Habitat Management Plan for the CLLMM region

NOVEMBER 2011

VOLUME 2: Detailed action plans & guidelines for on-ground works

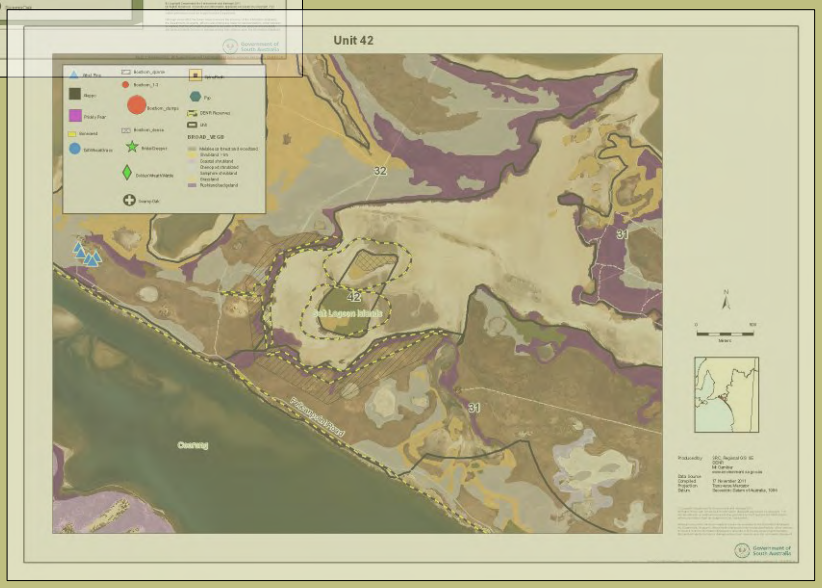

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Table of Contents

Habitat Management Plan for the CLLMM region

Executive Summary (for Volumes 1 & 2)

Introduction

The Coorong, Lower Lakes and Murray Mouth (CLLMM) region is a challenging area in which to plan and implement on-ground works for a number of reasons. In addition to the well known complex water management issues that impact the area, the peripheral wetland and terrestrial habitats of the site are themselves subjected to a wide range of land use and human impacts, after more than 150 years of European settlement.

These threatening processes are diverse and in many cases heavily entrenched, and often overwhelm land management staff looking for clear direction to guide their local works programs. Put simply, there will never be the resources available required to adequately address all known threatening processes to biodiversity in heavily impacted areas like the CLLMM region. With this in mind, a suite of individual weed and pest plans, of equal priority, recommending actions that are beyond the capacity of land managers to implement (as has often been the case in the past), was not the approach adopted for this assignment.

Instead, the novel approach and body of work summarised in these two Volumes is the culmination of over 12 months spent undertaking three parallel but inter-related investigations, that attempt to 'untangle' some of the complexity we face, by asking ourselves the following simple question: "given that we cannot do everything, where should we work on pest and weed management in the CLLMM region, and why?"

The document is arranged into two Volumes:

Volume 1: Provides a detailed explanation of the three complimentary prioritisation approaches (Sections B, C and D) enabling the reader to understand the logic of how the full suite of species, sites and management units considered across the CLLMM region were determined and narrowed down to the short-lists then recommended for action.

Volume 2: Explains how the lists of species, sites and management units recommended for action, were further refined through ground-truthing and additional prioritisation workshops (Sections E, F and G), to formulate the detailed action plans that follow. A range of supplementary materials for CLLMM managers and on-ground works staff are also provided in Section H that may assist with the implementation phase of this project.

An up-front warning however to participants in this process: you must be prepared for your 'pet' invasive species, site or patch of habitat to be submitted to an objective assessment that has no favourites. Our goal in developing this tool was simply to recommend works that provided the highest biodiversity benefit per unit of investment, and critically, that would have a high probability of long-term success (and being maintained) beyond the 5 year investment currently available to the CLLMM project.

Volume 1 Methods

A multi-dimensional prioritisation approach was developed by the authors for this project, to address pest and weed management issues in the CLLMM region, and may also be of particular interest to those wishing to apply the flexible logic of this novel prioritisation process in other locations.

The three inter-dependant and complimentary planning methods, of which the first two were based heavily on existing methodologies, were:

Section B: A **single-species approach** to determining **pest and weed species** feasible for region-wide control, by adapting a widely adopted process of weed and pest risk assessment developed by Biosecurity SA staff in PIRSA and the former DWLBC;

Section C: A **biodiversity asset approach** to determining specific, area based, **environmental assets** in the CLLMM region worthy of broader based pest and weed management. This component relied on a process adapted from the Environmental Weed Management Action Tool (EWeedMAT), a landscape prioritisation model previously developed by South East Conservation Programs staff, DENR; and,

Section D: An assessment of **key invasion sites (KIS)**, which are areas where threats (particularly weeds) are clustered, and often associated with frequent present or historic human use. Data layers representing these sites were created and the outputs of the Section C process used to determine priority KIS for detailed action planning.

Volume 1 Results

Section B: Seventeen weeds and four animal pests were assessed in the Lower Lakes region, whilst in the Coorong region, 21 weeds and eight animal pests were investigated. Of these assessed species, three weeds and none of the animal pests were considered as a priority for the Lower Lakes region, whilst seven weeds and one animal pest species were priorities for control in the Coorong region.

Additionally, Red Deer was earmarked for Action Plan development as it has a limited distribution in a part of site that straddles the Coorong and Lower Lakes regions. Further, a combined list of alert species was compiled in recognition of the fact that a wide array of additional species, currently not recorded in the CLLMM region, also pose a significant potential threat (should they be detected) to the values of Ramsar site.

Section C: Twelve management units (or clusters of similar units) were short-listed in each region for the development of detailed Action Plans. The identification of these priority management units (or clusters) seeks to achieve the greatest return on investment, by focussing concurrently on multiple threats to core biodiversity assets.

Section D: Two KIS in management units away from towns (quarries) were identified for further investigation and ground-truthing to evaluate recommendations for on-ground works in the Lower Lakes, whilst 63 were considered to be from high to very high priority in the Coorong region, based on their presence within high priority management units.

Volume 2 Summary

Volume 2 takes the most highly ranked species, sites and management units recommended for action in Sections B, C and D as a result of the planning process described in Volume 1, and further refines the data associated with them.

Firstly, in the case of management units, the prioritised lists are checked through a ground-truthing process to (a) verify the key threat information that underpins the site ranking, and (b) inform the development of detailed management strategies to address threats based on the most recent information available.

Secondly, additional prioritisation workshops were required to formulate the content of detailed Action Plans that follow for all three categories. This is one of the most critical steps in the process to ensure that (a) the priority issue or asset can be effectively managed at the scale recommended and (b) to ensure that all management recommendations can be justified on the basis that the works are feasible and able to be maintained in the long-term, well beyond the initial 5 year investment period of the CLLMM project.

The specific Action Plans produced as a result of the 3 approaches are as follows:

Section E: 11 actions plans produced as per the table below.

Management category	Lower Lakes	Coorong
Alert	(1) Alert Species	
Eradicate from region	-	-
Destroy infestations or populations	-	(5) Boneseed (6) Coastal Tea-tree
Contain spread	(2) Athel Pine (3) Boneseed (4) Prickly Pear	(7) Dolichos Pea (8) Pines (Aleppo Pine, Athel Pine, Tamarisk) (9) Spiny Rush (10) Feral Goat
Other	(11) Red Deer	

Section F: 24 actions plans produced as per the table below.

Lower Lakes	Coorong
(1) Unit 37, Tolderol	(13) Bird Island
(2) Unit 42, Salt Lagoon Islands	(14) Cattles (Cattle & Lady Clare)
(3) Unit 34, Ewe and Long Islands	(15) End of CNP (inland)
(4) Unit 9, Goose, Goat and Rat Islands	(16) Kartoo Scrub
(5) Unit 33, Mud Islands	(17) Northern YHP
(6) Unit 35, Mundoo Island	(18) Parnka islands (Rabbit, Bull & North Parnka)
(7) Unit 18, Mosquito Point	(19) Pelican Point to Long Point
(8) Unit 23, Low Point	(20) Pelicans (North Pelican, Seagull & Teal)
(9) Unit 16, Vercoe's property	(21) Potters Scrub
(10) Unit 13, Reedy Point	(22) Stony wells (Stony Well, Round & Long)
(11) Unit 37, Waltowa Swamp	(23) Wild dogs (Wild Dog, Snipe & 2 unnamed)
(12) Unit 3, Laffin Point	(24) Wyndgate

Section G: 5 actions plans produced as per the table below, with 5 additional Action Plans (shaded pink) integrated within Section F management unit Action Plans.

Lower Lakes	Coorong
(1) KIS in townships	(3) Past & Present Developments
(2) KIS away from towns	(4) Access tracks
	(5) Campsites
	Specific Coorong KIS within Section F Action Plans
	(15) End of CNP (inland)
	(16) Kartoo Scrub
	(17) Northern YHP
	(19) Pelican Point to Long Point
	(21) Potters Scrub
	(24) Wyndgate

Volume 2 concludes with **Section H**, a weed and pest management resource reference for project managers and deliverers working on the CLLMM project.

Conclusion

The growing number of recognised threatening processes to environmental values, and limited resources available to address them, are responsible for driving a demand for new ways to plan and prioritise on-ground works. Novel, systematic and objective approaches are therefore required in biodiversity management of the landscape to prioritise management actions for invasive species.

The integrated approach outlined in these documents provides the CLLMM project team with a clear basis for on-ground delivery of pest and weed management works as the project moves from planning to implementation.

It is also anticipated that the spatially flexible methodology outlined (particularly in Volume 1), will be of interest to site managers of other key biodiversity assets in Australia facing a complex suite of threatening processes, and where there is current uncertainty in determining the best management approach required to address them.

SECTION E: Single-species action plans

Summary

Introduction

Section B in the first volume of the CLLMM Habitat Management Plan describes the single-species component of the multi-dimensional assessment of landscape pest and weed priorities across the Coorong and Lower Lakes region.

From this assessment, 11 species were identified and shortlisted, and form the basis of the Action Planning exercise described here in Section E.

It is at this point that the process deliberately drills down to the 'site scale' for prescribing management actions. In doing so, it addresses a key criticism levelled at many regional weed and pest management plans developed in the past, which have often been too generic to inform localised, site specific on-ground works.

Methods

A number of activities were necessary to develop single-species specific action plans.

Information was attained through compilation of data relevant to each component, using ground-truthing (that built on knowledge gained through the Early Works project), GIS database interrogation and further liaison with key stakeholders. Specifically, for the single-species component, distribution and extent surveying was used to supplement existing information.

The final stage involved evaluation of this compiled information (in consultation with the project's Technical Working Group) to develop specific on-ground management actions for each of single-species. Our goal in this respect was simply to recommend works that provided the highest biodiversity benefit per unit of investment, and critically, that would have a high probability of long-term success (and being maintained) beyond the 5 year investment currently available through the CLLMM project.

Results

Management categories, actions and on-ground activities are identified and discussed for each invasive species considered in this process, and are listed over the following pages, numbered according to the order presented in Table E-1.

Table E-1 Summary of priority weed and pest species from the Lower Lakes and Coorong regions into management categories following risk assessment (action plan number in brackets).

Management category	Lower Lakes	Coorong
Alert	(1) Alert Species	
Eradicate from region	-	-
Destroy infestations or populations	-	(5) Boneseed (6) Coastal Tea-tree
Contain spread	(2) Athel Pine (3) Boneseed (4) Prickly Pear	(7) Dolichos Pea (8) Pines (Aleppo Pine, Athel Pine, Tamarisk) (9) Spiny Rush (10) Feral Goat
Other	(11) Red Deer	

SECTION F: Biodiversity assets action plans

Summary

Introduction

Section C in the first volume of the CLLMM Habitat Management Plan describes the biodiversity asset component of the multi-dimensional assessment of landscape pest and weed priorities across the Coorong and Lower Lakes region.

From this assessment, 24 biodiversity asset management units were identified and shortlisted, and form the basis of the Action Planning exercise described here in Section F.

It is at this point that the process deliberately drills down to the 'site scale' for prescribing management actions. In doing so, it addresses a key criticism levelled at many regional weed and pest management plans developed in the past, which have often been too generic to inform localised, site specific on-ground works.

Methods

A number of activities were necessary to develop biodiversity asset action plans.

Information was attained through compilation of data relevant to each component, using ground-truthing (that built on knowledge gained through the Early Works project), GIS database interrogation, and further liaison with key stakeholders.

A vitally important component at this stage is the checking of site conditions through ground-truthing, remembering that the process outlined in Volume 1 (by necessity given the size of the CLLMM site) is driven entirely by existing information brought to the process from participants and from databases. Hence, a field investigation of the smaller number of short-listed sites is able to (a) verify the key threat information that underpins the site ranking, and (b) inform the development of detailed management strategies to address threats based on the most recent information available. Relevant information collected includes the location of key conservation priorities and the presence and nature of infestations (extent & confidence of estimate) of weed and pest species (short-listed and other) impacting these key areas.

Secondly, additional prioritisation workshops (with the project's Technical Working Group) were required to formulate the content of detailed Action Plans for each shortlisted management unit. This is one of the most critical steps in the process to ensure that (a) the priority issue or asset can be effectively managed at the scale recommended and (b) to ensure that all management recommendations can be justified on the basis that the works are feasible and able to be maintained in the long-term, well beyond the initial 5 year investment period of the CLLMM project.

Results

Management categories, actions and on-ground activities are identified and presented in an Action Plan for each priority management unit (or cluster) considered in this process, and are found over the following pages, numbered according to the order presented in Table F-1

Table F-1 Summary of priority management units (or clusters) following biodiversity assets assessment (action plan number in brackets).

Lower Lakes (for KIS see section G)	Coorong (red box = also includes KIS)	
(1) Unit 37, Tolderol	(13) Bird Island	
(2) Unit 42, Salt Lagoon Islands	(14) Cattles (Cattle & Lady Clare)	
(3) Unit 34, Ewe and Long Islands	(15) End of CNP (inland)	
(4) Unit 9, Goose, Goat and Rat Islands	(16) Kartoo Scrub	
(5) Unit 33, Mud Islands	(17) Northern YHP	
(6) Unit 35, Mundoo Island	(18) Parnka islands (Rabbit, Bull & North Parnka)	
(7) Unit 18, Mosquito Point	(19) Pelican Point to Long Point	
(8) Unit 23, Low Point	(20) Pelicans (North Pelican, Seagull & Teal)	
(9) Unit 16, Vercoe's property	(21) Potters Scrub	
(10) Unit 13, Reedy Point	(22) Stony wells (Stony Well, Round & Long)	
(11) Unit 37, Waltowa Swamp	(23) Wild dogs (Wild Dog, Snipe & 2 unnamed)	
(12) Unit 3, Laffin Point	(24) Wyndgate	

SECTION G: Key invasion site action plans

Summary

Introduction

Section D in the first volume of the CLLMM Habitat Management Plan describes the key invasion site component of the multi-dimensional assessment of landscape pest and weed priorities across the Coorong and Lower Lakes region.

From this assessment, 65 key invasion sites were identified were identified and shortlisted (2 in the Lower Lakes and 63 in the Coorong), and form the basis of the Action Planning exercise described here in Section F.

It is at this point that the process deliberately drills down to the 'site scale' for prescribing management actions. In doing so, it addresses a key criticism levelled at many regional weed and pest management plans developed in the past, which have often been too generic to inform localised, site specific on-ground works.

Methods

A number of activities were necessary to develop key invasion site plans.

Information was attained through compilation of data relevant to each component, using ground-truthing (that built on knowledge gained through the Early Works project), GIS database interrogation, and further liaison with key stakeholders.

For the key invasion sites, it involved documenting the presence and nature of infestations (extent & confidence of estimate) associated with the key invasion sites identified. For the Coorong region, where the vast majority of priority KIS were situated, this process was not necessary for coastal shack KIS's as this information has previously been recently documented in Bartley (2010).

Secondly, additional prioritisation workshops (with the project's Technical Working Group) were required to formulate the content of detailed Action Plans for each shortlisted KIS. This is one of the most critical steps in the process to ensure that (a) the priority issue or asset can be effectively managed at the scale recommended and (b) to ensure that all management recommendations can be justified on the basis that the works are feasible and able to be maintained in the long-term, well beyond the initial 5 year investment period of the CLLMM project.

Results

The Action Plans in this section complement the Single-species Assessment and Biodiversity Asset Assessment processes, together providing a more holistic approach to invasive species management in the region. KIS in the Lower Lakes are concentrated in units associated with townships, whilst they are more widely spread in the management units of the Coorong, being more closely related to the long history of recreational use of the area.

Lower Lakes

The two short-listed KIS in the Lower Lakes were the only two identified not associated with townships.

At face value, further assessment of these KIS was warranted given the Units they are found in have the highest Biodiversity Asset Priority Index (BAPI) scores among management units around the Lower Lakes that contain KIS. Suggested components of the management plan for KIS in Units 32 and 20 should be composed of 'Monitoring', 'Control Actions' and 'Community Engagement & Awareness'. A brief management action table for the KIS in Units 32 and 20 is shown in Table G-1.

Table G-1: Management action table for KIS found in Units 32 and 20

Management objective:	- To locate, identify and control shortlisted invasive species in the Lower Lakes (refer to WRA in Section 4.0) that exist within KIS - To monitor and control occurrence of 'Alert Species' within KIS - To monitor and control other weed species in the KIS that may threaten biodiversity assets of Units 32 and 20

Management Units included:	**Type of Key Invasion Sites**
Unit 32	Quarry
Unit 20	Quarry

Components:	**Site Actions:**
Monitoring	Detailed survey of KIS to locate and map any occurrence of weed species included in the shortlist for the Lower Lakes as well as any initial outbreak of 'Alert Species'
	Conduct regular site visit to KIS (2x/year)
Control actions	Control infestation of shortlisted weed species as well as any initial outbreak of 'Alert Species' if found existing within KIS.
Community education and awareness	Engage landowner / land manager regarding exiting threats in KIS
	Provide IWM and IPM as well as best control practice information to landowner / land manager

The subsequent ground-truthing exercise for these sites clearly highlighted that they were not currently posing a risk to biodiversity, as these quarries had not operated for 2-3 decades and did not have invasive species outbreaks associated with their previous use. However, other more ubiquitous weeds were present at these sites.

Given the current status of these sites, it was deemed more appropriate to prepare a generic Action Plan to cover KIS in remote areas (rather than individual site-based Action Plans) to alert the CLLMM project to the potential management issues associated with them in the future, based on the management objectives outlined in Table G-1.

In addition to the two former quarry sites in more remote areas, the remainder of KIS were all associated with the several townships present on the Lake shoreline. Given the significant social aspect to the presence of KIS, and the interest of communities around the Lower Lakes in the health of the Ramsar site, an additional generic Action Plan was developed to account for the range of KIS associated with townships, highlighting some strategies that can be implemented to lessen their impact.

Management components for these KIS will mostly fall under 'Monitoring' and 'Community Engagement & Awareness' with the aim of strengthening institutional partnerships in managing invasive species. On-ground control activities for weeds and animal pests will be very limited on these sites since the BAPI scores are low for these units (see Table 8.2 in Volume 1) and management of these units are complex and difficult due to the high number of stakeholders involved. Control of invasive species will only be implemented if priority weeds and 'Alert Species' (see Chapter 4, Volume 1) have been identified in these KIS. A brief management action table for these KIS is shown in Table G-2.

Table G-2: Management action table for KIS found in Units associated with townships

Management objective:	- To locate, identify and control priority weeds (Athel Pine, Boneseed and Prickly Pear) in the Lower Lakes that exist within KIS - To monitor and control occurrence of 'Alert Species' within KIS

Management Units included:	**Type of Key Invasion Sites**
Unit 8	Quarry
Unit 6	Quarry
Unit 14	Oval, Caravan Park, Boat ramp, Quarry
Unit 22	Cemetery, Quarry
Unit 28	Cemetery
Unit 27	Oval, Boat ramp, Quarry

Unit 7	Caravan Park, Cemetery, Boat ramp, Quarry
Unit 2	Oval, Caravan Park, Golf course, Boat ramp
Unit 41	Oval, Caravan Park, Golf course, Swimming amenities, Rubbish dump, Boat ramp

Components:	**Site Actions:**
Monitoring	Detailed survey of KIS to locate and map any occurrence of Athel Pine, Boneseed, Prickly Pear and any initial outbreak of 'Alert Species'
	Conduct regular site visit to KIS (2x/year)
Control actions	Control infestation of Athel Pine, Boneseed, Prickly Pear and 'Alert Species' if found existing within KIS (refer to species action plan for best control options).
Community education and awareness	Engage landowner and other institutional partners such as local councils and NRM board regarding exiting threats in KIS
	Provide continuous feedback to landowner and institutional partners regarding results of regular site visit.

Coorong

In the Coorong, 63 KIS were identified across 5 priority management units. Rather than produce separate Action Plans for these KIS, the Biodiversity Asset Action Plans for these units have been modified to accommodate actions for KIS, and are included in Section F (shaded pink in Table G-3).

In addition, all KIS in the Coorong were classified according to 3 broad categories. Again, similar to the Lower Lakes, these high visitation sites pose significant management challenges to land managers in the CLLMM region, particularly as the remaining 78 sites are distributed widely in other management units. In this way KIS in the Coorong have a very different pattern of distribution to those around the Lower Lakes.

Overview

The first 5 generic KIS presented in Table G-3 cover the categories discussed (2 Lower Lakes & 3 Coorong), recognising that many of these occur in management units of lower biodiversity importance. Community engagement programs in the CLLMM region should particularly take these plans into account, where recommended actions have a strong community focus.

The inclusion of KIS in this planning process, and increasing awareness of the particular management challenges they pose, is a positive step towards taking a more comprehensive view of invasive species management in the CLLMM region.

Table G-3 Summary of priority KIS in Lower Lakes and Coorong region (action plan number in brackets). Note: site specific KIS for Coorong priority management units are in biodiversity assets action plans in Section F – shaded pink.

Lower Lakes	Coorong
(1) KIS in townships	(3) Past & Present Developments
(2) KIS away from towns	(4) Access tracks
	(5) Campsites
	Specific Coorong KIS within Section F Action Plans
	(15) End of CNP (inland)
	(16) Kartoo Scrub
	(17) Northern YHP
	(19) Pelican Point to Long Point
	(21) Potters Scrub
	(24) Wyndgate

SECTION H: General guidelines

1. Introduction

The Biodiversity Asset Assessment Approach (Section C) resulted in the prioritisation of management units in the Lower Lakes and Coorong regions based on the conservation values and threats at each site. This Section provides the 'General Guidelines' managers may require, as reference material, in undertaking the implementation of Action Plans provided earlier in Volume 2.

This Section also provides detailed description of each management component, description of weeds and best control options.

