Weeds of National Significance

African boxthorn

National best practice manual

Weeds of National Significance

African boxthorn

National best practice manual

Managing African boxthorn *(Lycium ferocissimum)* in Australia

Produced and published by the Tasmanian Department of Primary Industries, Parks, Water and Environment with funding from the Australian Government *Caring for Our Country* program.

Australian Government

Tasmanian Government

This manual is sponsored by the Department of Agriculture, Fisheries and Forestry.

This manual is intended to provide information only on the subject matter under review. It is not intended to be, nor does it constitute, expert advice. Readers are warned against relying solely on the information contained in this manual. Further professional advice should be sought before acting on any of the information supplied in this manual.

While all care has been taken in the preparation of this manual, neither the authors or the Crown in right of Tasmania, the Department of Primary Industries, Parks, Water and Environment, nor their officers or staff (collectively "the State") accept any responsibility for any loss or damage that may result from any inaccuracy or omission in the information contained in this manual. Readers rely upon all information contained in the manual entirely at their own risk.

The State provides no form of warranty, guarantee or endorsement about, and accepts no responsibility for:

(a) the effectiveness or otherwise of any control techniques including any products, (including herbicides) referred to in this manual; or
(b) the accuracy or otherwise of the costs of any control techniques referred to in this manual.

The fact that any product (including herbicide) is mentioned in this manual does not constitute any form of criticism of any competitor of, or alternative to, the named product (including herbicide).

Readers are fully responsible for any loss or damage that either the reader or any third party may incur, as a result of the reader's use of any of the control techniques, including products (including herbicides) referred to in this manual. The State accepts no responsibility for any loss or damage that either the reader or any third party may incur, as a result of the reader's use of any of the control techniques, including products (including herbicides) referred to in this manual.

All costs in this manual are based on 2013 figures, unless otherwise stated.

For copies of this manual contact:
Invasive Species Branch
Department of Primary Industries, Parks,
Water and Environment
PO Box 44 Hobart TAS 7001
Phone: 1300 368 550

Manual compiled by the Weeds of National Significance African Boxthorn National Coordinator in partnership with the Australian Government, funded by Caring for Our Country. The Coordinator is hosted by Department of Primary Industries, Parks, Water and Environment, Tasmania. Literature review performed using library catalogues, academic databases and internet searches. This manual represents a rigorous review of African boxthorn biology and management in Australia.

Photography: Jim Balnaves, Russell Best, Murray Fagg, Jon Fallaw, John Fitzhardinge, Alan Fletcher, Ross Gardiner, Andrew Lyne, Michael Noble, Matt Rose, Greg Stewart, Colin Wilson, Alan Wood, Karen Ziegler. Thanks to Australian National Botanic Gardens, Friends of Bass Strait Islands, NSW National Parks and Wildlife Service, Phillip Island Nature Parks, and South Coast NRM Inc. for access to and permission to use photos.

Illustration by: Dennis Morris
Cover photo by: Greg Stewart, NRM North
Maps prepared by: Christopher Auricht, Auricht Projects
Editing: Janice Bird
Design: Nova Design and Print, Devonport, Tasmania

National Library of Australia Cataloguing-in-Publication data:
Noble, Michael R, author of African Boxthorn National Best Practice Manual: Managing African boxthorn *(Lycium ferocissimum)* in Australia.

ISBN 978-0-9875693-0-1 (ebook)
978-0-9875693-1-8 (print)

1. Solanaceae – control – Australia – handbooks, manuals etc.
2. Invasive plants – control – Australia – handbooks, manuals etc.
3. Noxious weeds – control – Australia – handbooks, manuals etc.

581.6520994

AUTHORS AND CONTRIBUTORS

Authors

Michael Noble (Weeds of National Significance African Boxthorn National Coordinator) and Matt Rose (Operations Manager, Natural State)

Contributors

Jim Balnaves, Department of Primary Industries, Parks, Water and Environment (DPIPWE), Tasmania
Ross Gardiner, NSW National Parks and Wildlife Service, New South Wales
Matthew Kennewell, South Coast Natural Resource Management Inc., Western Australia
Graeme Simpson, South Coast Natural Resource Management Inc., Western Australia
Greg Taylor, Tasmania
Jarvis Weston, Phillip Island Nature Parks, Victoria
Karen Ziegler, Friends of Bass Strait Islands, Tasmania

ACKNOWLEDGEMENTS

Contributors and photographers shared their time, information and photos generously. Their contribution to the manual is gratefully acknowledged.

Thanks go to Michael Askey-Doran for feedback and advice, the Australian Government for Caring for Our Country funding, Janice Bird for editing, Margaret Quill and Angela Loveless (DPIPWE) for research assistance, Ashlee Griffiths from Nova Design and Print for design and layout, Chris Auricht for developing maps, and Brett Littleton (DPIPWE) for use of his illustrations.

Dr Robin Adair's (Australis Biological) work on the feasibility of biological control of African boxthorn made additional information available for this manual.

Craig Magnussen developed the African Boxthorn Weed Management Guide and has provided ongoing advice and information.

The authors and contributors to earlier Weeds of National Significance manuals – such as the gorse and boneseed manuals – are acknowledged for establishing a terrific format for this series of publications.

CONTENTS

INTRODUCTION

CHAPTER 1
Biology, distribution and impacts of African boxthorn

1.1 Name, origin and description 4

1.2 Biology and ecology 5

1.2.1 Dispersal 5

1.2.2 Germination 6

1.2.3 Disturbance and competition 6

1.3 Preferred climate and habitat 7

1.4 Current and potential distribution in Australia 7

1.4.1 Climate change and African boxthorn distribution in Australia 7

1.5 Impacts of African boxthorn in Australia 8

1.6 Native look-alikes 10

CHAPTER 2
Managing African boxthorn

2.1 Planning 16

2.2 Pathways of spread 16

2.2.1 Weed hygiene 17

2.2.2 Movement with fauna 17

2.3 Management considerations for specific situations 18

2.3.1 Native fauna using African boxthorn 19

2.3.2 Native flora benefiting from African boxthorn 20

2.3.3 Cultural heritage 21

2.3.4 Riparian areas 22

2.3.5 Steep or inaccessible areas 22

2.4 Developing an African boxthorn management plan 22

CHAPTER 3
Controlling African boxthorn

3.1 Mechanical control 28

3.1.1 Winching 28

3.1.2 Pulling or plucking 28

3.1.3 Dozing, stick raking and blade ploughing 29

3.1.4 Following up after the above techniques 29

3.1.5 Cultivation 29

3.1.6 Mechanical cut-stump 29

3.2 Chemical control ... 31
3.2.1 Chemical use certification ... 31
3.2.2 Herbicides ... 31
3.2.3 Foliar spraying ... 32
3.2.4 Cut-stump application ... 32
3.2.5 Stem injection/frilling ... 34
3.2.6 Basal bark application ... 34
3.2.7 Soil–root zone application ... 35
3.3 Biological control ... 35
3.4 Other control options ... 36
3.5 Hygiene protocols ... 36
3.6 Combining methods for long-term control ... 36
3.7 Post-control monitoring and evaluation ... 37
3.8 Site rehabilitation ... 38
3.8.1 Restoring native vegetation ... 38
3.8.2 Restoring agricultural lands ... 39

CHAPTER 4
Case studies

4.1 Oolambeyan National Park, south-west New South Wales ... 42
4.2 Furneaux Islands, north-east Tasmania ... 45
4.3 Phillip Island, southern Victoria ... 47
4.4 South coast, Western Australia ... 50

CHAPTER 5
Further information

5.1 African boxthorn legal status and responsibilities in Australia ... 56
5.2 Registered herbicides ... 56
5.3 Australian Pesticides and Veterinary Medicines Authority – off-label and minor use permits ... 64
5.4 Chemical and chainsaw use training certification ... 64
5.5 Regulations and permits for works in riparian lands ... 65
5.6 State and regional contacts for weed information ... 65
5.7 National core attributes for weed mapping ... 66

Greg Stewart NRM North

INTRODUCTION

African boxthorn – a Weed of National Significance

African boxthorn *(Lycium ferocissimum)* is endemic to southern Africa. It has been declared a Weed of National Significance (WoNS) in Australia due to its invasiveness, impacts, potential for spread and effects on socioeconomic and environmental values.

Introduced to Australia in the mid-1800s, African boxthorn was used as a hedge plant and windbreak. It has been recorded in all Australian jurisdictions and is still present in all except the Northern Territory. It infests natural and production lands through much of coastal and inland temperate and sub-tropical Australia.

African boxthorn is legally recognised (declared) as a weed under legislation in all Australian jurisdictions except Western Australia. It displaces native vegetation and degrades fauna habitat, as well as harbouring pest fauna including rabbits, foxes, feral pigs and starlings.

On production lands, African boxthorn can reduce access to grazing and water for livestock; animals are also at risk of injury from its large thorns, particularly in times of lean feed when they are browsing closely around boxthorn shrubs.

Boxthorn fruit can host insect pests such as the fruit fly and common house fly and, potentially, the tomato-potato psyllid (should it establish in Australia).

Being so widespread in Australia, African boxthorn has often become an integral component of the landscape. There are instances (such as in the case of the orange-bellied parrot, *Neophema chrysogaster*) where boxthorn is a threat to the habitat of an endangered fauna species in one landscape (where natural habitat exists), whilst providing important habitat for the same species in another area that is devoid of natural habitat.

The situation with heritage management is equally complex: boxthorn might be stabilising landscapes containing cultural heritage sites (such as middens), whilst also harbouring rabbits that burrow through and damage the integrity of the same sites.

With such factors to be taken into account, management planning and assessments are essential first steps in any substantial African boxthorn control program.

In Australia, management of African boxthorn is focused primarily on areas where significant environmental and economic assets are under threat. For example, some of the primary African boxthorn management locations in Australia (covered by the case studies in this manual) coincide with the nationally recognised Fitzgerald River Ravensthorpe biodiversity hotspot in Western Australia's south coast region, and Victoria's Phillip Island Nature Parks, which contain a substantial little penguin colony viewed by around 500 000 paying tourists annually. African boxthorn is also being controlled on grazing lands, in areas such as western New South Wales. As the plant's role as a psyllid host becomes more widely recognised, it is likely that control efforts will be stepped up in horticultural and cropping areas that would be threatened by the potato-tomato psyllid if it arrived in Australia.

Several chemical and mechanical control methods are effective for managing African boxthorn. As the plant has a remarkably resilient rootstock, and will readily shed its leaves when under stress, foliar spraying does not produce such reliable results as it does for some other weed species. Intensive methods, such as cut stump and mechanical plucking/pulling of plants, followed up with foliar spraying or cut stump of regenerating or newly establishing plants, seem to be the most effective formulae. As with most weeds, though, it is essential to follow up initial control work – and experience with African boxthorn around the country indicates a need to do it several times.

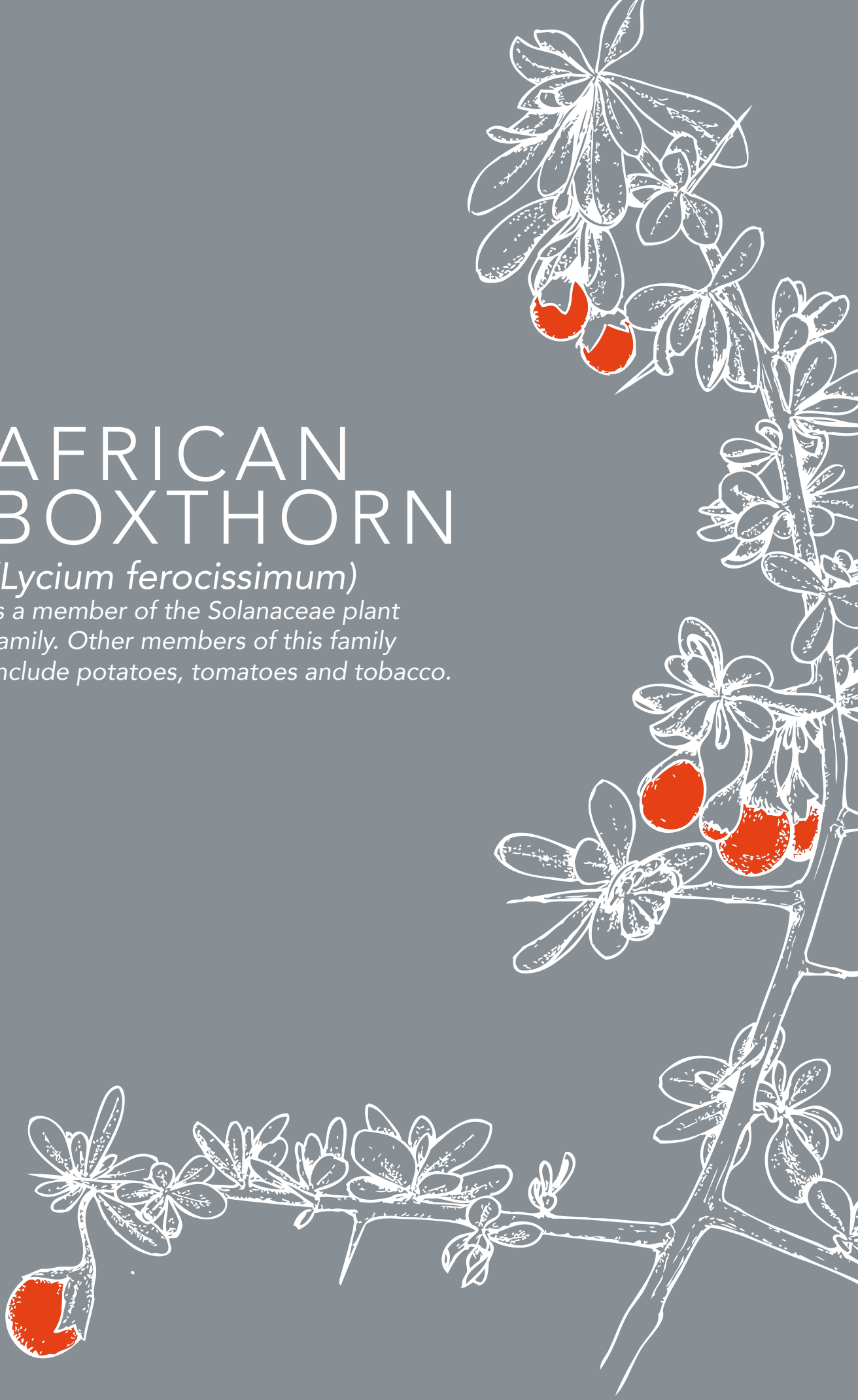
With this plant's declaration as a Weed of National Significance in 2012, a WoNS National African Boxthorn Strategic Plan (2012 to 2017) has been produced. The strategic plan establishes the following three broad goals for management of African boxthorn in Australia, underpinned by strategic actions.

1. Prevent new infestations from establishing.
2. Ensure existing infestations are under strategic management.
3. Increase stakeholder capability and willingness to manage African boxthorn.

One of the high-priority actions that the strategy identifies is the need for development of information on best practice, to promote efficient, effective long-term control of African boxthorn. This manual is the first step towards providing this.

AFRICAN BOXTHORN

(Lycium ferocissimum)
is a member of the Solanaceae plant family. Other members of this family include potatoes, tomatoes and tobacco.



CHAPTER 1
Biology, distribution and impacts of African boxthorn

Colin Wilson

CHAPTER 1
Biology, distribution and impacts of African boxthorn

1.1 Name, origin and description

African boxthorn *(Lycium ferocissimum)* is a member of the Solanaceae plant family. Other members of this family include potatoes, tomatoes and tobacco.

The name 'boxthorn' is thought to be derived from *boksdorn*, the name given to the plant by Dutch settlers in South Africa. The genus *Lycium* comes from Lycia, the name of an ancient country in Asia Minor (where a similar spiny shrub was found), and *ferocissimum* comes from the Latin *ferox*, meaning 'bold' or 'fearless', referring to the very spiny nature of the shrub.[1]

African boxthorn is a native of southern Africa, specifically the Western and Eastern Cape Provinces of South Africa, and Lesotho. It has not been distributed to many parts of the world but has been recorded in the United States of America, Morocco, Tunisia, south-west Spain and Cyprus,[1,2] as well as Australia and New Zealand.

Though it is recognised and legislated as a weed in other countries, including the USA, it is most troublesome in Australia and New Zealand, where it was deliberately introduced and is extensively distributed. African boxthorn is legally recognised (declared) as a weed in most jurisdictions in Australia.[1,3] A summary of the legal status of African boxthorn in each Australian jurisdiction is provided in Chapter 5 (section 5.1).

African boxthorn is a densely branched perennial shrub that can grow up to 5 m high (but more often is 2 to 3 m), and to 5 m (more commonly, up to 3 m) across. On windswept coasts, the plant's growth habit is often quite different. In these situations boxthorn is wind-pruned, very dense and often relatively short, with its shape determined by the predominant wind direction.[1,4]

Stems are smooth and silver-grey when young, becoming brown and fissured as they mature. Branches and stems end in sturdy thorns that are 20 to 150 mm long.

Leaves are slightly fleshy and oblong, up to 40 mm long, growing in clusters.

Flowers are approximately 10 to 12 mm in diameter and hang from the leaf axils on stalks, singly or in pairs. Their colour ranges from white to lilac and the five petal lobes often have a lilac base.

Fruit is 5 to 12 mm long, starting with a smooth green appearance and ripening to an orange-red berry, and with a prominent calyx. There are 20 to 70 seeds per fruit.[5,6]

African boxthorn shrub

Return to contents page

1.2 Biology and ecology

African boxthorn has become widely established in non-tropical Australia, having been deliberately introduced as a hedge plant during the nineteenth century.

In its native situation in southern Africa, the plant grows both in areas that receive winter rainfall and those with non-seasonal rainfall. In winter rainfall situations it sheds leaves at the beginning of summer. In areas of non-seasonal rainfall, it is evergreen.[2] In Australia the species seems to respond in a similar way to its location and climate. For example, in its southern distribution in the temperate zone of Australia boxthorn retains healthy leaf cover in winter, but it seems to have a deciduous habit in more northern (dry winter) regions.[1,2]

African boxthorn readily grows in a broad range of soil types, often establishing best on light soils. It thrives on marginal and waste lands, and along dry creek beds. It is considered a halophyte (a plant tolerant of high concentrations of salt in the soil and air) and is found on the margins of salt lakes and clay pans, as well as in coastal situations.[1,5,7]

African boxthorn plants do not flower and fruit until at least two years of age.[1]

1.2.1 Dispersal

African boxthorn is almost always spread via seed but it has also been known to spread by vegetative reproduction, growing from dislodged roots or stem fragments that come into contact with moist soil (fragments can remain viable for several months before taking root).[1,5]

Flowering and setting of seeds usually occur in summer, but can happen at any time of year.

Fruits are consumed by fauna, including foxes *(Vulpes vulpes)* and birds, and seeds remain viable when they have been excreted. The greater the range of birds that

Wind-pruned African boxthorn

African boxthorn stems and leaves

African boxthorn flower

Ripe African boxthorn berry

Return to contents page

African boxthorn in use as an evergreen hedgerow, north-west Tasmania

eat the fruit, the broader the foraging and movement patterns involved, and so seeds are dispersed to different microhabitats.[8] As African boxthorn seed is distributed by a range of native and non-native birds, even localised eradication and containment of the species is hard to achieve. A list of fauna species known to consume African boxthorn fruit is provided in Chapter 2 (section 2.2).

Seed can also be dispersed by movement in water, on machinery, and in soil.[5]

In Western Australia it was observed that sole African boxthorn plants that were remote from others of their species did not multiply or spread.[9] It appears that they are not self-compatible/apomictic (i.e. cannot self-fertilise). Some species have evolved this mechanism to prevent inbreeding.[10]

1.2.2 Germination

Seedlings germinate at any time of the year. Flowering and seeding begins when plants are two years old. There is little documented information available about how long the seeds might be viable. However, available information indicates seed-bank persistence is short, perhaps lasting only days to one year.[11]

1.2.3 Disturbance and competition

Established African boxthorn plants have long, deep root systems. If the above-ground plant is destroyed and the soil is disturbed, the root system sends up shoots or suckers.

In response to fire, African boxthorn re-sprouts from its rootstock. It has been found that 100% leaf scorch from fire will kill less than 30% of plants.[12]

It is not clear whether African boxthorn has allelopathic properties (i.e. can produce chemicals that inhibit growth of other plants that try to establish nearby). However, the harbouring of rabbits *(Oryctolagus cuniculus)*, which remove competing plants that emerge around the base of the boxthorn, can achieve a similar result.

Return to contents page

1.3 Preferred climate and habitat

From the mid-1800s African boxthorn appeared in Australian nursery catalogues, was grown in botanical gardens, and was recommended as a hedge plant.

African boxthorn has been recorded in all states and territories in Australia and is one of the nation's most widespread weeds. It is also widely distributed in New Zealand.[2,13]

Having evolved in the harsh South African environment, it thrives in Australia's many similar and suitable environments. African boxthorn distribution in Australia ranges from islands and coasts through to semi-arid areas, and from temperate to sub-tropical climates.[14]

Factors that limit the distribution of African boxthorn in Australia appear to include a tropical climate, lack of rainfall (below 200 mm/annum) and higher altitude (such as alpine areas of New South Wales, Victoria and Tasmania). In semi-arid environments infestations occur along dry stream beds.

