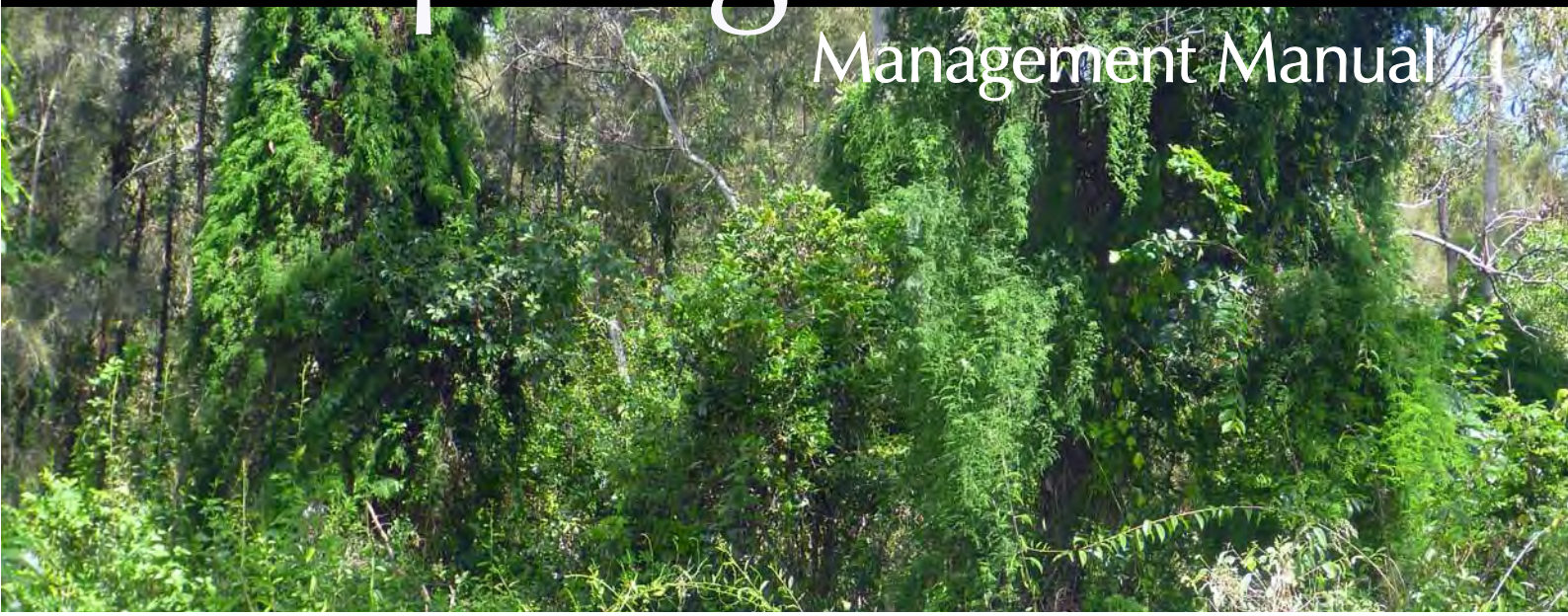
Weeds of National Significance

Asparagus weeds

Management Manual



Current management and control options for asparagus weeds (*Asparagus* spp.) in Australia

CARING FOR OUR COUNTRY

NSW GOVERNMENT Office of Environment & Heritage
NSW National Parks & Wildlife Service

National Asparagus Weeds Management Committee

Asparagus weeds

Management Manual

Current management and
control options for asparagus weeds
(*Asparagus* spp.) in Australia

Weeds of National Significance
2013

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Asparagus weeds management workshops

Workshops and discussions were held with weed managers and community volunteers in New South Wales, Queensland, South Australia, Tasmania, Victoria, and Western Australia in 2012 and 2013. Contributions from over 400 dedicated asparagus weed managers provided valuable information on current management and control practices, much of which forms the basis of this manual. Many thanks to all those who contributed.

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Foreword

Weeds are often referred to as an 'intractable' problem – that is, one that is difficult to deal with or solve. This, together with the size of the weed problem in Australia (yes, it's big!), can result in weed management being relegated to the 'too hard' basket. Readers of this manual will be aware that, while weeds are a significant and difficult problem, it is critical that we do manage them to protect the things that we value, in particular, Australia's unique environment.

Large and difficult problems require clever and effective solutions. The thousands of people working to tackle the weed problem in Australia are developing those solutions all the time. Over the last 20 or so years, we have built a well-stocked toolbox that contains strategic, effective tools and techniques to control weeds. This manual is yet another tool for the weed managers' toolbox. It contains the collective understanding and experience of hundreds of asparagus weed managers from across the country, who have kindly provided their knowledge and expertise.