2. Guiding principles in the management of invasive species in the CLLMM region

The Weed and Animal Pest Risk Assessment guidelines (Virtue, 2008; Williams, 2010) provided specific management principles (or actions) for each management category for the shortlisted weeds and pests in the Coorong, Lower Lakes and Murray Mouth region (refer to section B). These principles served as the main guide in the development of specific action plans for the weed and animal pest management within each unit (Table H-1).

3. Components of site management action plan

A range of actions have been identified to manage invasive species in prioritised units in the CLLMM region. These actions are divided into **monitoring**, **control actions**, **community education & awareness** and **assessment & research** components that will be incorporated into an adaptive management approach (Table H-2).

Table H-1. Lists of management principles / actions and respective invasive species.

Management Categories	No action	Protect sites	Protect sites and manage weed	Manage weed / animal pest	Manage sites	Contain spread	Destroy infestation	Eradicate	Alert
Management Actions		1) Surveillance and mapping to locate all infested areas in prioritised units 2) Control of infestations in close proximity to key sites/assets, aiming for a significant reduction in weed density 3) Limits on movement and sale of species within management area 4) Must not allow to spread from cultivated plants (if grown) in close proximity to key sites/assets 5) Monitor change in current distribution within and in close proximity to key sites/assets	1) Surveillance and mapping to locate all infested areas 2) Control of infestations in close proximity to key sites/assets, aiming for a significant reduction in weed density 3) Limits on movement and sale of species within management area 4) Must not allow to spread from cultivated plants (if grown) in close proximity to key sites/assets 5) Monitor change in current distribution within and in close proximity to key sites/assets 6) Research and develop integrated weed management (IWM) and integrated pest management (IPM) packages for the species, including herbicides (weeds) and biological control where feasible 7) Promote IWM packages to landholders 8) Monitor decrease in weed impacts with improved management 9) Ensure adequate resourcing to manage the weed /pest animal species	1) Research and develop integrated weed / pest management (IWM / IPM) packages for the species, including herbicides (weeds), cultural (pest animals), chemical (pest animals) and biological control (weeds and pest animals) where feasible 2) Promote IWM / IPM packages to landholders 3) Monitor decrease in weed / pest animal impacts with improved management 4) Ensure adequate resourcing to manage the weed /pest animal species	1) Promote general IWM / IPM principles to landholders, including the range of control technique, maintaining competitive vegetation/crops/pastures, hygiene and property management plans. 2) Broaden focus beyond weeds to all threatening processes	1) Surveillance and mapping to locate all infested properties 2) Control of all infestations, aiming for a significant reduction in weed density 3) Prevention of entry to management area and movement and sale within 4) Must not allow to spread from cultivated plants (if grown) 5) Monitor change in current distribution	1) Detailed surveillance and mapping to locate all infestations 2) Destruction of all infestations, aiming for local eradication at feasible sites 3) Prevention of entry to management area and movement and sale within 4) Must not grow 5) Monitor progress towards reduction	1) Detailed surveillance and mapping to locate all infestations 2) Destruction of all infestations including seedbanks 3) Prevention of entry to management area and movement and sale within 4) Must not grow and all cultivated plants to be removed 5) Monitor progress towards eradication	1) Prevention of entry to management area 2) Ongoing surveillance for incursions of the species (e.g. nursery inspections) 3) Training and awareness activities for the community to enable early detection
Target invasive species	Lower Lakes Weeds: Water Dropwort Animal pests: none Coorong Weeds: none Animal pests: Rusa Deer	Lower lakes Weeds: Aleppo pine, Swamp Oak, Tamarisk Animal pests: Red Deer Coorong Weeds: Pyp Grass, Western Coast Wattle, Caltrop, Olive, Apple of Sodom, Mrytle-leaf Milkwort, Cypress Pine, Khaki Weed, Radiata Pine, Stinkwort Animal pests: none	Lower lakes Weeds: Golden Wreath Wattle, Spiny Rush Animal pests: none Coorong Weeds: none Animal pests: Red fox, Feral cat, European rabbit, Red & Fallow Deer	Lower lakes Weeds: Phalaris, Tall Wheat Grass, Pyp Grass, Western Coast Wattle, Perennial Veldt Grass, African Boxthorn, Bridal Creeper Animal pests: Red fox, Feral cat and European rabbit Coorong Weeds: Bridal Creeper, African Boxthorn, Golden Wreath Wattle Animal pests:	Lower lakes Weeds: African Lovegrass Animal pests: none Coorong Weeds: none Animal pests: European Hare	Lower lakes Weeds: Athel Pine, Boneseed, Prickly Pear Animal pests: none Coorong Weeds: Athel Pine, Dolichos Pea, Tamarisk, Aleppo Pine, Spiny Rush Animal pests: Feral Goat	Lower lakes Weeds: none Animal pests: none Coorong Weeds: Boneseed, Coastal Tea-tree Animal pests: none	Lower lakes Weeds: none Animal pests: none Coorong Weeds: none Animal pests: none	

Table H-2. Components of the site management plan and summary actions for the Coorong, Lower Lakes and Murray Mouth

Components	Guiding Principles	Recommended Site Actions	Management Objectives	Management Units
Monitoring	Detailed surveillance and mapping to locate all infestations	Detailed survey to locate & map all infestations in the region including new infestations.	To locate and map occurrence of invasive species	Lower Lakes: Entire region for priority invasive species Coorong:
	Surveillance and mapping to locate all infested areas	Detailed survey to locate & map all infestations in priority units including new infestations.		Lower Lakes: All priority units Coorong: All priority units
	Monitor change in current distribution within and in close proximity to key sites/assets	Detailed survey to locate & map infestations adjacent to priority units		Lower Lakes: Units 3, 23, 37 Coorong: All priority units
		Set up photopoints in areas (within and adjacent to priority units) of known infestation.	To provide means of assessing success of management actions.	Lower Lakes: All priority units Coorong: All priority units
	Monitor progress towards reduction / eradication	Conduct regular site visit to ascertain success of control activities	To provide means of assessing success of management actions.	Lower Lakes: All priority units Coorong: All priority units
Control actions	Destruction of all infestations including seedbanks	Implement control actions for all identified infestations within the region and priority units (refer to individual "Site Action Plans"	To control infestation of shortlisted weeds and therefore protect the conservation value of priority units	Lower Lakes: All priority units Coorong: All priority units
	Destruction of all infestations, aiming for local eradication at feasible sites			
	Control of all infestations, aiming for a significant reduction in weed density			
	Prevention of entry to priority units and movement and sale within	Implement control actions for all identified infestations in areas adjacent to priority units		Lower lakes: Units 3, 23, 37 Coorong: All priority units
Community education and awareness	Must not allow to spread from cultivated plants (if grown)	Engage landowner identified of having used known weeds as planting materials with an aim of increasing awareness of landowners	To increase awareness of private landholders regarding invasive species and their responsibilities	Lower lakes: Units 37, 35 13, 16, 18, 9 Coorong: none
	Must not grow			
	Must not grow and all cultivated plants to be removed			
	Limits on movement and sale of species within priority units	Engage nursery owners to be aware of not selling identified weeds	To increase awareness of nursery owners regarding invasive species and their responsibilities	Lower Lakes: All nurseries around LL Coorong: All nurseries around Coorong
	Promote IWM / IPM packages to landholders	Distribute to adjacent landowners brochure and materials about IWM / IPM	To increase capability of private landowners regarding effective management of invasive species	Lower Lakes: All priority units Coorong: All priority units
	Training and awareness activities for the community to enable early detection	Conduct weed identification training among community members through Lakes Hub		Lower Lakes: One event in Milang and Meningie Coorong: none
	Ensure adequate resourcing to manage the weed /pest animal species	Encourage volunteerism for invasive species management in priority units by hosting community events.	To increase community awareness regarding the importance of priority units and the threat of invasive species	Lower Lakes: Unit 17 Coorong: none
Assessment & research	Research and develop integrated weed management (IWM) packages for the species, including herbicides (weeds) and biological control where feasible	Continuously conduct research on best practice methods in controlling invasive species	To have an up to date best practice method of control and to provide relevant information to private landowners	Lower Lakes: N/A Coorong: N/A
		Write information brochure if needed (e.g. Spiny Rush)		Lower Lakes: N/A Coorong: N/A
	Monitor decrease in weed impacts with improved management	Set up plots to record weed regrowth and native vegetation recruitment	To provide means of assessing success of management actions.	Lower lakes: Unit 17 Coorong: none
		Gather data for weeds before and after control.		Lower lakes: Units 17 Coorong:
		Conduct monitoring assessment on the impact of inundation to Spiny Rush	To gather information if Spiny Rush is killed by water inundation	Lower Lakes: Unit 20 Coorong: none
		Establish an experimental plot for Kikuyu and Paspalum to ascertain best control methods	To ascertain best control techniques	Lower Lakes: Unit 17 Coorong: none
		Conduct a survey of the extent of population of threatened flora species and assess the possibility of fencing	To protect state rated flora species with fencing	Lower Lakes: Unit 23, 37 Coorong: Unit 21
	Broaden focus beyond weeds to all threatening processes	Conduct assessment of other existing threats to the site	To mitigate other threats in specific priority units	Lower Lakes: To be assessed later on the implementation phase Coorong: To be assessed later on the implementation phase

3.1. Monitoring

The monitoring strategy to be implemented as part of the site action plan for priority units relies on guiding principles of:

(a) detailed surveillance and mapping to locate all infestations;

(b) surveillance and mapping to locate all infested areas;

(c) monitoring change in current distribution (of weeds) within and in close proximity to priority units; and,

(d) monitor progress towards reduction / eradication.

The objective of monitoring is to gather data / information so that success of management actions can be measured. Collected data / information will be the basis for the annual review so that overall management strategy will be adaptive.

3.1.1. Preliminary Survey

Preliminary surveys for priority units have been conducted to verify the presence of short-listed weeds identified during the Biodiversity Asset Assessment Approach and other weeds that may exist in each unit. Preliminary maps were produced from these initial surveys, which show the location of weeds identified as threat to the conservation values (refer to Site Action Plans).

3.1.2. Detailed survey of the region

Detailed survey of the region is recommended with an aim of locating and mapping occurrence of weeds belonging to the 'Eradicate', 'Destroy Infestations', 'Contain spread' management categories. GPS reference in the form of a waypoint or polygon should be collected so that targeted control can be done.

3.1.3. Detailed survey of priority units

A more detailed survey should be conducted to know the full extent of shortlisted weeds' and other weeds' distribution in priority units.

In priority units, it is highly recommended that perimeter and access tracks of priority units should be surveyed for weed incursion points. Ideally, more thorough surveys using transects placed throughout the unit should be conducted, if time and manpower permits. The surveys should consist of a combination of slow driving and walking. Any priority weeds species located should be mapped and recorded using a hand held GPS. Individual weed species located were recorded as 'point data', whereby a single GPS waypoint and quantity of species will be logged in a *proforma* log sheet (Appendix H-1). Areas containing infestations of weeds will be recorded as 'polygon data', which involved walking the boundary of the infestation and recording GPS waypoints. The weed infestation was then given a percentage cover score based on the graphic in Figure H-1 (Bayley 2001).

Detailed maps based from the surveys will be produced for an effective targeted control of significant weeds in each unit. Evidence of animal pest infestations (e.g. scats, rabbit warren) should also be noted during the survey.

3.1.4. Survey of adjacent properties

Properties adjacent to priority units should be surveyed to locate potential source of weeds that can cause reinvasion of priority units. Surveys should also be done along tracks and roads leading to the unit.

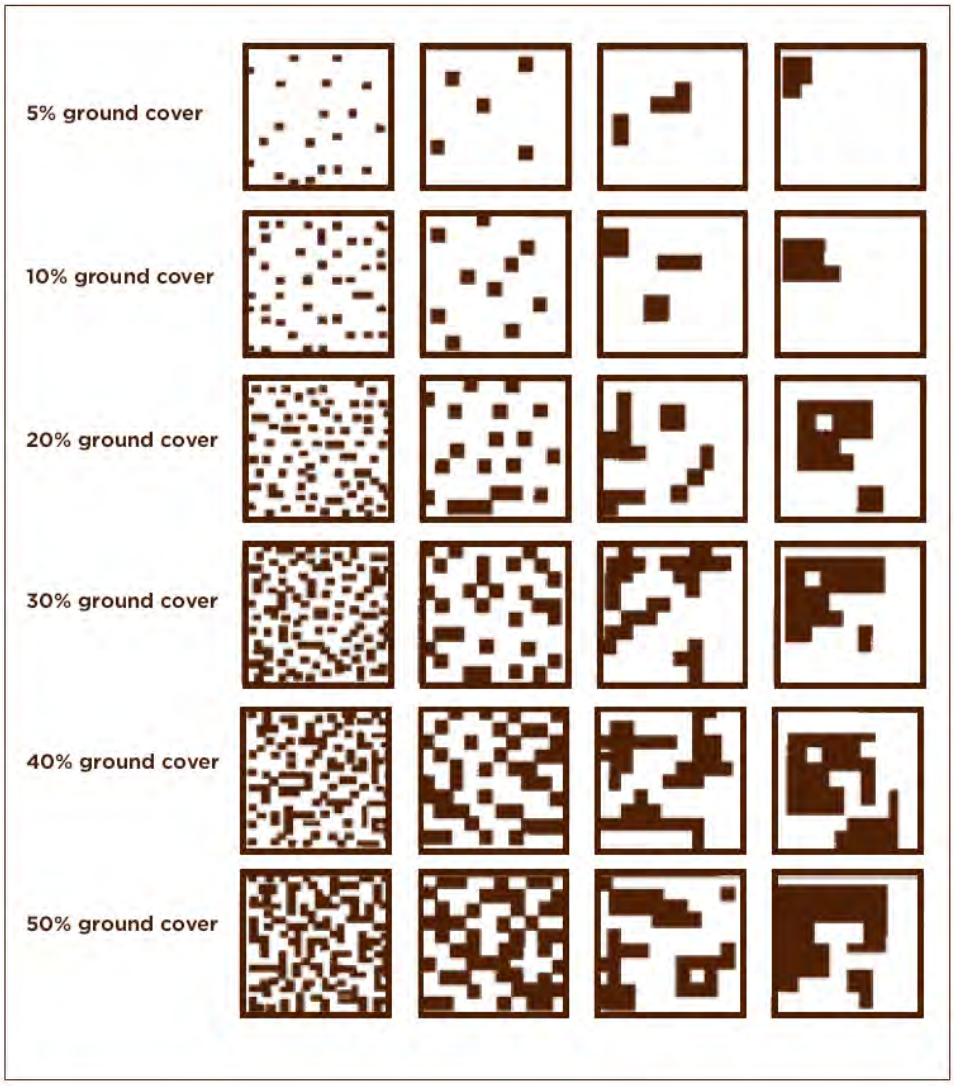


Figure H-1. Distribution of ground cover to assist in determining percentage cover (source: Bayley 2001)**.**

3.1.5. Set up of photopoints

Photopoints in known infestation of weeds should be established to have a visual record of weed density through time. Photographs of areas infested with a particular weed of concern should be taken across time with the same setting of camera, height from the ground and distance from the infestation. The time series photographs can be compared to assess the effectiveness of the management actions.

3.1.6. Conduct regular site visit

Visit to the priority sites should be conducted regularly to assess the success of control actions on weeds belonging to the 'Destroy Infestation' and 'Eradicate' categories. Regrowth and recruit of the weeds should be particularly noted as well as immediately controlled on-site by hand pulling of young plants or through chemical application.

3.2. Control actions

The control strategy for weeds in priority units should follow the following general guidelines:

- In large infestation, **tackle isolated and outlying plants first**.
- The direction of control should be **from the least weed infested bush towards weed-dominated areas**.
- If control cannot cover an entire infestation in a single day, **fruiting plants should be targeted first** (if possible).
- **Weed hygiene** should be conducted before moving to another unit or site (e.g. machinery, equipment and clothing inspection and cleaning)

3.2.1. Management options for shortlisted weeds in priority units

Not all of the shortlisted weeds for the Lower Lakes and the Coorong have been encountered in the priority sites. The Table below provides the lists of shortlisted species found in priority units and the best control options for each of the weed as well as references for more detailed descriptions of each species. Some of the control techniques for weeds are shown in Appendix H-2.

Shortlisted weeds found in CLLMM priority sites and the recommended control options

Weeds Species	Status under CLLMM WRA		Management options	Best Option		Reference for detailed description of species
	Lower lakes	Coorong		Preferred control technique	Timing of control	
Western Coast Wattle	Manage Weed	Protect Sites and Manage Weed	Mechanical and chemical control	Cut swab	August to November	Research availability of fact sheet or develop new one.
Golden Wreath Wattle	Protect Sites and Manage Weed	Manage Weed	Mechanical and chemical control	Cut swab and foliar spray using glyphosate	Information unavailable	Research availability of fact sheet or develop new one.
Bridal Creeper	Manage Weed	Manage Weed	Mechanical, biological and chemical control	Spot spray	August to October	Bridal Creeper WONS (Appendix H-3)
Swamp Oak	Protect Site	N/A	Mechanical and chemical control	Apply 250 ml Access® in 15 L of diesel to basal 50 cm of trunk (basal bark), or drill and fill with 50% glyphosate in mature plants.	May to August	Research availability of fact sheet or develop new one.
African Lovegrass	Manage Sites	N/A	Mechanical and chemical control	foliar spray using Glyphosate	Jan to April; Sept to Dec	Weed Identification Notes (Appendix H-4)
Perennial Veldt Grass	Manage weed	Manage Weed	Mechanical and chemical control	foliar spray using Glyphosate	April to Oct	Perennial Veldt Grass Fact Sheet (Appendix H-5)
Pyp Grass	Manage Weed	Protect Site	Mechanical and chemical control	Spot spray	Information unavailable	Harrington et al. 1998 (Appendix H-6)
Spiny Rush	Protect Sites and Manage Weed	Contain Spread	Mechanical and chemical control	Spot spray	November to July	Spiny Rush Fact Sheet (Appendix H-7)
African Boxthorn	Manage weed	Manage weed	Mechanical and chemical control	chemical control by basal spray	June to Nov	Weed Identification Notes (Appendix H-8)
Phalaris spp, Phalaris	Manage Weed	N/A	Mechanical and chemical control	Control not recommended for the Lower Lakes priority units	June to Dec.	Research availability of fact sheet or develop new one.
Aleppo Pine	Protect Sites	Contain Spread	Mechanical and chemical control	Cut-swab	All year round	Weed Identification Notes (Appendix H-9)
Athel pine	Contain Spread	Contain Spread	Mechanical and chemical control	Cut-swab using Garlon™ 600 Herbicide (triclopyr 600 g/l) in a 1L to 30L diesel dilution	March to May; Sept. to Nov.	Weed Management Guide (Appendices H-10 and H-11)
Tamarisk	Protect Site	Contain Spread	Mechanical and chemical control	Cut-swab using Garlon™ 600 Herbicide (triclopyr 600 g/l) in a 1L to 30L diesel dilution	March to May; Sept. to Nov.	*Tamarix* species (Appendix H-11)
Tall Wheat Grass	Manage	N/A	Mechanical and	Spot spray	Information	Tall Wheatgrass Fact

Weeds Species	Status under CLLMM WRA		Management options	Best Option		Reference for detailed description of species
	Lower lakes	Coorong		Preferred control technique	Timing of control	
	Weed		chemical control		unavailable	Sheet (Appendix H-12)
Apple of Sodom	N/A	Protect Sites and Manage Weed	Mechanical and chemical control	Spot spray	Information unavailable	Appendix H-13
Coastal Tea-tree	N/A	Destroy Infestation	Mechanical and chemical control	Spot spray and/or Cut-swab	Nov to July	Research availability of fact sheet or develop new one

3.2.2. Management of other weeds

The need for control actions for other weeds observed during preliminary surveys will be assessed per site and are indicated in the separate site action plans for each site. Some of the weed species that are not included in the shortlist but assessed to pose a threat to particular priority units are given below.

Weeds Species	Management Units		Management options	Best Option		Reference for detailed description of species
	Lower lakes	Coorong		Preferred control technique	Timing of control	
Mirror Bush	Unit 3	N/A	Chemical and mechanical	Cut swab	Information unavailable	Weed Identification (Appendix H-13)
Feral Olives	Unit 13	N/A	Chemical and mechanical	Cut swab	Feb to Nov	Weed Identification Notes (Appendix H-14)
Buckthorn	Unit 13	Unit 16	Chemical and mechanical	Spot Spray	Information unavailable	Research availability of fact sheet or develop new one
False caper	Unit 9	N/A	Chemical, mechanical and grazing	Spot spray followed by revegetation	Information unavailable	Research availability of fact sheet or develop new one
Onion weed	Unit 9	N/A	Chemical, mechanical and grazing	Spot spray followed by revegetation	Information unavailable	Research availability of fact sheet or develop new one
Willows	Unit 9	N/A	Chemical and mechanical	Drill and fill	All year round	Weed Management Guide (Appendix H-15)
Coastal Tea-tree	Unit 23	Unit 21	Chemical and mechanical	Spot spray and/or Cut-swab	Nov to July	Research availability of fact sheet or develop new one
Kikuyu	Unit 17	N/A	Establish an experimental plot to ascertain best control methods			Research availability of fact sheet or develop new one
Paspalum	Unit 17	N/A				Research availability of fact sheet or develop new one
White Weeping Broom	N/A	Unit 24	Chemical and mechanical	Spot Spray	Information unavailable	Weed Management Guide (Appendix H-17)
Lucerne Tree	N/A	Unit 24	Chemical and mechanical	Cut swab	March to Oct	Research availability of fact sheet or develop new one
Horehound	N/A	Unit 24	Chemical and mechanical	Spot Spray	Information unavailable	Weed fact sheet (Appendix H-18)

3.2.3. Management options for animal pests

Likewise, the need for control of animal pests will be assessed per site and are indicated in the separate site action plans for each site. Below are some of the lists of animal pests earmarked for control in some priority management units.