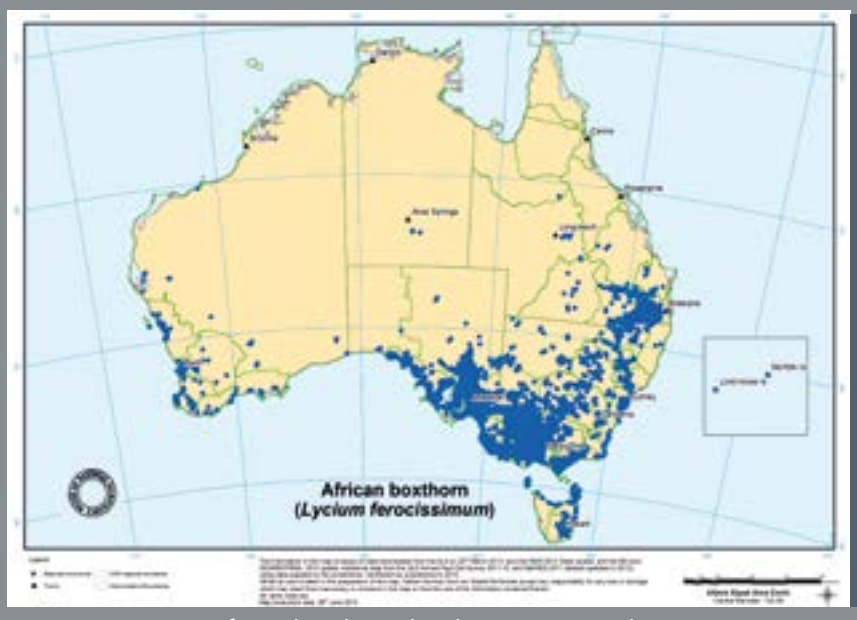
The species will readily grow in a range of positions, from partial shade to full sun, although it has been reported in New Zealand as being intolerant of full shade.[13]

1.4 Current and potential distribution in Australia

African boxthorn is common in all but northerly tropical parts of Australia. Because it is spread by birds, it often grows under trees, poles and fences, and is found on relatively remote islands (e.g. Houtman Abrolhos islands, islands in Bass Strait; Lord Howe and Norfolk Islands). It displaces local native vegetation on islands and coasts in most states of Australia and is widespread through inland areas, including much of inland New South Wales and Victoria.

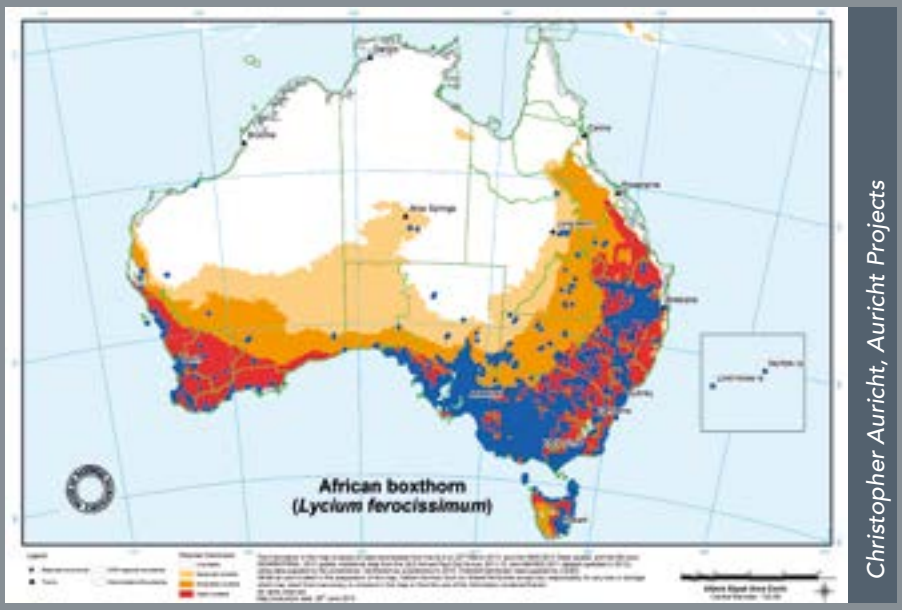
1.4.1 Climate change and African boxthorn distribution in Australia

Experts have looked at how the future distribution of African boxthorn might be affected by various climate-change scenarios. Modelling by Wilson et al.[15] indicates that, at a national level, the area of favourable climate for African boxthorn will contract considerably by 2050. The contraction is generally south-west.



African boxthorn distribution in Australia

Return to contents page



Christopher Auricht, Auricht Projects

Potential African boxthorn distribution in Australia, with existing distribution overlaid

Modelling by CSIRO, based on current climatic conditions, indicates that African boxthorn already occupies much of its potential distribution area in Australia, with the exception of the south of Western Australia.

The model indicates significantly less favourable conditions in Queensland and northern parts of New South Wales, a contraction southward of favourable conditions in Western Australia and South Australia, but a largely similar or slightly better climate for African boxthorn in parts of Tasmania and Victoria by 2050.

Climate change and invasive plants modelling projections for 2080 in South Australia by Kriticos et al.[2] indicate a southward retraction in climate suitability for African boxthorn. In this model, Kangaroo Island, Fleurieu Peninsula and the south-east of the state will become more suitable for African boxthorn, whilst most other areas of South Australia will become less suitable, or remain similar.

1.5 Impacts of African boxthorn in Australia

African boxthorn plants (fruit, leaves, stem and roots) are poisonous to people and livestock. Leaves may be toxic to poultry.[1,16,17] Tropane alkaloids are the suspected toxin and can affect all animal species, although the level of risk is believed to be low.

In the late 1990s research was undertaken in the lead-up to the Australian Government declaring 20 Weeds of National Significance (WoNS). WoNS candidates were selected on their invasiveness, impacts, potential for spread and implications for socioeconomic and environmental values. This research revealed that African boxthorn was one of only five weed species that were found in at least half of the surveyed regions across the country (the other top species were Paterson's curse, Bathurst burr, Noogoora burr and Mexican poppy). In 2000 African boxthorn was estimated to cost primary industries in Australia approximately $700 000 per annum.[18]

More recently, research in New South Wales found African boxthorn was the weed most frequently cited by catchment management authorities as impacting on that state's biodiversity.[19]

Return to contents page

A 2013 research report on coastal weeds found that African boxthorn was the species most often cited by natural resource managers as the worst coastal weed in southern Australia (as well as the most commonly managed). The report's authors estimate that coastal weed management in southern Australia costs about $30 million annually in total.[20]

African boxthorn affects a broad range of environments across Australia and is of concern for its current and potential impacts upon:

- the natural environment, e.g. displacing native vegetation and degrading fauna habitat
- grazing lands, e.g. reducing access to pasture and water, and harbouring pest animals such as rabbits and foxes
- cropping and horticulture, e.g. boxthorn fruit hosting fruit fly, the common house fly and, potentially, potato/tomato psyllid *(Bactericera cockerelli)*, should it enter Australia.[1,21]

African boxthorn is considered a biodiversity threat in at least two rangeland biodiversity hotspots: Brigalow North and South in Queensland, and the Carnarvon Basin in Western Australia.[22]

Where African boxthorn infests coastal areas and offshore islands it can significantly alter and interfere with native fauna habitats. In some small island and coastal sand-dune environments, including Bass Strait islands and coastal New Zealand, it becomes the only woody plant present, changing the vegetation structure. This can make a place less suitable for native fauna and more hospitable to shrub-dependent pest animals such as starlings *(Sturnus vulgaris)*.[13, 23]

On islands off South Australia and Western Australia, African boxthorn displaces the native shrub *Nitraria billardieri*, which is used by seals (*Arctocephalus* spp.) to shelter their pups. African boxthorn does not provide an equivalent nursery habitat, leaving pups more vulnerable to predation.[24]

On islands inhabited by Australian sea lions *(Neophoca cinerea)*, such as East Beagle Island off the coast of Western Australia, African boxthorn grows down to the beach and is known to impede the sea lions' access to the island for pupping.

African boxthorn root systems are thought to make burrowing more difficult for short-tailed shearwaters *(Puffinus tenuirostris)*. On Althorpe Island off the coast of South Australia, the fine, dense root systems of boxthorn have been observed to impede the birds' burrowing efforts.[25, 26] In Bass Strait the ongoing spread of boxthorn on islands is considered to have the potential to destroy burrowing seabirds' breeding habitat.[27]

The large thorns on boxthorn can be hazardous to native fauna such as seabirds and shorebirds, which can become fatally ensnared. On Bass Strait islands, short-tailed shearwaters become ensnared, and in New Zealand fairy prions *(Pachypptilla turtur)* and white-faced storm petrels *(Pelagodroma marina)* are known to become ensnared.[23, 28, 29]

Even long after the plant is dead, the thorns can injure people, livestock and wildlife, and pierce tyres. The eyes of livestock are particularly at risk when feed is limited and stock are grazing in and around boxthorn plants.

Controlling boxthorn by hand on Beagle Islands, Western Australia

Return to contents page

A short-tailed shearwater ensnared in African boxthorn

Once established, the plant can harbour pest animals including rabbits, foxes, feral pigs (*Sus scrofa*) and starlings. Impenetrable thickets exclude desirable vegetation (native vegetation and pasture), impede stock trying to access grazing and watering points (thus reducing the production potential of rangelands) and hinder mustering activities.

African boxthorn is also known to harm revegetation efforts. Revegetation provides habitat and roosting points for birds but, if these birds also visit African boxthorn, they will spread seed into revegetation sites, increasing the amount of work and money needed to maintain the revegetated area.

1.6 Native look-alikes

Several native plant species could be mistaken for African boxthorn. In different parts of the African boxthorn distribution in Australia, various species with similar appearance occur. These are described in this section, along with their general distribution, to indicate where they might be expected to be found.

The plants listed opposite and overleaf are valuable ecological contributors in their endemic locations and should be left in place.

Return to contents page

Australian boxthorn (Lycium australe)

Australian boxthorn *(Lycium australe)* grows across southern mainland Australia, mainly in drier areas west of the Great Dividing Range across to and including Western Australia. It is an Australian native species and should not be managed as a weed unless considered weedy in specific situations, such as where it grows outside its natural range. It is found in New South Wales, Victoria, South Australia and Western Australia.[30, 31]

Prickly box (Bursaria spinosa)

Prickly box *(Bursaria spinosa)* is found mainly in eastern Australia (including Tasmania), and in South Australia. It is also known as sweet bursaria, Australian boxthorn and by other common names. It is found in every Australian jurisdiction apart from Western Australia and the Northern Territory.[32]

Tree violet (Melicytus dentatus)

Tree violet *(Melicytus dentatus* – formerly *Hymenanthera dentata)* has a natural range from the Queensland–New South Wales border southward, including Victoria, Tasmania and South Australia.[33]

Currant bush (Scaevola spinescens)

Currant bush *(Scaevola spinescens)* is found across mainland Australia (in Western Australia, South Australia, the Northern Territory, Queensland, New South Wales and Victoria), but mainly in areas west of the Great Dividing Range.[34]

Return to contents page

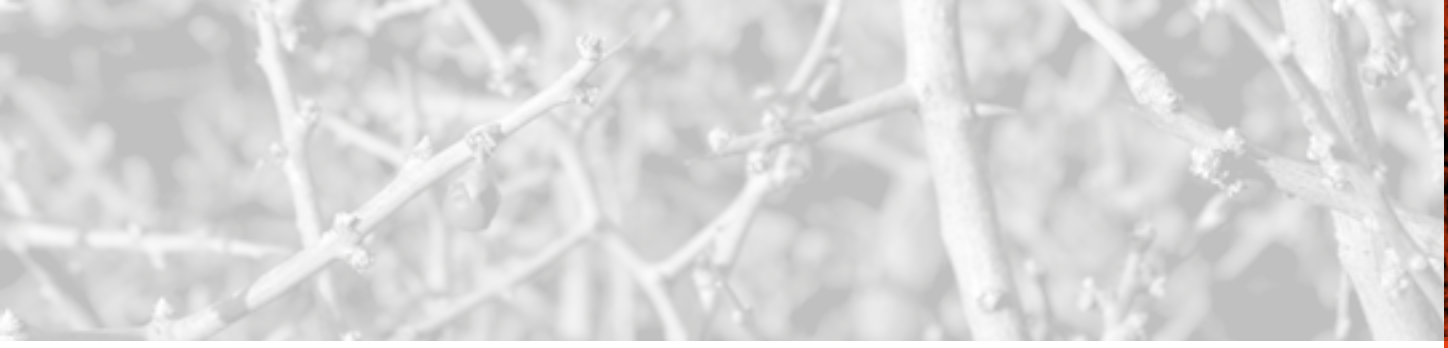
Spiky anchor plant (Discaria pubescens)

Spiky anchor plant *(Discaria pubescens)* is found in southern Queensland, New South Wales, Victoria and Tasmania.[35]

Nitre bush (Nitraria billardierei)

Nitre bush *(Nitraria billardierei)* has a natural range across inland areas of all mainland states (and into the Northern Territory). It is not found on the coast of eastern Australia, but grows in both coastal and inland parts of southern Australia and Western Australia.[36]

Return to contents page



References

1. Parsons WT, Cuthbertson EG. Noxious weeds of Australia. Melbourne: Inkarta Press, 2004.
2. Kriticos DJ, Crossman ND, Ota N, Scott JK. Climate change and invasive plants in South Australia. Canberra: Commonwealth Scientific and Industrial Research Organisation, 2010.
3. DiTomaso JM, Healy, EA. Weeds of California and other western states – Volume 2. Oakland, California: University of California, 2007.
4. Ziegler K, email, 22 May 2013.
5. Muyt A. Bush invaders of south-east Australia. Meredith, Victoria: RG and FJ Richardson, 2001.
6. Blood K. Environmental weeds: A field guide for SE Australia. Mt Waverley, Victoria: CH Jerram & Associates – Science Publishers, 2001.
7. Adair R, Feasibility of biological control of African boxthorn *(Lycium ferocissimum)*. Unpublished report, Bittern, Victoria, 2013.
8. Stanley MC, Lill A. Avian fruit consumption and seed dispersal in a temperate Australian woodland. Austral Ecology 2002;27(2):137–148.
9. Walker R, email via Sandy Lloyd, 8 May 2013.
10. Feliciano NM. 'Self-incompatibility in African Lycium *(Solanaceae)*'. PhD thesis, University of Massachusetts Amherst, 2008.
11. Department of Parks and Wildlife, 2013, Department of Parks and Wildlife, Western Australia, viewed 15 October 2013, <http://florabase.dpaw.wa.gov.au/browse/profile/6968>.
12. Choate J. Plant Species Response to Fire. South Australia: Department of Environment and Natural Resources, 1997.
13. Timmins SM, Mackenzie TW. Weeds in New Zealand protected natural areas database. Wellington, New Zealand: Department of Conservation, 1995.
14. Invasive Species Compendium 2013, CABI, Wallingford, UK, viewed 2 July 2013 <http://www.cabi.org/isc/?compid=5&dsid=31903&loadmodule=datasheet&page=481&site=144 >.
15. Wilson PD, Downey PO, Gallagher RV, O'Donnell J, Leishman MR, Hughes L. Modelling climate suitability for exotic plants in Australia under future climate. Final report on the potential impact of climate change on the distribution of national priority weeds in Australia. Sydney: Macquarie University and New South Wales Office of Environment and Heritage, 2011.
16. Shepherd RCH. Pretty but poisonous. Melbourne: RG and FJ Richardson, 2004.
17. McKenzie R. Australia's poisonous plants, fungi and cyanobacteria. Collingwood, Victoria: CSIRO Publishing, 2012.
18. Thorp JR, Lynch R. The determination of Weeds of National Significance. Launceston, Tasmania: National Weeds Strategy Executive Committee, 2000.
19. Turner P, email, 23 May 2012.
20. Cousens R, Kennedy D, Maguire G, Williams K. Just how bad are coastal weeds? Assessing the geo-eco-psycho-scio-economic impacts. Canberra: Rural Industries Research and Development Corporation, 2013.
21. Yen AL, email, 6 June 2013.
22. Martin TG, Campbell S, Grounds S. Weeds of Australian rangelands. The Rangeland Journal 2006;28:3–26.
23. Ziegler K, Hopkins K. Furneaux Islands boxthorn control. Tasmania: Friends of Bass Strait Islands – Wildcare, 2011.
24. Moritz C,Kikkawa J. Conservation biology in Australia and Oceania. Chipping Norton, New South Wales: Surrey Beatty, 1994.
25. Lawley EF, Lawley JJ, Page B. Effects of African boxthorn removal on native vegetation and burrowing of short-tailed shearwaters on Althorpe Island, South Australia. Transactions of the Royal Society of South Australia Incorporated 2005;129(2):111–15.

Return to contents page

26. CRC for Australian Weed Management. Weed management guide – African boxthorn *(Lycium ferocissimum)*. Glen Osmond, South Australia: CRC for Australian Weed Management, 2007.

27. Brothers N, Pemberton D, Pryor H, Halley V. Tasmania's offshore islands: seabirds and other natural features. Hobart: Tasmanian Museum and Art Gallery, 2001.

28. Priddel D, Carlile N, Wheele, R. Eradication of European rabbits *(Oryctolagus cuniculus)* from Cabbage Tree Island, NSW, Australia, to protect the breeding habitat of Gould's petrel *(Pterodroma leucoptera leucoptera)*. Biological Conservation 2000;94:115–125.

29. Taylor RH. Introduced mammals and islands: priorities for conservation and research. Proceedings of the New Zealand Ecological Society 1968;15:61–67.

30. Atlas of Living Australia 2013, Australian Government, Canberra, viewed 27 May 2013, <http://bie.ala.org.au/species/Lycium+australe>.

31. Magnussen C. Weed management guide – African boxthorn. Queensland Department of Agriculture, Fisheries and Forestry.

32. Atlas of living Australia 2013, Australian Government, Canberra. viewed 27 May 2013, <http://bie.ala.org.au/species/Bursaria+spinosa>.

33. Atlas of living Australia 2013, Australian Government, Canberra, viewed 27 May 2013, <http://bie.ala.org.au/species/urn:lsid:biodiversity.org.au:apni.taxon:296301>.

34. Atlas of living Australia 2013, Australian Government, Canberra, viewed 27 May 2013, <http://bie.ala.org.au/species/Scaevola+spinescens>.

35. Atlas of living Australia 2013, Australian Government, Canberra, viewed 29 May 2013, <http://bie.ala.org.au/species/Discaria+pubescens>.

35. Atlas of living Australia 2013, Australian Government, Canberra, viewed 29 May 2013, <http://bie.ala.org.au/species/urn:lsid:biodiversity.org.au:apni.taxon:387897>.

Return to contents page

CHAPTER 2
Managing African boxthorn

Friends of Bass Strait Islands

CHAPTER 2
Managing African boxthorn

For effective long-term management of African boxthorn, it is important to develop an appropriate plan before starting on-ground work. This chapter provides an overview that can be used as a basis for developing a local African boxthorn management plan.

2.1 Planning

In southern Africa where it originated, and as an invader of Australian environments, African boxthorn is recognised for being a particularly resilient shrub.[1,2] The root system of mature plants will usually survive mechanical management and fire, and often survive chemical treatments also.

If unmanaged African boxthorn infestations are left to continue in the vicinity of areas where boxthorn is being managed, birds and other fauna will almost certainly reintroduce it to the management area.

This resilience and mobility of the species are why poorly planned and executed attempts to control African boxthorn are likely to be a waste of effort and resources, and can potentially make the problem more difficult and expensive to manage.

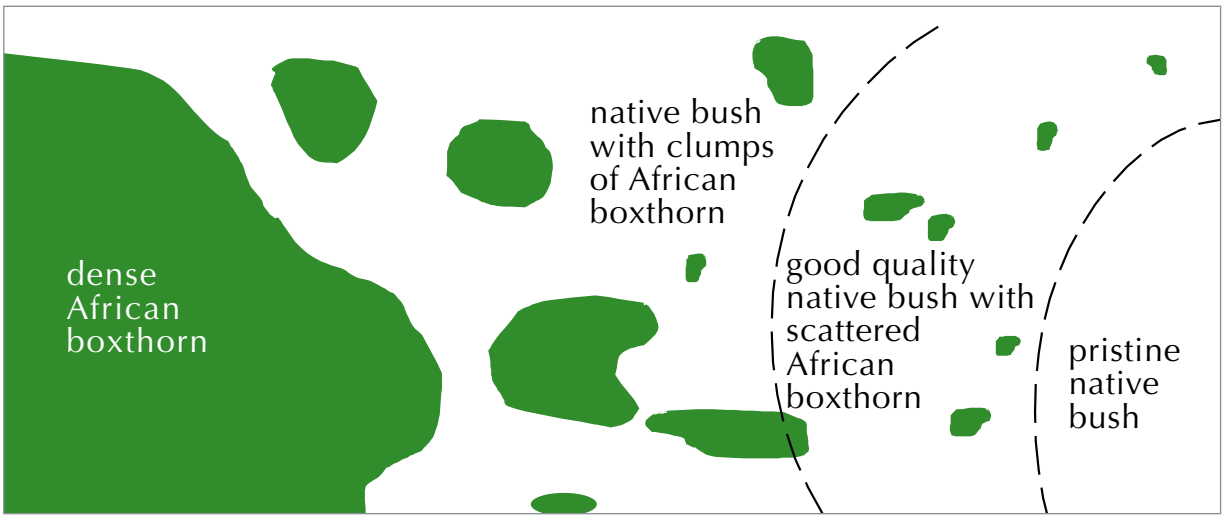
One of the keys to success in controlling African boxthorn is careful planning that considers the broader context (such as managing seed sources and considering potential environmental impacts of control), the most appropriate and effective control methods, and the best combination of methods to use for each specific situation. It is critical also to recognise and commit to a realistic budget and timeline for control (timeline may need to be a decade or more).

One of the fundamental strategies of weed management planning is to work from the least weed-infested areas of the site towards the most infested. The areas of lesser infestation will more readily recover and require smaller follow-up commitments. The diagram below illustrates grades of weed invasion and how they might be considered from a planning perspective.

Among the first considerations of weed management planning, though, must be the pathways of spread.

2.2 Pathways of spread

When planning management of boxthorn, it is important to consider the means by which it came to be in a specific location and its potential to re-infest.



Grades of weed invasion: dense infestation; patches of weed in native bush; good quality native bush with only scattered weeds; and native bush with no weeds. Adapted from Weeds of National Significance Boneseed Management Manual, Section 2 Managing boneseed.

2.2.1 Weed hygiene

The most cost-effective way to manage weeds is to prevent their spread. African boxthorn is sometimes spread via seed that is transported in gravel, soil or mud, on machinery, and in agricultural produce.[2,3]

Weeds can be spread by the vehicles and machinery of contractors or land managers travelling between sites and regions. Only use trusted suppliers to supply and transport soil and quarry materials to and from your sites and ensure that all vehicles, machinery, equipment and clothing entering or leaving the site are inspected and cleaned. Soil, vegetative material, fruit and seeds should be removed and disposed of appropriately.