This manual provides a wealth of information on the biology, ecology and effective control of the seven asparagus Weeds of National Significance that have invaded southern and eastern Australia. Importantly, it also highlights other new and emerging asparagus weeds that can be eradicated now, to prevent them becoming part of the weed problem. The manual includes advice on planning, holistic management, restoration and monitoring, as well as case studies that provide real examples of the successes and challenges of asparagus weed control.

Because they are passionate about protecting our biodiversity, thousands of dedicated community volunteers and weed professionals are chipping away every day at the weed problem. This manual can now be added to that well-stocked toolbox that supports their excellent work. While it will require long-term effort and continued dedication, the weed problem is not intractable – but rather more tractable and feasible every day. Although it may not always seem like it, we are on the winning side of the weed battle – keep the pressure on!

With sincere thanks to weed managers everywhere,

Hillary Cherry
Weeds of National Significance Coordinator

June 2013

Contents

National management

The continued spread of asparagus weeds threatens Australia's biodiversity, including endangered coastal and forest ecosystems. The Asparagus Weeds Strategic Plan (2012–2017) is a national Plan developed under the Australian Weeds Strategy as part of the Weeds of National Significance initiative. This Plan provides a framework to prevent the spread and reduce the impacts of asparagus weeds. Nationally coordinated implementation of the Plan, in conjunction with all stakeholders nationally, will allow for better protection of priority assets by providing tools and information, identifying management priorities, and fostering partnerships that lead to more strategic, collaborative management.

The Plan aspires to three goals:

1. New asparagus weed infestations are prevented from establishing.
2. Existing asparagus weed infestations are under strategic management.
3. There is increased capability and willingness to manage asparagus weeds.

These goals complement the Australian Weeds Strategy. Like the Australian Weeds Strategy, the Plan fosters a shared approach, and identifies efficiencies and collaborative actions that help to ensure existing resources can be allocated to achieve improved, strategic management outcomes. The Plan outlines measurable, targeted actions to allow progress towards its vision of ensuring that: 'Australia's environment is better protected from the negative impact of asparagus weeds'. The Plan is available at www.weeds.org.au/wons/asparagusweeds.

Using this manual

Who should use this manual?

This manual has been written to assist anyone who either wants or needs to manage asparagus weeds, from site managers, community groups, private landholders and volunteers to government agency staff. This manual is intended to help people make decisions about asparagus weeds management by providing a comprehensive guide.

This manual provides information on:

- Asparagus weeds and their impacts.
- Habitats invaded and their management considerations.
- How to choose an appropriate control method.
- How to plan management.
- Restoration, revegetation and repairing invaded habitats.
- Monitoring progress.
- Legislation and information for volunteers.
- Further resources.

How to use this manual

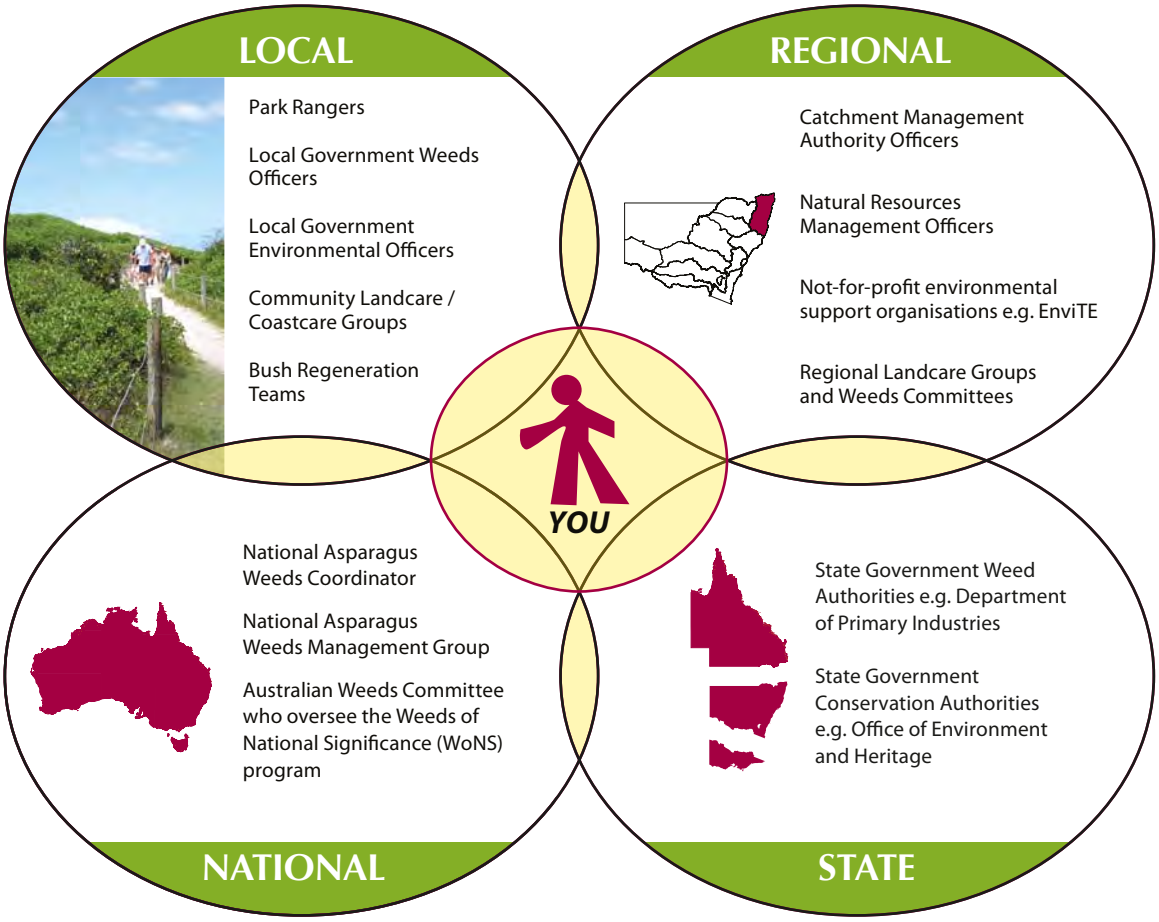
Sections can be read in isolation, or collectively if one's goal is to comprehensively investigate specific topics. To increase the usability of this manual, the following have been provided:

- A checklist for the planning stage.
- A decision matrix – especially for selecting an appropriate control method.
- Advantages/disadvantages of each control method.
- Important considerations for management.
- Case studies.
- Contacts and references for more information.

Asparagus weed network in Australia

Many groups of people are involved in asparagus weed management in Australia across a range of levels. Part of effective management is understanding where you fit within the 'asparagus weed network' in Australia. The diagram below illustrates the diversity of people and agencies involved, and their relationships. Relevant contact details are provided in Section 7 of this manual, and a portion of these are on the Australian Government Caring for our Country web page www.nrm.gov.au.

Consult with other groups working on asparagus weeds in surrounding areas to help understand your potential role in asparagus weed management nationally, as well as within your state, region and locality. For example, management at individual sites can feed into local government pest management plans, which feed into regional pest strategies at the natural resource management (NRM) board and catchment management authority (CMA) scale. These in turn feed into the Asparagus Weeds Strategic Plan and the Australian Weed Strategy. Thus your actions benefit not just your site, but ultimately the regional, state and national effort.



Section 1

Biology and threat

Biology and threat

Understanding asparagus weeds

Asparagus weeds are hardy plants that thrive in a range of habitats, from moist temperate forests to harsh coastal environments. They grow as vines and scramblers that climb over and smother native herbs, trees and shrubs. Their dense root systems can inhibit native seedling growth and change soil dynamics.

Which *Asparagus* species are weeds in Australia?

Common bridal creeper (*Asparagus asparagoides* (L.) Druce) is the focus of intense control efforts across southern Australia. However, other asparagus species are also weeds of great concern. Seven species of *Asparagus* are recognised as Weeds of National Significance (WoNS): *Asparagus aethiopicus* L., *A. africanus* Lam., *A. plumosus* Baker, *A. scandens* Thunb., *A. declinatus* L., Western Cape bridal creeper (*A. asparagoides* Western Cape form) and common bridal creeper (*A. asparagoides* (L.) Druce).

Several other species of *Asparagus* are also recognised as new and emerging weeds in Australia: *A. falcatus* L., *A. retrofractus* L. and *A. virgatus* Baker. Edible asparagus (*A. officinalis* L.) has also become weedy in some areas.

The only *Asparagus* species that is native to Australia is *A. racemosus* Willd.

Naming asparagus weeds – scientific vs. common names

Using common names for asparagus weeds can be very confusing, as one common name can refer to a number of species, and each species has more than one common name. For example, *A. africanus* and *A. plumosus* can both be called climbing asparagus, and these two species together with *A. scandens* and *A. aethiopicus* can all be called asparagus fern.

Two forms of *A. asparagoides* (bridal creeper) occur in Australia – the common form and Western Cape form. As both of these forms are currently classified with the same scientific name, this manual will refer to each by their common name. See pages 8, 9 and 21 for more information on the two forms.

To avoid confusion, scientific names are used for all species, except bridal creeper, throughout this manual.

Common names associated with each of the key asparagus weeds described in this manual

Asparagus aethiopicus	ground asparagus, basket asparagus, asparagus fern, Sprengeri's fern, bush asparagus, emerald asparagus
Asparagus africanus	climbing asparagus, ornamental asparagus, asparagus fern
Asparagus plumosus	climbing asparagus fern, ferny asparagus
Asparagus scandens	asparagus fern, climbing asparagus, climbing fern, snakefeather
Asparagus declinatus	bridal veil, asparagus fern
Asparagus asparagoides	common bridal creeper, Western Cape bridal creeper, smilax

How did they become weeds?