Weeds Species	Management Units		Management options	Best Option		Reference for detailed description of species
	Lower lakes	Coorong		Preferred control technique	Timing of control	
European Red Fox	Units 3, 9, 23, 33, 34, 42	Units 17	Baiting and Shooting	Baiting	Autumn and Spring	Appendix H-19
Feral Cats	Units 3, 9, 23, 33, 34, 42	N/A	Trapping and Shooting	Trapping and Shooting	Autumn and Spring	Appendix H-20
European Rabbit	Units 3, 9, 23, 33, 34, 42	Units 18, 20, 23	Baiting, shooting, warren destruction and biological control	Baiting and warren destruction	February to April	WA Dep't. of Agriculture Farmnotes (Appendix H-21)
Red Deer	Units 33, 34, 35	Unit 24	Shooting	Shooting	February to October	SAMDB NRM Board Deer Policy October 2007
Brown Hare	Units 33, 34	Units 18	Baiting and Shooting	Baiting and shooting	February to April	Appendix H-22

3.3. Community education and awareness

The engagement of individuals and communities for environmental sustainability initiatives has been claimed to be one of international public policy priority (Miller & Buys 2008). An effective community engagement is also suggested to contribute to a greater conservation success (Kainer et al. 2009). The understanding of the importance of community engagement and education will be the main driver towards the effective management of priority units. The principles guiding this management component provided five strategies that will ensure that the community and landowners are empowered in managing invasive species within and outside of priority units.

a) Engage landowner identified of having used known weeds as planting materials

Survey of priority units and adjacent properties should be conducted to determine if exotic plants have been used in some of the plantings (e.g. shelterbelts) of landowners. If such non-native plants were used, landowners should be engaged with an aim of raising awareness of the danger of such plants becoming weed. Plants belonging to 'Eradicate' category that have been used as planting materials should be destroyed. Control of planted weeds that became escapees should also be conducted.

b) Engage nursery owners to be aware of not selling identified weeds

Nurseries near in the CLLMM region will be surveyed to ensure that plant species that can potentially become a weed are not sold and that nursery operators are aware of the dangers weeds pose to the Ramsar site. Information brochures regarding weeds will be distributed to nurseries.

c) Distribute to adjacent landowners brochure and materials about IWM / IPM

Existing brochures and information from the SAMDB NRM Board regarding Integrated Weed Management (IWM) and Integrated Pest Management (IPM) will be mailed and discussed with adjacent landowners.

d) Conduct weed identification training among community members through Lakes Hub

Weed Identification and Weed Hygiene trainings are recommended. These should be conducted twice a year (one for the Milang Hub and one for the Meningie Hub).

e) Encourage volunteerism for invasive species management in priority units by hosting community events

Funding for invasive species management in priority units is ensured under the CLLMM Project for the next five years. However, volunteerism should be encouraged to ensure continuation of management actions beyond the life span of the project. Community empowerment and sense of ownership can be developed by conducting community events such as 'Spot the Weed' and revegetation in priority units.

3.4. Assessment and research

The aim of this component is to gather new information on the best practice in managing invasive species so that effective control is undertaken. In addition, research is highlighted so that new data is gathered to gauge the success of management and feed into an adaptive management that will guide future actions. Site actions recommended under this component are:

Continuously conduct research on best practice methods in controlling invasive species

If the best control options for a particular weed species is lacking (Kikuyu and Water Couch), then experimental trial should be conducted. The experimental plots are recommended to be set-up in Tolderol Game Reserve in Unit 17 since this is being managed by NPWSA. The number and sizes of quadrats (or transects) will be determined later so that appropriate qualitative analyses can be applied.

Write information brochure if needed

Information brochure for most of the weeds and pests are in existence and can be requested from either SAMDB NRM Board or Biosecurity SA. If such material is lacking for a specific weed, then information brochure should be developed.

Set up plots to record weed regrowth and native vegetation recruitment

Monitoring plots will be established in infestation areas so that quantitative data can be gathered regarding weed density, death and regrowth as well as native plant recruitment. Monitoring plots will provide the necessary technique to measure success or failure of management actions. This action is recommended in sites with heavy infestation of shortlisted weeds. In the Lower lakes, this could be done with Spiny Rush, Kikuyu (Unit 17, Water Couch (Unit 17) infestations as well as African Boxthorn infestation in Unit 42.

Gather density and cover data for weeds before and after control

Gathering information prior to implementation of any management actions will provide a way for a 'before' and 'after' comparison. This action is recommended for implementation in Units 17 and 42

Conduct assessment of other existing threats to the site

Priority sites that contain weed under the 'Manage Sites' category should be assessed for the presence of other threatening process that may exist in the site. This should be noted and appropriate action to mitigate the threat should be given.

Conduct monitoring assessment on the impact of inundation to Spiny Rush

The notion that Spiny Rush die when completely submerged under water is anecdotal at best. A monitoring protocol using transect lines along the different gradient of water depth towards Lake Alexandrina is recommended. This simple field monitoring and assessment will provide data that will ascertain the effect of water inundation to the survival rate of Spiny Rush. This action is recommended to be implemented in Unit 20. Though this unit is not a priority unit, the information gathered will answer some of the knowledge gap regarding Spiny Rush ecology.

Establish an experimental plot for Kikuyu and Paspalum to ascertain best control methods

Kikuyu and Paspalum are some of the most invasive species in the Lower Lakes region. These weeds smother native vegetation and cover all available space up to the Lakes' edge. However, there is lack of information as to how best to control these weeds. An experimental trial is recommended in Unit 17 to ascertain the best method of control. This action is recommended for implementation in Unit 17.

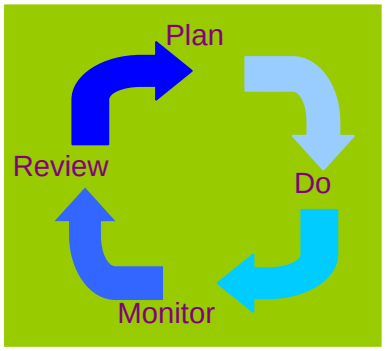
Conduct a survey of the extent of population of threatened flora species and assess the possibility of fencing

Integral to the conservation value of some priority units in the Lower Lakes are the sighting and identification of state rated flora species (units 23 and 37). To protect these rated flora species from grazing, the possibility of fencing their population should be

explored. A survey is recommended to determine the extent of the population of rated flora species and the possibility of fencing them should be explored.

4. Adaptive management

The management of invasive species in each unit will follow an adaptive management principles composed of 'Plan', 'Do', 'Monitor' and 'Review' stages (see figure below). An annual review has been incorporated in the workplan. Data gathered during monitoring will be reviewed and appropriate adjustment in the control of weeds and animal pests will be implemented after each review period in the five year workplan.



5. Workplan

The following is the recommended workplan for the implementation of management actions.

The five-year workplan for invasive management in the CLLMM region. The workplan is divided into monitoring (M), control (C), community education (CE) and assessment & research (AR) components.

Component	Management action	Actions	First year												Succeeding Years											
			J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
Monitoring	Surveillance and mapping to locate all infested areas within priority units	Detailed survey to locate & map all infestations in the unit including new infestations.																								
	Surveillance and mapping to locate infestation in adjacent properties	Detailed survey to locate & map infestations adjacent to priority units																								
	Monitor change in current distribution (weed) within and in close proximity to Unit 17	Conduct regular site visit to ascertain success of control activities																								
		Set up photopoints in areas (within and adjacent to priority units) of known infestation.																								
Control Actions	Control of all infestations, aiming for a significant reduction in weed density	Implement control actions for all identified infestations within priority units*																								
	Prevention of entry to priority units and movement and sale within	Implement control actions for all identified infestations in areas adjacent to identified unit (negotiate with landholders)*																								
Community education & awareness	Must not allow to spread from cultivated plants (if grown)	Engage landowner identified of having used known weeds as planting materials																								
	Limits on movement and sale of species within priority units	Engage nursery owners to be aware of not selling identified weeds																								
	Promote IWM / IPM packages to landholders	Distribute to adjacent landowners brochure and materials about IWM / IPM																								
	Training and awareness activities for the community to enable early detection	Conduct weed identification training among community members																								
	Ensure adequate resourcing to manage the weed /pest animal species	Encourage volunteerism for invasive species management in Unit 17 by hosting community events.																								
Assessment & research	Research and develop integrated weed management (IWM) packages for the species, including herbicides (weeds) and biological control where feasible	Continuously conduct research on best practice methods in controlling invasive species																								
		Write information brochure if needed																								
	Monitor change in current distribution (weed) or abundance (pest) within and in close proximity to priority units	Set up plots to record weed regrowth and native vegetation recruitment (Units 17 and 42)																								
		Gather data for weeds before and after control (Units 17 and 42)																								
		Implement research experiment on how best to control Spiny Rush (Unit 20)																								
		Establish an experimental plot for Kikuyu, and Paspalum to ascertain best control methods (Unit 17)																								
		Conduct a survey of the extent of population of threatened flora species and assess the possibility of fencing (Units 23 and 37)																								
Administration	Annual Review																									

J F M A M J J A S O N D J F M A M J J A S O N D

First Year | Succeeding Years

Shaded months and years indicate that activities under these schedules may change subject to annual review of gathered information

*Control actions activities are earmarked for the entire year as weed species differ in their optimum time for control. Refer to Site Action Plans and Species Action Plans for timing of control

6. References

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7. Appendices

Appendix H-1. *Proforma* log sheet for locating weed species in a unit

Map Ref No.	Weed Species	Common name	Cover density	quantity	Survey notes	LAT	LON

Appendix H-2. Methods of weed control

There are a variety of weed control methods that can be utilised to effectively control different weed species. Weed control methods include cutting and swabbing, drilling/ frilling and filling, stem scraping, spot spraying, hand pulling, hand digging (grubbing) and slashing. The way to carry out each method effectively and safely is detailed below:

Cut and Swab

- Cut off all stems as low as possible using a chainsaw or pruning saw, secateurs or long-handled loppers. The cut must be horizontal so that the herbicide rests on the cut area while being absorbed, rather than running down the side of the stem.
- Stumps will be left in the ground so as to not disturb the soil and to help retain the soil in place i.e. reduce the likelihood of soil erosion.
- Remove all stems from the stump, so that no active (or green) branches/shoots remain, no matter how small they are.
- Liberally swab all cut surfaces immediately with the herbicide mixture. This must be done preferably within half a minute, or immediately if possible. The cut surface cannot be allowed to dry out, otherwise the herbicide will be much less effective. Use a paintbrush, swabber or squeeze bottle (laboratory) to apply the herbicide mixture. Add a dye to the herbicide mixture that will help indicate where swabbing has already been done.

Image: sydneyweeds.org.au

- The tissues that take up and move the poison are immediately under the bark layer, so concentrate on applying the poison around the outer rim of the stump.
- Follow up work may be required. If the stumps resprout (which can be common with some species) cut and swab or spray the new regrowth with the herbicide.
- The most effective time of the year to cut and swab plants is when they are actively growing, which varies between species.

Drill /frill and fill (stump injection)

- This method is useful for large and medium sized trees and shrubs that are too large to cut down and have a large stump or lignotuber. This method avoids soil disturbance, preserves habitat value and gradually allows extra light to lower strata as the tree dies.
- This method can be used in conjunction with the cut and swab method to get a higher dose of herbicide into the plant, and to get a more thorough application of herbicide.
- The same herbicide mix used for cut and swab can be used for can be used for stump injection. This method used in conjunction with cut and swab should provide a much better kill rate when compared to the cut and swab method by itself.
- Drill a steeply angled hole into the plant's cambium layer (where sap flows just beneath the bark layer) with a cordless drill, using a 10mm drill bit.
- The holes should be as close to the base of the plant as possible, and it is essential for the hole to be steeply angled into the cambium otherwise the herbicide will not be absorbed into the sap flow.

- Alternatively a small axe or hammer and chisel can be used to ‘frill’ the bark to expose the cambium layer. The frills should be made in a downwards fashion such that the herbicide will rest in the bottom of the frill and be absorbed by the cambium layer of the plant.
- Immediately after the hole has been drilled / the bark frilled, it should be filled with herbicide. Syringes (without the needle) or squeeze bottles can be used to administer the herbicide into the hole.
- Holes are drilled every 2.5-5cm until the base of the plant has been circled.
- Follow up work may be required. If the plant resprouts (likelihood varies between species), the process will need to be repeated.

Stem scrape

- This technique is used when the stem is too small to be frilled with an axe / chisel, yet large enough to be scraped without cutting right through and is especially useful if the plant has aerial tubers that will drop and germinate if the plant is physically disturbed.
- Create a 15cm scrape along the stem of the plant, as close to the roots as possible and apply herbicide within 30 seconds to the exposed cambium layer.
- Do not disturb the plant until it is dead.

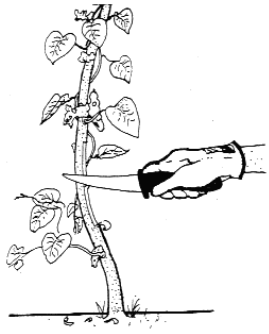

Image: sydneyweeds.org.au

Spraying

- The most effective time of the year to spray is when the plant is actively growing.
- Look for native plants and cover with plastic bags or sheeting while spraying. If there are too many native plants amongst the weeds then this method should not be used.
- Always read the label on the herbicide container, follow the instructions and wear protective clothing. Dilute the mixture as recommended. Add a dye to the herbicide mixture that will help to indicate where spraying has already been done.
- If spraying near creeks or other water bodies, do not spray herbicide in or near the water, because it can have a negative effect on aquatic fauna such as frogs. In such cases using a herbicide with a frog-friendly surfactant (eg Roundup Biactive or Weedmaster Duo) is more desirable because it has less of an impact on the aquatic fauna. It is preferable to use other more accurate methods such as cutting and swabbing along creeklines.
- Be aware that some chemicals such as metsulfuron methyl and triclopyr are residual in the soil for up to six weeks, and is absorbed by roots and bulbs; therefore it should not be used in areas with native orchids, lilies and other susceptible ground flora during the active growing season. It should also not be used near watercourses
- Surfactants can also be used when spraying plants such as Bridal Creeper which have a waxy leaf surface. A surfactant (e.g. Pulse Penetrant) can be added to the herbicide mix which will increase the uptake of the poison through the waxy leaf surface. Surfactants should not be used on or near plants growing in water as they are suspected of affecting frogs.

- Where weeds have narrow vertical leaves, spraying might result in herbicide running off or drifting onto non-target plants. In this situation, wipe on the herbicide mixture with a weed wand, sponge or wick applicator.
- To increase the effectiveness of the herbicide whilst spraying large tussocks of grass, the grass can be slashed and then left to re-grow for several weeks. The regrowth can then be sprayed.

Hand pulling and hand digging (grubbing)

- Hand pulling of smaller plants is easiest in the wetter months of the year when the soil is soft and the seedlings are much easier to pull out.
- Seedlings: take hold of the plant at ground level and pull. If you pull at any point higher on the stem it may break and the plant will then require swabbing with herbicide.
- Small woody plants with extensive root systems: expose the surface roots of the plant and cut lateral roots as close as possible to the main stem. Gently remove the lateral roots by pulling them back towards the main plant. Loosen the tap root by moving it back and forth then remove using a trowel, grub-axe or, mattock and replace soil and mulch
- For species that have a bulb, a screw driver can be used to gently lift the bulb out of the ground. Check the surrounding soil for bulbs and remove, bag (with a clod of soil if necessary) and dispose of off-site.
- For soft leafy species that have a large root system or tap roots a trowel or knife can be used to gently cut around the plant so that it can be lifted out of the ground. This technique is called crowning
- If possible place both feet or fingers on either side of the plant when pulling out. This helps to keep the soil in place and avoids unnecessary disturbance of the soil.

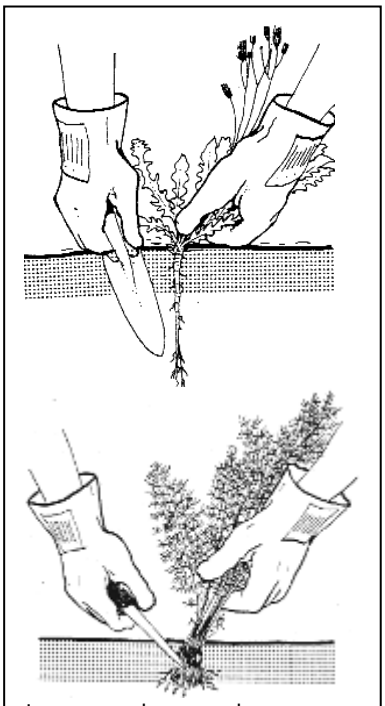

Image: sydneyweeds.org.au

Slashing

- This technique is useful for preventing seed set or encouraging new growth which can be sprayed. As many annual weed species only produce seed well above ground level, slashing stops them producing seed, eventually eliminating them. Slashing does not control prostrate weeds.
- Slashing should be done in the growing season shortly before seed-set.
- Follow-up slashing will be required in subsequent control seasons.

Spore Water/Rust application (For Bridal Creeper)

Requirements

- Bridal Creeper Leaves Well Rusted.
- Rainwater.
- Container to wash off rust in to (fish bin or similar).
- 60-litre garbage bags.

- Clean spray unit with circulation.
- Sieve (1mm mesh) to remove rubbish.

Method for 200 litre Spray Unit (Adjust quantities for amount of spray required)

- Collect rusted leaves 4.5 – 5 Kg (2 x 60 litre garbage bags full).
- Remove filters from spray unit & fill with 200 litres rainwater.
- Wash rust off leaves (using spray unit) into suitable container. (Small quantities can be dunked in a container of water and agitated by hand.)
- Place washed off leaves in to another garbage bag.
- Pour contents of the wash off container in to the spray unit, sieving any rubbish out at same time.
- You are now ready to spray.
- Washed off leaf in garbage bag can be used as a bouquet. We found that leaf stored in the garbage bag created humid conditions that reactivated the rust. (We will trial a second wash off of this leaf in 2004).

Spraying

- As there is only one plant (BRIDAL CREEPER) spore water affects you can spray under most conditions, except if the wind is too strong. We have sprayed in light rain and had good results.
- Spray to runoff. Start at the top of the plant and work down.
- (Also have had good results where we could not safely access Bridal Creeper growing on steep slopes above a beach. The area was misted from above. Good results were achieved with rust establishing 20 – 30 metres down the slopes).

Quantities (adjust quantities for amount of spray required)

- 4 - 6kg (2 x 60 litre garbage bags full) / 200 litres rainwater.
- 100 - 150 grams / 5 litres rainwater was successful at early trial site.
-

Cautions

- Recommend only rainwater. Mains water appears to reduce the results, as our worst site was 60% rainwater 40% mains. (Chlorine?). We have not tried dam / bore water.
- Do not over collect from any site. Always leave plenty of rust in area of collection.
- Wear gloves when collecting leaf.
- Wear dust mask if at all susceptible to respiratory ailments.
- Wear safety vests especially if working on roadsides.
- Use collected leaf ASAP. Do not hold longer than 24 hours.

Appendix H-3

Bridal creeper
(Asparagus asparagoides)
is a Weed of National Significance (WoNS)

Why is it a problem?

Bridal creeper is an aggressive and highly invasive weed that has serious impacts on the environment.

Introduced to Australia as a garden plant in the 1870s, it has since jumped the garden fence and spread throughout many parts of Australia.

Bridal creeper invades bushland, smothers native plants and reduces the health and diversity of our natural and agricultural resources. Bridal creeper:

- Produces a large volume of seed, which is readily spread by birds and animals;
- Roots form a thick, impenetrable mat, preventing natural regeneration of native plants;
- Survives harsh conditions such as fire, frost, and drought, and tolerates a range of soil types;
- Limits access to beaches, parks and trails;
- Can spread further than its current range; and
- Impacts on the quality and yield of primary industries such as citrus and forestry.

What does it look like?

Bridal creeper is a climbing vine with sharply pointed, shiny green leaves. A mass of scented white flowers appear in late winter, followed by small green berries in spring.

The berries ripen to red during summer and are an obvious food source for birds, who contribute to the weed's spread.

The plant typically loses its leaves in the dry summer months but its extensive root system allows the plant to survive and regrow with autumn rains. A mat of tuberous roots grows 10 – 20 cm below the soil surface and makes up 90% of the plant's biomass.

Bridal creeper prefers to climb, and is often seen scrambling over other plants, along fence lines and under bird roosting sites such as tall trees.

Bridal creeper (*Asparagus asparagoides*)

Where does it grow?

Bridal creeper invades a range of situations including coastal areas, forests, heathlands, woodlands and riparian areas. Vegetation on roadsides and farms is particularly vulnerable.

Bridal creeper is relatively common in South Australia, but there is still potential for further spread. Integrated control will reduce the chance of spread and protect vulnerable native plants and animals.

Current and potential distribution of bridal creeper (*Asparagus asparagoides*)

What can I do about bridal creeper?

Bridal creeper is a declared weed in South Australia and must not be sold, transported, traded or planted. Property owners are required by law to control bridal creeper.

There are several control options for bridal creeper. Consideration should be given to the following points:

- **Biological control.** Will suppress growth and limit reproduction.
- **Hand removal.** You must ensure all root material is dug up as bridal creeper can spread from root fragments.
- **Herbicide application.** Care must be taken to avoid damage to surrounding native vegetation. Follow all label directions.
- **Early Action.** New infestations are easier and more economical to control.
- **Follow up.** Seedlings or regrowth may emerge so ensure you revisit control sites.
- **Prevent spread.** Dispose of the weed appropriately. Don't dump garden waste in bushland or local reserves.
- **Seek advice.** Contact your regional NRM office for control advice (see website below).

Report any notifiable plant, pest or disease to the Exotic Plant Pest Hotline on 1800 084 881

Bridal creeper's weedy relatives

Other Asparagus weeds are having similar impacts on our environment. Look out for these closely related plants and seek advice on control options.

Western Cape bridal creeper (*Asparagus aspalathoides*) (tuber left) is even more damaging than the common form of bridal creeper as it is resistant to biological control agents. This form has larger tubers that grow in a rosette close to the soil surface. The leaves are larger, darker, duller and thicker than the common form. This form is very limited in distribution so please report this plant to your local NRM Board if you suspect you have found it on your property.

Bridal veil (*Asparagus declinatus*) is a scrambling, perennial vine with a large root system. The wiry stems are weakly climbing, with linear 'leaves' that are soft and fleshy. The green berries mature to white and are spread primarily by birds. The leaves die off during summer months, reshooting after autumn rains.

For more information

Visit these websites for more details on who to contact, weed identification, control options and other Asparagus weeds:
www.nrm.sa.gov.au/ www.pir.sa.gov.au/biosecurity/sa/nrm_biosecurity/weeds www.weeds.org.au/WoNS/bridalcreeper/

CARING FOR OUR COUNTRY

National Asparagus Weeds Management Committee

Government of South Australia
Biosecurity SA

Appendix H-4

Government of South Australia

WEED IDENTIFICATION NOTES

ANIMAL AND PLANT CONTROL COMMISSION

AFRICAN LOVEGRASS

African lovegrass with flowering and 3 seeding panicles

Closeup of flowering panicles

Dense African lovegrass infestation

AFRICAN LOVEGRASS

Government of South Australia

African lovegrass, *Eragrostis curvula*, is a perennial tussock grass, introduced from southern Africa as a pasture plant. It competes very effectively with other grasses, annuals and perennials, and can form dense pure stands excluding other species. Because of its high seed production, high germination rate and the difficulty of controlling it by herbicides or management practices, it is important to keep African lovegrass off clean properties or to recognise and destroy new infestations before they become established.

Distribution

Eyre Peninsula	– isolated patches
Northern pastoral	– isolated plants on roadsides
Northern ag districts / Yorke Peninsula	– common on roadsides, isolated in conservation parks
Murray Mallee	– isolated patches and roadsides
South East	– scattered along roadsides in upper south east
Central region	– isolated patches on roadsides

Impacts

African lovegrass is very invasive in pasture due to its high reproductive rate and low unpalatability for stock when mature. Its rapid rate of spread during summer and dense tussock form result in sparse pastures being overtaken by this weedy grass.