2.2.2 Movement with fauna

African boxthorn seed is spread primarily by fauna consuming boxthorn fruit and later excreting viable seed.

Fauna species known to consume African boxthorn fruit include the following.[4,5,6,7,8,9]

Birds

Blackbird *(Turdus merula)*

Currawong *(Strepera* spp.*)*

House sparrow *(Passer domesticus)*

Little raven *(Corvus mellori)*

Little wattlebird *(Anthochaera chrysoptera)*

Mistletoe bird *(Dicaeum hirundinaceum)*

Pacific gull *(Larus pacificus)*

Purple-crowned lorikeet *(Glossopsitta porphyrocephala)*

Red wattlebird *(Anthochaera carunculata)*

Starling *(Sturnus vulgaris)*

Silver gull *(Chroicocephalus novaehollandiae)*

Silvereye *(Zosterops lateralis)*

Singing honeyeater *(Lichenostomus virescens)*

Spiny-cheeked honeyeater *(Acanthagenys rufogularis)*

Yellow-faced honeyeater *(Lichenostomus chrysops)*

Mammals

Eastern barred bandicoot *(Perameles gunnii)*

Pacific rat *(Rattus exulans)* – record from New Zealand

Red fox *(Vulpes vulpes)*

Southern brown bandicoot *(Isoodon obesulus)*

Reptiles

Cunningham skink *(Egernia cunninghami)*

Shingleback *(Tiliqua rugosa)*

Available data and evidence indicates that, once expelled by fauna, seed frequently remains viable.

A study in the Canary Islands involving another *Lycium* species *(Lycium intricatum)* found viable seed comes from shrikes and kestrels who regurgitate pellets containing the remains of lizards that have fed on the *Lycium* fruit.[4,10]

The experience of the Friends of Bass Strait Islands (FOBSI) illustrates some of the considerations and strategies involved. Boxthorn has established on many of the small islands in the Furneaux Group in Bass Strait. The original vegetation on many of these islands was native grasses and herbs, with no shrub layer. Where the African boxthorn plants had been poisoned and the plant debris had been left in place, it continued to provide roosting habitat for starlings. The birds bring and excrete boxthorn seeds, which then grow under the dead bushes. By not only poisoning stems, but also piling and burning the dead plants, FOBSI found that its projects were significantly more successful.[5] Further information on this project is presented in a case study in Chapter 4 (section 4.2).

Another example of managing African boxthorn that takes reinfestation into consideration comes from South Coast Natural Resource Management Inc. in Western Australia, who developed an African boxthorn regional program (see case study in Chapter 4, section 4.4). When planning to eradicate relatively isolated infestations, the group estimated that the

Return to contents page

Starlings roost in dead boxthorn bushes, including this one on Chalky Island (Furneaux Group), *Bass Strait*

likely maximum distance that seed could be spread by local vectors (e.g. native birds and foxes) was 5 km. So they decided to create and maintain an African boxthorn–free buffer zone of 5 km around each boxthorn eradication area.[11]

This approach is viable in south-west Western Australia (and perhaps not many other parts of Australia) because there are no starlings in that region, due to concerted efforts by authorities and the barrier provided by the starling-unfriendly Nullarbor Plains. Should starlings establish in south-west Western Australia, it is likely that African boxthorn would be much more widely dispersed.

2.3 Management considerations for specific situations

As African boxthorn grows across a broad diversity of Australian landscapes, it can occur in areas with outstanding ecological and cultural values that have been recognised in national and state/territory legislation.

More broadly across Australian landscapes, African boxthorn is used by native fauna for habitat, often in lieu of alternative native vegetation that may have been cleared or has become degraded. In some cases the fauna species are listed as threatened at state or territory and/or national level.

Return to contents page

Ecological and heritage site surveys can provide important information for weed management planning, and may be required by the relevant jurisdiction's legislation. Cultural and historic heritage investigations will identify the presence and condition of sites and artefacts. The resulting baseline information can give land managers a better understanding of the values of the site and will be useful for making later comparisons.

Ecological surveys should record the flora and fauna (including threatened species), as well as the presence and condition of vegetation communities, providing information on the site's biodiversity. A survey might also find threatened species or identify native fauna habitats and corridors.

When planning a boxthorn control activity, it is very important to consider and manage any potential negative implications for landscape values.

Ecological and/or heritage surveys provide important information for weed management planning

2.3.1 Native fauna using African boxthorn

It is not unusual for weed species to provide habitat for native fauna. So, before removing the weed, it is important to assess whether this is the case. Having been in Australia for over 150 years, African boxthorn has become an integral component of many landscapes. Not surprisingly, native animals have adapted to utilise and, in some cases, rely on it.

African boxthorn provides habitat for a range of native fauna species, particularly birds. For example, where there is no indigenous vegetation to offer protective cover, it provides good alternative shelter for fairy wrens such as the superb fairy-wren *(Malurus cyaneus).*

Little penguins *(Eudyptula minor)* are also known to utilise boxthorn. One instance is found at Low Head at the mouth of the Tamar Estuary in northern Tasmania, where land was cleared for grazing early after European settlement. African boxthorn now grows at this site, and it provides the local little penguin colony with cover.

Superb fairy wrens make use of African boxthorn

Return to contents page

Holistic management of African boxthorn was needed in this situation, to ensure that its removal would not harm the little penguin colony. It involved planned removal, revegetation with 2200 suitable indigenous plants, and the provision of 100 artificial burrows. A detailed example of sensitive management of African boxthorn in little penguin habitat is provided in the Phillip Island Nature Parks case study in Chapter 4 (section 4.3).

A more complex example of the relationship between native fauna and African boxthorn involves the critically endangered orange-bellied parrot *(Neophema chrysogaster)*: boxthorn can threaten its natural habitat but also sometimes provides an important alternative. Invasive weeds, including African boxthorn, threaten to degrade the parrot's foraging habitat.[12] However, in parts of coastal Victoria and South Australia where the orange-bellied parrot's native habitat is degraded or gone and boxthorn is established, the invader is actually beneficial. Although it is lower-quality habitat than native vegetation, it is an alternative that is better than nothing. In this type of situation, the best long-term solution may be to re-establish indigenous vegetation in combination with gradual (staged) boxthorn removal.

Examples of usage of African boxthorn by mammals include documented evidence in southern New South Wales and northern Tasmania of a positive correlation between common wombat *(Vombatus ursinus)* burrows and African boxthorn shrubs (along with blackberry *Rubus* spp. in the NSW case).[13,14]

Also, the nationally endangered southern brown bandicoot *(Isoodon obesulus)* is known to use African boxthorn fruit as a seasonal food supplement;[9] and African boxthorn can provide habitat for the nationally vulnerable eastern barred bandicoot *(Perameles gunnii)*.[4]

These complex relationships between native fauna and African boxthorn illustrate how important it is to do considered research and management planning.

When planning a management regime for an African boxthorn infestation, it is important to survey the site to record the species present. You should also check natural-values databases or site-specific flora and fauna surveys, as they might contain records for threatened species on the site. Your management actions can then take into account habitat requirements and threat abatement for native flora and fauna.

2.3.2 Native flora benefiting from African boxthorn

Where African boxthorn is infesting quality intact native vegetation, it will generally be providing little or no benefit to native flora, but rather posing a threat. But in some situations where native vegetation is significantly degraded and/or faces ongoing threats from browsing by livestock and wildlife, African boxthorn can provide some benefits worthy of consideration.

Where browsing pressures are high, African boxthorn thickets can exclude livestock and larger wildlife, allowing native vegetation to establish within the thickets, where it might otherwise have been vulnerable. For example, on the Eyre Peninsula in South Australia, African boxthorn seems to protect threatened west-coast mintbush *(Prostanthera calycina)* juveniles from grazing.[15]

If such benefits can be achieved, it might be beneficial to apply chemicals (for example through the basal bark application method) to suppress the boxthorn, but retain its thorny structure. A potential downside of this is that the dead shrubs can continue to harbour rabbits *(Oryctolagus cuniculus)*, which heavily browse flora seedlings and small plants, native or otherwise. Also, left in situ, the dead boxthorn plants can harbour starlings and other birds that can continue to transport African boxthorn seed to the site.

Return to contents page

Native boobialla Myoporum insulare *establishing under dead African boxthorn at Doctors Rocks, Tasmania*

Retaining dead boxthorn combined with ongoing intervention can be a useful technique to encourage re-establishment of native vegetation. In circumstances where rabbits are less of an issue, such as at some coastal sites, dead boxthorn plants can be used to encourage visits by native birds that will carry and deposit seeds of native flora. However, the chances are that they will be carrying weed seed too, so ongoing intervention will be needed to prevent the establishment of undesirable vegetation.

2.3.3 Cultural heritage

Both the presence of African boxthorn and boxthorn control activities can impact on cultural heritage sites and artefacts. To create an appropriate boxthorn management strategy, you will need to know the location of any heritage sites and artefacts on the property in question. In some cases, site surveys may be necessary.

As an example, coastal areas are likely locations for Indigenous heritage, such as artefacts and other evidence of occupation. Prior to starting any boxthorn control work, it is essential to seek advice and, where relevant, appropriate approvals under cultural heritage legislation. Removal of plants could damage heritage sites and materials directly, e.g. through mechanical damage, and indirectly, e.g. by facilitating increasing soil erosion that might expose relics.

In certain situations appropriate management of African boxthorn can benefit heritage management – for example, where African boxthorn is harbouring rabbits and burrowing activity might damage heritage sites and materials. Boxthorn plants could also have a direct physical impact on historic heritage sites: for example, if plants grow and expand through fences, monuments and other relics.

Return to contents page

2.3.4 Riparian areas

Some states and territories require permits for works undertaken on waterways. It is important to consider carefully the appropriate control options, which may involve a combination of mechanical and chemical control techniques. In some cases boxthorn plants may be the only vegetation stabilising the bank, and consequently total removal of the plant and roots may not be advisable. Where possible, use machinery further away from the water's edge, to avoid destabilising the bank.

In more erosion-prone areas, it may be necessary to exclude stock and to stage works over several years, to allow alternative vegetative cover to establish. In sensitive areas, specific mitigation strategies may be needed, such as: retaining boxthorn roots in situ (for example, using the cut-stump method); soil or bank erosion protection; stock exclusion and provision of alternative watering points; and targeted revegetation. The most appropriate control techniques will depend on individual situations.

Avoid applying herbicides in riparian areas when rain is expected or when rising water levels or flooding are possible. Always check to make sure herbicides are registered for the intended use.

When waterways are involved, try to work in conjunction with neighbouring property owners to plan efforts strategically. Consider the potential for seed to be spread downstream after flooding. In some cases it will be best to start control work on the upstream properties first, and then work downstream.

2.3.5 Steep or inaccessible areas

When working on steep sites, always consider safety first. In some cases you may need to create exclusion zones to prevent injury to operators and the public.

Complete a Job Safety Analysis before work commences, detailing the proposed work methods, steps to be followed to prevent injury, a communications plan, and who is responsible for specific tasks. Safe work practices should be the highest priority.

If climbing equipment is necessary, ensure the operator is trained and holds the relevant permits for this task.

When planning to spray boxthorn, monitor weather forecasts then spray during favourable conditions. Remember that elevated or steep sites may be subject to higher winds.

If using residual herbicides, be aware that the residual effect can move downhill after rain and harm desirable vegetation that may be lower than the target infestations.

For inaccessible infestations of boxthorn, you might need to use mechanical control techniques or fire to create access to the site.

2.4 Developing an African boxthorn management plan

African boxthorn can be a difficult weed to manage. For your efforts to succeed, you will need to plan well.

As the plant grows in diverse situations, it requires a site-specific approach that takes into account a range of variables and determines the best management options for that situation. Every landowner or land manager will have different priorities and considerations.

Remember, whichever control techniques you choose, to be successful in the long term you will need to commit resources to ongoing follow-up.

The diagram overleaf provides a guide for developing an African boxthorn management plan.

Return to contents page

Boxthorn management activities on a steep site

Return to contents page

DEVELOPING AN AFRICAN BOXTHORN MANAGEMENT PLAN

1 Define the problem

- Use aerial photos, GIS software or hand-drawn maps to view your site on a property scale.
- Map the location and density of the African boxthorn infestations. Where possible, map the boxthorn, taking into account national core mapping attributes (see Chapter 5, section 5.7 for details of national core attributes for weed mapping).
- Identify and, where possible, map the 'valuable' assets within the control areas – these could be natural, heritage, agricultural or infrastructure assets.
  - **Natural assets** include the flora, fauna, vegetation communities and condition, waterways, and threatened species that may be present.
  - **Heritage assets** include cultural and historic heritage sites and artefacts.
  - **Agricultural assets** include infrastructure, water sources, soils, livestock and crops.
  - **Infrastructure assets** include buildings, fences, gates, roads and potential water sources.

2 Determine priorities

- Prioritise each infestation (management area) on your map.
- Common priorities for treatment:
  - outliers (to prevent further spread into boxthorn-free areas)
  - easier areas to control
  - where a specific asset is at risk (this will depend on what you value and consider to be important).
- Identify any difficult-to-control areas.
- What are your legal responsibilities in regard to weed control? (See Chapter 5, section 5.1 for details of legal responsibilities for African boxthorn management in your state or territory.)
- Consider local government, Catchment Management Authority or Natural Resource Management regional priorities and plans.

3 Determine integrated management options

- Minimise the spread of boxthorn onto or around your property via animals or machinery that might transport seed or viable plant materials (refer to section 2.2 for further information).
- Identify the available resources and what will be needed to complete your project (factor in at least five to 10 years), including:
  - labour
  - skilled, experienced and trained contractors
  - machinery and equipment (e.g. dozer, tractor, spray unit, chainsaws)
  - potential project partners or stakeholders (e.g. neighbouring properties, community groups, local Catchment Management Authority or Natural Resource Management programs).
- Does legislation affect what you can do, in regard to land clearing, threatened species, working on waterways, herbicide use and fire?
- Do you need to apply for permits for specific activities?
- Decide on management options for primary control, follow-up control and monitoring, for each infestation.

Return to contents page

4 Develop a financial plan

- Estimate the costs associated with each infestation (management area). Include contractors, machinery/vehicle running costs, chemicals and fuel.
- Account for future follow-up control being required, for up to 10 years.
- Find out whether there are financial incentives or labour programs available in your region for enhancing the condition of native vegetation or waterways on your property.
- Before committing a large amount of money, conduct small-scale trials or seek advice from weeds officers, local farmers, local land managers and experienced contractors.

5 Develop a management schedule

- Prepare a long-term timetable for boxthorn control.
- Begin primary control on areas small enough to follow up annually.
- Return to all sites each year after treatment for at least five years, to treat survivors, regrowth and new seedlings.
- Different control methods are effective in different seasons. Balance this against the time and labour available.
- Be flexible, to allow for wet or dry seasons.
- Integrate boxthorn control with other existing management activities, e.g. earthworks, pasture improvement and weed control.

6 Monitor progress

- Monitoring is critical to the long-term success of your project.
- Record the control methods, timing, herbicides and costs for each management area.
- Check treated infestations for regrowth or germination.
- Regularly inspect disturbed areas (affected by soil disturbance, fire, flood) for new outbreaks.
- Evaluate the effectiveness of each method.
- Take photos of the site over time, from the same position, to show and record the progress achieved.

7 Follow up what you have started

- Follow-up is critical!
- Follow up all treated infestations annually, or when they are identified through monitoring.
- Use the most suitable follow-up method for your situation.

Adapted from: Gouldthorpe J. Weeds of National Significance gorse national best practice manual. Hobart: Department of Primary Industries and Water, 2009. Spies P, March N. National case studies manual: prickly acacia. Queensland: Department of Natural Resources, Mines and Energy, 2004. Kirkpatrick JB, Gilfedder LA. Tasmanian Bushcare toolkit. Hobart: Department of Primary Industries, Water and Environment, 1999.

Return to contents page

References

1. Rutherford MC, Powrie LW, Husted LB. Herbivore-driven land degradation: consequences for plant diversity and soil in arid subtropical thicket in south-eastern Africa. Land Degradation & Development, 2012.
2. Muyt A. Bush invaders of south-east Australia. Meredith, Victoria: RG and FJ Richardson, 2001.
3. Parsons WT, Cuthbertson EG. Noxious weeds of Australia. Melbourne: Inkarta Press, 2004.
4. Adair R. Feasibility of biological control of African boxthorn *(Lycium ferocissimum)*. Bittern, Victoria: Australis Biological, 2013.
5. Ziegler K, Hopkins K. Furneaux Islands boxthorn control. Tasmania: Friends of Bass Strait Islands – Wildcare, 2011.
6. Taylor RH. Introduced mammals and islands: priorities for conservation and research. Proceedings of the New Zealand Ecological Society 1968;15:61–67.
7. Harris S, Buchanan A, Connolly A. One hundred islands: the flora of the outer Furneaux. Hobart: Tasmanian Department of Primary Industries, Water and Environment, 2001.
8. Stanley MC, Lill A. Avian fruit consumption and seed dispersal in a temperate Australian woodland. Austral Ecology 2002;27(2):137–48.
9. Quin D. Observations on the diet of the southern brown bandicoot, *Isoodon obesulus* (marsupialia: peramelidae), in southern Tasmania. Australian Mammalogy, 1985;11:11–25.
10. Nogales M, Delgado JD, Medina FM. Shrikes, lizards and *Lycium intricatum* (Solanaceae) fruits: a case of indirect seed dispersal on an oceanic island (Alegranza, Canary Islands). Journal of Ecology 1998;86:866–71.
11. Kennewell M, Simpson G, telephone communication, 24 May 2013.
12. Department of Primary Industries and Water. National recovery plan for the orange-bellied parrot *(Neophema chrysogaster)*. Hobart: Department of Primary Industries and Water, 2006.
13. Roger E, Laffan W, Ramp D. Habitat selection by the common wombat *(Vombatus ursinus)* in disturbed environments: Implications for the conservation of a 'common' species. Biological Conservation, 2007;137:437–49.
14. Taylor RJ. Observations on the behaviour and ecology of the common wombat *Vombatus ursinus* in northeast Tasmania. Australian Mammalogy, 1993;16:1–7.
15. Pobke K. Draft recovery plan for 23 threatened flora taxa on Eyre Peninsula. South Australia: Department of Environment and Heritage, 2007.

Return to contents page

CHAPTER 3
Controlling African boxthorn

NSW National Parks and Wildlife Service

CHAPTER 3
Controlling African boxthorn

Jon Fallaw, Phillip Island Nature Parks

Winching out an individual African boxthorn plant

This chapter lists and considers the suitability of various methods that can be used to control African boxthorn. As boxthorn grows in a variety of situations, it is important to be aware of the range of options available, and which ones will best suit a specific site.

Chapter 2 outlines issues to be considered when planning on-ground works. Assess these issues for each site before proceeding with works.

African boxthorn infestations almost always require a series of treatment combinations over many years as it is a very resilient species with an outstanding capacity to regenerate from rootstock, stems and seed.

3.1 Mechanical control

Suitable mechanical techniques for managing African boxthorn include the following:

- winching
- pulling or plucking
- dozing, stick raking and blade ploughing
- cultivation
- machine-based cut stump.

Mechanical control of boxthorn is best done when the plant is not carrying fruit or seed; otherwise, fresh seed is likely to be deposited into freshly disturbed soil.

3.1.1 Winching

Pulling or winching (for example with a tractor and chain) can be used to remove large plants in difficult-to-access or fragile areas (such as coastal dunes). The technique involves connecting a chain or cable to the base of large individual plants and using slow, consistent force to remove the plant, and as much root matter as possible. Remaining roots are then poisoned using cut stump technique to minimise regrowth (see section 3.2.4).

3.1.2 Pulling or plucking

Grabbing and lifting the plants mechanically is a useful technique for treating light to moderate infestations, and minimises impacts on surrounding vegetation. The technique involves using a front-end loader, articulated loader or excavator to physically remove individual plants and as much root mass as possible.

South Australian company Higgins Engineering Pty Ltd has developed a two-armed puller specifically for use on African boxthorn. The puller has hydraulically-operated arms. When these are mounted on the front of a tractor

Return to contents page

African boxthorn puller designed and built by Higgins Engineering Pty Ltd in South Australia

African boxthorn puller being used by New South Wales National Parks and Wildlife Service

they have a scissor action that closes against the trunk/stem of the boxthorn bush, then lifts and removes the bush and its root system. A case study in Chapter 4 explains how the puller has been used in Oolambeyan National Park in New South Wales.

3.1.3 Dozing, stick raking and blade ploughing

Dozing, stick raking and blade ploughing are most suitable for moderate to heavy African boxthorn infestations where the risk of damaging non-target vegetation and the landscape is not a concern. For example, this might be where boxthorn has established on production lands (typically beneath remnant trees in grazing country) and is preventing stock accessing pasture or water.

3.1.4 Following up after the above techniques

With each of the above techniques, boxthorn bushes should be piled and burnt. Dead boxthorn bushes can continue to harbour rabbits *(Oryctolagus cuniculus)*, starlings *(Sturnus vulgaris)* and other pests.

Return to the site and treat regrowth from the roots or plant base with herbicide, and hand pull, cut and paint, or spray seedlings. Follow-up will be required until there is no more regrowth or seed germination.

3.1.5 Cultivation

In areas that are to be used for pasture or crops, after physically removing the African boxthorn, cultivation can be a useful technique. It will break up roots remaining in the soil and bring root fragments to the surface, where they will dry out and/or should be raked and burned. The technique can also be used for the dual purpose of destroying rabbit burrows and habitat.

As cultivation may result in deeper root fragments shooting, it will almost certainly be necessary to follow up with chemical application to ensure regrowth and seedlings do not get a foothold. Spray regrowth once it reaches a suitable height (e.g. 500 mm), to ensure there is enough foliage for the uptake of herbicide.[1,2]

Establishing vigorous pasture or crop growth will help to prevent re-establishment of boxthorn, by providing competition.[1]

3.1.6 Mechanical cut-stump

Another option is machine-based cut-stump control, which involves cutting the plant

Dozing of African boxthorn in preparation for cultivation to manage rabbits

Return to contents page

Machine-based cut stump in action, south coast, Western Australia

near its base then immediately applying herbicide. Being a mechanical technique, it can be done far more quickly and on a larger scale than is possible with traditional cut-stump treatment.