The asparagus weeds listed as WoNS were introduced to Australia from southern and eastern Africa in the mid to late 1800s mainly for ornamental purposes such as hanging baskets and garden plants. Indeed, *A. aethiopicus* is commonly known as basket asparagus, and the flowers and foliage of *A. declinatus* (bridal veil) and *A. asparagoides* (bridal creeper) were commonly used in weddings. While the weedy asparagus species are no longer traded commercially, several species are still likely to be traded among home gardeners and many are still extremely common in gardens.

Due to their ability to easily disperse and establish in many environments, asparagus weeds have spread from gardens into native bushland where they cause major negative impacts.

Management note: Asparagus weeds can be difficult to control because: a) they generally have large underground reserves, and b) several species have fine or waxy foliage that impede herbicide uptake. After control, active restoration may be necessary because root mats can persist and continue to cause impacts long after plants have been killed. Any new outbreaks should be quickly controlled to ensure extensive root mats do not develop.

What do they look like?

Above ground

Most asparagus weeds have wiry, twining stems that can clamber over native vegetation. Some species (e.g. *A. aethiopicus* and *A. africanus*) have sharp spines along these stems. True leaves are reduced to small bracts or scales, while the branches are modified into leaf-like structures known as cladodes. The cladodes (leaves) vary among species, from very fine and needle-like (e.g. *A. declinatus*) to wide, thick leaf-like structures (e.g. *A. asparagoides*). The above ground foliage

Shauna Potter

Needle-like 'leaves' of A. declinatus compared to thick 'leaves' of A. asparagoides

may either dry off each summer or stay alive year round, depending on the species or climatic conditions. For example, the above ground foliage of *A. declinatus* and both forms of bridal creeper generally dies back each summer and re-sprouts the following autumn but, in cool, moist conditions, some plants may retain foliage all year.

Asparagus weeds have small, white or cream coloured flowers. They form fleshy berries that vary in colour depending on the species. Flowering and fruiting times can vary greatly with climate and location. The asparagus weeds described in this manual are bisexual, meaning that the male (stamens) and female (pistils) parts are contained within each flower.

Below ground

All asparagus weeds can form large root masses (rhizomatous roots), which persist year round and can be up to 85% of the plant's biomass. This allows the weeds to withstand harsh conditions, including drought and fire.

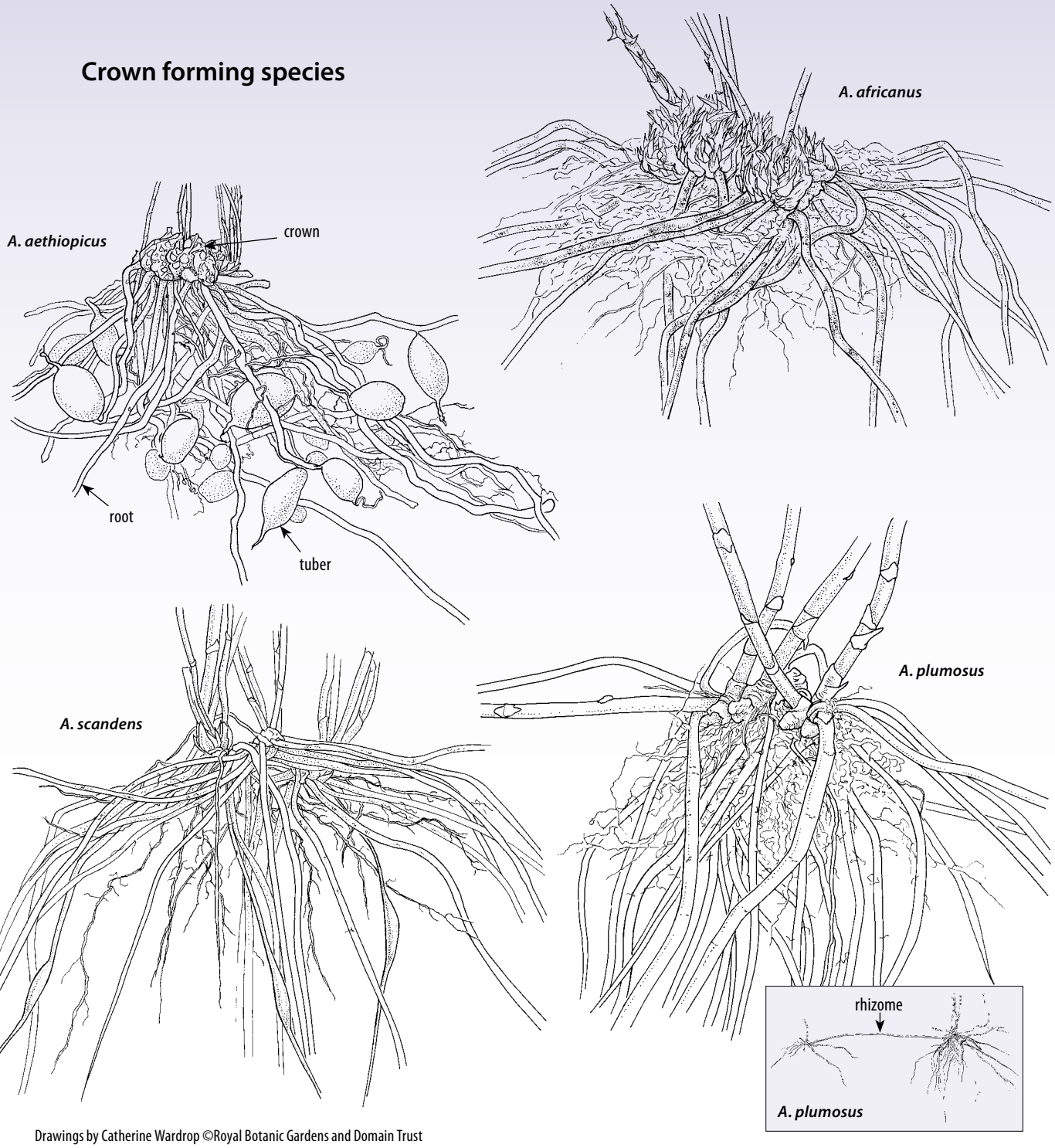
Some species form 'crowns' at the base of the stems, with a root mass radiating out from the crown. Other species form extensive root mats just under the soil surface. Asparagus roots often have many large tubers that act as storage organs to provide plants with nutrients and moisture (see pages 4 and 5 for root description).