However, one palatable cultivar, 'Consol', has been registered as a fodder plant and is being used for grazing and as a soil binding plant in areas suffering soil erosion.

Recognition

African lovegrass is a perennial grass forming dense tussocks 30 – 120 cm high. The root system is shallow and fibrous. Leaves are dark green to blue green and rough to touch, to 30 cm long and 3 mm wide. The sheath at the base of each leaf is smooth and there is a ring of hairs at the opening of the sheath.

The flowering stems are slender and arching, ending in loose, finely branched panicles 10 – 30 cm long. The panicle branches are very slender and drooping, bearing separate grey-green spikelets 4 – 10 mm long. The spikelets break up to release 4 – 13 ripe seeds, which are about 1 mm long and cream to brown in colour when ripe.

Biology

African lovegrass is most abundant on open grasslands on light sandy soils. It is a good invader of disturbed areas such as roadsides, and tolerates moderately saline or solodic soils

Seeds germinate in autumn or spring as long as the moisture levels and temperatures are suitable. Seedlings grow slowly in the early stages but growth accelerates after the five-leaf stage. Plants cease growth during winter, but are frost hardy; they reshoot when temperatures rise in spring. In southern parts of the State, flowering begins in December and ripe seeds are present from January to March. New stems and flowers may be produced all year round, as long as water is available, in warmer areas.

African lovegrass reproduces only by seed. This is normally produced without cross pollination, so there is little variation within a population of African lovegrass. Seed is spread by contaminated produce, soil and machinery, and over shorter distances by wind and water.

Further Information:

Lazarides, M. (1998) A revision of Eragrostis in Australia. Australian Systematic Botany 10: 11-187.
Parsons, W.T. & Cuthbertson, E.G. (2000). *Noxious Weeds of Australia*. 2nd edn. Inkata Press.

For more advice on recognising and controlling African lovegrass, contact your local Animal and Plant Control Board:

Appendix H-5

WANTED

VELDT GRASS

Ehrharta longiflora (Annual), ***Ehrharta calycina*** (Perennial)

Glossary

Annual
Completing the full cycle of germination to fruiting to a single year, and then dying.

Caespitose
Grows in dense tufts.

Inflorescence
The arrangement of the flowers and flower axes.

Perennial
With a life span extending over more than two growing seasons.

Rhizomes
A creeping stem, usually below ground from which new aerial shoots arise.

Sheath
Clasping or enveloping the stem.

Tussocky
Dense or large tufts.

For More Information

Contact

Eastern Hills Catchment Management Program
Tel: (08) 9424 2222

Shire of Mundaring Bushcare Co-ordinator
Tel: (08) 9290 6685

Shire of Kalamunda
Bushcare Co-ordinator
Tel: (08) 9257 9936

Introduction

E. calycina is a highly opportunistic grass, capable of overwhelming road verges, which is common in temperate regions of Australia and the Swan Coastal Plain.

It is rapidly becoming a major pest species on roadsides and bushland reserves.

E. longiflora is now a widespread and common weed of coastal areas and disturbed creeklines.

It is a widespread weed of offshore islands, coastal dunes and sandy soils.

Origin

South Africa.

Lifeform

E. calycina: perennial grass
E. longiflora: annual grass.

Description

Caespitose; tussocky; up to 1.2 m tall.

Leaves: Blades with dark stem clasping bases and a membranous tongue (Ligule) between blade and sheath.

Flowers: *E. longiflora*: Purple/green, loose inflorescence with large drooping spikelets.

E. calycina: reddish/purple heads, drooping erect; 7-22 cm long.

Reproduction & Dispersal

Reproduces by seeds. The species seeds prolifically during the cooler months. *E. calycina* spreads via rhizomes as well.

Seed dispersal is facilitated by airborne means, water, birds and in the fur of animals.

Distribution

E. calycina: Geraldton - Esperance, scattered populations at Shark Bay and inland south along the Nullabor.

E.longiflora: More prevalent; Shark Bay - Esperance and inland.

Growing Season

E. Calycina: cooler months *E. Longiflora*: Autumn-Spring.

Flowering Season

E. longiflora: July - December.

E. calycina: March - April and August - September.

Effect on Ecosystem

The species is capable of invading and overwhelming native bushland vegetation.

Fire enhances seed germination.

Control

Manual Removal
Small populations are easy to hand-pull, as roots are very shallow, ensuring crown removal.

Avoid dumping garden refuse containing these grasses in areas where they may establish. Do not slash.

E. Longiflora: Prevent seed set for 2-3 years. Graze heavily and continually. Mow regularly, cultivate, hand weed or use herbicides to prevent seed set.

Chemical Treatment
Plants can be sprayed with grass selective herbicide over Autumn-Winter before flowering stems emerge. Follow-up treatment may be necessary. Spray seedlings within four to six weeks of emergence. In areas with native grasses, reduce the herbicide dose.

Please see 'Herbicides and Pesticides' factsheet for more information about spraying chemicals.

Appendix H-6

BIOLOGY AND CONTROL OF PYPGRASS

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ABSTRACT

Pypgrass (*Ehrharta villosa*) is an invasive rhizomatous grass weed which is smothering the native dune flora at Turakina Beach, near Wanganui. A deep rhizome system, sunken stomata, in-rolled leaves and a mycorrhizal association contribute to the aggressive nature of this weed in the dune community. A field trial showed that haloxyfop will successfully control pypgrass; successive applications give best results. Several other monocotyledons from the dune community were shown in a pot trial to be unaffected by haloxyfop. Studies of pypgrass biology suggest that, although vegetative spread is aggressive, establishment from seedlings is poor. Eradication should be an achievable goal.

Keywords: pypgrass, haloxyfop, mycorrhiza, weed seeds, vegetative spread.

INTRODUCTION

Pypgrass (*Ehrharta villosa*), a perennial rhizomatous grass species native to South Africa, was introduced to Turakina Beach, 16 km south of Wanganui, in the early 1960s to evaluate its ability to stabilise sand dunes. Although pypgrass has never been used in New Zealand for sand stabilisation, there is now a dense infestation of the species in the Kotiata Domain reserve at Turakina Beach and scattered infestations also exist through the nearby Santoft Forest. In parts of the reserve, pypgrass is growing so aggressively that all other species have been excluded. It has long stems which allow the plant to grow up over surrounding vegetation, often to a height of 2 m or more. As the Department of Conservation is trying to preserve the native dune flora in this reserve (Ravine 1992), eradication is necessary. Turakina Beach appears to be the only place in New Zealand where pypgrass is established at present and, because it appears capable of causing major weed problems, immediate eradication may be prudent.

Microscopic examinations of Turakina Beach specimens of pypgrass by Hodder (1997) have confirmed that plants are the same as those described by Ellis (1987). Pypgrass is a C3 plant, so does not have the physiological advantages of C4 plants with respect to efficient use of water. However, it has sunken stomata over-arched with four cuticular flanges. The leaves are in-rolled, leaving only the adaxial surface, which has very few stomata, exposed to sun and wind. This arrangement of the stomata and leaves would be expected to reduce loss of water from the leaf and thus be of selective advantage in a dry environment.

Field observations on the distribution and spread of pypgrass were made at Turakina Beach. Herbicide experiments were conducted both at Turakina Beach and Massey University. Haloxyfop was chosen for herbicide experiments because a selective, translocated chemical was required to ensure good control of rhizomes while causing minimal damage to non-target native vegetation in the reserve.

METHODS AND MATERIALS

Study of vegetative spread

To determine the rate of vegetative spread, six 20 m long permanent line transects each 4 m apart were marked out on the edge of the pypgrass infestation in the Kotiata Domain. Each line transect passed from a zone of very dense pypgrass out to an area

totally devoid of pypgrass. In October 1994 and October 1995, plant species composition and plant density were recorded every 3 m along each line transect within a 1 m^2 quadrat.

Observations of weed biology

Further information on the biology of pypgrass was obtained from a series of measurements and observations. Seed production was estimated over three separate seasons (1993/94 to 1995/96) by collecting seed-heads from randomly selected 1 m^2 quadrats, and counts were made of reproductive tillers, fertile florets per seed-head and the number of viable seeds. Observations were made on the appearance of seedlings at the sites throughout 1994 and 1995. The presence of mycorrhizal associations was investigated both for pypgrass and other nearby plant species using light microscopy and the staining technique described by Phillips and Hayman (1970). Percentage infection was determined by recording presence or absence of mycorrhizal material in a grid, with 600 observations per species (Hodder 1997).

Herbicide field trial

A field trial was conducted on well-established pypgrass stands in the Santoft Forest. Haloxyfop-ethoxy-ethyl ester (Gallant) was applied to plots (4.3 m by 4.0 m) using an LPG-powered precision boom sprayer at 200 kPa and a water rate of 320 litres/ha, with spraying oil (Uptake) added at 10 ml/litre of spray mixture. Six treatments involved application of 1.0 kg/ha of haloxyfop, with time of application either in February, April, June, August, October or December 1995, depending on the treatment. Another two treatments involved two split applications of haloxyfop in April and October 1995; one at 0.5 kg/ha for each application and the other at 1.0 kg/ha each time. All treatments were compared against an untreated control, and were replicated five times using a randomised block design, with each block being located at a different site within Santoft Forest. Distance between blocks varied from 0 m (adjacent blocks) to 1 km.

The effect of each treatment on pypgrass was assessed at 2-monthly intervals after each application by counting the number of new tillers within randomly placed quadrats. Differences between treatments were analysed using the Student-Newman-Keuls multiple range test.

Herbicide pot trial

Plants of club rush (*Isolepis nodosa*), flax (*Phormium tenax*), marram grass (*Ammophila arenaria*) and pingao (*Desmochoenus spiralis*) were established in PB 6 planter bags by transplanting field-established specimens. A commercial bark-based potting mixture was used for the flax and pingao, and beach sand fertilised by slow-release fertiliser (Osmocote) for the other two species. They were kept outdoors at Massey University and watered twice daily by an overhead watering system. Plants were transplanted into the bags then left for 2 months to fully establish before being sprayed on 19 February 1996. Haloxyfop at 0.5 and 1.0 kg/ha was applied using a laboratory pendulum sprayer operating at 200 kPa and delivering 256 litres/ha of spray solution (with oil added as for the herbicide field trial). An untreated control was used for comparison within a completely randomised design with five replicates. Plants were scored for phytotoxicity 2 months after application, with each plant being allocated a score between 0 (dead) and 10 (totally healthy). Results were analysed as for the herbicide field trial.

RESULTS AND DISCUSSION

Study of vegetative spread

The position of the outermost pypgrass plant along each line transect had moved between 4.1 m and 9.0 m (average of 7.0 m) from the main clump of pypgrass over the 12-month period, which equates to an average rate of lateral spread of 58 cm per month.

The average tiller density in the dense areas was 109/m^2 in October 1994 and 172/m^2 in October 1995. Although these densities were low compared with figures for perennial ryegrass exceeding 7000 tillers/m^2 in grazed swards (Matthew 1996), the pypgrass communities were rank un-grazed swards on very drought-prone sand dunes

with each tiller often exceeding 1 m in length. The effects of competition were obvious, with less than half the number of plant species present at high pypgrass densities than at lower densities. However *Isolepis nodosa, Meulenbeckia complexa, Galium aparine, Sonchus oleraceus, S. asper, Hypochaeris radicata* and *Lactuca virosa* were among the species found growing at all densities of pypgrass. Several of these species are annuals which presumably die as competition for water increases in summer.

Observations on weed biology

The deep rhizome system of pypgrass should help with competition for water, allowing access to water from deep below the soil surface. A further adaptation of the underground organs which assists with competition on sand dunes is the presence of mycorrhizal associations (Crawley 1993). Measurements showed that pypgrass had a higher level of mycorrhizal infection than most of the other species tested with which it competes at Turakina Beach (Table 1). Only flax had similar levels of infection.

TABLE 1: Percentage mycorrhizal infection found in the roots of some dune plants at Turakina Beach.

Common Name	Botanical Name	Percentage infection
club sedge	*Isolepis nodosa*	56.0
flax	*Phormium tenax*	70.3
tree lupin	*Lupinus arboreus*	7.8
marram grass	*Ammophila arenaria*	9.8
pingao	*Desmoschoenus spiralis*	42.0
pypgrass	*Ehrharta villosa*	88.9
spinifex	*Spinifex hirsutus*	57.0
LSD 0.05		22.2

Although pypgrass has effective vegetative reproduction and competes well on sand dunes, it appears less effective at producing seeds and seedlings. At no time during visits to the sites at Turakina Beach were seedlings of pypgrass observed. All new plants were the result of vegetative spread by rhizomes. Many florets produced no seeds, and often there would be less than one viable seed produced per seed head. Seed production was very low at the Kotiata Domain site, varying from 8 to 27 seeds/m^2. Production was higher in Santoft Forest, with the highest production measured at 276 seeds/m^2. Highest seed production occurred where pypgrass plants were growing next to tree lupin bushes, suggesting nitrogen may be limiting seed production elsewhere. Poor seed production and the lack of seedlings observed in the field suggests eradication of the species may be possible if existing established plants can be killed.

Herbicide field trial

Haloxyfop caused most pypgrass foliage to become necrotic, with this effect occurring most rapidly in spring and autumn, more slowly in summer and slowest in winter (Hodder 1997). Likewise, the 0.5 kg/ha rate caused a slower rate of foliar kill than the 1.0 kg/ha rate, but a similar level of above-ground damage was eventually caused by both rates.

However, with a rhizomatous perennial weed like pypgrass, control of the underground organs is more important than foliar necrosis. Two months after applying treatments, the number of new tillers emerging from plots was low (Table 2), with no significant differences between any treatments ($P>0.05$). Despite this, there were always some new tillers being produced, signifying that a complete kill was never obtained.

Regrowth 4 months after application suggested that applications made in late winter and spring were not as effective as those made in late summer or autumn (Table 2). Best control was obtained when haloxyfop was applied at 1.0 kg/ha both in autumn and then again in spring to kill off the continued regrowth of recovering rhizomes.

Note however, that the difference between the lower rate (0.5 kg/ha) and the 1.0 kg/ha rate was not significant.

TABLE 2: Growth of new pypgrass tillers 2 and 4 months after application of 1 kg/ha haloxyfop (or 0.5 kg/ha in italics) at different times of the year at Turakina Beach.

	Conditions when treated		New tillers/m^2	
Date sprayed (1995)	Air temp. (°C)	Relative humidity (%)	After 2 mths	After 4 mths
10 February	25	64	0.5	1.7 c*
20 April	*24*	*59*	*0.8*	*1.2 c*
20 April	24	59	0.6	0.7 c
10 June	17	68	0.4	2.5 bc
19 August	15	66	3.2	5.0 ab
14 October	19	51	0.4	7.0 a
19 December	23	48	0.5	-
20 Apr/14 Oct	*24/19*	*59/51*	*3.0*	*2.5 bc*
20 Apr/14 Oct	24/19	59/51	0.5	0.5 c

*Means followed by the same letter are not significantly different (P>0.05).

Results after 4 months could not be used as lateral spread of rhizomes from neighbouring areas was probably occurring. Even the results given in Table 2 need careful interpretation as some of this regrowth may have been occurring from lateral invasion by rhizomes. However, tiller counts were generally taken from the middle of plots to minimise this problem.

Note that a new formulation of haloxyfop (Gallant NF) has been released since this trial was conducted, but this methyl ester of the active isomer of haloxyfop would probably not give different results from those obtained in our work.

Herbicide pot trial

Of the plants tested for susceptibility to haloxyfop, only marram grass suffered significant levels of damage. No signs of damage were detectable in the pingao or club rush plants (both members of the Cyperaceae family) nor in the flax (Agavaceae family). These results were expected based on information from label recommendations for haloxyfop (O'Connor 1994) and past research results (Harris 1987). Although dicotyledonous plants are generally unaffected by haloxyfop, some uncertainty exists about monocotyledons other than grasses, hence the choice of species tested. Although marram grass was damaged, even 1.0 kg/ha did not give complete kill of this species, suggesting that it is reasonably tolerant of haloxyfop. Poor control of marram grass was also noticed in some plots of the field herbicide trial.

CONCLUSION

Pypgrass is an aggressive competitor under the sandy conditions found at Turakina Beach; its colonisation is assisted by lateral spread from its rhizome system, morphological adaptations to dry conditions, and by mycorrhizal associations. Although pypgrass can be selectively removed from the sites where it is growing at present using haloxyfop, several sequential applications will probably be required, with autumn applications being the most effective. Re-invasion by seedlings once plants have been killed will probably not be a problem.

ACKNOWLEDGEMENTS

Financial assistance from the New Zealand Plant Protection Society for L.M. Hodder (nee Eustace) and the Massey University Research Fund were much appreciated.

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Appendix H-7

Government of South Australia
Adelaide and Mount Lofty Ranges
Natural Resources Management Board

FACT SHEET

Spiny Rush (*Juncus acutus*)

Flowers/Seed head
Flower throughout the year but mostly in spring and summer. Flowering stems (culms) 2–4 mm wide. Inflorescence 4–13 cm long, consisting of clusters of 1–6 flowers; 1 or 2 leaf-like bracts 4–25 cm long at base of inflorescence. Stamens 6.

Description
Shortly rhizomatous, tussocky perennial rush to 1.6 m high. Fruit an ovoid 3-celled brown capsule. Seeds 1.2–2 mm long, brown. Photographs P Drew Plain seed revegetation services

Distinguishing features
The plant's sharp spiny leaves and flower stems look similar, giving the whole plant a characteristic globe shape. The sharp spines, that project at many angles, make it especially dangerous for children. Unlike native rushes the stiff spiny stems will pierce skin. Care should be taken to not to confuse this weed with smaller softer native rushes. If in doubt seek advice on identification.

Dispersal
Spread by seed. Much of the spread appears to be by seed contaminated mud attached to vehicles and animals. Spread into damp places and watercourses of the Adelaide and Mount Lofty Ranges area.

ORIGIN / DISTRIBUTION
Native of Europe, Africa and North America.

PROBLEM
This large tough weed, which grows to 1.6 meters high, will displace pasture species, and if left unchecked can form into impenetrable thickets. Spiny rush is fond of damp areas and will quickly invade watercourses.

STATUS
The Adelaide and Mount Lofty Ranges Natural Resources Management Board is working on legally restricting and controlling this weedy species with its landholders.

CONTROL
Aim
To prevent the spread of Spiny Rush. Eradicate small infestations, contain and reduce larger infestations. Destroy root system, establish desirable species.

Methods
A combination of methods will give the best long term results. Use hand-grub or cultivate. Spray with herbicides only when actively growing. Thoroughly wet all foliage. Grubbing may encourage growth from the remaining root system.

HERBICIDES
Use away from susceptible desirable species such as vegetables, native trees, crops, pastures and grape vines including watercourses use only as per chemical label directions. Treat only during active growth (Spring to Autumn as a guide depends on season and area). Apply by wiper equipment to actively growing plants. Where there is a large proportion of dead foliage, pre slashing is recommended. Allow adequate regrowth before treatment.

Glyphosate bio active (360 g/L) at 1 litre with 2 litres clean water in wiper equipment. Re wipe if necessary to control regrowth. Avoid wiping onto desirable plants. Regrowth may occur and re-treatment will be required.

WARNING: Some warning statements and precautions have been omitted. **Read and understand the herbicide label.** Use is at the reader's discretion but must conform to the requirements of the Agricultural Chemicals Act and no warranty is implied.

For further information please contact your nearest Natural Resource Management (NRM) office:
Willunga 8550 3400
Gawler 85237 700
Lobethal 8389 6166

Appendix H-8

Government of South Australia

WEED IDENTIFICATION NOTES

ANIMAL AND PLANT CONTROL COMMISSION

AFRICAN BOXTHORN

Closeup of leaves, flowers and thorns

Closeup of fruit

A large African boxthorn

AFRICAN BOXTHORN

Government of South Australia

African boxthorn, *Lycium ferocissimum*, is a large perennial shrub introduced from southern Africa. Boxthorns were originally planted in Australia as hedges to provide shelter from the wind and barriers to stock movement. The weed has spread into pastures from these hedges.

Distribution

Eyre Peninsula	- common in coastal environments
Northern pastoral	- very common along water courses
Northern ag districts / Yorke Peninsula	- widespread, especially on coastal areas and watercourses
Murray Mallee	- widespread
South East	- isolated plants with heavier infestations in the south
Central region	- widespread in the northern and coastal areas

Impacts

Where neglected the thorny bushes will form dense impenetrable thickets. The plant becomes a nuisance along fences, creeks, floodouts and around dams and leaking troughs where it blocks passage along roads and prevents stock access to watering points. Boxthorns also provide excellent harbour for vertebrate pests such as foxes and rabbits. Due to the sharp spines, boxthorns are not grazed heavily by stock and therefore replace desirable pasture plants. They also invade native vegetation after disturbance.

Recognition

African boxthorn is an erect, deep-rooted shrub growing to 5m high and 3m across. The densely tangled twigs end in spines that can reach 8cm long. Leaves are oval, 3.5cm long and 2cm wide, light green and fleshy in texture. Flowers are white with purple dots and about 1cm in diameter, with five small petals and stamens hanging downwards. They are followed by round orange-red berries 5 to 10 mm diameter, each containing 30 to 70 irregular seeds. Boxthorn has an extensive, deep and branched root system that can produce sucker shoots if broken.

Biology

Boxthorn seeds germinate at any time of the year and seedlings are competitive with other shrub species. Plants can start to flower at 2 years old and bear mainly fruit in summer, but flowering and fruiting can occur throughout the year. Plants are sometimes deciduous in winter or during drought; if so, new leaves appear in spring or after rain.

Seeds are the only method of reproduction of boxthorn and are carried by birds and mammals that eat the fruits. Seeds may also be moved by flood waters and in contaminated soil or produce.

Further Information:

Parsons, W.T. & Cuthbertson, E.G. (2000). *Noxious Weeds of Australia* . 2nd edn. Inkata Press.

For more advice on recognising and controlling African boxthorn, contact your local Animal and Plant Control Board:

Appendix H-9

Government of South Australia

WEED IDENTIFICATION NOTES

ANIMAL AND PLANT CONTROL COMMISSION

ALEPPO PINE

Aleppo pine seedlings invading roadside scrub

Mature Aleppo pine tree

ALEPPO PINE

Government of South Australia

Aleppo pine, *Pinus halepensis,* is a fast-growing tree introduced from the Mediterranean. Aleppo pine is now common throughout South Australia as it has been widely planted for windbreaks. However, because it is so invasive, it is important to keep Aleppo pine out of uninfested native vegetation or to recognise and destroy new infestations before they become established.

Distribution

Eyre Peninsula	- widespread in the south, scattered in the north
Northern pastoral	- absent
Northern ag districts / Yorke Peninsula	- scattered, more common in higher rainfall areas
Murray Mallee	- isolated in the western area of the region
South East	- isolated plants
Central region	- isolated plants in lower rainfall areas

Impacts

Aleppo pine is an aggressive invader of cleared roadsides and native vegetation. It will compete with established vegetation and will eventually dominate the area infested if left unchecked.
It has been used with great success as a windbreak or for stock shelter in cereal growing areas. It has also been used to reduce soil erosion.