One example of the machinery that can be used for this process is Ecoblade®, which has been used by Phillip Island Nature Parks in Victoria. Custom-made equipment also exists. For example, a contractor for South Coast Natural Resource Management (NRM) in Western Australia has used custom-made cut-stump gear. Both of these examples are detailed in case studies in Chapter 4.

Ecoblade® (pictured in the Phillip Island Nature Parks case study in Chapter 4, section 4.3) is a machinery-mounted slasher and herbicide applicator as a single unit, which can carry out cut stump on a large scale. Blades cut the boxthorn stem then herbicide is wiped onto the cut surface from the bottom of the blades. This machinery is most suited to moderate to heavy African boxthorn infestations on sites where environmental (e.g. native vegetation) and cultural heritage values are not of concern. It is not suitable, for example, for coastal sites where ground-nesting birds such as short-tailed shearwaters *(Puffinus tenuirostris)* and/or middens might be found.

Phillip Island Nature Parks has had success using Ecoblade® for follow-up where African boxthorn reshoots from roots after initial control efforts.[3] One advantage of Ecoblade® is that the slashing process mulches the plant debris, reducing the need for burning. It is unlikely to be suitable for primary control of large, woody plants, but it is ideal for the follow-up work.

Return to contents page

3.2 Chemical control

This section provides an overview of chemical use certification requirements, background on herbicide choice, and an overview of chemical control techniques suitable for use on African boxthorn.

3.2.1 Chemical use certification

In Australia commercial operators who apply herbicides generally must have training and certification, though the situation varies between states and territories. Some jurisdictions require land managers to obtain certification before they apply certain chemicals (for example, herbicides containing the active ingredient triclopyr).

An example of a nationally accredited chemical-use training package is the ChemCert Australia Accreditation. The training package includes information on how to do the following:

- follow basic chemical safety rules
- prepare and apply chemicals
- apply chemicals under supervision
- transport, handle and store chemicals.

It is your responsibility to comply with the relevant rules and legislation for your location. Contact the relevant department in your state or territory for further information

These are listed in Chapter 5 (section 5.6).

3.2.2 Herbicide

There are hundreds of chemical brands registered for use on African boxthorn in Australia. These are listed in full in Chapter 5 (section 5.2).

All herbicides come with a label which is a legal document that the user must read and follow when preparing and applying the herbicide. The label details the Personal Protective Equipment (PPE) required, the mix rate and the appropriate growth stage for application, as well as how to use the herbicide safely and effectively. Before undertaking chemical control, make sure you have read the Material Safety Data Sheets (MSDS) for the herbicides being used, and keep them close at hand in case of emergency.

In choosing the most appropriate herbicides to use on African boxthorn for your situation, you will need to ascertain:

- which application techniques are to be used (e.g. cut-stump initially, and later foliar spray to manage regrowth)
- which herbicides are registered/ permitted for application with those techniques in your state or territory.

It is recommended that you seek advice from your relevant state or territory department in regard to permitted chemical options in your area for management of African boxthorn. This should be done before you make choices about techniques and herbicides.

Examples of suitable herbicides are provided in the sections below that detail each technique. However, in some instances (such as with the use of certain chemicals on African boxthorn in natural areas), off-label permits differ between states and territories. Refer to Chapter 5 (section 5.3) for further information on these.

Some jurisdictions provide specific advice on their websites. For example, the New South Wales Government publishes a *Noxious and environmental weed control handbook* that provides herbicide recommendations for African boxthorn and can be downloaded from www.dpi.nsw.gov.au/agriculture/pests-weeds/weeds/publications/noxious-enviro-weed-control. The Tasmanian Government provides specific advice on *Herbicides for African boxthorn control* at www.dpipwe.tas.gov.au/inter.nsf/WebPages/LBUN-7ZD55J?open.

Suitable chemical (herbicide-based) control techniques for managing African boxthorn include the following:

- foliar spraying
- cut-stump application
- stem injection or frilling
- basal bark application
- soil–root zone application.

Return to contents page

Regrowth after foliar spraying

3.2.3 Foliar spraying

Large African boxthorn plants can potentially reach a height of several metres. For safety reasons, foliar spraying should be limited to the control of small to mid-sized plants, regrowth and seedlings. Also, mature African boxthorn plants have deep root systems which seem to be resilient beyond primary control by foliar spraying, often requiring numerous re-treatments.

Successful control of African boxthorn is dependent on the season, weather conditions during spraying, the vigour of the plants, how thoroughly the herbicide is applied, and the herbicide mix and application rate. To maximise effectiveness, plants should be sprayed when they are actively growing and have enough foliage to absorb the herbicide. Avoid spraying when plants are stressed by hot or dry conditions, or in periods of waterlogging or extreme cold.

Choose the appropriate herbicide for each situation. For example, when spraying boxthorn regrowth in or adjacent to a wheat cereal crop, broadleaf selective herbicides are more appropriate than non-selective herbicides, as they will not damage the crop.

Herbicides used for foliar application on African boxthorn include those based on:

- triclopyr and picloram mix (e.g. Fightback®)
- triclopyr, picloram, aminopyralid mix (e.g. Grazon® Extra)
- glyphosate (e.g. Roundup® Biactive)
- picloram and 2,4-D amine (e.g. Tordon® 75-D).

Adding an adjuvant (e.g. wetting agent) when spraying can improve results by improving the rate of leaf wetting and herbicide absorption. Using a marker dye to highlight the herbicide coverage will help the operator to spray efficiently, saving time and money. Always read the additives' product labels to ensure they are compatible. Do not add these wetting agents to the mix when spraying near waterways.

African boxthorn is renowned for losing its leaves after being sprayed and appearing to be dead, but then later producing new foliage. This can happen several times before the plants die, so follow-up control will be required for at least several years.[1,4]

3.2.4 Cut-stump application

Sometimes called 'cut and paste' or 'cut and paint', this method involves cutting the stem or stump approximately 100 mm above ground level, then applying a herbicide to the surface of the cut *within 15 seconds*. It

Return to contents page

is most easily done by working in pairs, with one person cutting the stumps and another applying the herbicide. The addition of a marker dye is recommended, to indicate which plants have been treated.

The cut can be made with a range of tools, usually a combination of chainsaw, long-handled loppers and bowsaw. The New South Wales National Parks and Wildlife Service has successfully used pneumatic loppers for this technique (see the Oolambeyan National Park case study in Chapter 4 (section 4.1) for more details). In some cases you will need to prune the plant carefully to gain access to the main stem and make the final cut.

Take great care to avoid injury when cutting and handling boxthorn. Protect your skin and eyes. The long, dangerous thorns can easily puncture skin, even through sturdy gloves. The resulting wound can become infected and might be painful for several weeks.

The cut-stump method uses a higher concentration of herbicide mix, but in lower volumes than foliar spraying. Chemicals applied to the cut surface will travel down the stem to the root system. The herbicide is often applied with a pump-spray bottle, trigger-spray bottle or knapsack sprayer.

Once the cut has been made, *herbicide needs to be applied immediately* to prevent the wound healing. *Do not make the cut unless herbicide can be applied within 15 seconds.*

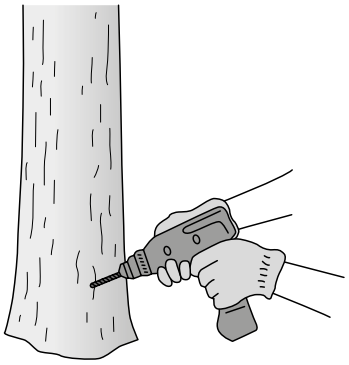
Herbicides used for cut-stump application on African boxthorn include triclopyr and picloram mix–based herbicides (e.g. Access®), and triclopyr-based herbicides (e.g. Garlon® 600). Check the label to ensure that particular products can be used in your state or territory with this method.

Dead boxthorn debris can continue to harbour rabbits, starlings and other pests. After they have been cut away, green boxthorn stems and trunks can survive and regrow if they are left in contact with the soil and conditions are suitable. Therefore it is important to destroy the remnants of the plant wherever possible. Depending on circumstances (such as environmental sensitivities), pile and burn or mulch this woody mass. At the very least, roll large bushes over so that they rest on the dead outer branches and the main trunk is not in contact with the ground.

This method can be labour-intensive, depending on the size of the plants, density of the infestation and the resources available. Regrowth will require follow-up control for at least several years.

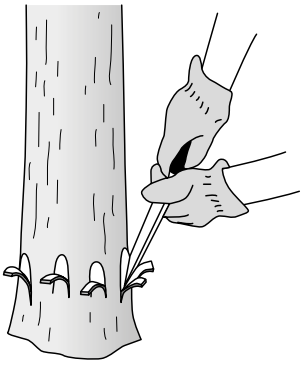
Completed cut-stump work including indicator dye

Return to contents page



Brett Littleton, DPIPWE, Tasmania

Applying herbicide via the stem injection method



Brett Littleton, DPIPWE, Tasmania

Applying herbicide via the frilling method

The cut-stump method is useful for isolated plants, smaller infestations near waterways, and plants close to sensitive native vegetation or infrastructure.

3.2.5 Stem injection/frilling

Stem injection is generally done by using a cordless drill, pneumatic drill or specialised tree surgeon's tools to drill into the trunk at an angle. Frilling involves using an axe or similar tool to wedge/lever away a section of bark. Both methods involve making wounds at regular intervals around the whole trunk, just under the bark, between the living and dead wood. Herbicide is then applied immediately (within 15 seconds) directly into the cambium (actively growing) layer, using spray bottles, a tree injector or a knapsack sprayer.

As with the cut-stump method, beware of injury when in such close proximity to thorns. (See precautions outlined in section 3.2.4.)

This method is best suited to large isolated plants with a trunk diameter over 50 mm. It will not be practical for African boxthorn in most situations (where plants are smaller and closer together); in those circumstances, the cut-stump or foliar spray methods are preferable.

Stem injection or frilling will suit environmentally sensitive areas where it is desirable to retain dead standing boxthorn biomass to provide temporary habitat for native fauna, or for other environmental considerations. If there are no other boxthorn infestations nearby, it is possible that leaving the plant debris in situ will aid the re-establishment of native vegetation, as native birds may roost in it and deposit local native plant seed on the ground below. However, there is still a risk of birds introducing more weeds to the site. Dead boxthorn plants can also assist native vines, by providing a framework for them to climb on.

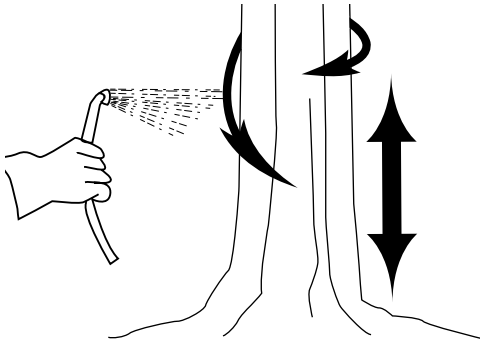
Herbicides used for stem injection/frilling application on African boxthorn include triclopyr and picloram mix–based herbicides (e.g. Access®), and triclopyr-based herbicides (e.g. Garlon® 600). Check the label to ensure that particular products can be used in your state or territory with this method.

3.2.6 Basal bark application

This technique is generally effective on bushes with a trunk diameter of up to 50 mm. Each trunk or stem needs to be sprayed, ensuring complete coverage around the whole stem, from ground level to a height of 400 mm. The herbicide is absorbed into the basal bark and root system. It is often mixed with diesel and applied with a knapsack sprayer.

You might need to clear the vegetation beneath the boxthorn plants, to ensure enough herbicide reaches the target area. To avoid being injured by thorns, try changing or adjusting the nozzle of the sprayer so that you can treat the whole trunk or all stems without changing your position

Return to contents page



NSW NPWS

Applying herbicide via the basal bark method

Alan Wood

Likely bio-control candidate: a rust (Puccinia rapipes) *on* Lycium *sp. (most likely* Lycium ferocissimum*) in South Africa*

(this may not be a practical option for large multi-stemmed plants). Adding a marker dye is recommended, to make it easy to see which plants have been treated.

Herbicides used for basal bark application on African boxthorn include triclopyr and picloram mix–based herbicides (e.g. Access®), and triclopyr-based herbicides (e.g. Garlon® 600). Check the label to ensure that particular products can be used in your state or territory with this method.

This method is best suited to isolated bushes where boxthorn trunks and/or stems are easily accessed, and is useful for boxthorn control where you want to retain dead standing plants as temporary habitat for native fauna, or for other environmental reasons.

3.2.7 Soil–root zone application

In this method, herbicide is applied evenly to the soil near the drip line of the bush, when the soil is wet or rainfall is predicted. Soil-applied herbicides move through the root zone after rain and are absorbed into the roots.

Treated plants can lose and regrow their foliage several times before dying. It can take several years to kill the target plant.

It is important to note that residual herbicides can remain active in the soil for a long time, might travel downhill on steep or sloping ground and can leach into the water table. Native trees and shrubs are very susceptible to residual herbicides. This method is best suited for use in agricultural areas away from non-target trees and shrubs, native vegetation or waterways. It is not suitable for use in environmentally sensitive areas, or where revegetation is planned.

The number of registered herbicides available for this method is limited. Herbicides that can be used for soil-root zone application on African boxthorn include picloram-based herbicides (e.g. Tordon®), and tebuthiuron-based herbicides (e.g. Graslan®). Check the label to ensure that particular products can be used in your state or territory with this method.

3.3 Biological control

Biological control is not a management option for African boxthorn in Australia now or in the immediate future. To date, the potential of biological control for African boxthorn has not been thoroughly investigated. An initial feasibility study was completed in 2013. This provides recommendations on progressing biological control research for African boxthorn.

Potential African boxthorn biological control agents, such as a rust fungus *(Puccinia rapipes)*, are known from southern Africa. However, even if biological control research for African boxthorn is pursued, it would still take significant time, involving rigorous assessment of any potential agent before it could ever be released in Australia.

Return to contents page

African boxthorn re-sprouting after the 2013 bushfires in south-eastern Tasmania

Vehicle wash-downs on entering and leaving sites can help minimise the spread of weeds. African boxthorn seed can be spread in mud and be carried by vehicles.

3.4 Other control options

Hand pulling can be an option for very small plants. It is generally easier to do after rain, when the soil is wet. The entire tap root must be pulled out, or the plant will regrow.

Fire can be useful to clear the woody branches and improve access, but will also encourage African boxthorn regrowth from rootstock. Fire can be useful for small to medium infestations where foliar spraying is the preferred follow-up control method. However, as mature boxthorn rootstock is substantial and hard to kill, wait until sufficient re-sprout (leaf area) has grown before foliar spraying, to ensure effective uptake of herbicide.

As mentioned in section 3.1.4, piling and burning the dead bushes can help to prevent injury to animals and humans, reduce habitat for rabbits and starlings, and avoid the risk of puncturing vehicle tyres. Mulching is an alternative, but will likely leave thorn and seed residue on site.

Grazing is generally not a recommended control option. African boxthorn plants (fruit, leaves, stem and roots) are considered poisonous to livestock.[4,5]

3.5 Hygiene protocols

The most cost-effective way to manage weeds is to prevent their spread. African boxthorn is sometimes spread via seed or vegetative material that is transported in gravel, mud and agricultural produce, either carried in vehicles or attached to vehicles and machinery.[4,6] State and territory laws prohibit the transporting of legally recognised (declared) weeds.

Weeds can be spread by the vehicles and machinery of contractors or land managers travelling between sites and regions. Only use trusted suppliers to supply 'clean' soil and quarry materials to your sites, and ensure all vehicles, machinery, equipment and clothing entering or leaving any site are inspected and cleaned. Soil, vegetative material, fruit and seeds should be removed and disposed of appropriately.

3.6 Combining methods for long-term control

Every site is different and will present its own unique challenges for African boxthorn management. For effective long-term results, your planning and management approach will need to consider each individual situation and combine the control methods that best suit your circumstances.

Experience outlined in the Oolambeyan National Park (New South Wales) case study (Chapter 4, section 4.1) showed that the combination of cut-stump (using hydraulic shears) and machinery-based plucking of plants could be followed up by foliar spraying of regrowth to achieve lasting results. The team on this project

Return to contents page

Ross Gardiner, NSW National Parks and Wildlife Service

Integrating control methods in southern NSW: the National Parks and Wildlife Service found that pulling boxthorn needed to be followed up later with foliar spraying of regrowth

found that it was best to use cut stump in environmentally sensitive areas, but it was more labour-intensive and slow. The quicker technique of machinery-based plucking was suitable for less sensitive areas.

Foliar spraying with its limited effectiveness on African boxthorn was only used on follow-up spraying of regrowth after the more effective cut-stump and plucking work.

However, when staff numbers are low, park managers use foliar spraying as the next best option. It is clear that with African boxthorn, as with many other weeds, the keys to success include persistence and flexibility in the use of integrated control methods.

3.7 Post-control monitoring and evaluation

It is important to monitor and evaluate the results of your control efforts. This can potentially save a lot of time and money by increasing efficiency through learning from mistakes and making ongoing improvements.

Ongoing monitoring will help you to plan and implement follow-up control when it needs to be done. If you do not inspect treated areas for several years, regrowth may reach the size of the original infestation, meaning you have wasted your time and money.

Evaluating the results will show you which management regime works best for a particular situation. This need not be an onerous process: a good start would be simply to record the time of year control work is done and the herbicide mix used, and to take some 'before' and 'after' photos. Even basic documented evaluations can be useful to share with managers of neighbouring properties, community groups, contractors and funding bodies.

Return to contents page

3.8 Site rehabilitation

To prevent re-infestation of control sites, take a long-term approach to restoration of native vegetation, pasture or other desirable vegetation. Also remember that, if some African boxthorn remains in the general area of the control site, the weed can readily be re-deposited on-site by fauna, so additional ongoing management will be necessary.

Where primary control efforts have disturbed the soil, many weeds are likely to take advantage of the situation. Monitor the species that germinate in the bare ground. You may need to control these new weeds until more desirable species become established.

3.8.1 Restoring native vegetation

When African boxthorn occurs where native vegetation is present or desired, promoting regeneration, or revegetation with local native species can provide improved wildlife habitat and, if managed well, reduce the likelihood of boxthorn re-establishing.

To restore native vegetation successfully, you will need to consider whether the site is best suited to regeneration or revegetation, and the best way to continue to manage African boxthorn infestations alongside the restoration work.

Natural regeneration or revegetation?
Natural regeneration is the process in which indigenous species recolonise a site, over time, either via seed bank or from adjacent areas. Natural processes such as soil disturbance, fire, or seed deposited on-site by animals, wind or water, may be required to facilitate regeneration. Native vegetation can sometimes be slow to establish via natural regeneration but, compared with revegetation techniques, the resulting plants are hardier and more likely to continue to regenerate in the long term. Encouraging natural regeneration processes can be the most cost-effective way to restore native vegetation.

Revegetation involves introducing native plants to a site using tube stock, direct seeding, or other methods. This is generally done on sites that have been degraded, and a combination of methods may be used. Local-provenance seed or vegetative material should be collected from indigenous species that suit the soil type and vegetation community being restored. Seek advice on this from your local council, regional natural resource management (NRM) organisation or catchment management authority (CMA), or organisations such as Greening Australia.

For large sites where dispersal of boxthorn seed is still a risk, it might be better to focus efforts on follow-up control for several years (up to 10 years), before attempting revegetation. If the boxthorn regrows or germinates amongst revegetation, it can be difficult to control without damaging the new native plants.

Options for revegetation
Where revegetation is the preferred option, it will need to be planned at least six to 12 months ahead, and in some circumstances even longer. Depending on the scale of the task, seed may need to be collected and plants grown and hardened either by a nursery or by you well in advance. Generally, if you order the plants at least six months before they are required, you will pay less than if you buy 'off the shelf'. The tube-stock method potentially allows a wider variety of species to be used in the mix than direct seeding does. Conditions may change during the lead-up to planting, and contingency plans are needed, to allow for situations such as drought or flood.

Direct seeding relies on rainfall and can be done on prepared sites by hand sowing or machine direct seeding. Hand sowing is useful for small, rocky, steep or otherwise

Return to contents page

hard-to-access sites. Another method is to lay seed-laden branches on the surface. Machine-based direct seeding uses specialised seeding machinery calibrated to handle various seed sizes and sowing depths. This is useful for establishing the vegetation community 'structure' on a broadacre scale. For maximum success, the sites must be properly prepared.

Site preparation and ongoing management
It will be necessary to control browsing by stock, rabbits, deer and wildlife before attempting to restore native vegetation and for several years afterwards, until the plants are established. Depending on the type of browsing pressure, management options could include fencing, tree guards and, in some situations, seeking permits to shoot or poison animals to reduce the impacts of browsing.

All revegetation methods require site preparation, which may include controlling weeds with a knockdown spray or scraping away the topsoil to provide a weed-free area to plant or sow seed into. It may take several years of weed control to exhaust the weed seed bank and regeneration capacity. For some sites, ground preparation might involve ripping, mounding or cultivation to aid planting or sowing of seed.

Monitor revegetation sites for pest insects and, where necessary, implement control programs.

Larger revegetation sites should be staged over several years. Where possible, monitor long-range weather forecasts and schedule activities for times when conditions improve chances of success. Start on a small scale until you achieve good results, then increase the size of the project.

Ongoing maintenance of sites is important. Even natural regeneration sites can, at times, benefit from reduction of weed competition. Always make sure that access for vehicles and machinery (and, if necessary, stock access for limited grazing as a management tool) is available for follow-up maintenance of the revegetated area. If fencing impedes access, consider installing gates at strategic points for vegetation management activities.

3.8.2 Restoring agricultural lands

On agricultural land where African boxthorn is controlled and debris managed, re-establishment of pasture or other crops should be carried out as soon as possible where the ground is disturbed. Land management practices such as pasture improvement and encouraging adequate ground cover can prevent or reduce boxthorn seedling establishment.

Follow-up control measures will be required when boxthorn reshoots from rootstock and germinates from the soil seed bank. Livestock grazing is generally not a good follow-up strategy for African boxthorn control due to the weed's toxicity, limited palatability and thorns. Agricultural lands cleared of African boxthorn should be revegetated with pasture grasses, and selective herbicide can later be applied to boxthorn regeneration with minimum impact on non-target vegetation.