Management note: It is important to know what is going on underground in order to plan your management and select the most effective control techniques.

What's going on underground?

Crown	A compressed group of underground rhizomes (stem mass) that forms a central growing point for stems.
Rhizome	An underground stem, growing horizontally, that can vegetatively reproduce by sending out roots and shoots from its nodes. ▪ **Asparagus plants readily re-shoot from rhizomes.**
Roots	Used for nutrient uptake and storage (not reproductive). Often fibrous in asparagus species. Assist in anchoring rhizome and tubers.
Tubers (below ground)	Enlarged structures on roots used to store nutrients. Tubers in *Asparagus* species only act as storage organs and form when sections of the root swell. They can be produced anywhere along the root but do not have growing points (nodes). Tubers store nutrients when plants are dormant, thereby permitting survival from one year to the next. ▪ **Plants can only re-shoot from the rhizomes, not the tubers. But be aware that rhizome fragments can re-shoot.**

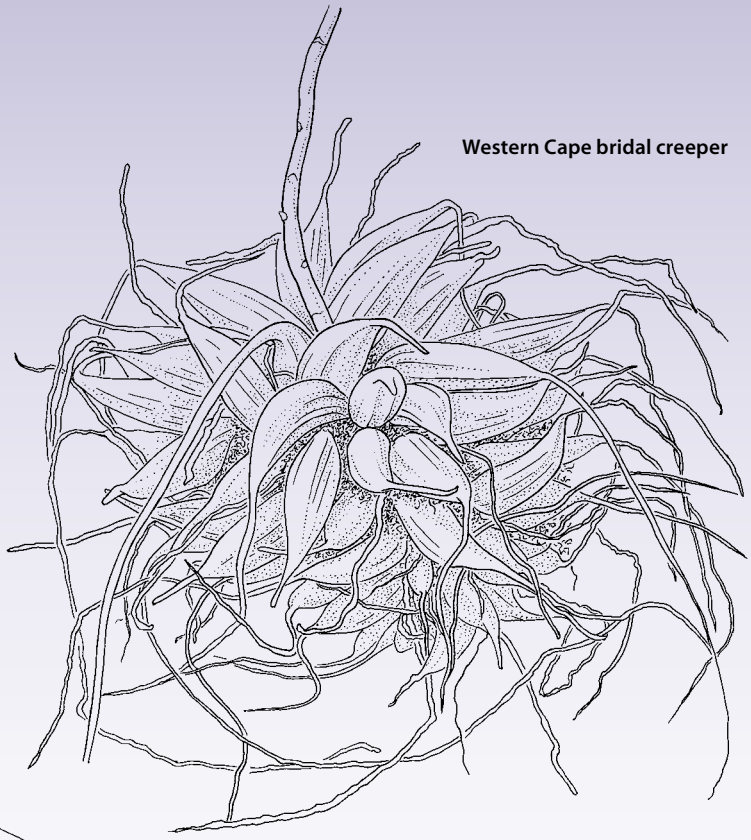
Crown forming species



Drawings by Catherine Wardrop ©Royal Botanic Gardens and Domain Trust

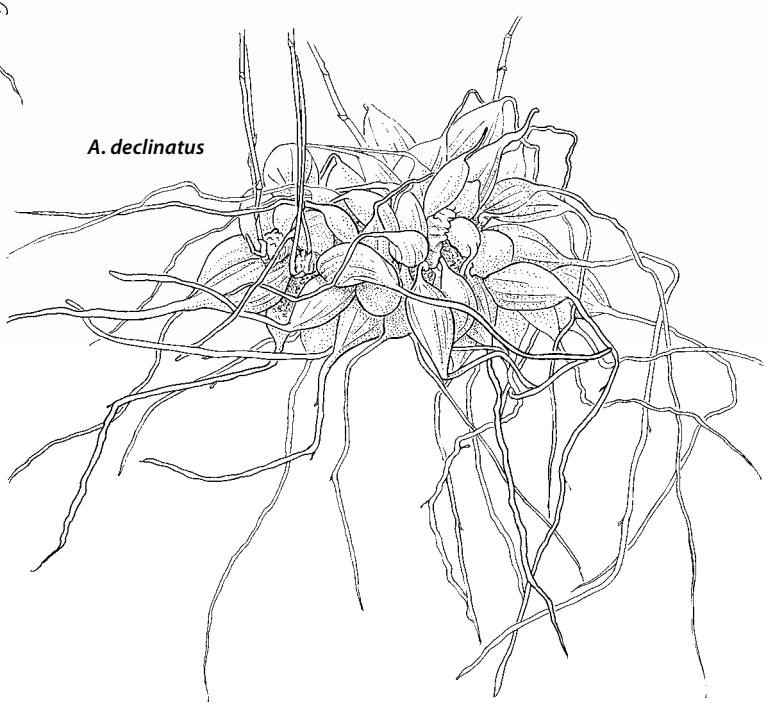
Mat forming species

Western Cape bridal creeper



Common bridal creeper

A. declinatus



Drawings by Catherine Wardrop ©Royal Botanic Gardens and Domain Trust

Identifying asparagus weeds

Distinguishing between five asparagus weeds and Australia's native asparagus

Species	*A. aethiopicus* (ground asparagus)	*A. declinatus* (bridal veil)	*A. scandens* (asparagus fern)
Habit	Perennial, low growing herb with sprawling or arching stems arising from a crown  Hillary Cherry	Creeping or climbing plant up to 3 m tall with annual twining stems and perennial rhizomes and tubers  Shauna Potter	Perennial, low growing herb with twining stems up to 3 m high  Matt Sheehan