Recognition

Aleppo pine is an evergreen tree to 20 metres in height, often becoming asymmetrical. It has an extensive root system with the main taproot extending many metres into the ground. The single trunk divides into several main branches above to form an open, round-topped crown. The bark is scaly, dark grey on the outside and red-brown inside. The leaves are bright green needles, 6 to 10 cm long, often curved or twisted and held together in pairs by a basal sheath about 1 cm long. Buds are covered by scales with fringed edges. Pollen is shed in spring. The seed cones are 5 to 11 cm long and 2.5 to 4 cm wide, reddish-brown in colour; they grow singly or in dense groups, hanging downwards on short stalks that bend backwards along the branch. The seeds are about 6 mm long with a wing 25 mm long; they may remain in the cone for several years before being shed.

Pinus brutia should not be mistaken for Aleppo pine. It has longer, more rigid leaves to 15 cm long and stalkless cones that spread at right angles to the branches.

Biology

Aleppo pine is adapted to dry, rocky limestone soils but will grow in other well-drained soils. It is drought tolerant and can persist in low rainfall areas but will thrive in higher rainfall areas.

Aleppo pine reproduces by seed only. Seeds are mostly shed during summer. Up to 90% of seeds can germinate but survival of the seedlings is low. Once Aleppo pine seedlings become established, their growth is rapid. Saplings grow densely with branches down to the ground and will exclude other plants from the site. Cones may be produced as soon 4 years from germination.

The wing on the seed of Aleppo pine enables it to be dispersed by wind. Seeds may travel up to 40 m from the parent plant. They may also be moved short distances by black cockatoos that feed on the seeds by forcing open the cones.

Further Information:
Spencer, R.D. (1995) Horticultural Flora of South-eastern Australia Vol. 1. University of NSW Press.

For more advice on recognising and controlling Aleppo pine, contact your local Animal and Plant Control Board:

Appendix H-10

Athel pine or tamarisk (*Tamarix aphylla*)

The problem

Athel pine is a *Weed of National Significance*. It is regarded as one of the worst weeds in Australia because of its invasiveness, potential for spread, and economic and environmental impacts.

Athel pine affects the pastoral industry by forming dense stands along inland rivers. It consumes water more quickly than native plants, thereby reducing the number and quality of watering holes. It concentrates salt, which is excreted by its leaves. This makes the ground beneath athel pines more salty and excludes native pasture grasses and other salt-sensitive plants. It can change river flow patterns and cause overland flooding and bank erosion.

It is harder and more expensive to muster cattle in athel pine infestations. Because they are drought tolerant and fire resistant, athel pines decrease the frequency of fires and alter vegetation structure. Infestations reduce the cultural and aesthetic value of affected land and may impact on tourism in the region.

There are several other *Tamarix* species, all commonly known as tamarisks, that are weeds in Australia.

The weed

Athel pine is a spreading tree to 15 m with pendulous, jointed branches. Immature trees have light grey trunks and stems. Mature trees have a thick, rough, dark grey to black bark, and grey-brown stems, and can be up to 1 m in diameter. The minute, dull green leaves superficially resemble pine tree 'needles'. However, athel pine is misleadingly named as it is a flowering plant, not closely related to true pine trees (conifers).

Its small flowers are pinkish-white without stalks, growing on 30–40 mm long spikes from the ends of the previous year's branches. The fruit is bell shaped with a hairy tuft, and contains numerous small cylindrical seeds. The seeds have a tuft of fine hairs which assists wind dispersal. The trees have strong woody roots which penetrate and spread deeply throughout the soil.

Athel pine has infested hundreds of kilometres of the Finke River in central Australia.
Photo: Colin G. Wilson

Key points

- Athel pine, planted for shade, shelter and erosion control throughout arid and semi-arid Australia, can escape cultivation and naturalise, especially around riverine habitats.
- It causes significant environmental and economic damage by using up valuable water resources, hindering mustering, and altering vegetation and river structure.
- New infestations should be prevented because control is difficult and costly.
- Mechanical and chemical methods are the main control options. Care must be taken using either method around waterways.

Natural Heritage Trust

2

Growth calendar

After flowering in summer, athel pine seeds drop in autumn. Germination occurs soon after seed drop. After one year's growth, seedlings are typically 600–1000 mm in height. They continue to grow rapidly, between 2 and 5 m in a year in suitable conditions. Flowering normally takes place in about the third year and continues annually thereafter.

Tamarix ramosissima, or salt cedar, is closely related to athel pine and is similar in appearance. It is known to hybridise with *T. aphylla* in the USA.
Photo: Colin G. Wilson

How it spreads

Athel pine can reproduce by dropping seeds or, more commonly, by revegetation of plant parts. Although athel pine seeds die quickly if not kept moist, they are easily dispersed by both wind and water and may also be spread by animals. A single tree can produce thousands of seeds every year.

Athel pine is classified as a 'sleeper' weed because it was present in Australia for some time before it became weedy. A native of northern Africa and Asia, it was first introduced into Whyalla, South Australia, in 1930 via California. Since then it has been extensively planted as shade and wind breaks and for erosion control around rural South Australia, New South Wales, Queensland, Western Australia, and the Barkly Tablelands and Alice Springs regions of the Northern Territory.

The worst infestations of athel pine occur along 600 km of the Finke River in Central Australia near Alice Springs. The explosion in its abundance and range is thought to have been caused by large floods in the 1970s and 1980s, which washed seeds and vegetation downstream and provided the moist conditions required for germination.

Flower buds near Carnarvon, WA, in early February.
Photo: John Stretch

Its habit of making nearby soil saltier may be assisting its expansion because it thrives in saline conditions.

Other athel pine outbreaks have occurred throughout inland Australia since the 1990s at Starvation Lake and Tilcha Flow (SA), Burnett and Darling Downs regions (Qld) and Menindie Lakes (NSW). Infestations on the Gascoyne and Avon Rivers (WA) have recently been shown to include both athel pine (*Tamarix aphylla*) and another weedy tamarisk species *Tamarix parviflora*.

Where it grows

Athel pine is drought resistant and is well suited to arid and semi-arid rangelands. It is tolerant of saline and alkaline soils and, although it flourishes best in and around rivers, is not restricted to the riverine environment. It has escaped cultivation and become naturalised in all mainland states and territories except Victoria.

Potential distribution

Based on climate, athel pine could potentially infest inland watercourses throughout Australia, including parts of northwestern Victoria. A few infestations exist outside of the projected distribution, perhaps surviving on below-ground water resources.

Do not confuse athel pine with native she-oaks

Athel pines resemble native she-oaks (*Casuarina* and *Allocasuarina* species), which are found in similar locations. Although both have needle-like 'leaves', they may be distinguished by careful examination of the needles and fruit. The segments of she-oak needles are 5–10 mm long, whereas the segments on athel pine needles are only 1–2 mm long. The hard, woody casuarina fruit resembles a small pine cone, whereas athel pine fruit is tiny and bell shaped. Additionally, athel pine flowers (white–pink, growing at the end of stems) are conspicuous during the summer.

The segments of athel pine needles are only 1–2 mm long.
Photo: Les Tanner

What to do about it

Prevention of spread–plant other species instead

Preventing the further spread of athel pine in Australia is critical to the successful management of this problem. As part of the prevention of spread measures, the planting of athel pine for windbreaks, shade or erosion control is now actively discouraged. Weedy *Tamarix* species should not be imported or further planted, and alternative species should be used. Generally, a native *Casuarina* or *Allocasuarina* species will make a good alternative, especially for windbreaks. However, local councils or state/territory government agencies will be able to provide appropriate advice.

The drooping needles are superficially similar to native *Casuarina* and *Allocasuarina* species.
Photo: John Gavin

Control athel pine near rivers

Athel pine needs to be carefully controlled to ensure that it does not escape cultivation. Its potential to threaten environmental integrity and human interests, especially in the extensive arid and semi-arid parts of Australia, warrants an aggressive management approach.

Athel pine in the upper catchments of rivers are the highest priority for control

Experience clearly indicates that athel pine spreads fastest along waterways, especially when summer flooding aids the downstream dispersal of vegetative material and germination of seeds. Therefore, mature athel pines in the uppermost parts of catchments are the highest priority for eradication. Control can then focus on downstream infestations. The lowest priority for control are mature trees away from water.

Early control efforts

Athel pine was not formally recognised as a weed in Australia until the late 1980s when control attempts first examined its susceptibility to different herbicides and different application techniques. In the mid 1990s mechanical control was attempted on the Finke River, and since then integrated control methods using both mechanical and chemical means have been used to combat the spread of athel pine.

Remove seedlings by hand and mature trees mechanically

Seedlings can be easily removed by hand in sandy ground, and large trees can be removed by ripping and bulldozing, taking care to remove as much of the root system as possible. A large bulldozer is required if the trees are fully grown. If possible the area should be deep ripped to bring any root material to the surface and, where appropriate, a suitable pasture should be sown to outcompete any regrowth of athel pine. Otherwise, care must be taken to reduce the amount of soil covering felled stems and exposed roots as they may re-shoot. Follow-up treatments will be required as some re-shooting is likely. Permits may be required to conduct mechanical control if native species will be affected. Weed control contacts (see table p. 4) will be able to provide relevant advice.

Herbicides may be better suited where erosion is a problem

Herbicides may be used as part of the follow-up to initial mechanical control, and are preferred in sensitive environments (eg riverbanks) where mechanical control may damage non-target species and cause erosion and habitat loss.

Herbicide control generally entails treating each stem separately.

Weed control contacts

State / Territory	Department	Phone	Email	Website
ACT	Environment ACT	(02) 6207 9777	EnvironmentACT@act.gov.au	www.environment.act.gov.au
NSW	NSW Agriculture	1800 680 244	weeds@agric.nsw.gov.au	www.agric.nsw.gov.au
NT	Dept of Natural Resources, Environment and the Arts	(08) 8999 4567	weedinfo.nreta@nt.gov.au	www.nt.gov.au
Qld	Dept of Natural Resources and Mines	(07) 3896 3111	enquiries@nrm.qld.gov.au	www.nrm.qld.gov.au
SA	Dept of Water, Land and Biodiversity Conservation	(08) 8303 9500	apc@saugov.sa.gov.au	www.dwlbc.sa.gov.au
Vic	Dept of Primary Industries/Dept of Sustainability and Environment	136 186	customer.service@dpi.vic.gov.au	www.dpi.vic.gov.au www.dse.vic.gov.au
WA	Dept of Agriculture	(08) 9368 3333	enquiries@agric.wa.gov.au	www.agric.wa.gov.au
Australia wide	Australian Pesticides and Veterinary Medicines Authority	(02) 6272 5852	contact@apvma.gov.au	www.apvma.gov.au

For up-to-date information on which herbicides are registered to control athel pine and the best application methods and dosages, contact your state or territory weed management agency or local council. This information varies from state to state and from time to time. Contact details are listed above, including contacts for the Australian Pesticides and Veterinary Medicines Authority, which hosts the PUBCRIS database. This database contains information on all herbicides that are registered for use on weeds in each Australian state and territory.

When using herbicides always read the label and follow instructions carefully. Particular care should be taken when using herbicides near waterways because rainfall running off the land into waterways can carry herbicides with it. Permits from state or territory Environment Protection Authorities may be required if herbicides are to be sprayed on riverbanks.

An appropriate registered herbicide can be applied in several different ways. Frilling, where small notches are cut into the bark until the white sapwood is reached and herbicide is injected immediately into the notches, has been used successfully in the Carnarvon area. There should be about 50 mm between notches, and drenching guns or veterinary syringes can be used to deliver herbicide into each notch. An alternative approach with larger stems is the cut-stump technique, where the main stem is cut off by chainsaw and the stump is immediately painted with herbicide. Care must be taken to reach as close to the roots as possible.

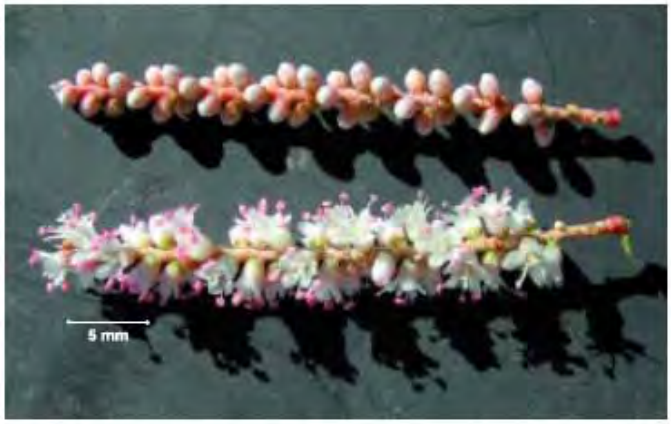
Smaller trees that have not developed rough bark can be treated by the basal bark technique, which involves soaking the circumference of the stem, to a height of 250 mm above soil level, with herbicide to the point of run-off. Very small stems can be snapped or cut, and herbicide applied to the stem. Foliar spray over the entire plant is effective on small trees (less than 2 m). However, the impacts on non-target species (both natives and crops) prevent this method being used in the Carnarvon area.

Other weedy tamarisk species

There are other closely related species, such as *Tamarix parviflora* and *Tamarix ramosissima*, present in Australia that have shown weedy tendencies in New South Wales and Western Australia. These species are considered major pests in the United States and are known to hybridise with athel pine, producing an evergreen hybrid with an extended flowering season. Attention should be also given to these species to ensure future impacts are avoided.

Biological control

Experience in the United States with tamarisks may also help to provide solutions for controlling athel pine in Australia. For example, the US Department of Agriculture has introduced biological control agents against some tamarisk species. Although there are currently no biological control agents being investigated for use in Australia, this option remains a desirable part of any integrated weed management control program.



Flowers and fruit from Bingara, NSW, in February.
Photo: Les Tanner

5

...case study

Athel pine on the Finke River in Central Australia

The Finke River is an ancient river system. It rises in the West Macdonnell Ranges, about 150 km west of Alice Springs, and may reach Lake Eyre during extreme floods. The Finke River only flows irregularly but is nevertheless important from environmental, economic and cultural perspectives. It provides habitat and refuge for a wide range of plants and animals, supports valuable grazing lands and is a significant component of European and Aboriginal cultural heritage.

Athel pine was first planted around homesteads, communities and bores in the region in the 1940s and 1950s as shelter from the sun and wind. However, it was not until the 1970s and 1980s that the true weedy potential of this species was recognised, by which time an infestation had developed along 600 km of the Finke River. This period of sudden and rapid expansion corresponded to several large summer floods, which are thought to have provided the perfect environment for seed germination and establishment.

Following the recognition of the detrimental impacts of athel pine to the environment and economy, it was declared a noxious weed in the Northern Territory in 1988. In 1989 the Northern Territory Government tested the effectiveness and suitability of different herbicides and application methods on athel pine in the Finke River. Stem injection was found to give a greater percentage of kills than basal bark application.

In March 1994 the mechanical control of athel pine was investigated at Horseshoe Bend Station with a 200 hp bulldozer and a 3 m blade plough. This trial was successful and was followed up by more control work with a larger bulldozer and 4 m blade plough over a 25 km stretch of infestation. Approximately 10–20 % of mature trees survived this treatment, and follow-up mechanical and chemical control was used to treat the scattered regrowth.

A strategic approach targeting upstream infestations of the Finke with integrated chemical and mechanical control was then initiated. By 1998 a distance of some 130 km of the upper Finke River from Glen Helen Gorge to the Stuart Highway had been treated. Since then, sections downstream of the Stuart Highway have been further controlled, and follow-up chemical control of seedlings and regrowth is ongoing.

The latest efforts were part of a cooperative project aimed at controlling the remaining 400 km of Northern Territory infestation downstream of the Stuart Highway. The project 'Eradication of athel pine from the Finke River' involved the Northern Territory Government, Centralian Land Management Association, landholders and community groups (Landcare and Bushcare), and was funded through the Commonwealth Government's Natural Heritage Trust.

Finke River athel pine infestation after blade ploughing.
Photo: John Gavin

Extensive flooding in the Finke River between 2000 and 2002 resulted in the establishment of a large number of seedlings spread over an expanded range. This increase in the athel pine infestation will require a significant effort to control.

Legislation

It is illegal to introduce athel pine into the Northern Territory, and its spread must be controlled by landholders in the Northern Territory and Queensland. Its status as a weed is under consideration in other states, notably New South Wales and Western Australia. Check with your local council or state/territory government agency about the latest requirements for athel pine control.

Acknowledgments

Information and guide revision: John Gavin (NT DIPE), Richard Carter (NSW Dept of Agriculture/Weeds CRC), Philip Maher (Qld DNRM), Damian Collopy, John Peirce and John Stretch (WA Dept of Agriculture), Les Tanner (North West Weeds County Council) and John Thorp (National Weeds Management Facilitator).

Maps: Australian Weeds Committee.

Bulldozers of at least 200 hp are required to pull large blade ploughs.
Photo: John Gavin

Although tamarisks have been planted to control erosion, especially in highly saline soils, this practice is now discouraged.
Photo: John Stretch

How to control athel pine

Quick reference guide

Athel pine or tamarisk – *Tamarix aphylla*

Do not plant athel pine

Athel pine is difficult and expensive to control when it escapes cultivation and becomes naturalised. To prevent its further spread, it should not be planted.

Target upstream infestations first...

As athel pine tends to spread downstream, upper catchment infestations should be targeted for control and eradication. Control should then focus on downstream infestations and isolated shade trees away from watercourses.

...using mechanical and chemical control

Heavy infestations of mature athel pine can be controlled by combining mechanical and chemical control:

- Mechanical control has been used most extensively on the Finke River, where bulldozers are used to remove trees and roots.
- Two main chemical control methods (frilling and cut-stump) are effective especially when stems are treated immediately. Use only registered herbicides and follow instructions on the label.

Seedlings can be easily removed by hand or sprayed with a registered herbicide if there is no risk to other species.

Take care near waterways

Care must be taken when treating athel pine alongside rivers and in riverbeds:

- Mechanical control can impact on non-target species, especially when heavy machinery is used. Additionally, any soil disturbance can actually promote weed species and/or contribute to erosion.
- Chemicals can also affect non-target species and be washed into waterways.

Ongoing follow-up is required

Follow-up control will be required to treat plants that survive initial treatment. As athel pine shoots readily from vegetative material, it can quickly re-establish itself if left unchecked.

Athel pine was traditionally planted around homesteads for shade.
Photo: Les Tanner

Control options

Tree size	Physical	Mechanical	Chemical	Biological
Small (plants under 2 m)	Hand pulling in sandy soil will easily remove small athel pine.	Not suitable.	Snap the stem and wet the area with registered herbicide. Seedlings can also be foliar sprayed.	No biological control agents in Australia.
Medium and large trees (greater than 2 m tall)	Not suitable.	Rip and bulldoze with large bulldozer. Take care to remove all roots.	Use frilling around the base or cut-stump methods. Immediately apply registered herbicide.	

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CRC Weed management

Appendix H-11

Northern Territory Government

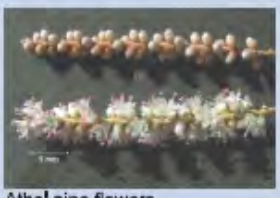
Tamarix species
how to tell the difference

There are three species of Tamarisk in Australia - Athel pine (*Tamarix aphylla*), Tamarisk (*T ramosissima*) and Smallflower tamarisk (*T parviflora*). Each of these weed species has distinctive characteristics.

Athel pine - *Tamarix aphylla*

- **Evergreen not deciduous**
- **5 flower petals**
- **Up to 18m tall**
- Flower colour pinkish-white, small and stalkless
- Flower spikes 3-4cm long growing at the end of the previous year's branches
- Strong woody roots that penetrate and spread deeply throughout the soil
- Pendulous, jointed branches
- Minute leaves are a dull grey-green and form a sheath around the fine branchlets giving them the appearance of pine needles
- Needle segments are uniform and 1-2mm long
- Surface of leaf is whitish due to salt secretion with prominent pores
- Immature trees have light grey trunks and stems
- Mature trees have thick, rough grey-brown to black bark on older stems
- Bark on new stems is smooth and reddish-brown to grey-green
- Naturalised along Finke River, Walker Creek and Karinga Creek NT; Kings Creek Mt Isa, Flinders River Hughenden, Gemfields and Cracow QLD; Gascoyne River, Carnarvon, Telfer and Laverton WA; Kenmore Park, Mt Fitton, Mt Searle, Frome Downs and Quinyambie Stations SA; Imperial Lake and Stephens Ck Broken Hill NSW.

Athel pine leaves
Photo: Les Tanner



Athel pine flowers
Photo: Les Tanner

Athel pine seedlings

Severe Athel pine infestation along the Finke River, Northern Territory

Athel pine bark

Athel pine mature tree

For more information please contact:

National Athel Pine Coordinator
Phone: 0427 186 153
www.weeds.org.au/WoNS/athelpine

NATIONAL Athel Pine MANAGEMENT COMMITTEE

Tamarisk - *Tamarix ramosissima*

- **Deciduous to semi deciduous**
- **5 flower petals**
- **Up to 6m tall and wide**
- Flower colour pinkish-white to purple, small and stalkless
- Flower spikes 3-5cm long growing at the end of the current year's branches
- Loosely branched shrub or small to medium tree
- Generally bushy in appearance
- Leaves are rhombic to ovate, sharply pointed to gradually tapering, 1.5–3.5mm long and evenly thick from base to tip
- Surface of leaf is more or less smooth with scattered pores
- Bark on older stems is grey-brown and on new stems is reddish-brown
- Easily confused with *T parviflora*
- Naturalised around Imperial Lake Broken Hill, Lake Cargelligo and Deniliquin NSW; creek-lines near Yunta and Mannahill, and Lake Alexandrina SA; Lake Boonderoo and Norseman Dam near Kalgoorlie WA; Lakes Murphy and Meran Victoria.

Severe infestation of *T ramosissima* at Lake Boonderoo, Western Australia

T ramosissima flowers

T ramosissima bark

T ramosissima leaves

T ramosissima mature shrub

Smallflower tamarisk - *Tamarix parviflora*

- **Deciduous to semi deciduous**
- **4 flower petals**
- **Up to 6m tall and wide**
- Flowers are small, pinkish-white
- Loosely branched shrub or small to medium tree
- Leaves lanceolate acuminate and distinctly thickened towards base
- New bark is brown-deep purple
- Naturalised along the Avon River (Toodyay, Northam, York area) WA from salinity and amenity plantings

T parviflora along the Avon River, WA

T parviflora flower
Photo: Barry A Rice

T parviflora bark

T parviflora leaves

Appendix H-12

Government of South Australia
Northern and Yorke Natural Resources Management Board

NRM Plan
FACT SHEET NO. 1.023

June 2011

NRM Plan

CONTACT

Main Office
Northern and Yorke NRM Board
PO Box 175
41-49 Eyre Road
Crystal Brook SA 5523
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CARING FOR OUR COUNTRY

This fact sheet was produced with the support of the Australian Government's Caring for Our Country program.