Return to contents page

References

1. Department of Primary Industries, Parks Water & Environment, 2013. African boxthorn control guide. DPIPWE, Tasmania, viewed 29 July 2013, <http://www.dpipwe.tas.gov.au/inter.nsf/WebPages/RPIO-523VU9?open>.

2. Gray PG, Joshua EMK, McCaffery AC. African boxthorn, 2012. Department of Primary Industries, New South Wales, viewed 29 July 2013, <http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0004/206176/African-boxthorn-Primefact-654-2nd-Ed-web.pdf>.

3. Weston J, phone conversation, 22 January 2013.

4. Parsons WT, Cuthbertson EG. Noxious weeds of Australia. Melbourne: Inkarta Press, 2004.

5. McKenzie R. Australia's poisonous plants, fungi and cyanobacteria. Collingwood, Victoria: CSIRO Publishing, 2012.

6. Muyt A. Bush invaders of south-east Australia. Meredith, Victoria: RG and FJ Richardson, 2001.

Return to contents page

CHAPTER 4
Case studies

Jon Fallaw, Phillip Island Nature Parks

CHAPTER 4
Case studies

4.1 Oolambeyan National Park, south-west New South Wales

Jim Balnaves (former Pest Control Officer, NSW National Parks and Wildlife Service) was part of a substantial effort between 2006 and 2008 to reduce the African boxthorn infestation in Oolambeyan National Park in inland New South Wales. He says that having a range of control tools at hand, and ensuring follow-up, were critical to on-ground achievements.

Ross Gardiner (Technical Officer Pest Management, NSW National Parks and Wildlife Service) continues the current effort to keep African boxthorn suppressed to a level that minimises the negative impact on the values of Oolambeyan National Park.

Oolambeyan National Park was created in 2002 and covers an area of 21 851 hectares near Carrathool and Hay in the Western Riverina region of New South Wales. It was formerly a wool-growing property and has a broad range of important environmental and heritage values. These include: provision of habitat for threatened fauna, such as the plains wanderer *(Pedionomus torquatus)* – a ground-dwelling bird; a diversity of significant vegetation communities; and substantial Aboriginal and historic heritage values.[1]

NSW National Parks and Wildlife Service staff using pneumatic shears to gain access to an African boxthorn base for cut-stump treatment

African boxthorn is a major problem affecting approximately 5000 hectares of the national park.[2] Boxthorn provides habitat for foxes *(Vulpes vulpes)*, rabbits *(Oryctolagus cuniculus)* and feral cats *(Felis catus)*, compounding the management challenges at Oolambeyan. Where African boxthorn is present, effective rabbit control is impossible until the boxthorn has been controlled.

Work to manage boxthorn at Oolambeyan began around 2006. Jim Balnaves was part of the crew that worked on the infestation during the first couple of years. He recalls that a key part of the formula was putting together a specialised set of tools for the job. The team used pneumatic shears (usually used for pruning in vineyards, though a higher-capacity compressor was required for boxthorn plants) to cut branches and eventually the base of plants (up to about 50 mm in diameter). Once the plant was cut to a stump, to avoid contact with the thorns a specialist handmade tool was used to push away the bulky mass of the plant. A mix of triclopyr/picloram/liquid hydrocarbon–based herbicide (e.g. Access®) and diesel was painted onto the stump as soon as possible following cutting. This was found to be very effective. The removed plant debris was stockpiled and burnt at a later date. If the debris is not piled and burnt, it can continue to harbour rabbits.[2,3]

The blade of the pneumatic shears. The shears are run from an air compressor based on a trailer.

Return to contents page

Boxthorn puller mounted on a tractor

In this situation it was important to minimise harm to the surrounding environment and an advantage of this approach was that it had a low impact on non-target plants (e.g. salt bush and eucalypts). In many instances in the national park, alternative techniques such as use of machinery (e.g. dozing) and different herbicide application methods (e.g. foliar spraying or the use of granule-based herbicides) would have the potential to cause unacceptable levels of damage to and destruction of non-target plants.

The success of foliar herbicide application to African boxthorn can depend heavily on the season, the health of the plants and local conditions. However, cut-stump is a more certain technique that can be used successfully in any season.

In sandy soil areas, for smaller to mid-size plants and where treatment was less likely to damage non-target plants (e.g. in relatively pure stands of boxthorn), a boxthorn puller – a grab (manufactured by Higgins Engineering Pty Ltd in South Australia) mounted (in this case) on a tractor – was used to physically remove plants. It was found that follow-up was critical with this technique, as any roots left behind would subsequently send up shoots. Regrowth was later foliar sprayed.

In suitable situations (i.e. where off-target damage was less likely), chains were also used to physically remove plants. As was the case with boxthorn puller, regrowth was later foliar sprayed.

Problems encountered by the Oolambeyan crew included boxthorn bushes growing near to buildings or fences and in native vegetation, making access more difficult. They also needed to consider cultural heritage and threatened species issues and manage them appropriately. However, Jim Balnaves recalls that tackling these situations was made much easier by having a range of control tools at their disposal.

Return to contents page

African boxthorn in natural sand-hill area vegetation, southern NSW

For example, pneumatic shears made it possible to cut and paint boxthorn bushes near buildings and fences.

Ross Gardiner says that, in more recent times, foliar spraying has been successfully used in Oolambeyan. Once the larger plants are removed, foliar spraying (of regrowth) is much simpler. The crew used a glyphosate-based herbicide with a surfactant. Ross found that the most effective time to spray was during September when the plants are a vibrant green before flowering.

By 2013 it was clear that the work on boxthorn needed to be revisited. Ross says that staff loss has been a challenge that has slowed down their ability to control boxthorn regrowth in recent years. The NSW National Parks and Wildlife Service's ongoing strategy for managing boxthorn in Oolambeyan is to protect the environmental assets (the reasons for the park's declaration) as well as visitor and management infrastructure. For example, Ross comments that the boxthorn infestations are mostly in the sand-hill area at this point, and one aim is to keep it out of other areas that the plains wanderer relies on for primary habitat.

For Jim Balnaves, the satisfaction was in acquiring and using the right tools to achieve efficient and successful treatment of this notoriously hard-to-kill weed. Looking back, Jim says:

The follow-up is the critical thing. You must go back and spray the reshoot. On the positive side, each time you go back it is an ever-decreasing problem.

Return to contents page

4.2 Furneaux Islands, north-east Tasmania

Karen Ziegler and Katriona Hopkins work as natural resource management professionals and volunteers with Friends of Bass Strait Islands (FOBSI). In 2011 they produced a report, Furneaux Islands Boxthorn Control, which documents FOBSI's findings through experience with boxthorn management. Having both an established and proven boxthorn control method and a schedule for ongoing management are key components of their group's work in the Furneaux Islands.

The Furneaux Group of islands, to the north-east of mainland Tasmania, consists of about 50 islands (or up to 100 if rocky outcrops and reefs are included) and centres on Flinders, Cape Barren and Clarke Islands (the three biggest). Many of the islands have limited vegetation diversity, but provide good seabird and marine mammal habitat.

African boxthorn (which appeared on a Tasmanian nursery list from as early as 1845) was introduced to the islands to establish windbreaks. In seabird rookeries on the islands the soil is highly fertile and is significantly disturbed by seasonal seabird activities. This is an ideal environment for the establishment of weeds like boxthorn.

It is thought that African boxthorn spread within the Furneaux Group has occurred via starlings *(Sturnus vulgaris)*, ravens *(Corvus* spp.*)*, blackbirds *(Turdus merula)* and silvereyes *(Zosterops lateralis)*.[4-7] Other species, such as the black currawong *(Strepera fuliginosa)*, silver gulls *(Chroicocephalus novaehollandiae)* and Pacific gulls *(Larus pacificus)*, probably also play a role (the latter two species are recognised as having spread the weed in South Australia).[7] African boxthorn shrubs impede the nesting activities of certain seabird species, such as the short-tailed shearwater *(Puffinus tenuirostris)*, and the thorns can ensnare birds. For pest species such as starlings, African boxthorn shrubs (which often establish on islands that have no other shrubs) increase their nesting habitat.

Bird ensnared in African boxthorn, Furneaux Islands, Bass Strait

African boxthorn control work in the Furneaux Islands began over 20 years ago, although the current concerted effort only began in 2002.[6] Since then, boxthorn has been treated by volunteers on at least 18 islands, including multiple sites on Flinders Island.

Karen Ziegler says that, through experience, the group has developed a very successful control technique for African boxthorn, as follows.

- Work from the least infested areas back towards the core infestations, using the cut-and-paste technique.
- Make a cut as low as possible, and then quickly apply a 1:1 glyphosate/water mix (with pink dye).
- Before treating a large plant, check the periphery for small plants and seedlings, and treat these first.
- Then treat the large plant and fastidiously check the area below it for small shoots and suckers.

For boxthorn shrubs that are large, thorny and difficult to handle, the group recommends initially cutting quite high and removing the bulk of the plant. Ropes and driftwood can be used for additional leverage to topple intimidatingly large bushes.[6] Once you can access the base of the stem (which can consist of anything from one trunk to dozens of smaller stems), cut a fresh surface on each stem and apply herbicide immediately, ensuring all stems are cut and poisoned. No matter how large the plant, tip it over to ensure every last stem is severed.

Return to contents page

Cut-stump African boxthorn control – ensuring every last stem is severed

Once this process is completed, Karen recommends burning the boxthorn debris, to reduce the chances of starlings roosting and depositing new seed, or the risk of seabirds being ensnared. FOBSI's efforts have been less successful when permission to burn the debris has been denied (e.g. where there have been concerns about potential escape of fire or impacts on seabirds).

Karen and FOBSI make clear that follow-up is vitally important and should entail a return visit within 12 to 24 months. At this time, treat any surviving plants with cut-stump, and hand pull small seedlings. Thereafter, aim to revisit the site for follow-up treatments at intervals of around three to four years, or earlier if a large number of seedlings were found during the first follow-up.

Treat other significant environmental weeds during the same site visit, as otherwise these may fill the gap created by boxthorn removal.

The advantage of the technique outlined above is that it can be readily carried out by volunteers on small islands where machine-based removal is unlikely to be possible or desirable. Foliar spraying would require the use of higher-impact herbicides, and (as African boxthorn can drop leaves after spraying, and then regenerate) could be less effective. Unlike foliar spraying, the cut-stump technique is not season-dependent. However, when working on islands with breeding colonies of seabirds, it is important to schedule works for the off-season. In the Furneaux islands, FOSBI consider May to be the ideal time to minimise the impact of the work on breeding seabirds.[6] However, timing will vary from place to place, depending on the habits of the seabirds and/or mammals using the area.

Karen says that some of the boxthorn that had been treated earlier on Flinders Island was found to have re-sprouted, and was re-treated by FOBSI. She believes that variations in the project's success are due to variable levels of attention to detail. It is essential that the cut-stump work is thorough and consistent. If it is carried out properly, she says, six months to a year later most sites are covered with native colonisers.

African boxthorn infestations growing in areas with mobile sands have proven

Return to contents page

challenging to manage. Karen says that the depth of sand in places makes it difficult to tell whether all the stems have been found and treated. The group has noticed that there tends to be more post-control regrowth in these situations.

In general, FOBSI have found that boxthorn seedling regeneration is hugely variable between sites: in some there is none, in others there are thousands of plants. Karen suggests that seasonal factors might play a role. She notes that the longevity of boxthorn seed appears to be unknown. However, field evidence suggests that emergence of seedlings rapidly decreases after four years. Also, she believes that grazing by native Cape Barren geese *(Cereopsis novaehollandiae)* has helped to reduce the number of seedlings that survive.

Perhaps the key message from the experience of FOBSI is that it is possible to achieve good long-term outcomes from African boxthorn control in coastal situations. Karen says:

Even we have been surprised at the level of success we have had. For example, on low- to mid-infestation islands, after 10 years of work and follow-up, only three-to four-year follow-ups are required, and only for minimal boxthorn presence, to maintain the status quo.

4.3 Phillip Island, southern Victoria

Jarvis Weston works as Ranger in Charge at Phillip Island Nature Parks. Since 2010, he has led a project to restore little penguin habitat. African boxthorn has been one of numerous factors that have, over time, reduced the quality of seabird habitat in the park, causing little penguin numbers to decline. However, 28 years into an ongoing major habitat restoration project, their numbers have stabilised. During the project, Jarvis and his team have learnt and can share much about African boxthorn control in a coastal environment.

Phillip Island is about 140 km south-east of Melbourne and is approximately 100 square km in area. About 90% of the island has been cleared of native vegetation, with conversion to farming and urban areas. The island has seabird colonies – primarily little penguins *(Eudyptula minor)* and short-tailed shearwaters *(Puffinus tenuirostris)*. Phillip Island Nature Parks ('the Nature Parks') is a not-for-profit organisation charged by the Victorian Government, since 1996, with managing conservation parks and infrastructure on Phillip Island. The Nature Parks manages a total area of 1805 hectares of reserves, and its work is funded through revenue generated by ecotourism activities, including the renowned Penguin Parade – a tourist attraction that enables viewing of the nightly return of little penguins to their burrows and draws more than 500 000 visitors per year to the island.[9]

Jarvis Weston (left) and the team tackling African boxthorn removal

African boxthorn is a high-priority weed for management on Phillip Island. The species threatens little penguin and short-tailed shearwater habitat and is a physical hazard: birds have been trapped in the thorny bushes, which also harbour feral predators.[9]

Jarvis Weston has worked at the Nature Parks since 1998. He says that, when the parks were created, many of the reserve areas were significantly degraded, partly due to major infestations of African boxthorn. At the Penguin Parade on the island's south-western Summerland Peninsula, boxthorn control had been ongoing for decades, but it was not until

Return to contents page

1998 that clearing began in earnest in other areas of little penguin habitat. Staff spent hundreds of hours cut-stumping boxthorn, then burning the plant debris. They continue to have success using pure glyphosate herbicide (or a minimum 80% mix with water) for cut-stump control.

In 2000, in addition to the cut-stump efforts, a contractor began using a tractor and backhoe to remove boxthorn mechanically. This included using a grab on a backhoe to pluck plants from the ground. In more recent times, boxthorn plants in more difficult-to-access sites (for example, amongst sand dunes) have been removed by running a chain from a tractor-based winch, securing it around the base of mature plants and winching them from the ground. Immediately afterwards, neat glyphosate is applied to any fragments of root that remain embedded in the ground. After removal, plants are piled and burnt.

The Nature Parks staff have tried foliar spraying of African boxthorn with a broad range of herbicides, but with limited success. Jarvis puts this down to the coastal environment and the fact that these are hardened boxthorn plants with small leaves, resulting in poor uptake of herbicide. Another downside of foliar spraying is that the dead plants remain in place (i.e. not piled and burnt), which makes follow-up more difficult, and does not decrease their potential to snare seabirds.

Follow-up has been an ongoing challenge. Jarvis says that it is still necessary to return to and manage many sites that were treated more than a decade ago, as germination or regeneration from roots persists. Follow-up during most of the control-work period has mainly consisted of foliar spraying, and cut-stump new germination and regrowth from remnant roots.

A major strength of the African boxthorn control work on Phillip Island is the Nature Parks' capacity to guarantee consistent,

Cut-stump control of mature boxthorn in little penguin habitat on Phillip Island

On Phillip Island, a winch on the back of the tractor pulls boxthorn out of the ground by putting a chain noose around the stump and winching it out

The winch used by the Nature Parks pulls out mature boxthorn, roots and all

The tractor used on Phillip Island, with adaptation to grab the uprooted boxthorn and place it on piles for burning

Return to contents page

The Ecoblade® in action on Phillip Island, treating boxthorn regrowth

ongoing funding from its own revenue source. Phillip Island Nature Parks attracts approximately 800 000 paying visitors per year, with most of those (approximately 500 000) attending the Penguin Parade. Sales of park passes, tickets and other items through visitor centres provide revenue for parks management.

Around 2006, African boxthorn control work extended to new areas such as Cape Woolamai and along the south coast of Phillip Island. Several years after this, Jarvis recalls, they realised that they had done so much primary control work that the follow-up task had become hard to handle. He says:

We nearly made the mistake of biting off more than we could chew and without follow-up work we would have been in a worse situation than we were to begin with. Where we once had one mature plant, we now had 50 new plants to replace it.[10]

Follow-up foliar spraying did not prove effective and cut-stump had become logistically impossible, due to the size of the area that now required follow-up. Relief has come in recent times in the form of Ecoblade®. Jensen Farm Services have worked for the Nature Parks using this machine-based blade with herbicide applicator on African boxthorn. Jarvis says that their trials of Ecoblade® for follow-up work have shown it to be 80% to 90% effective.

Critical considerations when planning boxthorn work programs on Phillip Island are the breeding habits of the little penguins and the migratory patterns of the short-tailed shearwaters.

The shearwaters breed on the island between September and April. Each April they migrate to the northern hemisphere, returning in September. The penguins breed between June and September. Some little penguins return consistently to their burrows year round but most stay at sea throughout the autumn–winter period.[11] With these movements in mind, the Nature Parks determined that the best time to undertake works on African boxthorn in the vicinity of burrows is from May to September.

The Nature Parks has found that the machinery can be safely used around the shearwater burrows, but not around little penguin burrows. This is because shearwaters are absent from May to September and will renovate burrows when they return, but some penguins occupy their burrows all year round. Therefore, work around penguin burrows is restricted to cut stump and foliar spraying.

The Nature Parks also realised that burn piles must be fenced off from little penguins. The penguins appear not to have evolved with an awareness of the danger of fire and, if there is no fence, will readily walk straight into hot coals.

Return to contents page

Burnt piles of boxthorn need to be fenced, to prevent penguins walking through the hot coals when they return to Phillip Island at night

As in any bird rookery, many African boxthorn infestation areas have a high level of soil nutrients, so removing the boxthorn often provides opportunities for new weed species. Jarvis reports that species such as apple of Sodom *(Solanum linnaeanum)*, fat hen *(Chenopodium album)* and various thistles commonly appear, and that a good way to prevent them becoming an ongoing problem is to encourage regeneration of local native species such as bower spinach *(Tetragonia tetragonoides)* and seaberry saltbush *(Rhagodia candolleana)*.

After nearly 15 years of work, The Nature Parks considers it is now well advanced on the path to eradication of African boxthorn from the parks. The group also works with Phillip Island Landcare and the Bass Coast Landcare Network to promote removal of boxthorn and other weeds on private land. Fortunately, on Phillip Island there are only a couple of major boxthorn infestations outside the parks.

Jarvis says that the Nature Parks acknowledges that follow-up work will always need to be done if African boxthorn is to be kept under control. For this, it will continue to use the combination of foliar spraying, cut-stump, and Ecoblade®.

4.4 South coast, Western Australia

Matt Kennewell is Invasive Species Coordinator with South Coast Natural Resource Management Inc. based in Albany, Western Australia. Since 2011 he has led a very large Australian Government–supported African boxthorn management program on the south coast, tackling more than 1500 hectares of infestations, from Bremer Bay and Ravensthorpe through to Esperance. Two years down the track, Matt and his project manager Graeme Simpson have used a range of African boxthorn control methods.

The major centre in Western Australia's South Coast NRM region is Albany (approximately 420 km south-south-east of Perth). The region covers hundreds of kilometres, east-north-east to Ravensthorpe, and across to Esperance.

Return to contents page

Ravensthorpe is near to the 330 000-hectare Fitzgerald River National Park, which contains 15% of Western Australia's described plant species.

This is the Fitzgerald River Ravensthorpe biodiversity hotspot area that provides habitat for an extraordinary number of nationally listed threatened species (more than 40 species of fauna and over 100 flora species).[12] The region is internationally recognised for its biodiversity, including, for example, the Fitzgerald Biosphere (United Nations designation), and two Ramsar-listed wetlands.

African boxthorn is present particularly around Ravensthorpe and Esperance. Its ongoing spread poses a significant threat to a range of environmental and production values on the south coast, due to its capacity to change the structure and floristic composition of vegetation communities.[12] Following its deliberate introduction to Australia, African boxthorn has spread in the South Coast NRM region as it has in other parts of Australia, primarily via seeds dispersed by birds and foxes.

At the outset of the regional boxthorn management project, a steering committee was formed, consisting of representatives of organisations, agencies and industry that owned or managed boxthorn-affected lands and/or had an interest in and capacity for helping to guide project implementation. Matt believes that the committee was critical in providing direction, making decisions about methodology, prioritising control areas and maintaining communication between project partners and the broader community.

The committee decided on the following top priorities:

- Contact stakeholders who could/should fund and undertake African boxthorn works themselves, such as roads and power authorities, government agencies and local government.
- Establish a 5-km African boxthorn–free buffer zone around high-value assets such as Fitzgerald River National Park and Ramsar sites.
- Focus efforts on public and private land at Stokes Inlet, an isolated area of African boxthorn infestation surrounded by high-value natural assets.
- Aim to control boxthorn at the top of waterway catchment areas before areas lower down.

Matt believes that the absence of starlings (not established in WA, thanks to ongoing eradication efforts by the Western Australian Government) has, so far, limited the dispersal of boxthorn in the South Coast region. This thinking is supported by research indicating that, the greater the diversity of species that disperse seeds, the greater the potential for the plant to move to different microhabitats and for seeds to be dispersed to suitable germination sites.[13]

As the African boxthorn infestations were sometimes hundreds of kilometres apart, the on-ground work was delegated to Indigenous work teams and two contractors, who were given training in plant identification, pesticide handling, and hygiene protocols to prevent the spread of weeds and diseases.

The project used a number of control methods, giving the team flexibility for various situations and the opportunity to compare

Indigenous work teams and contractors received training in plant identification, pesticide handling and weed hygiene protocols prior to the project commencing

Return to contents page

Regeneration after spraying with glyphosate, metsulfuron-methyl, penetrant and water

effectiveness. The methods used included foliar spraying, cut stump, basal bark, soil–root zone application, plucking/pulling, and machine-based cut stump. To help with later monitoring and evaluation of control efforts, the team kept Global Positioning System (GPS) details for each treated site.

Before the project began, Matt researched successful African boxthorn control work done in South Australia. From this, the WA team understood that the success of foliar application of herbicides depends on correct timing; in particular:

- Foliar spraying should only be done between autumn and spring, avoiding summer application when the plants are inactive and shed leaves.
- African boxthorn plants must be actively growing at the time of application.
- Temperatures must be below 28°C.
- Ideally, herbicides should be applied shortly before rain, as the plant system is more active after rain and this will maximise chemical uptake.