Cladodes (leaves) and stems	Flattened with distinct midrib; single or clustered (2–5), up to 20 mm long; no hairs; pale green  Stems up to 2 m long; green to brown, rounded but ridged along length, with many small branches and short sharp spines  Glen Sanders	Needle-like, soft, greyish-green or bluish-green; in groups of 3 along stem, up to 20 mm long Stems with many side branches that bear cladodes giving a fern-like appearance. Stems smooth (no thorns)  Shauna Potter	Lance-shaped, flat with distinct midrib, in groups of 3 and deep green, 5–15 mm long and 0.5–1 mm wide Stems branch in one flat plane. Stems smooth (no thorns)  Glen Sanders
Flowers	Creamy white to pale pink in elongated clusters of 4–8  Ros Shepherd	Greenish white; solitary or in pairs; on short stalks  Glen Sanders	White to pinkish-white; solitary or 2–3 per axil on short stalks  Murray Fagg
Fruits	Glossy berries 5–8 mm in diameter; initially green turning bright red when mature; contain a single black seed 3–4 mm in diameter  Hillary Cherry	Spherical or ovoid berry 8–15 mm in diameter; initially green turning pale bluish-grey or whitish-translucent when mature; contain 2–14 black seeds  Colin Wilson	Fleshy, globular berries 5–7 mm diameter; initially green turning to orange-red when mature; contain one black seed  Shauna Potter
Roots	Dense mat of underground stems (rhizomes) and fleshy tubers scattered along roots; stems arise from a central crown  Hillary Cherry	Dense mat of fibrous rhizomes, with clusters of thick bulb-like ribbed tubers to 6 cm long; stems arise from the length of rhizomes  Kerinne Harvey	Short rhizomes with fibrous roots, often with narrow tubers; stems arise from a small central crown  Biosecurity SA