Tall wheatgrass (Thinopyrum ponticum)

Reducing its impact in the Northern and Yorke NRM Region

Description of this weed

Tall wheatgrass is a temperate perennial grass which tolerates soils of moderate subsoil salinity and moderate waterlogging. It has been widely used as a saltland pasture in south-west Victoria and the upper south-east of South Australia. Tall wheatgrass is an easy pasture to establish and manage.

Tall wheatgrass is a drought tolerant, summer active, tussock-forming perennial that grows to a height of 2 metres, in clumps about 20cm across.

The stems are tough and smooth with prominent nodes. Leaves are green, long, flat to in-rolled, prominently veined, more or less hairless and with a rough upper surface towards the sharply-pointed tips. Flower-heads are long (to 40 cm) erect, spikes and similar to wheat. The stalkless spikelets are 10-25 mm long, and grow out of notches either side of the stem, often curving away from the central stem (rachis) of the spike. Each spikelet is orientated with its flattened side towards the rachis and contains about 8-12 closely overlapping florets.

Tall wheatgrass flowers from spring to autumn and is often noticeable in late summer as the only green grass on salt affected land.

Why is it a weed and what is the impact?

Tall wheatgrass was imported into Australia via the USA in the 1940s and its main value then was for soil conservation on saline areas. Landholders were encouraged to allow it to seed in the first year of growth to ensure good ground cover, but this led to its spread as a weed into non-target areas.

Government of South Australia
Northern and Yorke Natural
Resources Management Board

June 2011

Tall wheatgrass is considered to be a serious weed when it escapes into native wetland environments, as it can quickly become dominant through crowding out all other species. Controlled management of farm stands is essential to maximise livestock nutritional value, control vermin (e.g. rabbits, foxes) habitat, reduce fire hazard and prevent unintentional spread.

Tall wheatgrass is strongly tussock forming and can quickly become clumpy and unpalatable to livestock if not well managed. In addition, the clumps or tussocks can become so large as to make a paddock almost un-trafficable,

What can you do?

If you identify this weed in native wetland please contact your local NRM Authorised Officer for advice on control.

Help and Assistance

NRM Authorised Officers
Snowtown 8865 2166
Riverton 8847 2544
Minlaton – 8853 2795
Port Augusta 8641 1513
Peterborough 8651 3577
Orroroo 8658 1086

Appendix H-13

Weed Identification

Australia > > Apple of Sodom

Apple of Sodom

Solanum linnaeanum

Pictorial glossary of plant part terms used in this guide.

Alternative Name(s): *Solanum hermannii, Solanum sodomeum.*

Family: Solanaceae.

Form: Shrub

Origin: Native of South Africa.

Flowers/Seedhead: Produced singly or in few-flowered groups, each flower 1.5–2.5 cm wide. Flowers most of year.

Description: Erect bushy dark green perennial shrub to 1.5 m high. Leaves 4–8 cm long, elliptic in outline, margins deeply lobed; on a stalk to 2 cm long. Flat light brown to orange seeds 2–3 mm long.

Distinguishing features: Distinguished by prickles 3–15 mm long that are common on most parts (longest on leaf mid-veins); star-shaped hairs and some glandular hairs, upper leaf surface sparsely hairy, lower leaf surface more densely hairy; mauve flowers with anthers 4.5–6 mm long; berries globe-shaped, mottled green at first, ripening yellow, 2–3 cm wide, drying brown.

Dispersal: Spread by seed usually in berries blown or dragged about.

Flower, immature fruit with green mottling, ripe yellow fruit, deeply lobed leaves & prickles on stems & leaf veins
Flinders Ocean Beach, Victoria, January
photo J. R. Hosking

Notes: First collected in Australia in 1801. Now mainly found in coastal areas, often associated with sandy calcareous soils. Minor weed of disturbed areas, especially roadsides and in rough pastures. Not eaten by stock. Fruits are poisonous to stock and humans, especially when green.

References:

Noxious Weeds of Australia.W. Parsons and E. Cuthbertson, 1992, pages 614–616.

Web References: Search Australian web sites for further information on this weed.

Appendix H-14

Weed Identification

Australia > > Looking glass bush

Looking glass bush

Coprosma repens

Pictorial glossary of plant part terms used in this guide.

Photo: T. Rudman, DPIWE Tas

Alternative Name(s): Mirror bush, Creeping mirror plant, New Zealand mirror bush

Family: Rubiaceae

Form: Shrub / Tree

Origin: Native to New Zealand

Weed Type(s): Weed, Naturalised, Garden Escape, Environmental Weed

Notes: Looking glass bush is a shrub to small tree up to 8m tall. Branches spreading prostrate sometimes self-layering. Leaves are broadly oblong 80 x 50 mm, glossy green above and pale beneath. Flowers are white and arranged in terminal clusters. The fruit is orange and dispersed by birds.

Looking glass bush smothers other plants. It has become naturalised in South Australia, New South Wales, Victoria and Tasmania. In Tasmania it is a weed of the Furneaux Island group. It grows on coastal headlands and heathland and tolerates drought, fire and most soil types. It is resistant to salt spray and often grown in coastal gardens because of its hardiness. There are several cultivars.

References:

Randall, R. P. (2002). *A Global Compendium of Weeds*. R. G. & F.J. Richardson, Melbourne.
Csurhes, S. and Edwards, R. (1998). *Potential Environmental Weeds in Australia*. National Weeds Program, Environment Australia, Canberra.
Blood, K. (2001). *Environmental Weeds. A Field Guide for S E Australia*, C. H. Jerram & Associates-Science Publishers, Mt Waverley ,Victoria.

Web References: Search Australian web sites for further information on this weed.

Photo: T. Rudman, DPIWE Tas

This weed has been included in the **'Jumping the Garden Fence' report** (*WWF-Australia PDF - 1.19mb*) which examines the impact of invasive garden plants on Australian agricultural land and natural ecosystems.

Australia > > Looking glass bush

SITE MAP

National Weeds Strategy | Weed Identification | State and Territory Contacts | About Weeds Australia
Australian Weeds Committee | Target Species for Biological Control | Training and Materials
Web Addresses | Feedback | Weeds of National Significance | Noxious Weeds List
Glossary of Acronyms | National Weeds Management Facilitator

National Weeds Strategy
Telephone: (03) 6344 9657
Fax: (03) 6343 1877
Email: ihorp@weeds.org.au

Privacy Statement

Legal Notice

Appendix H-15

Government of South Australia

WEED IDENTIFICATION NOTES

ANIMAL AND PLANT CONTROL COMMISSION

OLIVES

Olive seedling

Olive flowers

Olive fruits

Cleared hillside invaded by olive trees

OLIVES

Government of South Australia

The olive tree, *Olea europaea,* was introduced from the Mediterranean area as a tree crop. It is now established in many parts of South Australia, causing a major problem in native vegetation.

Distribution

Eyre Peninsula	- isolated infestations but high risk of spread to native vegetation
Northern pastoral	- common in southern Flinders Ranges, isolated plants elsewhere
Northern ag districts / Yorke Peninsula	- common on roadsides and native vegetation in the higher rain fall areas
Murray Mallee	- isolated outbreaks along the Murray River and in irrigated areas
South East	- isolated plants on roadsides and some reserves
Central region	- common in the Mt Lofty Ranges

Impacts

Olive is an invader of native vegetation, especially dry sclerophyll forest or woodland, and adjoining cleared, ungrazed land. If uncontrolled it can alter the composition, decrease biodiversity and increase the fire hazard of native vegetation. As it is very long-lived, such changes are permanent unless controlled.

The fruit and oil of the olive tree have a high commercial value and the industry is currently undergoing a boom, resulting in larger areas of plantations throughout South Australia.

Recognition

Olive is an erect, bushy evergreen tree growing to about 12 m tall with a deep, widely-branched, woody root system. The trunk branches from the base and has rough black bark. Leaves are undivided, narrowly elliptic and tapered to a point, glossy dark green on top, silvery below, 3 to 8cm long and 1 to 4cm wide. The tiny cream flowers appear in large clusters in late spring; each has four petals and four protruding stamens. The fruit reaches1.5 to 3cm long, ellipsoid in shape and purple-black when fully ripe; each contains one brown oblong seed about 1.5cm long.

Olive seedlings have smaller oblong leaves arranged rigidly in opposite pairs. They are densely branched and can produce many new stems from the base if cut or grazed.

Biology

Olive grows well in most environments, particularly where winter rainfall is high and summers dry. It will grow on a wide range of soil types but will not survive in waterlogged soil. Like eucalypts, olives are highly inflammable due to their oil content and can regenerate from stumps after fire.

Seeds germinate mainly in autumn and seedlings grow during winter. Flowering does not begin for several years. Flowers appear in October/November and fruit develops slowly over summer. The ripe fruits hang on the tree for a long period during the following winter.

The spread of olives is mainly due to birds and foxes eating the fruit and dropping the seeds elsewhere. The development of olive orchards has lead to spread throughout the State. Some seed may be moved locally in soil during earthworks.

Further Information :

APCC (1999) *Risk Assessment and Management of Olives.*
Parsons, W.T., Cuthbertson, E.G. (2000). *Noxious Weeds of Australia.* 2nd edn. Inkata Press.

For more advice on recognising and controlling olive, contact your local Animal and Plant Control Board :

Appendix H-16

Willow (*Salix* spp.)

The problem

Most species of willow are *Weeds of National Significance*. They are among the worst weeds in Australia because of their invasiveness, potential for spread, and economic and environmental impacts. They have invaded riverbanks and wetlands in temperate Australia, occupying thousands of kilometres of streams and numerous wetland areas.

Unlike most other vegetation, willows spread their roots into the bed of a watercourse, slowing the flow of water and reducing aeration. They form thickets which divert water outside the main watercourse or channel, causing flooding and erosion where the creek banks are vulnerable. Willow leaves create a flush of organic matter when they drop in autumn, reducing water quality and available oxygen, and directly threatening aquatic plants and animals. This, together with the amount of water willows use, damages stream health.

The replacement of native vegetation (eg river red gums) by willows reduces habitat (eg nesting hollows, snags) for both land and aquatic animals.

Millions of dollars are spent each year on willow control in southeastern Australia using chemical and/or mechanical techniques. In Victoria alone, the cost of willow management is about $2 million annually.

Weeping willow *S. babylonica*, and two hybrid species of pussy willow *S.* x *calodendron* and *S.* x *reichardtii*, are not *Weeds of National Significance*. Nevertheless, these species are of concern because they can hybridise with other species that would otherwise not produce seeds, so they should not be planted near other willows.

Willows shade out and displace native vegetation, potentially leading to erosion and poor water quality
Photo: Kate Blood

The weed

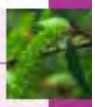
Willows are deciduous trees or shrubs. They have small seeds with long, silky hairs attached to one end like a parachute, which help them spread. The seeds are usually short-lived, from days to a few weeks.

With the exception of the pussy willows, the leaves of all species are long and narrow, with finely toothed edges and usually a paler underside. Upright catkins (flower stalks) carry numerous tiny flowers.

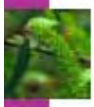
The trees form large, dense root-mats on the surface of the soil or in shallow water and slow-moving streams.

Key points

- Early detection and control are essential to prevent the spread of new infestations.
- Most willows are easily spread by stems and twigs breaking off and taking root.
- Some varieties of willow can also spread by seed, which can be carried up to 100 km by wind or water.
- Control techniques need to be carefully chosen to minimise unintended impacts. Stem injection of registered herbicide is recommended.
- Follow-up monitoring and control of regrowth (from stumps, pieces of stems or seeds) may be required for 3–5 years after initial control.



Natural Heritage Trust



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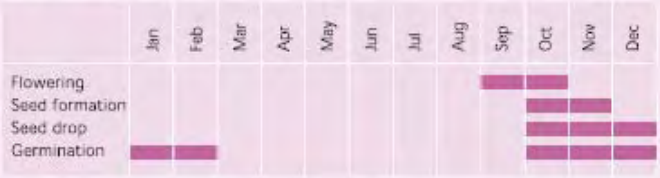
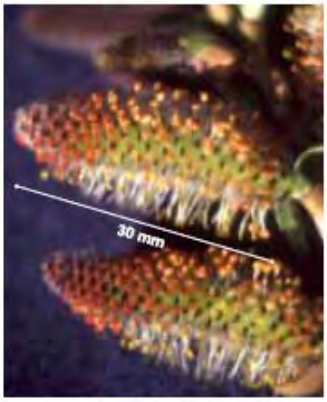
Growth calendar



General growth pattern

Willows are either male or female and most groups in Australia are single-sex clones. However, they readily hybridise when opposite sexes come together. They flower in spring, the flowers only lasting for 2–3 weeks. The tiny seeds ripen about 3–4 weeks later in late spring or early summer. Germination is very fast, occurring within 24 hours, and seedlings grow rapidly under favourable conditions. The hybrid species are vigorous and can breed just two or three years after germination.



The catkins of a male hybrid shrub willow, *S. x reichardtii*. Shrub willows have black flower scales, whereas tree willows have pale scales.
Photo: Kurt Cremer

How it spreads

Most willows spread by fragments of stems or twigs breaking off and growing new roots in water. Pieces can travel many kilometres before establishing at a new site. Fishermen often break off twigs and stick them in the riverbank to hold their lines, and these pieces will also grow.

Seed is the main method of spread for several species, especially grey sallow and black willow. These species can invade off-stream wetlands from sea level to alpine locations. Seed carried by wind or water easily travels more than 1 km, with small amounts potentially spreading up to 100 km.

Seed production is becoming more common as more willows are introduced into Australia. However, the conditions required for germination (ie continuously wet, bare sediment) do not commonly occur and the seed only remains viable for between two and six weeks, depending on the species.

There are 32 different groups (species, varieties, subspecies and hybrids) of willows in Australia. Nearly all the different species have become naturalised here and can cross-breed with other willow species that flower at the same time. Most naturalised willow populations are hybrids and can be practically impossible to identify precisely.

Willow leaves brown off and drop during autumn and winter, causing an input of nutrients which can reduce water quality: Tambo River at Bruthen, Vic, in May.
Photo: Kate Blood

The introduction of New Zealand willows (*Salix matsudana* hybrids) throughout the Murray–Darling Basin in the 1980s and their widespread sale since then has only just begun to cause problems. These are about to escalate seriously, because the females produce abundant seed and the males fertilise the weeping willow (*Salix babylonica*), a widespread species that in the past usually did not seed because it had no male partner flowering at the same time.

Where it grows

Willows occur naturally in permanently or seasonally wet, inundated or waterlogged sites. The largest infestations in Australia are in Victoria, Tasmania, New South Wales and the Australian Capital Territory. Several species (weeping, basket and crack willows) have been widely planted along the rural waterways of southeastern Australia for erosion control.

Potential distribution

Willows have only invaded about 5% of their potential geographic range in temperate Australia. The most seriously invasive willow, grey sallow (*Salix cinerea*), is expanding its range rapidly in Victoria and New South Wales, and possibly in Tasmania.

Key willow species and hybrids

Grey sallow or pussy willow (*Salix cinerea*)

This is the most seriously invasive willow in Australia. It is a large spreading shrub or small tree with twigs or branches that are hard to break. It reproduces mainly by seed. Pussy willow is highly invasive in swamps, drainage lines and other moist sites including lowland and mountain streams. Large and rapidly expanding populations occur in Victoria, and this species will probably become a major wetland and riverside weed (as it is in New Zealand). It forms hybrids with other shrub willows.

Crack willow (*Salix fragilis* var. *fragilis*) and basket willow (*Salix* x *rubens*)

These single- or multi-stemmed trees are by far the most widespread and abundant willows in Australia, and are the most serious problem willow in Tasmania. They are found along thousands of kilometres of streams in southeastern Australia where they were widely planted for stream stabilisation. Crack willow spreads almost exclusively by plant parts so it is only associated with streams.

Black willow (*Salix nigra*)

This tree willow has been widely planted in northeastern Victoria and at several sites in New South Wales. It is now very abundant in some streams. Black willow has the potential to behave in the same invasive manner as grey sallow in wetlands.

Black willow, *Salix nigra*. Female (*left*) and male (*right*) catkins.
Photo: Kurt Cremer

What to do about it

Prevention of spread

Early detection and control are essential to prevent the spread of new infestations. The deliberate planting of willows along waterways has virtually ceased and extensive removal operations are common. It is fairly easy, given enough resources, to prevent the spread of willows that propagate by plant parts, as they are confined to streams and are spread downstream. For seeding willows, prevention of spread is difficult because seed can be dispersed over large areas.

Willows are still widely planted, eg for windbreaks on farms, and many groups (including weedy ones) are sold by the nursery trade in Australia. There is potential for additional willow taxa to become naturalised if importation is not closely regulated.

A strategic approach involves surveys and staged removal

A long-term plan should be devised before any attempt is made to eliminate problem willows. Removal of trees can actually increase erosion problems, so a plan to replace willows with more desirable species is needed.

Start by carrying out an extensive survey to identify potential seed sources. The willow species that set seed flower between September and November, so this is the best time to search for catkins on or under trees.

Grey sallow or pussy willow, *Salix cinerea*. *Left* to *right*: female catkin elongated after flowering, female catkin at flowering, male catkin at start of flowering and peeled stem showing characteristic ridges.
Photo: Kurt Cremer

CSIRO recommends identifying seed trees by attaching conspicuous plastic ribbons to them which will endure floods and grazing animals and last for 2–3 years. Trees growing more than 2 km away from a river may still be a significant seed source.

Staged removal should be undertaken over a number of years, starting in the upper reaches of each catchment and working downstream. Where willows have been planted to stabilise soils or banks, alternative vegetation should be established before the willows are removed.

Remove trees first which will not destabilise banks (eg on the inside of bends). Anticipate stream flow changes and be aware that removal of constrictions will allow greater pressure at restricted points further downstream. In these cases it may be advisable to start working on the lower end of the section, progressing upstream.

Control options

Willows are relatively easy to kill and mechanical and chemical control techniques are well understood. However, it should be noted that indiscriminate removal of willows is not recommended as it may lead to stream instability. Control should be conducted in consultation with state or territory authorities (see weed control contacts p. 4).

Weed control contacts

State/ Territory	Department	Phone	Email	Website
ACT	Environment ACT	(02) 6207 9777	EnvironmentACT@act.gov.au	www.environment.act.gov.au
NSW	NSW Agriculture	1800 680 244	weeds@agric.nsw.gov.au	www.agric.nsw.gov.au
SA	Dept of Water, Land and Biodiversity Conservation	(08) 8303 9500	apc@saugov.sa.gov.au	www.dwlbc.sa.gov.au
Tas	Dept of Primary Industries, Water and Environment	1300 368 550	Weeds.Enquiries@dpiwe.tas.gov.au	www.dpiwe.tas.gov.au
Vic	Dept of Primary Industries/Dept of Sustainability and Environment	136 186	customer.service@dpi.vic.gov.au	www.dpi.vic.gov.au www.dse.vic.gov.au
Australia wide	Australian Pesticides and Veterinary Medicines Authority	(02) 6272 5852	contact@apvma.gov.au	www.apvma.gov.au

For up-to-date information on which herbicides are registered to control willows and the best application methods and dosages, contact your state or territory weed management agency or local council. This information varies from state to state and from time to time. Contact details are listed above, including contacts for the Australian Pesticides and Veterinary Medicines Authority, which hosts the PUBCRIS database. This database contains information on all herbicides that are registered for use on weeds in each Australian state and territory.

When using herbicides always read the label and follow instructions carefully. Particular care should be taken when using herbicides near waterways because rainfall running off the land into waterways can carry herbicides with it. Permits from state or territory Environment Protection Authorities may be required if herbicides are to be sprayed on riverbanks.

Stem injection into cuts. Make cuts to a depth of 20–30 mm into the sapwood with a small axe or chisel and immediately inject herbicides.
Photo: Lisa Menke, NSW DEC, Mudgee

Stem injection with the 'drill and fill method'. Drill holes at 50–100 mm intervals around the circumference of the stem and immediately inject herbicides.
Photo: Trish Chadwick, NSW DIPNR

Stem injection is the best suited of all herbicide applications

Herbicides available for woody weeds are effective in controlling willow. Trees can be killed by stem injection, application to leaves and stems, bark (chemical girdling) and cut and paint methods (check with state/territory agencies for current recommendations). In dry conditions herbicide can also be applied by basal bark spraying and treatment of seedlings. Although stem injection may be a slower, more laborious method, it is an important option for avoiding chemical runoff and protecting native vegetation. In general, herbicide should be applied from summer to early autumn, although stem injection or cut and paint application is effective year round.

Stem injection is suited to large trees. Make cuts or drill holes below the branches, around the trunk, 20–30 mm into sapwood. The injection points should be single cuts spaced at less than 130 mm intervals, or holes drilled at 50–100 mm intervals, around the circumference. Angle holes and cuts downwards to minimise herbicide leakage. Herbicide should be immediately injected into each cut or hole at the recommended rate. Leave the tree undisturbed for at least 12 months after herbicide application to ensure a successful kill.

The cut-stump method should only be used to kill willows that can be easily and safely disposed of (ie smaller specimens). Cut the aerial trunk off completely at a level below the first branches and immediately apply a recommended herbicide to the cut stump. Remove all material to prevent regeneration from pieces. The cut surface of the removed stem should also be painted with herbicide for safe disposal. Minimal transport of branches and stems will help avoid broken fragments being spread. Willow wood chips can take root and grow so trees for chipping should be killed prior to removal.

New infestations can occur when trees are cut and moved away from waterways with heavy equipment. Small pieces of branch embedded in the attached soil may take root or enter the water to float away to new sites.

The fluff attached to seeds allows dispersal by wind or water.
Photo: Kate Blood

Foliar spraying (spraying the entire plant) should only be used to kill willows less than 2 m tall before the start of leaf fall and where herbicides will not affect native plants or make contact with water bodies.

Mechanical removal of seedlings, or of larger trees in dry areas

Elimination of young seedlings is a cost-effective way of keeping waterways free of potential blockages, erosion and streambed change. Hand pulling of seedlings less than 0.5 m tall is the most practical and environmentally safe way of removing young plants. Leaving small roots in the ground does not lead to suckering or regrowth.

Using large machinery such as excavators or bulldozers to remove larger trees and root systems is not recommended except in dry areas. In wet areas bulldozers push broken branches into the ground and thus generate numerous new plants.

Disposal recommendations

Trees killed while they are standing (ie by stem injection) should be left for 12 months before they are removed. They can then be cut at a suitable height and stacked away from watercourses. If it is necessary to remove live trunks and limbs from the site, stack them to dry above flood level, taking care to minimise the spread of small pieces. Smaller twigs should be bagged and disposed of at tip facilities so that they do not sprout and cause further problems.