Matt says the herbicides they used for foliar application included triclopyr/picloram–based herbicide, and a mix of glyphosate, metsulfuron-methyl, penetrant and water.

Early results from using the latter mix on approximately 3000 plants in Esperance show that this was effective (90% die-off) on boxthorn plants with stems smaller than 140 mm. However, 80% of plants with stems larger than 140 mm were regenerating six months after initial treatment. The contractor working in the Ravensthorpe area saw similar results. In both cases, the kill rate has been improved by multiple follow-up foliar sprays.

In areas where plants were sprayed with triclopyr/picloram–based herbicide, Matt says no regeneration has been observed to date. This is likely to be due to picloram's residual qualities extending its impact.

Return to contents page

Herbicide treatments of African boxthorn in the Esperance area appear to have achieved a good kill. However, sites will still need to monitored for regrowth/regeneration.

Plucking African boxthorn at Ravensthorpe

Also in the Esperance area, the team applied tebuthiuron pellets to the root zone of African boxthorn plants. As this method has the potential to do significant off-target damage, it was used cautiously and in situations where there was minimal potential to damage non-target species. The result to date is apparently 100% die-off.

Another control method used was mechanical plucking or pulling. Graeme and Matt say that the team found this most effective with larger plants whose stronger root systems are most effectively removed from the ground. Herbicide was applied to any remaining roots. The plucking process was easier if the ground was moist to some degree.

The team used the plucking method at Ravensthorpe Golf Club over a 100m x 50m area, then piled and burnt the African boxthorn debris. So far the team estimates that this method has achieved 90% mortality of the plants; it was effective but expensive.

The project also trialled a mechanical cut-stump operation, using custom-built equipment – a chainsaw on the end of a small excavator, plus a mechanism to apply herbicide immediately after cutting. This proved successful: two years after the trial, only a small amount of regrowth has appeared, mainly under trees, and this may be from seed germination.

Matt and Graeme say that a major benefit of the machine-based methods they trialled was the capacity to remove the plant debris and apply herbicide to the stump without exposing personnel to the weed's hazardous thorns.

The South Coast NRM African boxthorn project team has involved local media and placed signage at work sites, to inform the community about threats posed by African boxthorn and to detail how it is being managed.

Matt and Graeme say that two of the most important factors contributing to the success of the project were the commitment of landholders and having adequate human and financial resources. The biggest challenges the ongoing project faces are to maintain communication with stakeholders and keep them engaged in the process and, particularly, to secure the resources to continue follow-up actions after the current project funding ends in 2013. Both agree they will do whatever they can to ensure the ongoing decline of African boxthorn in the South Coast region.

Landholder commitment has been good, and the project has been well resourced, meaning a solid start to removing African boxthorn from the region. However, for a weed like African boxthorn, the time limitations on resourcing provide an ongoing challenge.

Return to contents page

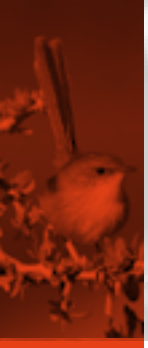
References

1. NSW National Parks and Wildlife Service. Draft plan of management – Oolambeyan National Park. South Sydney, New South Wales: NSW Office of Environment and Heritage, 2012.
2. Balnaves J, face-to-face interview, 22 February 2013.
3. Gardiner R, telephone interview, 22 February 2013.
4. Parsons WT, Cuthbertson EG. Noxious weeds of Australia. Melbourne, Victoria: Inkarta Press, 1992.
5. Harris S, Buchanan A, Connolly A. One hundred islands: the flora of the outer Furneaux. Hobart: Tasmanian Department of Primary Industries, Water and Environment, 2001.
6. Ziegler K, Hopkins K. Furneaux Islands – boxthorn control. Tasmania: Friends of Bass Strait Islands – Wildcare, 2011.
7. Government of South Australia. Declared plant policy – African boxthorn *(Lycium ferocissimum)*, Government of South Australia, viewed 29 July 2013, <http://www.pir.sa.gov.au/__data/assets/pdf_file/0005/137291/African_boxthorn_policy.pdf>.
8. Weston J. Weed management to optimise seabird habitat in the Phillip Island Nature Park, in: Eighteenth Australasian Weeds Conference 2012, Council of Australasian Weed Societies Inc., viewed 29 July 2013, <http://www.caws.org.au/awc/2012/awc201211541.pdf>.
9. Phillip Island Nature Parks Weed Management Strategy 2007–2012, Phillip Island Nature Parks, Victoria, viewed 30 July 2013, <http://www.penguins.org.au/assets/Conservation/Environment/PDF/pinp-weed-management-strategy-2007-12.pdf>.
10. Weston J, telephone interview, 22 January 2013.
11. Parks and Wildlife Service. Little penguin *(Eudyptula minor)*. Parks and Wildlife Service, Tasmania, viewed 23 January 2013, <http://www.parks.tas.gov.au/index.aspx?base=5091>.
12. Gilfillan S, Mitchell P, Newell J, Danks A, Comer S. South Coast threatened species & ecological communities regional strategic management plan. Department of Environment and Conservation, Albany, Western Australia, 2009, viewed 30 July 2013, <http://www.conservation.wa.gov.au/media/14355/ref%207%20gilfillian_etal_2009_scregionaltsplan.pdf>.
13. Stanley MC, Lill A. Avian fruit consumption and seed dispersal in a temperate Australian woodland. Austral Ecology 2002;27(2):137–48.

Return to contents page

CHAPTER 5
Further information

Alan Fletcher



CHAPTER 5
Further information

5.1 African boxthorn legal status and responsibilities in Australia*

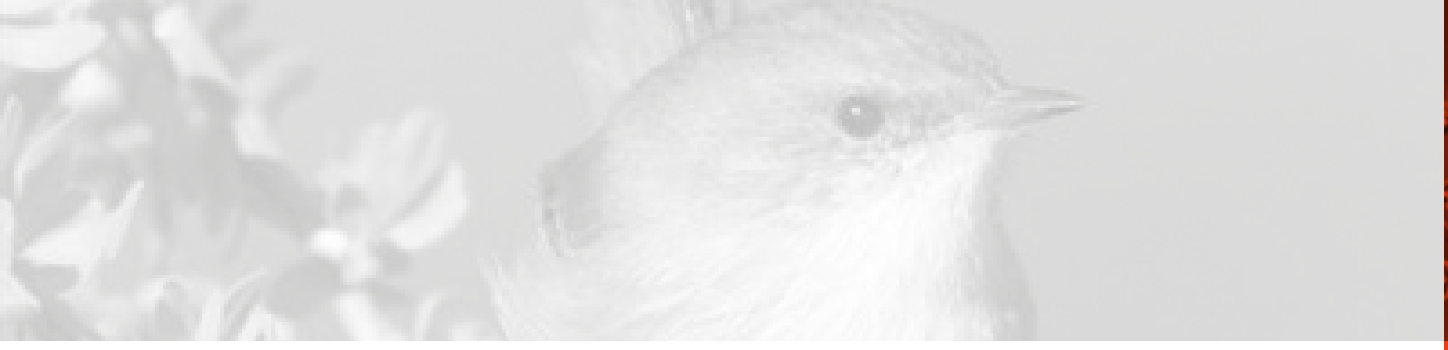
STATE/ TERRITORY	LEGISLATION	DECLARATION	DESCRIPTION
ACT	Pest Plants and Animals Act 2005	Declared	C2 – pest plant that must be suppressed, and C4 – prohibited pest plant (propagation and supply prohibited).
New South Wales	Noxious Weeds Act 1993	Declared	Control Class 4 across most of the NSW land area. Not to be sold, propagated or knowingly distributed (in certain local authority areas).
Northern Territory	Weeds Management Act 2001	Declared	Schedule Class A/C – to be eradicated if found and not to be introduced to the NT.
Queensland	Land Protection (Pest and Stock Route Management) Act 2002	Declared	Declared Class 2 pest plant. Illegal to sell the plant or its seed.
South Australia	Natural Resources Management Act 2004	Declared	Declared state-wide under Category 2 of the Act. Management actions prescribed on regional basis.
Tasmania	Weed Management Act 1999	Declared	Zone A (eradication) in four municipalities. Zone B (containment) across most of the Tas land area.
Victoria	Catchment and Land Protection Act 1994	Declared	Category C – regionally controlled in each region.
Western Australia	Biosecurity and Agriculture Management Act 2007 (BAMA)	Not declared	Permitted entry to WA.

*May change as legislation and situations are reviewed.

5.2 Registered herbicides

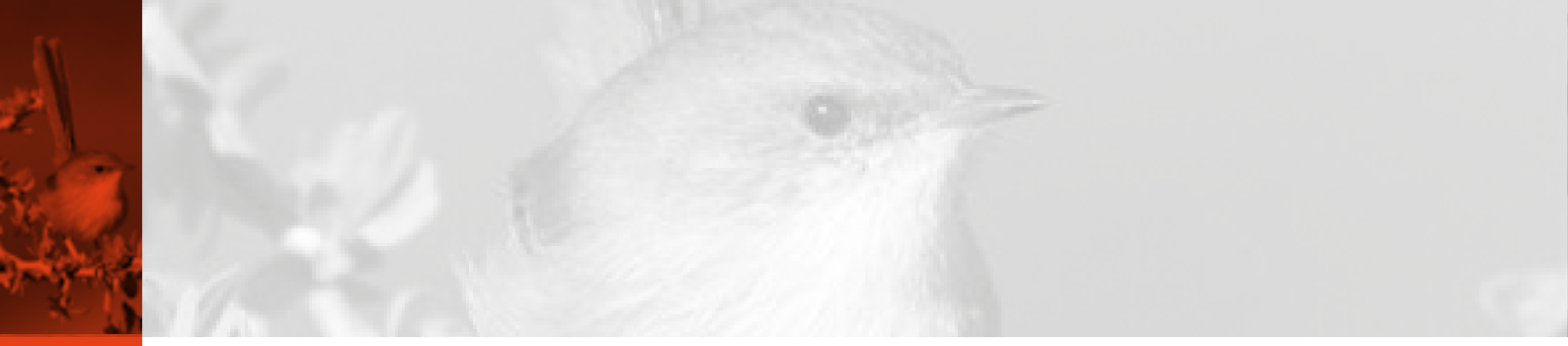
This table lists herbicides registered for African boxthorn control in Australia (as at 30 July 2013).[1] To do an updated search, go to the Australian Pesticides and Veterinary Medicines website www.apvma.gov.au and click on 'PUBCRIS: search registered chemical products' in the right-hand 'services' menu.

PRODUCT NAME	ACTIVE CONSTITUENTS
4FARMERS 2,4-D PLUS PICLORAM HERBICIDE	PICLORAM AS THE TRIISOPROPANOLAMINE SALT	2,4-D AS THE TRIISOPROPANOLAMINE SALT
4FARMERS GLYPHOSATE 360 HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
4FARMERS POTASSIUM GLYPHOSATE 500 HERBICIDE	GLYPHOSATE PRESENT AS THE POTASSIUM SALT
4FARMERS POTASSIUM GLYPHOSATE 540 HERBICIDE	GLYPHOSATE PRESENT AS THE POTASSIUM SALT
4FARMERS TRI-PICK HERBICIDE	PICLORAM PRESENT AS THE HEXYLOXYPROPYLAMINE SALT	TRICLOPYR PRESENT AS THE BUTOXYETHYL ESTER
4FARMERS TRICLOPYR 600 HERBICIDE	TRICLOPYR PRESENT AS THE BUTOXYETHYL ESTER
AC HOWL 360 BIO HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
AC MUT 700 HERBICIDE	GLYPHOSATE PRESENT AS THE MONO-AMMONIUM SALT
AC PULVERIZE HERBICIDE	PICLORAM AS THE TRIISOPROPANOLAMINE SALT	2,4-D AS THE TRIISOPROPANOLAMINE SALT
AC SCRUBBA HERBICIDE	PICLORAM PRESENT AS THE HEXYLOXYPROPYLAMINE SALT	TRICLOPYR PRESENT AS THE BUTOXYETHYL ESTER
AC SNARL 510 HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
AC TRESSEL 250 SL HERBICIDE	HEXAZINONE
AC TRICKY 600 HERBICIDE	TRICLOPYR PRESENT AS THE BUTOXYETHYL ESTER
ACCENSI 2,4-D / PICLORAM HERBICIDE	PICLORAM AS THE TRIISOPROPANOLAMINE SALT	2,4-D AS THE TRIISOPROPANOLAMINE SALT
ACCENSI GLYPHOSATE 360 HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
ACCENSI GLYPHOSATE 450 SSD HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
ACCENSI GLYPHOSATE 495 HERBICIDE	GLYPHOSATE PRESENT AS THE POTASSIUM SALT
ACCENSI GLYPHOSATE 600 HERBICIDE	GLYPHOSATE PRESENT AS THE POTASSIUM SALT
ACCESS HERBICIDE	PICLORAM AS ISOOCTYL ESTER	TRICLOPYR PRESENT AS THE BUTOXYETHYL ESTER	HYDROCARBON LIQUID
ACP BLUE CHIP 540 HERBICIDE	GLYPHOSATE PRESENT AS THE POTASSIUM SALT



PRODUCT NAME	ACTIVE CONSTITUENTS
ACP BROADLEAF 75-D HERBICIDE	PICLORAM AS THE TRIISOPROPANOLAMINE SALT | 2,4-D AS THE TRIISOPROPANOLAMINE SALT
ACP GLYPHOGRAN 680 HERBICIDE	GLYPHOSATE PRESENT AS THE MONO-AMMONIUM SALT
ACP GLYPHOSATE 450 HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
ACP REGROWTH HERBICIDE	PICLORAM PRESENT AS THE HEXYLOXYPROPYLAMINE SALT | TRICLOPYR PRESENT AS THE BUTOXYETHYL ESTER
ACP TRICLOPYR 600 HERBICIDE	TRICLOPYR PRESENT AS THE BUTOXYETHYL ESTER
AGCP GLYPHOSATE 450 HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
AGRIMART GLYPHOSATE 360 HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
AGRIMART GLYPHOSATE CT 450 HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
AGRIMART TRICLOPYR 600 HERBICIDE	TRICLOPYR PRESENT AS THE BUTOXYETHYL ESTER
AGRISATE 700 SG HERBICIDE	GLYPHOSATE PRESENT AS THE MONO-AMMONIUM SALT
AGRISMART DRY-GLY 700 HERBICIDE	GLYPHOSATE PRESENT AS THE MONO-AMMONIUM SALT
AGRISMART TRICLOPYR 600 HERBICIDE	TRICLOPYR PRESENT AS THE BUTOXYETHYL ESTER
AGRISMART WOODPECKER HERBICIDE	PICLORAM PRESENT AS THE HEXYLOXYPROPYLAMINE SALT | TRICLOPYR PRESENT AS THE BUTOXYETHYL ESTER
AGRITRADING GLYPHOSATE 700 SG HERBICIDE	GLYPHOSATE PRESENT AS THE MONO-AMMONIUM SALT
AGRO-ESSENCE GLYPHOSATE 450SL	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
AGRO-ESSENCE GLYPHOSATE 510 HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
AGRO-ESSENCE GLYPHOSATE 700 HERBICIDE	GLYPHOSATE PRESENT AS THE MONO-AMMONIUM SALT
AGRO-ESSENCE TRICLOPYR 600 HERBICIDE	TRICLOPYR PRESENT AS THE BUTOXYETHYL ESTER
AGRONICA POLARIS 360 HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
AGRONICA POLARIS 450 HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
AGSPRAY GLYPHOSATE 450 CT	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
AGSPRAY GLYPHOSATE HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
AIMCO TRICLOPYR 600 HERBICIDE	TRICLOPYR PRESENT AS THE BUTOXYETHYL ESTER
ALL-SEASON 450 WEEDKILLER	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
ALL-SEASON BIO 360 WEEDKILLER	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
ALLOUT 450 HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
AMGROW CHEMSPRAY WEED CONTROL TREE & BLACKBERRY KILLER	TRICLOPYR PRESENT AS THE BUTOXYETHYL ESTER
AMGROW ERAZE BIAQUATIC TOTAL WEED KILLER	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
AMGROW ERAZE MAX TOTAL WEED KILLER	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE AND MONO-AMMONI
AMGROW GLYPHO 360 NON SELECTIVE HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
ANKA PLATINUM 450 CT HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
APPARENT AXEMAN 600 HERBICIDE	TRICLOPYR PRESENT AS THE BUTOXYETHYL ESTER
APPARENT BRUSH 'N' WOOD HERBICIDE	PICLORAM PRESENT AS THE HEXYLOXYPROPYLAMINE SALT | TRICLOPYR PRESENT AS THE BUTOXYETHYL ESTER
APPARENT GLYPHOSATE 450 HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
APPARENT GLYPHOSATE 510 IPA HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
APPARENT GLYPHOSATE 510 K HERBICIDE	GLYPHOSATE PRESENT AS THE POTASSIUM SALT
APPARENT GLYPHOSATE GREEN 360 HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
APPARENT KNOCK-OUT 360 HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
APPARENT TRICLOPYR 600 EC HERBICIDE	TRICLOPYR PRESENT AS THE BUTOXYETHYL ESTER
APPARENT TRIPLE SEVEN HERBICIDE	GLYPHOSATE PRESENT AS THE MONO-AMMONIUM SALT
APPARENT WOODY HERBICIDE	PICLORAM PRESENT AS THE HEXYLOXYPROPYLAMINE SALT | TRICLOPYR PRESENT AS THE BUTOXYETHYL ESTER
AUSAGRI TRICLOPYR 600 HERBICIDE	TRICLOPYR PRESENT AS THE BUTOXYETHYL ESTER
AW FRENZY HERBICIDE	PICLORAM AS THE TRIISOPROPANOLAMINE SALT | 2,4-D AS THE TRIISOPROPANOLAMINE SALT
AW GNARLY HERBICIDE	PICLORAM PRESENT AS THE HEXYLOXYPROPYLAMINE SALT | TRICLOPYR PRESENT AS THE BUTOXYETHYL ESTER
AW RAWHIDE 250 SL HERBICIDE	HEXAZINONE
AW REK HERBICIDE	GLYPHOSATE PRESENT AS THE MONO-AMMONIUM SALT
AW TRICLOPYR 600 HERBICIDE	TRICLOPYR PRESENT AS THE BUTOXYETHYL ESTER
BANISH 360 SYNC KNOCKDOWN HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE AND MONO-AMMONI
BANISH 360 WEED KILLER	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
BAYER GLYPHOSATE 450 HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT

Return to contents page



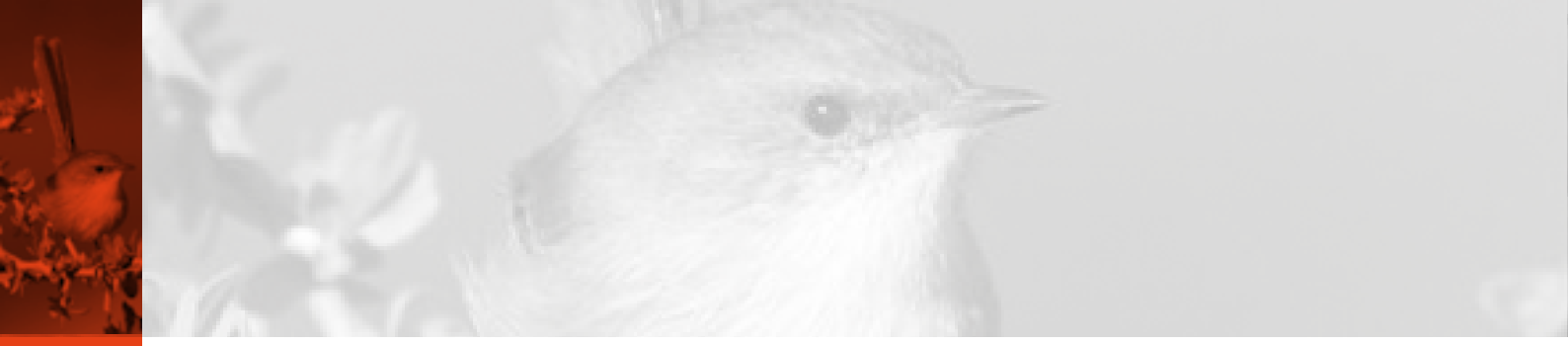
5.2 Registered herbicides *cont.*

PRODUCT NAME	ACTIVE CONSTITUENTS
BIO-SMART 360 HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
BIOCHOICE 360 HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
BIOSORB 600 HERBICIDE	TRICLOPYR PRESENT AS THE BUTOXYETHYL ESTER
BIOTIS GLYPHOSATE 360 HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
BIOTIS GLYPHOSATE 450 HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
BIOTIS GLYPHOSATE 510 HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
BIOTIS HI-LOAD HERBICIDE	GLYPHOSATE PRESENT AS THE POTASSIUM SALT
BOBCAT SL HERBICIDE	HEXAZINONE
BONZER HERBICIDE	GLYPHOSATE PRESENT AS THE POTASSIUM SALT
BRUNNINGS GLYPHOSATE 360 WEED KILL	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
CACHET GLYPHOSATE 450 HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
CENTURION HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
CHEMAG ENVIROSPRAY 360 HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
CHEMAG REBELLION 450 HERBICIDE	GLYPHOSATE PRESENT AS THE MONOETHANOLAMINE SALT
CHEMFORCE TRICLOPYR 600 HERBICIDE	TRICLOPYR PRESENT AS THE BUTOXYETHYL ESTER
CHEMFORCE TRICLOPYR HERBICIDE	TRICLOPYR BUTOXYETHYL ESTER
CHEMTURA GLYPHOSATE 700 HERBICIDE	GLYPHOSATE PRESENT AS THE MONO-AMMONIUM SALT
CHOICE HEXAZINONE 250 HERBICIDE	HEXAZINONE
CONCENTRATE ADVANCE ROUNDUP WEEDKILLER	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
CONCENTRATE ROUNDUP XTRA WEEDKILLER	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
CONQUEST DEPIC 75-D HERBICIDE	PICLORAM AS THE TRIISOPROPANOLAMINE SALT I 2,4-D AS THE TRIISOPROPANOLAMINE SALT
CONQUEST HATCHET HERBICIDE	PICLORAM PRESENT AS THE HEXYLOXYPROPYLAMINE SALT I TRICLOPYR PRESENT AS THE BUTOXYETHANOL ESTER
CONQUEST KNOCKOUT BLOW 510 HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
CONQUEST KNOCKOUT PRO 540 HERBICIDE	GLYPHOSATE PRESENT AS THE POTASSIUM SALT
CONQUEST MACA 600 HERBICIDE	TRICLOPYR PRESENT AS THE BUTOXYETHYL ESTER
CONQUEST SQUAREDOWN 360 HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
COUNTRY GLYPHOSATE 360 HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
COUNTRY GLYPHOSATE 450 HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
COUNTRY GLYPHOSATE 540 HERBICIDE	GLYPHOSATE PRESENT AS THE POTASSIUM SALT
COUNTRY PICLORAM/TRICLOPYR HERBICIDE	PICLORAM PRESENT AS THE HEXYLOXYPROPYLAMINE SALT I TRICLOPYR PRESENT AS THE BUTOXYETHYL ESTER
COUNTRY TRICLOPYR 600 HERBICIDE	TRICLOPYR PRESENT AS THE BUTOXYETHYL ESTER
CROP CARE GRANDO 600 HERBICIDE	TRICLOPYR PRESENT AS THE BUTOXYETHYL ESTER
CROP CULTURE TRICLOPS HERBICIDE	TRICLOPYR PRESENT AS THE BUTOXYETHYL ESTER
CROP CULTURE WILDEBEEST 700 HERBICIDE	GLYPHOSATE PRESENT AS THE MONO-AMMONIUM SALT
CROPPRO GLYPHOSATE 450 IPA SALT HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
DAVID GRAYS TRICLOPYR 600 HERBICIDE	TRICLOPYR BUTOXYETHYL ESTER
DOW AGROSCIENCES AMINE 625 HERBICIDE	2,4-D PRESENT AS THE DIMETHYL AMINE SALT
DUPONT VELPAR L HERBICIDE	HEXAZINONE
EARTHCORE GLYPHOSATE 360 WEED KILL	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
EARTHCORE GLYPHOSATE 360 WEED KILL AG PACK	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
EASYFARM GLYPHOSATE 360 SL HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
ECHEM GLYPHOSATE 360 HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
ECHEM GLYPHOSATE 510 K HERBICIDE	GLYPHOSATE PRESENT AS THE POTASSIUM SALT
ECOMAX 510 HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
ECOMAX HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
ENVIROMAX GLYPHOSATE 700 SG HERBICIDE	GLYPHOSATE PRESENT AS THE MONO-AMMONIUM SALT
ERAZE 360 BI-AQUATIC HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
ERAZE 510 BIAQUATIC HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
EUREKA! GLYPHOSATE 800 HERBICIDE	GLYPHOSATE AS AMMONIUM SALT
EZYCROP GLYPHOSATE 360 HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT

Return to contents page

PRODUCT NAME	ACTIVE CONSTITUENTS
EZYCROP GLYPHOSATE 510SL HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
EZYCROP GLYPHOSATE 700 SG HERBICIDE	GLYPHOSATE PRESENT AS THE MONO-AMMONIUM SALT
EZYCROP TRICLOPYR 600 HERBICIDE	TRICLOPYR PRESENT AS THE BUTOXYETHYL ESTER
FARMALINX BAZOOKA DRY 800 SG HERBICIDE	GLYPHOSATE AS AMMONIUM SALT
FARMALINX GLYPHO 450 HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
FARMALINX GLYPHO 680 DRY HERBICIDE	GLYPHOSATE PRESENT AS THE MONO-AMMONIUM SALT
FARMALINX SIXGUNz 360 HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
FARMALINX SIXGUN 450 NON-RESIDUAL HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
FARMALINX SIXGUN 510 HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
FARMALINX STUKA 75-D HERBICIDE	PICLORAM AS THE TRIISOPROPANOLAMINE SALT | 2,4-D AS THE TRIISOPROPANOLAMINE SALT
FARMALINX TRIPICLORAM 400 HERBICIDE	PICLORAM PRESENT AS THE HEXYLOXYPROPYLAMINE SALT | TRICLOPYR PRESENT AS THE BUTOXYETHYL ESTER
FARMALINX TRIPYR 600 EC HERBICIDE	TRICLOPYR PRESENT AS THE BUTOXYETHYL ESTER
FARMALINX TRIPYR HERBICIDE	TRICLOPYR PRESENT AS THE BUTOXYETHYL ESTER
FARMALINX WARLORD 540 HI-LOAD HERBICIDE	GLYPHOSATE PRESENT AS THE POTASSIUM SALT
FARMCOCHEM GLYPHOSATE 450 HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
FARMOZ ENFORCER 75-D HERBICIDE	PICLORAM AS THE TRIISOPROPANOLAMINE SALT | 2,4-D AS THE TRIISOPROPANOLAMINE SALT
FARMOZ FIGHTBACK HERBICIDE	PICLORAM PRESENT AS THE HEXYLOXYPROPYLAMINE SALT | TRICLOPYR PRESENT AS THE BUTOXYETHYL ESTER
FARMOZ WIPE-OUT 360 NON-RESIDUAL HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
FARMOZ WIPE-OUT ACCELERATE HERBICIDE	GLYPHOSATE PRESENT AS THE POTASSIUM 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
FARMOZ WIPE-OUT PLUS HERBICIDE	GLYPHOSATE PRESENT AS THE MONOETHANOLAMINE SALT
FIREBOLT HERBICIDE	GLYPHOSATE PRESENT AS THE POTASSIUM SALT
FMC GLYDER 450 HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
FMC GLYDER DRY 700 HERBICIDE	GLYPHOSATE PRESENT AS THE MONO-AMMONIUM SALT
FMC GLYDER OFFENSE 540 HERBICIDE	GLYPHOSATE PRESENT AS THE POTASSIUM SALT
FMC GLYPHOSATE 510 HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
FMC GLYPHOSATE 517 POTASSIUM HERBICIDE	GLYPHOSATE PRESENT AS THE POTASSIUM SALT
FMC GLYPHOSATE 540 K HERBICIDE	GLYPHOSATE PRESENT AS THE POTASSIUM SALT
FMC TRICLOPYR + PICLORAM HERBICIDE	PICLORAM PRESENT AS THE HEXYLOXYPROPYLAMINE SALT | TRICLOPYR PRESENT AS THE BUTOXYETHYL ESTER
FMC TRICLOPYR 600 HERBICIDE	TRICLOPYR PRESENT AS THE BUTOXYETHYL ESTER
FOSTERRA GLYPHOSATE 450 HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
FREEZONE GLYPHOSATE 360 AQUATIC TUFFWEED LIQUID CONCENTRATE HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
FREEZONE GLYPHOSATE 680 TUFFWEED GRANULAR CONCENTRATE HERBICIDE	GLYPHOSATE PRESENT AS THE MONO-AMMONIUM SALT
FREEZONE TUFFWOOD WOODY WEED AND UNWANTED TREE KILLER	PICLORAM PRESENT AS THE HEXYLOXYPROPYLAMINE SALT | TRICLOPYR PRESENT AS THE BUTOXYETHYL ESTER
FUHUA GLYPHOSATE 450 HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
GALAXY GLYPHOSATE 360 HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
GARDENLINE GARDEN WEEDKILL 360G/L	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
GARLON 600 HERBICIDE	TRICLOPYR PRESENT AS THE BUTOXYETHYL ESTER
GENEREX HEXAZINONE HERBICIDE	HEXAZINONE
GENEREX TRICHLORAM HERBICIDE	PICLORAM PRESENT AS THE HEXYLOXYPROPYLAMINE SALT | TRICLOPYR PRESENT AS THE BUTOXYETHYL ESTER
GENEREX TRICLOPYR 600 HERBICIDE	TRICLOPYR PRESENT AS THE BUTOXYETHYL ESTER
GENFARM OXYFLUORFEN 240EC HERBICIDE	OXYFLUORFEN | N-METHYLPYRROLIDONE | HYDROCARBON LIQUID
GENFARM PANZER 360 HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
GENFARM PANZER 510 HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
GENFARM PANZER 540 K HERBICIDE	GLYPHOSATE
GENFARM PANZER 680 DRY HERBICIDE	GLYPHOSATE PRESENT AS THE MONO-AMMONIUM SALT
GENFARM TRICLOPYR 600EC HERBICIDE	TRICLOPYR PRESENT AS THE BUTOXYETHYL ESTER
GENFARM TRICLOPYR/PIC HERBICIDE	PICLORAM HEXYLOXYPROPYLAMINE SALT | TRICLOPYR PRESENT AS THE BUTOXYETHYL ESTER

Return to contents page



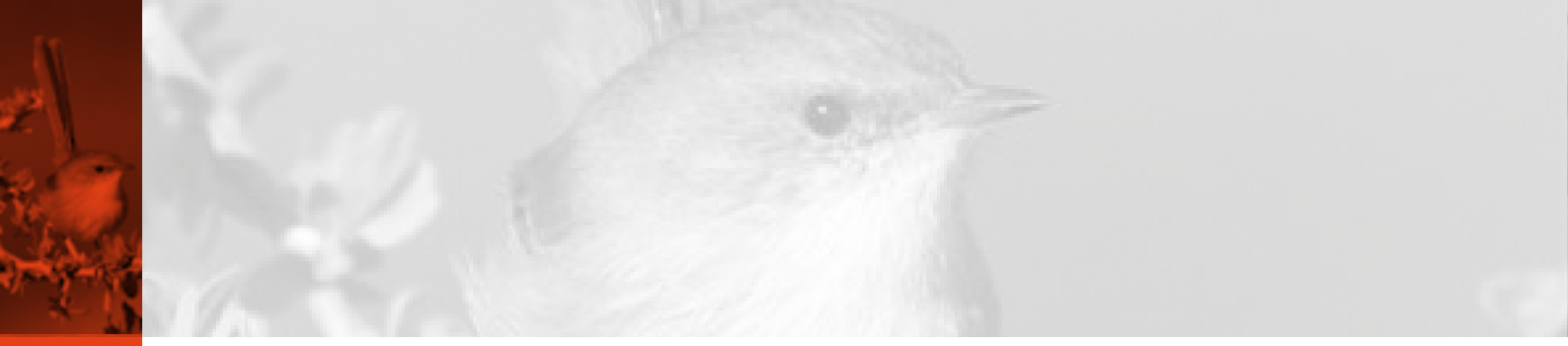
5.2 Registered herbicides *cont.*

PRODUCT NAME	ACTIVE CONSTITUENTS
GF-2576 HERBICIDE	AMINOPYRALID PRESENT AS TRIISOPROPANOLAMINE SALT | PICLORAM AS THE TRIISOPROPANOLAMINE SALT | 2,4-D AS THE TRIISOPROPANOLAMINE SALT
GLADIATOR DRY 680 WG HERBICIDE	GLYPHOSATE PRESENT AS THE MONO-AMMONIUM SALT
GLADIATOR HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
GLADIATOR MAXIMUS HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
GLADIATOR OPTIMAX HERBICIDE	GLYPHOSATE PRESENT AS THE POTASSIUM SALT
GLISTER 360 HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
GLISTER 450 HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
GLISTER 680SG HERBICIDE	GLYPHOSATE PRESENT AS THE MONO-AMMONIUM 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
GLYFOS HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
GLYFOS K-POWER HERBICIDE	GLYPHOSATE PRESENT AS THE POTASSIUM SALT
GLYFOS UPGRADE 510 HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
GLYMAX 700 HERBICIDE	GLYPHOSATE PRESENT AS THE MONO-AMMONIUM SALT
GLYPHOKILL 360 HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
GRASLAN HERBICIDE	TEBUTHIURON
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
GRAZON EXTRA HERBICIDE	AMINOPYRALID PRESENT AS HEXYLOXYPROPYLAMINE SALT | PICLORAM PRESENT AS THE HEXYLOXYPROPYLAMINE SALT | TRICLOPYR PRESENT AS THE BUTOXYETHYL ESTER
GROW GREEN GLYPHOSATE 360 HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
GROWGARD 360 HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
GULLF AG CLEARUP BIO 360 HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
GULLF AG CLEARUP BIO 360 SL HERBICIDE	GLYPHOSATE PRESENT AS THE MONOETHANOLAMINE SALT
GUNDY GLY 510 HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
HALLEY GLYPHOSATE 360 HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
HALLEY TRICLOPYR 600 HERBICIDE	TRICLOPYR PRESENT AS THE BUTOXYETHYL ESTER
HALLEY TRICLOZON HERBICIDE	PICLORAM PRESENT AS THE HEXYLOXYPROPYLAMINE SALT | TRICLOPYR PRESENT AS THE BUTOXYETHYL ESTER
HEINIGER TREE KILLER	TRICLOPYR PRESENT AS THE BUTOXYETHANOL ESTER
IMTRADE COMMANDER 75-D HERBICIDE	PICLORAM AS THE TRIISOPROPANOLAMINE SALT | 2,4-D AS THE TRIISOPROPANOLAMINE SALT
IMTRADE ERADICATOR 450 HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
IMTRADE ERADICATOR 540 HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
IMTRADE ERADICATOR PRO 450 HERBICIDE	GLYPHOSATE PRESENT AS THE MONOETHANOLAMINE SALT
IMTRADE ERADICATOR ULTIMATE 625 HERBICIDE	GLYPHOSATE PRESENT AS THE POTASSIUM SALT
IMTRADE ERADICATOR X 450 HERBICIDE	GLYPHOSATE PRESENT AS THE POTASSIUM SALT
IMTRADE HURRICANE 600 HERBICIDE	TRICLOPYR PRESENT AS THE BUTOXYETHYL ESTER
IMTRADE PICKER HERBICIDE	PICLORAM PRESENT AS THE HEXYLOXYPROPYLAMINE SALT | TRICLOPYR PRESENT AS THE BUTOXYETHYL ESTER
JNO GLYPHOSATE 450SL HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
KENDON KNOCKOUT 360 HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
KENSO AGCARE BUCKO 75-D HERBICIDE	PICLORAM AS THE TRIISOPROPANOLAMINE SALT | 2,4-D AS THE TRIISOPROPANOLAMINE SALT
KENSO AGCARE KEN-PAM 423 FUMIGANT	METHAM PRESENT AS SODIUM SALT
KENSO AGCARE KEN-UP AQUATIC 360 HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
KENSO AGCARE KEN-UP DRY 680 WG HERBICIDE	GLYPHOSATE PRESENT AS THE MONO-AMMONIUM SALT
KENSO AGCARE KEN-ZON HERBICIDE	PICLORAM PRESENT AS THE HEXYLOXYPROPYLAMINE SALT | TRICLOPYR PRESENT AS THE BUTOXYETHYL ESTER
KENSO AGCARE MAX OUT 540 HERBICIDE	GLYPHOSATE PRESENT AS THE POTASSIUM SALT

Return to contents page

PRODUCT NAME	ACTIVE CONSTITUENTS
KENSO AGCARE NUGGET DRY 680 WG HERBICIDE	GLYPHOSATE PRESENT AS THE MONO-AMMONIUM SALT
KENSO AGCARE TRICLOPYR 600 HERBICIDE	TRICLOPYR PRESENT AS THE BUTOXYETHYL ESTER
KLIN-UP 360 BIAQUATIC HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
KLIN-UP DRY 680 HERBICIDE	GLYPHOSATE PRESENT AS THE MONO-AMMONIUM SALT
LORAL IPSUM WEEDSTRIKE 450 NON-SELECTIVE HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
LORAL IPSUM WEEDSTRIKE NON-SELECTIVE HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE 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
MACPHERSONS GLYPHOSATE HI-LIGHT RED HERBICIDE	GLYPHOSATE PRESENT AS THE MONO-AMMONIUM SALT
MACSPRED GLYMAC 360 HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE 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
MASTRA GLYPHOSATE HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
MISSION GLYPHOSATE 450 HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
MISSION GLYPHOSATE 540 HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
MISSION PICLORAM 100 EC HERBICIDE	PICLORAM PRESENT AS THE HEXYLOXYPROPYLAMINE SALT I TRICLOPYR PRESENT AS THE BUTOXYETHYL ESTER
MISSION PICLORAM 75-D HERBICIDE	PICLORAM AS THE TRIISOPROPANOLAMINE SALT I 2,4-D AS THE TRIISOPROPANOLAMINE SALT
MISSION TRICLOPYR 600 EC HERBICIDE	TRICLOPYR PRESENT AS THE BUTOXYETHYL ESTER
NAADCO GLYPHOSATE 450 HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
NIHIL NON SELECTIVE HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
NOVA AGRO GLYPHOSATE 360 HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
NOVA AGRO GLYPHOSATE 700 SG HERBICIDE	GLYPHOSATE PRESENT AS THE MONO-AMMONIUM SALT
NOVAGUARD GLYPHOSATE 360 HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
NOVAGUARD GLYPHOSATE 450 SL HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
NOVAGUARD GLYPHOSATE 510SL HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
NOVAGUARD GLYPHOSATE 700 SG HERBICIDE	GLYPHOSATE PRESENT AS THE MONO-AMMONIUM SALT
NOVAGUARD TRICLOPYR 600 HERBICIDE	TRICLOPYR PRESENT AS THE BUTOXYETHYL ESTER
NUFARM CONQUEROR HERBICIDE	PICLORAM PRESENT AS THE HEXYLOXYPROPYLAMINE SALT I TRICLOPYR PRESENT AS THE BUTOXYETHYL ESTER
NUFARM CREDIT BROADHECTARE HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE AND MONO-AMMONI
NUFARM CREDIT DUO DUAL SALT TECHNOLOGY HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE AND MONO-AMMONI
NUFARM GLYPHOSATE 360 HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
NUFARM GLYPHOSATE 540 HERBICIDE	GLYPHOSATE PRESENT AS THE POTASSIUM SALT
NUFARM GLYPHOSATE CT BROADHECTARE HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
NUFARM INVADER 600 HERBICIDE	TRICLOPYR PRESENT AS THE BUTOXYETHYL ESTER
NUFARM TROOPER 75-D HERBICIDE	PICLORAM AS THE TRIISOPROPANOLAMINE SALT I 2,4-D AS THE TRIISOPROPANOLAMINE SALT
NUFARM WEEDMASTER DRY HERBICIDE	GLYPHOSATE PRESENT AS THE MONO-AMMONIUM SALT
NUFARM WEEDMASTER DUO DUAL SALT TECHNOLOGY HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE AND MONO-AMMONI
NUTURF RAZOR HERBICIDE DUAL SALT TECHNOLOGY	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE AND MONO-AMMONI
OPAL TRICLOPYR 600 EC HERBICIDE	TRICLOPYR PRESENT AS THE BUTOXYETHYL ESTER
OSPRAY GLYFOS 700SG HERBICIDE	GLYPHOSATE PRESENT AS THE MONO-AMMONIUM SALT
OSPRAY PICKOUT HERBICIDE	PICLORAM PRESENT AS THE HEXYLOXYPROPYLAMINE SALT I TRICLOPYR PRESENT AS THE BUTOXYETHYL ESTER
OSPRAY SCRUBMASTER HERBICIDE	TEBUTHIURON
OSPRAY TIMBA HERBICIDE	HEXAZINONE
OSPRAY TRICLOPYR 600 HERBICIDE	TRICLOPYR PRESENT AS THE BUTOXYETHYL ESTER
OZCROP GLYPHOSATE 450 HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
OZCROP GLYPHOSATE 700 SG HERBICIDE	GLYPHOSATE PRESENT AS THE MONO-AMMONIUM SALT
OZCROP TEBUTHIURON 200 HERBICIDE	TEBUTHIURON
OZCROP TRICLOPYR 600 EC HERBICIDE	TRICLOPYR PRESENT AS THE BUTOXYETHYL ESTER
OZTEC GLYPHOSATE 360 NON SELECTIVE HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT

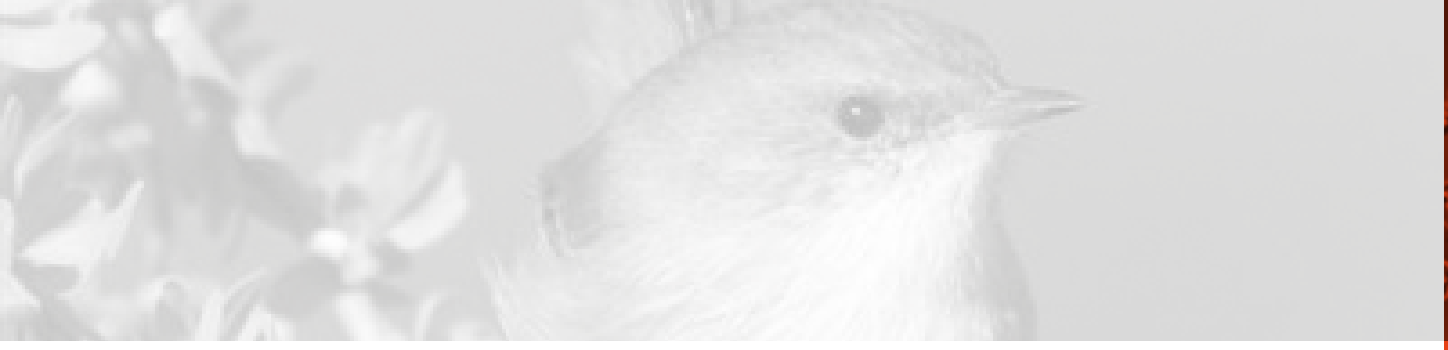
Return to contents page



5.2 Registered herbicides *cont.*

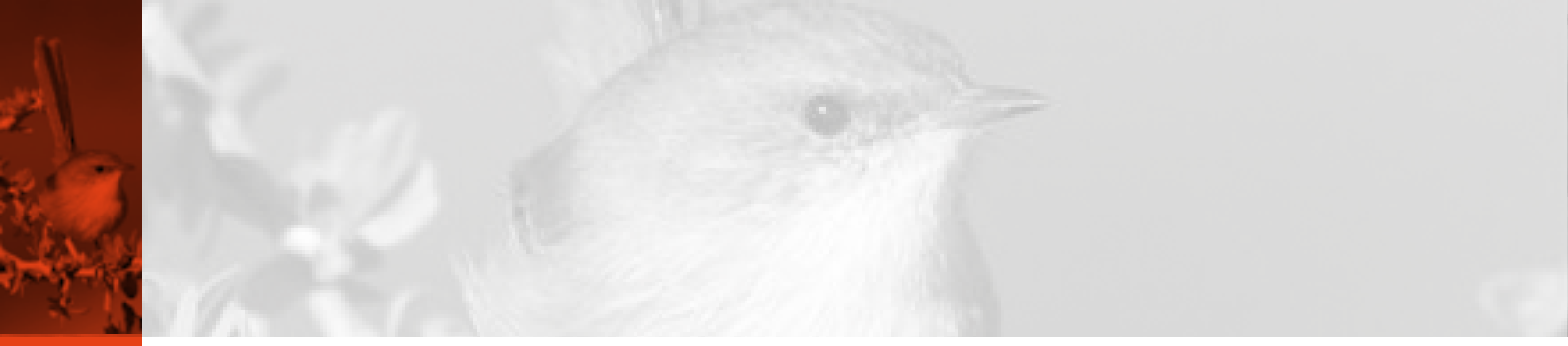
PRODUCT NAME	ACTIVE CONSTITUENTS
OZTEC GLYPHOSATE 450 NON SELECTIVE HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
PACIFIC GLYPHOSATE 360 SL HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
PACIFIC TRICLOPYR 600 HERBICIDE	TRICLOPYR PRESENT AS THE BUTOXYETHYL ESTER
PESTMASTER AQUA-TECH GLYPHOSATE 360 HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
POLYGON GLYPHOSATE 540 HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
PRO STOMPER GLYPHOSATE 510	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
PRO TRICLOPYR 600 HERBICIDE	TRICLOPYR PRESENT AS THE BUTOXYETHYL ESTER
PROTERRA HI-GLY 510 HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
RACS HEXAZINONE HERBICIDE	HEXAZINONE
RAINBOW GLYPHOSATE 450 HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
RAINBOW GLYPHOSATE 700 HERBICIDE	GLYPHOSATE PRESENT AS THE MONO-AMMONIUM SALT
RAINBOW GLYPHOSATE BIO 360 HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
RAINBOW TEBUTHIURON 200 HERBICIDE	TEBUTHIURON
RAINBOW TRICLOPYR 600 EC HERBICIDE	TRICLOPYR PRESENT AS THE BUTOXYETHYL ESTER
RANGER 600 HERBICIDE	TRICLOPYR PRESENT AS THE BUTOXYETHYL ESTER
RAVENSDOWN DEVASTATOR 250 HERBICIDE	HEXAZINONE
RAVENSDOWN GLYPHOSATE 540 HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
RAVENSDOWN TRICLOPYR 600 HERBICIDE	TRICLOPYR PRESENT AS THE BUTOXYETHYL ESTER
RAZE HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
RC GLYPHOSATE 450 HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
RC TRICLOPYR 600 HERBICIDE	TRICLOPYR PRESENT AS THE BUTOXYETHYL ESTER
REDCHEM ANGER 450 HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
REDEEM 600 HERBICIDE	TRICLOPYR PRESENT AS THE BUTOXYETHYL ESTER
REDOX GLYPHOSATE 680 HERBICIDE	GLYPHOSATE PRESENT AS THE MONO-AMMONIUM SALT
RESOURCE GARDENING GLYPHO 360 NON SELECTIVE HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
RESOURCE GARDENING GLYPHO 360 WEEDKILL	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
RHODIA GLYPHOSATE POTASSIUM EXPRESS HERBICIDE	GLYPHOSATE PRESENT AS THE POTASSIUM SALT
RHODIA GLYPHOSATE POTASSIUM HIGH LOAD HERBICIDE	GLYPHOSATE PRESENT AS THE POTASSIUM SALT
RICHGRO GLYPHOSATE 360 HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
RICOCHET HERBICIDE	PICLORAM AS THE TRIISOPROPANOLAMINE SALT	2,4-D AS THE TRIISOPROPANOLAMINE SALT
RIPPER 480 FLEXI HERBICIDE	GLYPHOSATE PRESENT AS THE DIMETHYLAMMONIUM SALT
RIPPER 480 HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
ROLLDOWN 360 BIO HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
ROUNDUP ATTACK HERBICIDE WITH IQ INSIDE	GLYPHOSATE PRESENT AS THE POTASSIUM SALT
ROUNDUP BIACTIVE HERBICIDE BY MONSANTO	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
ROUNDUP DRY HERBICIDE BY MONSANTO	GLYPHOSATE PRESENT AS THE MONO-AMMONIUM SALT
ROUNDUP HERBICIDE BY MONSANTO	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
ROUNDUP MAX HERBICIDE BY MONSANTO	GLYPHOSATE PRESENT AS THE MONOETHANOLAMINE SALT
ROUNDUP POWER MAX HERBICIDE BY MONSANTO	GLYPHOSATE PRESENT AS THE POTASSIUM 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 510 HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
RYGEL CLEARUP 517 K HERBICIDE	GLYPHOSATE PRESENT AS THE POTASSIUM SALT
RYGEL CLEARUP 700 BIO-DRI HERBICIDE	GLYPHOSATE PRESENT AS THE MONO-AMMONIUM SALT
RYGEL CLEARUP 700 DRI BROADACRE HERBICIDE	GLYPHOSATE PRESENT AS THE MONO-AMMONIUM SALT
RYGEL CLEARUP BIO 360 HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
RYGEL CLEARUP BIO 360 SL HERBICIDE	GLYPHOSATE PRESENT AS THE MONOETHANOLAMINE SALT
RYGEL CLEARUP IMPRESS 540 HERBICIDE	GLYPHOSATE PRESENT AS THE POTASSIUM SALT
RYGEL TRICLOPYR 600 HERBICIDE	TRICLOPYR PRESENT AS THE BUTOXYETHYL ESTER
SABAKEM GLYPHOSATE 360SL HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT

Return to contents page



PRODUCT NAME	ACTIVE CONSTITUENTS
SABAKEM GLYPHOSATE 450CT HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
SABERO TRICLOPYR 600EC HERBICIDE	TRICLOPYR PRESENT AS THE BUTOXYETHYL ESTER
SAFARI 600EC HERBICIDE	TRICLOPYR PRESENT AS THE BUTOXYETHYL ESTER
SANONDA HERBICIDE GLYPHOSATE 510SL	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
SANOS 360 NON SELECTIVE HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
SANOS 450 NON SELECTIVE HERBICIDE BY SANONDA	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
SEARLES TREE & BLACKBERRY KILLER	TRICLOPYR BUTOXYETHYL ESTER
SET-UP 450 HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
SET-UP BIAQUATIC 360 HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
SET-UP DRY 680 HERBICIDE	GLYPHOSATE PRESENT AS THE MONO-AMMONIUM SALT
SHARDA GLYPHOSATE 700 SG HERBICIDE	GLYPHOSATE PRESENT AS THE MONO-AMMONIUM SALT
SHARP SHOOTER WEED KILLER 360 GLYPHOSATE CONCENTRATE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
SHOOT 360 HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
SHOOT 450 HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
SHUTDOWN 450 HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
SICKLE 540 HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
SINOCHEM CHISEL 450 HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
SINOCHEM CHISEL DRY 700 SG HERBICIDE	GLYPHOSATE PRESENT AS THE MONO-AMMONIUM SALT
SINON GERLAN 600 EC HERBICIDE	TRICLOPYR PRESENT AS THE BUTOXYETHYL ESTER
SMART DRY 680 HERBICIDE	GLYPHOSATE PRESENT AS THE MONO-AMMONIUM SALT
SMART GLYPHOSATE 450 HERBICIDE	GLYPHOSATE
SMART LOADED 517 HERBICIDE	GLYPHOSATE PRESENT AS THE POTASSIUM SALT
SMART TRICLOPYR 600 HERBICIDE	TRICLOPYR PRESENT AS THE BUTOXYETHYL ESTER
SPALDING GLYPHOSATE 360 HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
SPALDING TRICLOPYR 600 HERBICIDE	TRICLOPYR PRESENT AS THE BUTOXYETHYL ESTER
SQUAREUP 360 GLYPHOSATE HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
SUPERWAY GLYPHOSATE 360 HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
SUPERWAY TRI-PIC HERBICIDE	PICLORAM PRESENT AS THE HEXYLOXYPROPYLAMINE SALT | TRICLOPYR PRESENT AS THE BUTOXYETHYL ESTER
SUPERWAY TRICLOPYR 600 HERBICIDE	TRICLOPYR PRESENT AS THE BUTOXYETHYL ESTER
SUPREMO 680 GRANULAR CONCENTRATE HERBICIDE	GLYPHOSATE PRESENT AS THE MONO-AMMONIUM SALT
SUREFIRE GLYPHOSATE 360 HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
SURIA 450 CT NON-SELECTIVE, TRANSLOCATED HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
SURIA 510 HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
SURIA 700 SG HERBICIDE	GLYPHOSATE PRESENT AS THE MONO-AMMONIUM SALT
SURIA BIAQUATIC 360 HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
TEBULAN 200GR HERBICIDE	TEBUTHIURON
TITAN GLYPHOSATE 450 HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
TITAN GLYPHOSATE 540 K SALT HERBICIDE	GLYPHOSATE PRESENT AS THE POTASSIUM SALT
TITAN GLYPHOSATE 700 HERBICIDE	GLYPHOSATE PRESENT AS THE MONO-AMMONIUM SALT
TITAN HEXAZINONE SL HERBICIDE	HEXAZINONE
TITAN PICLORAM + TRICLOPYR 400 HERBICIDE	PICLORAM PRESENT AS THE HEXYLOXYPROPYLAMINE SALT | TRICLOPYR PRESENT AS THE BUTOXYETHYL ESTER
TITAN PICLORAM 75-D HERBICIDE	PICLORAM AS THE TRIISOPROPANOLAMINE SALT | 2,4-D AS THE TRIISOPROPANOLAMINE SALT
TITAN TEBUTHIURON HERBICIDE	TEBUTHIURON
TITAN TRICLOPYR 600 HERBICIDE	TRICLOPYR PRESENT AS THE BUTOXYETHYL ESTER
TOKEN HERBICIDE	PICLORAM PRESENT AS THE HEXYLOXYPROPYLAMINE SALT | TRICLOPYR PRESENT AS THE BUTOXYETHYL ESTER
TORDON 75-D HERBICIDE	PICLORAM AS THE TRIISOPROPANOLAMINE SALT | 2,4-D AS THE TRIISOPROPANOLAMINE SALT
TORDON GRANULES-WEED & BRUSH HERBICIDE	PICLORAM AS THE TRIETHANOLAMINE SALT
TOUCHDOWN 360 HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
TOUCHDOWN BROADACRE HERBICIDE	GLYPHOSATE-TRIMESIUM
TOUCHDOWN HERBICIDE	GLYPHOSATE-TRIMESIUM
TOUCHDOWN HITECH HERBICIDE	GLYPHOSATE PRESENT AS THE POTASSIUM SALT

Return to contents page



5.2 Registered herbicides *cont.*

PRODUCT NAME	ACTIVE CONSTITUENTS
TOWELUP 2,4-D HERBICIDE	PICLORAM AS THE TRIISOPROPANOLAMINE SALT I 2,4-D AS THE TRIISOPROPANOLAMINE SALT
TRICLON 600 HERBICIDE	TRICLOPYR PRESENT AS THE BUTOXYETHANOL ESTER
TRIO STOMP GLYPHOSATE 510 HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
TRIO TRICLOPYR 600 HERBICIDE	TRICLOPYR PRESENT AS THE BUTOXYETHYL ESTER
TRIPICLO HERBICIDE	PICLORAM PRESENT AS THE HEXYLOXYPROPYLAMINE SALT I TRICLOPYR PRESENT AS THE BUTOXYETHYL ESTER
TURF CULTURE KERMIT 360 HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
TURF CULTURE OSKAR 510 HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
UNI-LON 600 HERBICIDE	TRICLOPYR PRESENT AS THE BUTOXYETHYL ESTER
WATKINS WEED KILLER 360 CONCENTRATE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
WEEDFREE GLYPHOSATE GRANULES HERBICIDE	GLYPHOSATE PRESENT AS THE MONO-AMMONIUM SALT
WEEDPRO TRYCLOPS 600 HERBICIDE	TRICLOPYR PRESENT AS THE BUTOXYETHYL ESTER
WHITESTAR DRI GLYPHOSATE 700 HERBICIDE	GLYPHOSATE PRESENT AS THE MONO-AMMONIUM SALT
WIPE-OUT 450 NON-RESIDUAL HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
WIPE-OUT DRY 700 SG HERBICIDE	GLYPHOSATE PRESENT AS THE MONO-AMMONIUM SALT
WSD GLYPHOSATE 360 HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT
WSD TRICLOPYR 600 HERBICIDE	TRICLOPYR PRESENT AS THE BUTOXYETHYL ESTER
WYNCA GLYPHOSATE 680 HERBICIDE	GLYPHOSATE PRESENT AS THE MONO-AMMONIUM SALT
YATES TREE AND BLACKBERRY KILLER	TRICLOPYR PRESENT AS THE BUTOXYETHYL ESTER
YATES TREE AND BLACKBERRY WEED KILLER	TRICLOPYR PRESENT AS THE BUTOXYETHANOL ESTER
YATES ZERO AQUA HERBICIDE	GLYPHOSATE PRESENT AS THE ISOPROPYLAMINE SALT

5.3 Australian Pesticides and Veterinary Medicines Authority – off-label and minor use permits

African boxthorn control off-label and minor use permits for some herbicides have been issued for specific situations in individual state and territory jurisdictions.[1]

To do a search for off-label and minor use permits, go to the Australian Pesticides and Veterinary Medicines website www.apvma.gov.au and click on 'PERMITS: search' in the right-hand 'services' menu.

In addition to a web search it is recommended that you contact the relevant department of your state or territory government to seek further information on any off-label and minor use permits for herbicide use on African boxthorn in your jurisdiction. Contact details for relevant state and territory departments are provided in section 5.6.

5.4 Chemical and chainsaw use training certification

Chemical users may be required to have training and certification to apply certain herbicides and/or to apply them in a commercial context. The situation varies between Australian states and territories so, when planning African boxthorn management, you should seek advice from your state or territory's relevant agency.

Before on-the-ground work commences, project managers should ensure that staff and contractors involved in the application of herbicides have the required training and qualifications.

Also, project managers should ensure that people using chainsaws have the required training, experience and personal protective equipment. Chainsaw users may be required to undertake training and certification depending on the state or territory they are operating in. It is recommended that you contact your relevant state or territory government department for advice.

Return to contents page

Contact details for relevant state and territory departments are provided in section 5.6.

5.5 Regulations and permits for works in riparian lands

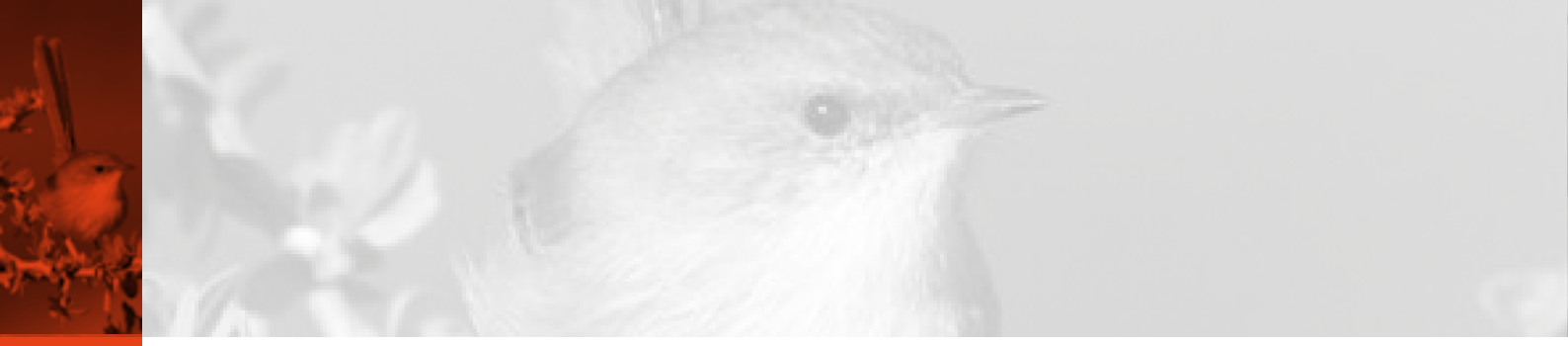
Some states and territories have regulations and/or require permits for works in riparian lands. Riparian lands are those that adjoin, directly influence, or are influenced by a body of water at any time of the year.[2]

As the situation varies between Australian states and territories, when planning to control African boxthorn that is in or influencing riparian lands, you should seek advice from your state or territory's relevant agency.

5.6 State and regional contacts for weed information

STATE/ TERRITORY	DEPARTMENT	PHONE	EMAIL	WEBSITE
National	Australian Pesticides and Veterinary Medicines Authority	02 6210 4701	contact@apvma.gov.au	www.apvma.gov.au
ACT	Department of the Environment, Climate Change, Energy and Water	13 22 81	environment@act.gov.au	www.environment.act.gov.au/environment
NSW	Department of the Environment, Climate Change, Energy and Water	1800 680 244	weeds@dpi.nsw.gov.au	www.dpi.nsw.gov.au/agriculture/pests-weeds/weeds
NT	Department of Land Resource Management	08 8999 4567	weedinfo@nt.gov.au	www.lrm.nt.gov.au/weeds
Qld	Department of Agriculture, Fisheries and Forestry	13 25 23	callweb@daff.qld.gov.au	www.daff.qld.gov.au
SA	Biosecurity SA, Dept of Primary Industries and Regions SA	08 8303 9620	nrmbiosecurity@sa.gov.au	www.pir.sa.gov.au/biosecuritysa/nrm_biosecurity/weeds
TAS	Department of Primary Industries, Parks, Water and Environment	1300 368 550	See contacts at www.dpipwe.tas.gov.au/weeds	www.dpipwe.tas.gov.au/weeds
VIC	Department of Environment and Primary Industries	13 61 86	customer.service@dpi.vic.gov.au	www.dpi.vic.gov.au/agriculture/pests-diseases-and-weeds
WA	Department of Agriculture and Food	08 9368 3333	enquiries@agric.wa.gov.au	www.agric.wa.gov.au

Return to contents page



5.7 National core attributes for weed mapping

Consistent mapping of African boxthorn across the nation is an essential component of establishing and maintaining a greater national understanding of distribution and management of the weed.

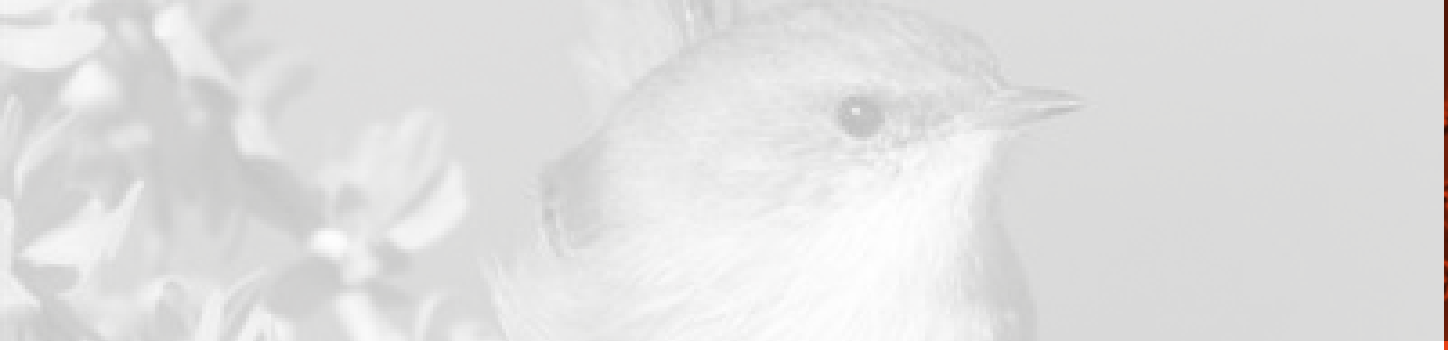
In 2006 the Australian Government (Bureau of Rural Sciences) published *A field manual for surveying and mapping nationally significant weeds*. This can be downloaded from http://nrmonline.nrm.gov.au/catalog/mql:22. The Weeds of National Significance mandatory and optional core mapping attributes (mapping features to be recorded consistently at a national level) taken from this manual are provided below.

Mandatory and optional core mapping attributes for weeds of national significance

	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 from which 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/density	measured by class intervals. Prefer data that records raw density as a percentage. For rapid survey density data may be collected as classed data e.g. 55–100% cover=dense. CLASS NO. — CLASS DESCRIPTIONS 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.**

Return to contents page



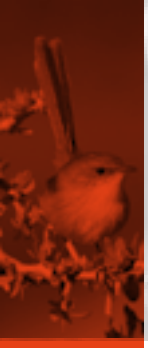
References

1. Australian Pesticides and Veterinary Medicines Authority, 2013, Public Chemical Registration Information System Search, Australian Pesticides and Veterinary Medicines Authority, Canberra, viewed 30 July 2013, <http://www.apvma.gov.au/>.

2. Department of Primary Industries, Parks, Water and Environment, 2013, Guidelines for safe and effective herbicide use near waterways, Department of Primary Industries, Parks, Water and Environment, Tasmania, viewed 30 July 2013, <http://www.dpiw.tas.gov.au/inter.nsf/Attachments/CART-8WP49P/$FILE/herbicide_guidelinesFINAL2012.pdf>.

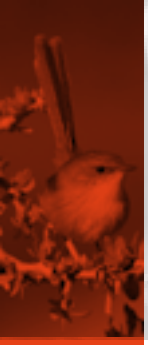
3. McNaught I, Thackaway R, Brown L, Parsons M. A field manual for surveying and mapping nationally significant weeds, Canberra: Bureau of Rural Sciences, viewed 31 July 2013, <http://nrmonline.nrm.gov.au/catalog/mql:22>.

Return to contents page



NOTES

NOTES



NOTES