Species	*A. plumosus* (climbing asparagus fern)	*A. africanus* (climbing asparagus)	*A. racemosus* (native asparagus)
Habit	Perennial climber with stems 5 m or more in length  Ian Hutton	Perennial climber with stems up to 5 m long  Hillary Cherry	A slender, shrub or climbing, perennial vine that can grow up to 4 m long  Sheldon Navie
Cladodes (leaves) and stems	Needle-shaped, fine and thread-like in clusters of ten or more; to 7 mm long, 0.5 mm wide Stems, green to red-brown, spineless or with scattered spines; with twining branches in a flattened plane  Sheldon Navie	Spine-like and cylindrical; in clusters of 6–12, up to 15 mm long; with sharp tips; appears fern-like Stems hairless, often bearing thorns or spines 2–10 mm long; twining and become woody and thick with age   Hillary Cherry	Spine-like and linear; in clusters of 3–6; 10–30 mm long, 0.2–0.5 mm wide Stems slender to 2 cm in diameter; with some curved spines 1–5 mm long   Sheldon Navie
Flowers	Greenish-white; single or paired in axils, along lateral branches	Greenish-white; solitary or in clusters of up to 6, on short stalks  Sheldon Navie	Minute, white flowers on short, spiky stems; single or paired, 4–6 mm in diameter
Fruits	Globular berry 4–5 mm in diameter; initially green turning bluish-black to black with maturity; contain 1–3 black seeds  Sheldon Navie	Globular berry 5–6 mm in diameter; initially green turning orange-red and shrivelled with maturity; contain a black single seed  Sheldon Navie	Globular berry 5–6 mm in diameter; red when mature; contain a single black seed
Roots	Fibrous and fleshy, root swelling but without distinct tubers; with short rhizomes; stems arise from a central crown  Hillary Cherry	Fibrous, fleshy, root swelling but without distinct tubers; with short rhizomes; stems arise from a central crown  Hillary Cherry	Fibrous with long tubers

Biology and threat

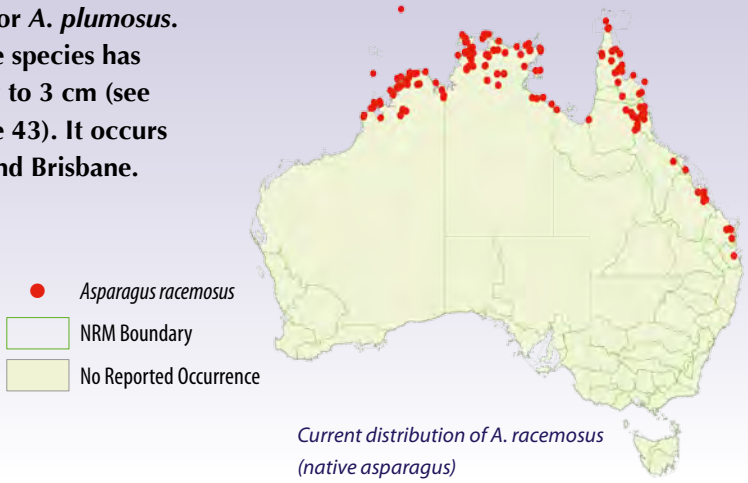
Look out for the native asparagus!

The only *Asparagus* species that is native to Australia is *A. racemosus*. Clear identification between the native and weedy asparagus is imperative because their distribution and habitats can overlap.

***Asparagus racemosus* is a vine or small shrub that can be easily mistaken for *A. africanus* or *A. plumosus*. The key difference is that the native species has longer leaflets (cladodes) that grow to 3 cm (see table on page 7 and photos on page 43). It occurs in northern Australia south to around Brisbane.**

Sheldon Navie

A. racemosus; note long 'leaflets' (cladodes)



Current distribution of A. racemosus (native asparagus)

Distinguishing between common and Western Cape bridal creeper

Common bridal creeper (*Asparagus asparagoides*) is one of southern Australia's worst weeds. It is an aggressive and highly invasive environmental weed that is capable of smothering native ground flora, shrubs and small trees. It forms a thick, tuberous root mass that inhibits growth of other plants and prevents over-storey regeneration. It was generally accepted that the bridal creeper present in Australia originated from a single South African source, but another distinct form of bridal creeper, known as Western Cape bridal creeper, has now been recorded in South Australia (SA) and south-west Victoria (VIC).

This Western Cape form is potentially more damaging than the common form. Western Cape bridal creeper stems and leaves stay alive longer before they naturally dry off in the summer. It also appears resistant to the bridal creeper rust fungus, a biological control agent introduced to help contain and reduce infestations of common bridal creeper.

While taxonomic work is not complete, it is suspected that Western Cape bridal creeper is a different species to common bridal creeper.

Western Cape bridal creeper invades similar habitats to common bridal creeper and can be seen growing alongside the common form. It has the potential to spread into and infest areas where the common form has been controlled.

Important note

It is likely that Western Cape bridal creeper has spread more widely, so land managers should be on the lookout and report suspected infestations to local weed authorities.