Follow-up

Regrowth from stumps, pieces of stems or seeds will need to be followed up with monitoring and further control for 3–5 years after the initial effort. Check that treated trees have died, and remove trees that could cause problems if they become snared elsewhere by floods. Look for the spread of any new willows and follow up with substantial re-assessments at least every five years.

Legislation

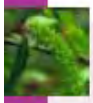
Relatively few species of willow are classified as noxious weeds across Australia, and the status of different species varies in the different states and territories. Similarly, the sale and trade of willow species is banned in some states but not others. However, the legislative status of willows is changing, so check with your local council or state/territory government agency for the most up-to-date information.

Acknowledgments

Information and guide revision: Bob Trounce (NSW Agriculture), Lynton Auld (Blue Mountains City Council), Richard Carter (NSW Agriculture/Weeds CRC), Vanessa Richardson (NSW NPWS) and John Thorp (National Weeds Management Facilitator).

Maps: Australian Weeds Committee.

Although planted for bank stability, changes to stream flow caused by willow roots can undermine banks.
Photo: Trish Chadwick, NSW DIPNR



...case study

Keeping willows out of Wollemi National Park, northwest of Sydney

The Wollemi National Park is the scene of a vigorous campaign involving the New South Wales National Parks and Wildlife Service (NPWS) and community volunteers against invading willows.

Black willows were imported from the USA and planted along the lower reaches of the Colo River in the 1930s. Although they were later removed, their offspring had already spread into the Wollemi National Park.

The problem was first brought to the attention of the NPWS in 1998 by bushwalkers and canoeists who were alarmed at the number of willows along the river. A subsequent survey listed the willow population along a 60–70 km section running down to the edge of Wollemi National Park at about 5000 trees.

A control program 'Willows Out of Wollemi' began, and the community group Friends of the Colo was formed to help tackle the problem.

Groups of volunteers travel down the Colo River in canoes and rafts, stopping to apply herbicide to willows by stem injection. They use a dye to mark the trees that have been treated and to show if any herbicide has been spilt. They also map the position of the willows and other weeds to help monitor progress.

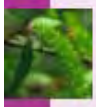
Many follow-up inspections down the river have confirmed that the willows have been killed without harming other species. Once the willows are gone, native species quickly take their place.

The volunteers will continue their trips along the upper Colo to treat trees they may have missed, but gradually their focus will shift to other weeds within the park as well as willows and other weeds along the lower Colo River outside the national park boundary.

How to control willow

Quick reference guide

Willow – *Salix* spp.



Willows damage stream health by using water rapidly, altering stream flow and reducing habitat availability for plants and animals. Photo: Kate Blood

Pull seedlings by hand

The simplest strategy is to pull all seedlings (and rooted branches) while they are still small. This works best if it is done regularly, especially if there are limited sources of seed and few suitable regrowth sites.

Mature trees should be injected with herbicide

Kill trees where they stand unless this is not possible for safety, practical or aesthetic reasons. Use stem injection of a registered herbicide to avoid chemical runoff. Best results will be achieved from summer to early autumn. Leave trees undisturbed for 12 months after herbicide application to ensure a successful kill.

Start control in the uppermost part of the catchment...

A long-term planned approach to control is needed. Staged removal should start in the upper reaches of the catchment. In the case of seeding species (eg pussy willow and black willow) which can recolonise treated areas, a coordinated catchment-scale intensive attack is the best option.

...preferably on the inside of bends...

First remove trees on the inside of bends because these banks are more stable. Where willows have been planted to stabilise soil or creek banks, alternative vegetation should be established before all willows are removed.

...but be aware of stream flow dynamics

The flow of the river will change once the willows are removed, and this may place greater pressure on restricted points downstream. In these cases it may be advisable to start working on the lower end of the section, progressing upstream.

Follow-up will be required

Monitor treated areas and use follow-up control on any regrowth for 3–5 years after the initial control.

Control options

Type of infestation	Chemical	Physical	Mechanical
National parks and sites with a low risk to downstream infrastructure	Treat using stem injected registered herbicide. Leave stems standing to break down over time.	Hand pull young seedlings.	Not suitable.
Waterways through cleared areas, eg farmland	Cut and paint with concentrated herbicide. Fell trees and immediately treat stump and cut trunk with herbicide.		Only use large machinery such as excavators or bulldozers to remove larger trees and root systems in dry areas. In wet areas large machinery can push broken branches into the ground and thus generate numerous new plants.
Local government reserves / other crown land	Treat and leave where possible; eg on paths, roads or limited public access areas. Cut and paint and remove from creek banks or where treated plants have the potential to fall and destabilise the creek bank.		

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CRC Weed management

Appendix H-17

White weeping broom (*Retama raetam*)

The problem

White weeping broom is on the *Alert List for Environmental Weeds*, a list of 28 non-native plants that threaten biodiversity and cause other environmental damage. Although only in the early stages of establishment, these weeds have the potential to seriously degrade Australia's ecosystems.

White weeping broom was brought to Australia as an ornamental shrub. It was first recorded in South Australia in 1841. Like many of the broom plants, it invades nutrient-poor to fertile, well-drained soils where it can fix nitrogen and form a scrub layer that can outcompete and shade out native plants. This species is possibly the most drought tolerant of the exotic brooms in Australia, making it a particular threat in dry regions and during drought years. It may infest grazing land and prevent access to stock. It is also probably the least palatable to stock of the exotic brooms.

The weed

White weeping broom is a Mediterranean shrub that grows to about 3 m tall and may reach 6 m across. Plants are grey-green with slender, drooping branches. Young plants are wispy with a single stem and strong taproot. The leaves, which are very small (about 5 mm long) and narrow (only 1 mm wide), are quickly dropped and the plant remains leafless for most of the year.

White weeping broom is an aggressive invader which thrives on nutrient-poor soil.
Photo: Ken Rudd, Northern Yorke Peninsula Animal & Plant Control Board

Flowers are 8–10 mm long, white and pea-like, appearing close to the stems in clusters of 3–15. Each flower tube contains ten stamens, the pollen bearing stalks that are the male reproductive parts of the flower. The hairless grape-shaped seed pod (10–15 mm diameter) contains one or two kidney-shaped seeds, which are about 6.5 mm long and may be yellow, green, brown or black in colour. Stems of young plants are covered with long soft hairs but become hairless with age. An extremely similar looking and closely related species, *Retama monosperma*, is a popular garden plant in Australia and also a potential weed (see p. 5).

Key points

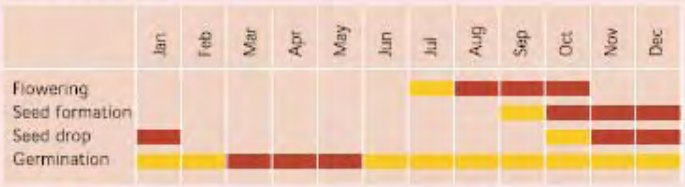
- Prevention and early intervention are the most cost-effective forms of weed control. It is important to identify existing sources of white weeping broom, such as garden specimens, and remove them before they invade natural ecosystems.
- White weeping broom is an aggressive invader which spreads by seed, each plant producing a large number of seeds.
- It is a very drought-tolerant species, making it a particular threat in dry regions and during drought years.
- Contact your state or territory weed management agency or local council if you find white weeping broom.

Natural Heritage Trust

ALERT

2

Growth calendar



White weeping broom flowers from late winter to mid spring and sheds its seed pods in late spring to early summer. Growth occurs whenever there is moisture, but mainly from autumn to spring. Seeds mainly germinate in autumn, but can germinate year round under suitable conditions.

The white, pea-like flowers occur in clusters of 3–15.
Photo: Ron Mittler, University of Nevada, USA

How it spreads

White weeping broom reproduces from seed. Each plant produces hundreds of seed pods and up to thousands of seeds on larger plants. The seeds drop when the seed pods split open, and can be further spread by water. A hard seed coat renders most seeds dormant initially, but as the seed coat wears away germination can take place. Seeds remain viable in the soil for several years.

Where it grows

White weeping broom is native to northern Africa and western Sahara, Sicily and the Middle East. It has become naturalised in Australia, the United States and Great Britain. In its native range, white weeping broom grows in grasslands in the Mediterranean region and is a common feature of deserts and grasslands in the Sahara.

In Australia white weeping broom has become naturalised in South Australia, particularly around and to the east of Adelaide, on the Yorke Peninsula where it has taken over an area planted to native vegetation, and on the Eyre Peninsula where it is invading she-oak (*Casuarina, Allocasuarina*) woodlands. In Western Australia it is growing around and to the north of Perth.

In the Mediterranean region, white weeping broom is found in dry sandy conditions.
Photo: Botany Department, University of Catania, Italy

Why we need to be 'alert' to white weeping broom

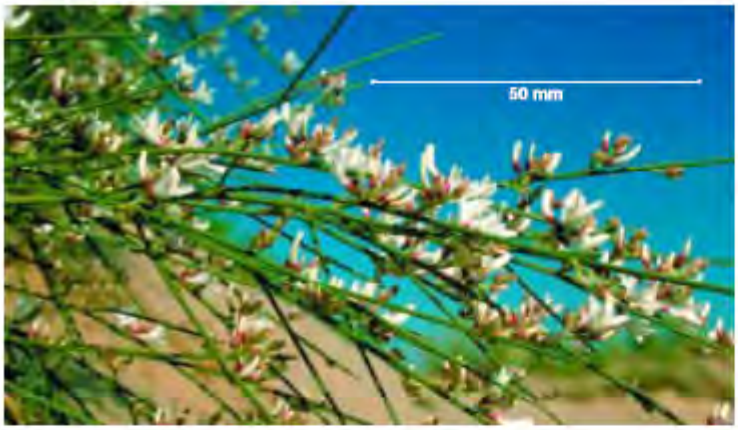
White weeping broom has several adaptations, including its lack of leaves, that reduce water loss and make it ideally suited to the warm dry conditions of its native range. It has the potential to become a significant threat to Australia's pastoral industry if it escapes containment.

In California the closely related species *Retama monosperma* displaces native plants, threatening the survival of several animal species that rely on the native vegetation. It can also increase the severity of bushfires if it dies off in large stands.

What to do about it

Prevention is better than the cure

As with all weed management, prevention is better and more cost-effective than control. The annual cost of weeds to agriculture in Australia, in terms of decreased productivity and management costs, is conservatively estimated at $4 billion. Environmental impacts are also significant and lead to a loss of biodiversity. To limit escalation of these impacts, it is vital to prevent further introduction of new weed species, such as white weeping broom, into uninfested natural ecosystems.



The plant is well adapted to saving water in dry conditions, with green stems and tiny leaves that are quickly dropped.
Photo: Botany Department, University of Catania, Italy

In the past various *Retama* species have been offered for sale in nurseries around Australia. If found for sale, notify the vendor of the risks posed by both *Retama raetam* and *Retama monosperma*. These are not recommended for ornamental situations and safer alternatives should be used instead. White weeping broom can be replaced with native species such as Australian native broom, *Viminaria juncea*, which has perfumed yellow–orange flowers in spring.

Early detection and eradication of small infestations are important to prevent the spread of white weeping broom. An ongoing commitment to ensure that new infestations do not establish in surrounding areas should be a priority.

Quarantine to prevent further introductions

The importation of white weeping broom into Australia is not permitted because of the risk of further spread, and the potential introduction of new genetic diversity that could make future control more difficult.

Do not plant white weeping broom in gardens – use local native species instead

Do not buy seeds via the internet or from mail order catalogues unless you check with quarantine first and can be sure that they are free of weeds like white weeping broom. Call 1800 803 006 or see the Australian Quarantine and Inspection Service (AQIS) import conditions database <www.aqis.gov.au/icon>. Also, take care when travelling overseas that you do not choose souvenirs made from or containing seeds, or bring back seeds attached to hiking or camping equipment. Report any breaches of quarantine you see to AQIS.

The Alert List for Environmental Weeds

The Federal Government's *Alert List for Environmental Weeds* was declared in 2001. It consists of 28 weed species that currently have limited distributions but potentially could cause significant damage. The following weed species are therefore targeted for eradication:

Scientific name	Common name	Scientific name	Common name
Acacia catechu var. *sundra*	cutch tree	*Koelreuteria elegans*	Chinese rain tree
Acacia karroo	Karroo thorn	*Lachenalia reflexa*	yellow soldier
Asystasia gangetica ssp. *micrantha*	Chinese violet	*Lagarosiphon major*	lagarosiphon
Barleria prionitis	barleria	*Nassella charruana*	lobed needle grass
Bassia scoparia	kochia	*Nassella hyalina*	cane needle grass
Calluna vulgaris	heather	*Pelargonium alchemilloides*	garden geranium
Chromolaena odorata	Siam weed	*Peroskia aculeata*	leaf cactus
Cynoglossum creticum	blue hound's tongue	*Piptochaetium montevidense*	Uruguayan rice grass
Cyperus teneristolon	cyperus	*Praxelis clematidea*	praxelis
Cytisus multiflorus	white Spanish broom	*Retama raetam*	white weeping broom
Dittrichia viscosa	false yellowhead	*Senecio glastifolius*	holly leaved senecio
Equisetum spp.	horsetail species	*Thunbergia laurifolia*	laurel clock vine
Gymnocoronis spilanthoides	Senegal tea plant	*Tipuana tipu*	rosewood
Hieracium aurantiacum	orange hawkweed	*Thanoptiles solitaria*	subterranean cape sedge

Weed control contacts

State / Territory	Department	Phone	Email	Website
ACT	Environment ACT	(02) 6207 9777	EnvironmentACT@act.gov.au	www.environment.act.gov.au
NSW	NSW Agriculture	1800 680 244	weeds@agric.nsw.gov.au	www.agric.nsw.gov.au
NT	Dept of Infrastructure, Planning and Environment	(08) 8999 5511	weedinfo.ipe@nt.gov.au	www.nt.gov.au
Qld	Dept of Natural Resources and Mines	(07) 3896 3111	enquiries@nrm.qld.gov.au	www.nrm.qld.gov.au
SA	Dept of Water, Land and Biodiversity Conservation	(08) 8303 9500	apc@saugov.sa.gov.au	www.dwlbc.sa.gov.au
Tas	Dept of Primary Industries, Water and Environment	1300 368 550	Weeds.Enquiries@dpiwe.tas.gov.au	www.dpiwe.tas.gov.au
Vic	Dept of Primary Industries/Dept of Sustainability and Environment	136 186	customer.service@dpi.vic.gov.au	www.dpi.vic.gov.au www.dse.vic.gov.au
WA	Dept of Agriculture	(08) 9368 3333	enquiries@agric.wa.gov.au	www.agric.wa.gov.au

The above contacts can offer advice on weed control in your state or territory. If using herbicides always read the label and follow instructions carefully. Particular care should be taken when using herbicides near waterways because rainfall running off the land into waterways can carry herbicides with it. Permits from state or territory Environment Protection Authorities may be required if herbicides are to be sprayed on riverbanks.

Raising community awareness

Some 65% of weeds, including white weeping broom, which have recently established in Australia have escaped from plantings in gardens and parks. The detrimental impacts of these weeds far outweigh any potential horticultural benefits. The public should be made more aware of these impacts, and of other issues such as how to identify white weeping broom and what to do if they find it.

White weeping broom can be distinguished by its weeping or drooping habit. Its stems are green and normally free of leaves, which are linear and narrow when present. It has smooth, grey-green bark and abundant white flowers during the flowering season (July–October).

New infestations of white weeping broom

Because there are relatively few white weeping broom infestations, and it can potentially be eradicated before it becomes established, any new outbreaks should be reported immediately to your state or territory weed management agency or local council. Do not try to control white weeping broom without their expert assistance. Control effort that is poorly performed or not followed up can actually help spread the weed and worsen the problem.

A roadside infestation of white weeping broom near Kadina, SA.
Photo: Ken Rudd, Northern Yorke Peninsula Animal & Plant Control Board

Methods to control white weeping broom

White weeping broom is known in Australia only from several small populations and a preferred method of control has not yet been developed. However, experience in controlling broom (*Cytisus scoparius*), which is a major weed in southern Australia, can be applied to this species. Any control of white weeping broom should be undertaken cooperatively with your state or territory weed management agency or local council.

Using herbicides

No herbicides are registered for control of white weeping broom. In the case of *Cytisus scoparius*, chemical control is effective in the short term but is expensive and needs to be followed up for many years until the seedbank has been depleted. There is also a risk of damage to non-target species.

Physical control

Physical removal is an option for isolated plants, especially if they have not seeded, although seedlings are hard to hand pull. Monitor the area in summer and remove any young plants that may have germinated.

5

Retama monosperma – another weedy species to look out for

Retama monosperma is popular as an ornamental shrub and has been sold throughout Australia since the early 1900s, occasionally under the name of the virtually identical *Retama raetam*. However, *Retama monosperma* is no longer considered suitable as an ornamental plant in Australian gardens due to the weedy behaviour of its very close relative *Retama raetam* and because it has become a serious weed in California. It should no longer be planted in gardens, and infestations which threaten bushland should be prioritised for control.

The seed pod and flowers of *Retama monosperma*.
Photo: Gavin Lodge

Retama monosperma (above) is extremely similar to white weeping broom, and is a weed overseas.
Photo: Jason Emms

Mechanical control

Bulldozing infestations into heaps and burning the resulting weed mounds has been a common method used to control broom but it only provides a temporary solution. Bulldozing causes massive soil disturbance and physical movement of plants, not only burying seeds but also spreading them beyond the original infestation. In at least one place this practice and a lack of follow-up treatments has exacerbated the *Cytisus scoparius* problem.

Cutting stems off near the ground with saws will stress the plant but cut plants resprout vigorously, so cutting alone will not kill them.

Because white weeping broom has a more continuous growth than some of the other broom species, it can be treated throughout the year whenever it is growing actively. It should be killed before it sets seed. Permits to mechanically clear vegetation may be required if native species are likely to be affected.

Fire

Fire effectively kills plants and can help to break seed dormancy. Experience using fire to control other species of broom indicates that it kills a large proportion of seeds but lightly scorched plants may resprout. Follow-up chemical treatment after fire will probably be needed for many years until the seedbank is depleted. Usually though, fire is not recommended to control broom in Australia due to the risk of out-of-control fires and because it leaves the land initially unusable, with many burnt stems remaining in the ground. Permits may be required to light fires – check with your local council or state or territory weed management agency.

Follow-up

Once an area of white weeping broom has been treated, it will be necessary to monitor the treated area for many years and destroy new plants.

Careful disposal

Hand-pulled plants can be placed into large plastic bags and left in the sun. Seeds present on pulled plants should be cut from plants, collected in bags and placed in the household rubbish. Take care not to spread seeds beyond the current infestation.

If removed weed material cannot be accommodated on the site, (eg mulched or dried in the sun), it should be bagged and removed to tip facilities. Seeds should not be included in vegetation to be used for the production of garden compost.

If the plant is being removed from gardens, dispose of waste by carefully bagging all material and putting it in the household rubbish. As seeds are difficult to destroy, it is advisable to dispose of plants when they are carrying seeds. Never give plants to other people or dump plants on vacant land, over back fences or in bushland areas. Contact your local council for specific advice before attempting to dispose of white weeping broom.

Legislation

There is currently no legislation to control white weeping broom but, as part of the *Alert List of Environmental Weeds*, it is marked for eradication and should not be imported into Australia or further spread.

Acknowledgments

Andy Sheppard (CSIRO/Weeds CRC), John Virtue (SA DWLBC/Weeds CRC), Jason Emms (University of Adelaide/Weeds CRC), Sandy Lloyd (Agriculture WA/Weeds CRC) and John Thorp (National Weeds Management Facilitator).

Map: Base data used in the compilation of distribution map provided by Australian herbaria via Australia's Virtual Herbarium.

If you find a plant that may be white weeping broom

Quick reference guide

White weeping broom – *Retama raetam*

Identification

You will first need to confirm its identity. Contact your state or territory weed management agency for help in identifying the plant. You will need to take note of the characteristics of the plant in order to accurately describe it. Some important features of white weeping broom include:

- plants are grey-green, almost entirely leafless, and grow to 3 m tall with slender branches that droop like a weeping willow
- seedlings are most visible in late summer and early autumn
- flowers are small, white and pea-like, in clusters close to the stems
- seed pods are grape-shaped, 10–15 mm in diameter and contain one or two small, kidney-shaped seeds.

Reporting occurrences

Once identified, new occurrences of white weeping broom should be reported to the relevant state or territory weed management agency or local council, who will offer advice and assistance on its control. Because it poses such a serious threat, its control should be undertaken with the appropriate expertise and adequate resources.

Follow-up work will be required

Once the initial infestation is controlled, follow-up monitoring and control will be required to ensure that reinfestation does not occur.

Collecting specimens

State or territory herbaria can also identify plants from good specimens. These organisations can provide advice on how to collect and preserve specimens.

State/Territory	Postal Address	Phone	Web
Australian National Herbarium	GPO Box 1600 Canberra, ACT, 2601	(02) 6246 5108	www.anbg.gov.au/cpbr/herbarium/index.html
National Herbarium of New South Wales	Mrs Macquaries Rd Sydney, NSW, 2000	(02) 9231 8111	www.rbgsyd.nsw.gov.au
National Herbarium of Victoria	Private Bag 2000 Birdwood Avenue South Yarra, Vic, 3141	(03) 9252 2300	www.rbg.vic.gov.au/biodiversity/herbarium.html
Northern Territory Herbarium	PO Box 496 Palmerston, NT, 0831	(08) 8999 4516	http://www.nt.gov.au/ipe/pwcnt/
Queensland Herbarium	c/- Brisbane Botanic Gardens Mt Coot-tha Rd Toowong, Qld, 4066	(07) 3896 9326	www.env.qld.gov.au/environment/science/herbarium
South Australian Plant Biodiversity Centre	PO Box 2732 Kent Town, SA, 5071	(08) 8222 9311	www.flora.sa.gov.au/index.html
Tasmanian Herbarium	Private Bag 4 Hobart, Tas, 7000	(03) 6226 2635	www.tmag.tas.gov.au/Herbarium/Herbarium2.htm
Western Australian Herbarium	Locked Bag 104 Bentley DC, WA, 6983	(08) 9334 0500	http://science.calm.wa.gov.au/herbarium/

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CRC Weed management

Appendix H-18

Molonglo Catchment Group

Weed Fact Sheet

HOREHOUND

(Marrubium vulgare)

Lynton Bond

Weed: horehound

Jackie Miles/Max Campbell

Weed: horehound
Note the flowers in axil of upper leaves

Why is horehound a weed?

