Cooperative Research Centre for Australian Weed Management:
Website: www.weedscrc.org.au > Publications > Factsheets and Guidelines > herbicides: guidelines for use in and around water
Phone: (08) 8303 6590

Also useful is: http://www.weedscrc.org.au > Publications > Weed Management Guides > habitat management guides > Riparian Weed management in riparian areas: south-eastern Australia

5.9 Regulations and permits for works in riparian zones

Some states and territories have regulations or require permits for work undertaken in riparian zones. Contact details for Victorian and NSW Catchment Management Authorities are listed here.

In Victoria, search the internet to find your area's Catchment Management Authority:

For example: www.glenelg-hopkins.vic.gov.au > About Us > Waterways > Waterway Management

Or: www.necma.vic.gov.au > Rescource Guide > Works on Waterways

Or: www.nccma.vic.gov.au > NCCMA Functions > North Central RCS > Works on Waterways Permits

NSW guidelines can be found at:
website: www.nativevegetation.nsw.gov.au > State Protected Land > Guideline for the clearing of Exotic Trees and Dead Native Trees on State Protected Land

5.10 State and regional contacts for gorse information

For more information about gorse control in your state, contact the relevant agency:

State	Telephone number	Internet
Western Australia	08 9368 3333	www.agric.wa.gov.au
South Australia	08 8303 9620	www.dwlbc.sa.gov.au
Victoria	13 61 86	www.dpi.vic.gov.au
Australian Capital Territory	13 22 81	www.tams.act.gov.au/live/environment
New South Wales	Your local council or shire	
Tasmania	1300 368 550	www.dpiw.tas.gov.au

5.11 National Mapping

Accurate mapping of gorse distribution is a vital part of nationally strategic best practice management. To facilitate this, the Bureau of Rural Sciences' new *A field guide for surveying and mapping nationally significant weed* is enclosed as a CD in the rear cover and will give government and community land managers in all states the tools they need to map gorse consistently.

Below is the agreed Weeds of National Significance (WoNS) mandatory and optional core attributes (from the above-mentioned field manual [4])

5.12 WoNS Core Attributes for mapping gorse from enclosed CD 'A Field Manual for Surveying & Mapping Nationally Significant Weeds'

	Attribute	Description
1	Data record	Unique identifier for the site record. Allocated and maintained by the data custodian
2	Name of weed	Common name, genus, species, sub-species, variety, hybrid. Any uncertainty on naming recorded in the 'comments' field
3	Day/month/year	Collection/observation date or the date the survey commenced. Prefer DD-MON-YYYY, e.g. 12-DEC-2001 as this format is less error-prone than pure numeric dates
4	Source of data	Name of collector or institution, identifies either personal contact details or the name of the institution where the record is derived
5	Purpose of visit	Reason/s site was chosen. For example, to assess type and extent of WoNS prior to treatment or monitoring to determine effectiveness of management action after treatment
6	Place name or locality	Plain language description of location e.g. '10 km west of Bourke'. Provides a useful cross-check against specified geocode (latitude and longitude)
7	Latitude	Latitude in degrees, minutes and seconds. Prefer decimal degrees or AMG coordinates with Zone and datum noted – for GPS entries
8	Longitude	Longitude in degrees, minutes and seconds. As for latitude
9	Precision of latitude-longitude	Precision of measurement in its locating the site. Measured in metres. Records how the latitude/longitude was determined (GPS, topographic map or estimated)
10	Area	Area of the infestation measured in hectares. Area of the infestation defined by the outside boundary. For infestations measured by transect, indicate length of transect (in metres)
11	Cover/densityDensity	measured by class intervals. Prefer data that records raw density as a percent. For rapid survey density data may be collected as classed data e.g. 55–100% cover=dense
		Class number / **Class description[5]** 1 absent 2 less than 1% 3 1% to 10% 4 11% to 50% 5 greater than 50% 6 present (density unknown) 7 not known or uncertain 8 not assessed
12	Treatment/s	Types/s of control or management. Management could include subcategories of mechanical, chemical, biological. No treatment should also be recorded.
13	Comments	Qualifications and factors likely to affect the adequacy of the record e.g. inadequate time spent. Anecdotal observations of the sites or photograph/s
14	*Core site number of records**	*Number of records for the site or overlapping site. Records multiple sites spatially or multiple visits over time. May be left blank*
15	*Land use category**	*Land use/s observed at the site according to agreed national classification. Select from Australian Land Use and Management Classification land use categories.*

*** Attributes 1–13 are mandatory core attributes. Attributes 14 and 15 (shown in italics) are optional core attributes.**

1% to 10% gorse cover

11% to 50% gorse cover

Greater than 50% gorse cover

10% weed cover

25% weed cover

75% weed cover

(Tasmanian weed mapping guidelines)

References

1. Gorse Task Force. Controlling gorse successfully. Breakwater: Department of Sustainability and Environment and Department of Primary Industries, Victoria, 2005.
2. Baker M, email, 10 January 2006, Tasmanian Museum and Art Gallery.
3. Australian Pesticides & Veterinary Medicines Authority, 21 July 2009, www.apvma.gov.au > Search PUBCRIS for Registered Chemicals
4. Thackway R., McNaught I, Cunningham D. A national set of core attributes for surveying, mapping and monitoring Weeds of National Significance (WoNS). Canberra: Bureau of Rural Sciences, Australian Capital Territory, 2004.
5. McNaught I, Thackway R, Brown L, Parsons M. A field manual for surveying and mapping nationally significant weeds. Canberra: Bureau of Rural Sciences, 2006.