- Tolerates drought and poor soils
- Spreads when overgrazing or drought removes more palatable species
- Invades disturbed ground especially in old stock camps, rabbit warrens, on grazing land, roadsides and waste ground
- Not very palatable to stock and the plants flavour taints meat if grazed

Description

Plant: bushy perennial aromatic herb (in the mint family) to about 30cm high, square stems
Leaves: near-circular, opposite, grey-green, velvety, wrinkled with toothed edges, hairy
Seeds: 1-2mm long, up to 4 per burr
Flowers: small white flowers carried in dense clusters in the axils of the upper leaves

Dispersal via

- Burrs are spread when they attach to animals, clothing and car tyres
- Seed can be spread in mud carried on vehicles
- In water
- In the gut of stock then dispersed in dung

Status

Horehound is listed as a class 4 noxious weed in both the Palerang Council and Cooma-Monaro Shire Council. The growth and spread of the plant must be controlled in accordance with local management plans published by each local council. Although it is not listed as noxious in the Queanbeyan City Council or as a pest plant in the ACT, it is an important species to control in all areas due to its invasive nature.

Lynton Bond

Weed: horehound

Fact sheets are available from the Molonglo Catchment Group website. Visit www.molonglocatchment.com.au or call 6128 3376 for more information about getting involved in your living environment.

Information used to compile this fact sheet was kindly provided by the Southern Tablelands and South Coast Noxious Plants Committee: www.southeastweeds.org.au

Look-alikes

The related **wild sage** (*Salvia verbenaca*) is another common aromatic weed with a less bushy habit. Its leaves are oval and more deeply toothed, less woolly and on longer stalks. Flowers are blue-purple in terminal spikes.

Jackie Miles/Max Campbell

Weed: wild sage

Jackie Miles/Max Campbell

Weed: wild sage

Jackie Miles/Max Campbell

Weed: wild sage

Control methods

For advice on what time of year to implement the following management options, see the Molonglo Catchment Weed Control Calendar.

Dig or spot spray small plants/infestations. Boom spray larger infestations prior to seeding. Burn plants after chipping or spraying if seed is present, or bag and dispose of at local government tip. Fire will stimulate germination of most soil-stored seed but must be followed by a comprehensive control program or it will just create a greater problem.

Seek advice on chemical application from your Council Weeds Officer or local 'bush friendly' nursery. Always use chemicals as directed on the label. Consult the Rural Fire Service for permits and advice before using fire as part of your management methods; in urban areas also contact the local council/control authority.

The biological control, plume moth (Wheeleria spilodactylus), has been released in NSW. It is available and easy to rear and has made a reasonable impact. Contact the Molonglo Catchment Coordinator for information on how to access these biological controls.

Combine these control methods with revegetation using desirable perennial species.

Appendix H-19

European red fox (*Vulpes vulpes*)

Since they were introduced for recreational hunting in the mid-1800s, foxes have spread across most of Australia. They have played a major role in the decline of a number of species of native animals and they also prey on newborn lambs. Control of foxes relies heavily on conventional techniques such as shooting, poisoning and fencing. In the future, a combination of biological and conventional control methods may be able to reduce the damage foxes cause.

History

The European red fox was deliberately introduced to Australia for recreational hunting in 1855 and fox populations became established in the wild in the early 1870s. Within 100 years the fox had spread across most of Australia, though it currently does not occur in the tropical north and some off-shore islands remain fox free. In 2001, evidence began to emerge suggesting that foxes had been introduced into Tasmania, which was previously fox free.

Ecology

The fox survives in many different habitats, including urban, alpine and arid areas. Outside urban areas, it appears to be most abundant in lightly wooded areas that are typically found in agricultural landscapes offering a wide variety of shelter and food.

Distribution of the European red fox in Australia

Adapted from: Clarke GM et al (2000). *Environmental Pest Species in Australia*. Internal report, Department of the Environment and Heritage, Canberra.

During the day, the fox sleeps in dens, logs and other shelter — it is mainly active at night. The fox eats almost anything, scavenging and preying on whatever is available. Its main food source is small animals, but it also eats insects and fruit, particularly in summer when preferred prey is less abundant.

Both males and females are sexually mature at the age of one year. Litters, averaging four cubs, are born during August and September, and emerge from the den in late spring. The cubs move away from the family territory in late summer or autumn.

Causes of fox mortality include shooting, trapping and predation by dingos. Diseases such as mange and distemper may also be a significant cause of death in fox populations.

Impact

The fox has played a major role in the decline of ground-nesting birds, small to medium sized mammals such as the greater bilby, and reptiles such as the green turtle. It is thought to have caused a severe reduction in populations of many other threatened species, including the bridled nail-tail wallaby and the night parrot.

The fox causes significant economic losses to farmers by preying on newborn lambs, goat kids and poultry.

The fox could also act as a carrier of rabies, should the disease accidentally be introduced into Australia. Rabies mostly affects members of the dog family, but can also be passed on to humans, livestock and native mammals.

Control

In the past, bounties have been paid to remove foxes from the wild, but these have rarely been effective in reducing the damage caused by foxes. Similarly, hunting does not seem to have had a significant or lasting impact on fox numbers or the damage they cause.

Foxes are one of the most widely distributed feral animals in Australia and can be found in most habitats, except in the tropical regions of the far north. They prey on a wide variety of small animals. Photo: C Marks

Fencing and broadscale fox control with poison baits has been used successfully in Western Australia, allowing populations of some native mammals to begin to recover and return to former habitats. Similar control activities have been undertaken in eastern Australia. Such control can ease the pressure on populations of native animals, but it is expensive and must be maintained indefinitely.

Preventing the introduction of foxes to new areas, such as islands, is a high priority. Islands are often refuges for animals no longer found on the mainland.

The use of poison baits for fox control must take into account possible effects on non-target species. Burying baits reduces the likelihood of the baits being taken by native animals, and foxes can still find them.

Scientists are investigating ways to improve conventional fox control methods to make them more effective and humane, and less likely to harm non-target animals. New biological control techniques are also being investigated. These include a vaccine to prevent pregnancy.

Foxes are less common where dingos are present, and this may be another form of biological control. Researchers are looking at the interactions between foxes, dingos and feral cats; their findings could help in integrating fox and feral cat control.

Foxes can be poisoned using baited meat, or specially prepared baits like the one shown here. Baits are often buried to reduce the chance of them being taken by native animals. Photo: Animal Control Technologies Australia

How the Australian Government is dealing with a national problem

Predation by the European red fox is listed as a key threatening process under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (the EPBC Act). Under the EPBC Act, the Australian Government in consultation with the states and territories has developed the *Threat Abatement Plan for Predation by the European Red Fox.*

The threat abatement plan aims to reduce the impact of predation by foxes by:

- implementing fox control programs in specific areas of high conservation priority
- encouraging the development and use of innovative and humane control methods for managing foxes
- educating land managers to improve their knowledge of fox impacts, and to ensure skilled and effective participation in control activities
- collecting and disseminating information to improve our understanding of the ecology of foxes in Australia, their impacts and methods to control them.

Fox control programs need to be coordinated with other activities that may be taking place, including the on-ground protection of threatened plants and animals and control of other invasive species such as feral rabbits and feral cats. The plan provides a framework that enables the best use of the resources available for fox management. The Australian Government works with the states and territories to deal with this national problem.

More information about the *Threat Abatement Plan for Predation by the European Red Fox* can be found at http://www.deh.gov.au/biodiversity/threatened/tap/foxes/index.html

Further reading:

Saunders G, Coman B, Kinnear J and Braysher M (1995). *Managing Vertebrate Pests: Foxes*. Australian Government Publishing Service, Canberra.

Illustration of European fox by Karina Hansen McInnes

Printed on recycled paper (2004)

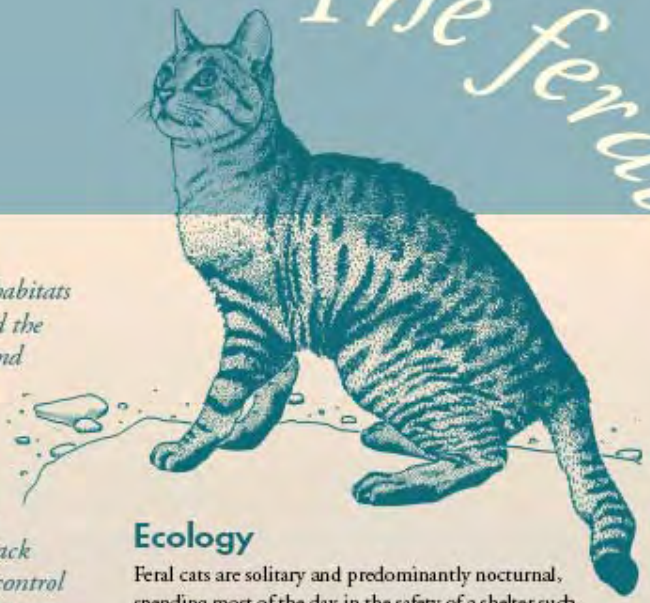
For further information, contact:

Australian Government
Department of the Environment and Heritage

GPO Box 787 Canberra ACT 2601
Phone: 1800 803 772
Web site: http://www.deh.gov.au

Appendix H-20

The feral cat (*Felis catus*)



The feral cat is found in most habitats across Australia. It has caused the extinction of some species on islands and is thought to have contributed to the disappearance of many ground-dwelling birds and mammals on the mainland. On islands, feral cat control is feasible, but elsewhere management is difficult due to the lack of effective and humane broadscale control techniques, and the presence of domestic cats.

History

Cats have been in Australia at least since European settlement, and may have arrived with Dutch shipwrecks in the 17th century. By the 1850s, feral cat colonies had become established in the wild. Intentional releases were made in the late 1800s in the hope that cats would control rabbits, rats and mice.

Feral cats are now found in most habitats on the mainland, Tasmania and many offshore islands, although not in the wettest rainforests.

For management purposes, cats are divided into three categories — domestic, stray and feral — although individual cats may move between categories. Domestic cats are owned and cared for, and stray cats are those found roaming cities, towns and some rural holdings. Feral cats, which survive without any human contact or assistance, are the main target of control programs.

Distribution of feral cats in Australia — they are now found in all areas.

Adapted from: Clarke GM et al (2000). *Environmental Pest Species in Australia.* Internal report, Department of the Environment and Heritage, Canberra.

Ecology

Feral cats are solitary and predominantly nocturnal, spending most of the day in the safety of a shelter such as a burrow, log or rock pile. Rabbits have aided their spread by providing food and burrows for shelter. Males usually occupy a home range of ten square kilometres but this may be larger if food supplies are scarce.

Feral cats are carnivores and can survive with limited access to water, as they use moisture from their prey. They generally eat small mammals, but also catch birds, reptiles, amphibians, fish and insects, taking prey up the size of a brush-tail possum. In pastoral regions, they feed largely on young rabbits, but in other areas feral cats prey mainly on native animals.

From the age of about one year, feral cats can breed in any season. They have up to two litters of about four kittens each year, but few of the young survive.

Dingos and foxes may restrict feral cat numbers by both direct predation and competition. Feral cats also fall prey to wedge-tailed eagles.

Impact

There is clear evidence that feral cats have had a heavy impact on island fauna. On Macquarie Island, for example, feral cats caused the extinction of a subspecies of the red-fronted parakeet. On the mainland, they have probably contributed to the extinction of many small to medium sized mammals and ground-nesting birds in the arid zone, and seriously affected bilby, mala and numbat populations. In some instances, feral cats have directly threatened the success of recovery programs for endangered species.

Feral cats carry infectious diseases such as toxoplasmosis and sarcosporidiosis, which can be transmitted to native animals, domestic livestock and humans. If rabies were to be accidentally introduced into Australia, there is a high risk that feral cats would act as carriers of the disease.

Although it is known that feral cats prey on native mammals, birds and reptiles, the details of their impact on native wildlife are still being researched. Photo: C Potter

Control

Conventional control techniques have been successful in eradicating feral cats from some offshore islands. Due to a very successful program conducted between the Commonwealth and Tasmania with funds from the Natural Heritage Trust, feral cats have been successfully removed from Macquarie Island. This has protected the long-term survival of colonies of nesting seabirds, including albatrosses. One bird species, the grey petrel, has started breeding on the island again for the first time in over 100 years.

On the mainland, management is more difficult because feral cats are shy of traps, do not take baits readily and generally avoid human contact, making them hard to shoot. Control techniques must also not harm domestic cats. Even if cats are removed from an area, it is quickly recolonised.

Barrier fencing, combined with eradication inside the fences, has proved to be effective for protecting endangered species that are being reintroduced. For example, fences are now used to exclude feral cats and other predators from bilby colonies in Queensland.

Researchers are attempting to improve the effectiveness and humaneness of baits and traps in controlling feral cats. In various parts of Australia, researchers are also studying the impact of feral cats on native wildlife, so that they can target control measures more effectively and assess how well they have worked.

Animals killed by feral cats include endangered mammals such as the bridled nail-tail wallaby, shown here with the remains of two brush-tailed possums. Photo: M Evans

How the Australian Government is dealing with a national problem

Predation by feral cats is listed as a key threatening process under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (the EPBC Act). Under the EPBC Act, the Australian Government in consultation with the states and territories has developed the *Threat Abatement Plan for Predation by Feral Cats.*

The threat abatement plan aims to reduce the impact of feral cats on native wildlife by:

- implementing feral cat control programs in identified regions of high conservation priority
- encouraging the development and application of innovative, humane feral cat control methods
- collecting and disseminating information to improve our understanding of the ecology of feral cats in Australia, their impacts and humane methods to control them
- educating land managers and others about feral cat impacts to ensure their skilled and effective participation in control activities.

Feral cat control programs need to be coordinated with other activities that may be taking place, including the on-ground protection of threatened plants and animals and control of other invasive species such as rabbits and foxes. The threat abatement plan provides a framework that will enable the best use of the resources available for feral cat management. The Australian Government will continue to work with the states and territories in dealing with this national problem.

More information about the threat abatement plan can be found at http://www.deh.gov.au/biodiversity/threatened/tap/cats

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Illustration of feral cat by Karina Hansen McInnes

Printed on recycled paper (2004)

For further information, contact:

Australian Government
Department of the Environment and Heritage

GPO Box 787 Canberra ACT 2601
Phone: 1800 803 772
Web site: http://www.deh.gov.au

Natural Heritage Trust
Helping Communities Helping Australia
A Commonwealth Government Initiative

Appendix H-21

Department of Agriculture
Farmnote
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Options for rabbit control

Revised by Gary Farrelly, Paul Merks and staff of Vertebrate Pest Research Services

In 1859 when Thomas Austin released 24 wild rabbits on his Geelong property, he could not have foreseen that they would breed so prolifically and spread across the southern parts of the continent. Each year rabbits cause an estimated $600 million worth of damage to agriculture. They also cause serious erosion problems, prevent native vegetation from regenerating, attack domestic gardens and undermine farm sheds and other buildings.

Landholders planning to grow broadacre, horticulture or tree crops or to preserve native vegetation need to control rabbits first.

Even landholders not growing crops are still legally obliged to control rabbits to protect their neighbours' land from the impact of rabbits.

Control issues

- The key to success is persistence. One-off efforts produce only short-term results as rabbits may produce many offspring and populations can recover quickly even after successful control programs.
- Maximum effectiveness is achieved by integrating appropriate control methods. Best control is achieved in late summer when rabbit numbers are decreasing and feed is limited.
- District-wide campaigns can reduce the problem of re-infestation by covering a large area.
- Sometimes it will not be possible to use poison but other methods are available. (For example, fumigation, ripping.)

Are rabbits present?

Areas intended for seeding, planting or conservation efforts, especially near rabbit harbourage, should be thoroughly checked. This is particularly important in areas where rabbits have previously been a problem.

Rabbit activity is usually indicated by scratchings, dung heaps and active burrows or warrens. More revealing checks can be made late in the day or at night by spotlighting when rabbits are active and more observable.

Baiting

Baiting is the most cost-effective way to reduce rabbit populations, particularly over large areas, but restrictions do apply.

1080 baits

Several types of 1080 (sodium fluoroacetate) rabbit bait is available. Trained landholders can purchase bait products after they have obtained Baiting Approval from an authorised officer of the Department of Agriculture.

1080 is quickly broken down in the environment. Many native animals have developed a high degree of tolerance to 1080. Domestic stock and pets are however very sensitive to the poison in both baits and poisoned rabbits.

Pindone baits

Pindone is an anticoagulant with an effect similar to products used in some rat poisons. It can sometimes be used near settlements where pets might be at risk from 1080, because unlike 1080, an antidote is available for pindone.

However, pindone poses a risk to native animals including kangaroos, birds of prey and perhaps bandicoots. The poison must not be used in the presence of these animals.

For further advice on this issue contact the Department of Agriculture.

Warren fumigation

Rabbits use warrens as refuges and for breeding. Fumigation is the best method to use when a few rabbits live in widely scattered warrens or inaccessible areas. Fumigant tablets (commonly Phostoxin®) are placed in burrows to release poisonous phosphine gas.

Warren ripping

Areas where warrens have been destroyed by cross-ripping the soil are much less likely to be recolonised by rabbits. A tractor-mounted ripper is used to penetrate the soil to a depth of at least 60 centimetres.

Harbourage destruction

Areas that rabbits use for harbourage/refuge include rock piles, deadfall timber and stumps, old buildings and abandoned farm machinery. Such material should be removed, buried or surrounded with rabbit-proof fences. Permission will usually be required before remnant or roadside vegetation can be cleared.

Rabbit-proof fencing

Rabbit-proof fences can be effective in preventing animals moving into or re-infesting an area. Well-maintained fences can provide a permanent solution to rabbit problems. Fencing can also be used to contain rabbits in an area where they can be more efficiently poisoned.

Myxomatosis and Rabbit Calicivirus Disease (RCD)

These viruses have been introduced to help reduce rabbit numbers, but may be difficult to manipulate. Following up immediately with other control methods can enhance their benefits.

Other methods

Shooting, trapping and the use of ferrets can be useful additional tools when very few rabbits are present. All these methods should be used legally and humanely.

Further information

Contact any office of the Department of Agriculture, or the South Perth office on phone 9368 3333.

See also Farmnotes:

- Guide to the safe use of 1080 poison
- Landholder use of 1080 One Shot oat rabbit bait
- Fumigation for rabbit control
- Rabbit warren and harbourage destruction

Summary of options for rabbit control

Options	When to use	Cost	Advantages	Disadvantages
1080 baiting	Late summer. Before seeding, planting or regeneration efforts.	Most cost-effective method.	Large areas covered quickly. Most native animals tolerant of 1080 but can be affected if baits misused. Foxes killed by eating poisoned rabbits.	No effective antidote. Livestock and pets can be at risk. Uneaten baits should be buried or weathered by exposure to rain. Dry weather required.
Pindone baiting	Best late summer. Before planting/ seeding.	Moderate cost.	Less hazard to domestic animals. Antidote available.	Must not be used in presence of some native animals.
Warren fumigation	Best late summer. Before planting/ seeding.	Labour-intensive. Follow-up to ripping.	Useful if rabbits are underground in inaccessible or scattered areas. Follow-up after baiting, ripping. Does not cause erosion.	Cannot be used where rabbits live above ground or where warrens cannot be sealed.
Warren ripping	Summer for sandy areas. Winter for areas with clay soils. Before planting/ seeding.	Labour-intensive.	Good for large paddock infestations. Reduces recolonisation. Long-term solution.	Can cause soil erosion. Cannot be used in bushland as it destroys native vegetation. Cannot be used in some rocky country.
Harbourage destruction	Before planting/ seeding.	Labour-intensive. Little value alone - combine with other methods.	Good follow-up method.	Cannot be used in all situations (e.g. native vegetation)
Rabbit-proof fencing	Before planting/ seeding.	Very labour-intensive. High initial cost.	Long-term effect, stops reinvasion.	Needs regular checking.
Myxomatosis and RCD.	Naturally spread.	No cost.	Effective in reducing numbers before other controls are used.	Timing and effectiveness unpredictable.
Shooting, trapping, ferrets	Best late summer.	Very labour intensive.	Must be used with other methods, to be useful. Need permit for many trap types.	Only appropriate for low rabbit numbers. Trapping and shooting not suitable in built-up areas.

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Appendix H-22

Click on images to enlarge

Family

Leporidae

Genus

Lepus

Species

europaeus

Threats/Control Methods - Regional

Shooting is carried out in rural areas to control population numbers and limit the damage to crops and native vegetation. Population numbers are also controlled by the prolific spread of rabbits, which take the majority of resources and limit hare numbers.

Threats/Control Methods - Local

Currently there are no control methods for the hare within the ACT.

Local/Urban Actions

In the unlikely event that a hare is spotted within the suburbs, it is not advisable to approach them closely. When confronted by humans or, if handled, wild adult hares become extremely stressed and may even die from a cardiac event. If caged or boxed, by inexperienced handlers, they become distressed and can potentially injure themselves fatally.

Common name/s

European Hare, Brown Hare, Hare, European Brown Hare, Jackrabbit

Distinguishing Features

Hares are very similar in appearance to Rabbits (*Oryctolagus cuniculus*). The most outstanding differences are the larger body size, longer and more powerful hind legs and very long ears, which have a black tip. Their colouring is speckled brown with a white underside. They have red-brown legs and a light patch across the face from the eyes down to the dark nose. Hares can grow to a length of about 70 cm from their nose to the tip of their tail.

Similar Species

Rabbits (*Oryctolagus Cuniculus*) are very similar but substantially smaller and more abundant.

Distribution

The European hare is found in all Australian states, excepting WA and the NT.

Country of Origin

This species was introduced to Australia during the 1860s for hunting sport.

Survey Techniques

This species was identified visually during day and night searches and with scats.

Conservation (Pet/Pest) Status - National

Introduced Species. Common across its range. Its diet of agricultural makes it a pest in agricultural areas and the Australian Government classifies it as a minor pest.

Conservation (Pet/Pest) Status - Regional

Common, especially in open, agricultural areas.

Associated vegetation community

This species thrives on native grassland and open woodland.

Limiting Resources

This species requires open grassland and low-lying shrubs for food. Its numbers are known to drop in response to rising rabbit and fox (*Vulpes vulpes*) numbers.

Breeding

Their slower reproductive cycle partly explains why rabbits out compete hares. Compared to rabbits, hares have much longer gestation periods, more selective breeding patterns, and smaller litters. Females give birth to around 3 litters each year of 2-3 leverets (young hares). Leverets are born with their eyes open and are left alone by the mothers all day to ward away predators not returning till sunset. In the wild, they usually live up to 10 years of age.

Behaviour

The brown hare is a nocturnal animal, so most of its feeding occurs during the night. They are shy and unlikely to be seen by residents of urban areas. Unlike rabbits which occur in borrows, hares are surface dwellers and during the day they rest in small depression in grassland environments. The Hare can run at up to 50km an hour over short distances.

Functional Group

Herbivore

Food Species

While hares prefer eating young shoots of grasses and herbs, they will also graze agricultural crops of vegetables and cereals in rural areas and on the bark of young fruit trees and wines.

Predators

Foxes (*Vulpus vulpus*) and Wedgetail Eagles *(Aquila audax)* attack hares, while Feral Cats (*Felis catus*) prey on young hares.

Interesting Fact

The isolated populations of hares in parts of QLD are due to the sale of hares for coursing (bait for greyhound racing).

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