Comparing the two forms of bridal creeper

Western Cape bridal creeper looks similar to the common form. Like the common form:

- it is a climbing vine with many twisting stems that can scramble along the ground or climb up to 3 m on supporting vegetation,
- the leaves are broad near the stem and pointed at the tips,
- the stems and leaves grow rapidly during autumn and winter,
- a mass of small, white flowers grow in late winter, followed by green berries in spring that ripen to red,
- as berries ripen, leaves and stems dry off, leaving berries exposed for birds and other animals to eat, and
- large tuberous root system allows the plant to survive the hot, dry summer and regrow after autumn rains.

Compared to the common form, it has larger tubers that grow in a rosette close to the soil surface and larger, darker leaves that are thick, waxy and leathery.

Above ground – leaves and stems

Don't just rely on above ground features for identification, as they can easily be confused with the common form. Dig up the tubers and compare them.

Western Cape bridal creeper

- Larger, flatter and darker green
- Waxy, thick and leathery
- More angular stems
- Resistant to rust fungus (although some rust may appear on leaves but the plant is not impacted)

(NB. technically the leaves are flattened cladodes)

Common form of bridal creeper

- Usually lighter, grass-green
- Soft and shiny
- Less angular stems
- Affected by rust fungus

BUT, in ideal conditions, can look very similar to the Western Cape form; so check the tubers to be sure

Below ground – tubers and roots

Western Cape bridal creeper

- Large, thick tubers (40–75 mm long) arranged in a tight rosette around the rhizomes
- Tubers end in a fine root and grow close to ground surface

Tubers are the best defining characteristic!

Dig them up to be sure you are looking at Western Cape form

Common form of bridal creeper

- Small tubers (to 42 mm long) arranged along branching rhizomes, giving a 'mat-like' appearance
- Tubers do not typically end in a root and usually grow at least 10 cm underground

Biology and threat

Where to find asparagus weeds

How do they spread?

Asparagus weeds are mainly spread by birds and other animals, or by water. They reproduce mostly by seed and many species reach reproductive maturity within the first two years. They can spread long distances as they produce large amounts of fleshy fruit that is readily dispersed by birds and some mammals.

Asparagus weeds can also spread vegetatively by rhizomes. They are spread by humans, who still plant them, transport them unintentionally with machinery or dump them in garden waste. They also often re-sprout following control efforts, so follow-up management is critical.

Where do they grow?

Asparagus weeds tolerate a wide range of soils and climates. Most prefer shady, moist conditions, but they can withstand full sun, drought and impoverished soils. Some asparagus weeds, such as Western Cape bridal creeper, *A. scandens* and *A. declinatus*, can tolerate cold winters and frost. Other species, such as *A. plumosus*, successfully invade both sub-tropical and temperate regions (see maps on pages 11–21).

What impacts do they cause?

Asparagus weed infestations expand quickly due to the rapid growth of root systems, even under harsh conditions, and can form monocultures and displace native plants. Above ground biomass may:

- dominate the ground and shrub layer (e.g. *A. aethiopicus*, *A. scandens*, *A. declinatus*, Western Cape bridal creeper and common bridal creeper) and/or the canopy layer (e.g. *A. africanus*, *A. plumosus*),
- restrict movement of some native animals and thereby reduce their access to food and dens,
- provide harbour for exotic animals, such as foxes and rabbits, and
- alter rates of litter decomposition and nutrient cycling, due to the large amount of foliage shed by some asparagus weeds each summer.

Below the ground, the often impenetrable root mats can:

- impede the growth of native seedlings,
- alter the composition and ultimately reduce the diversity of organisms in the soil and litter, and
- compete for water and nutrients with native plants.

Due to their impacts, asparagus weeds are listed as a Key Threatening Process (KTP) under the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) within the category: 'Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants'.

Paul Lennon

Biology, ecology and impacts of asparagus weeds in Australia

Asparagus aethiopicus

Asparagus aethiopicus is predominantly known as ground asparagus but other common names include basket asparagus, asparagus fern, Sprengeri's fern, bush asparagus and emerald asparagus. It was previously known as *A. densiflorus* 'Myers' in Australia, but this is now considered to be a different species not known to be recorded in Australia (Navie and Adkins 2008). *Asparagus aethiopicus* has also been known as *Protasparagus aethiopicus* (L.) Oberm. and *P. densiflorus* (Kunth) Oberm. Cultivars of *A. aethiopicus* also exist and include 'Sprengeri', 'Meyersii' and 'Variegata'. The cultivar 'Sprengeri' is considered to be the invasive form of *A. aethiopicus* throughout Queensland (QLD). The other cultivars are not known to be naturalised in Australia. More research is required to determine what forms may have naturalised in Australia, and whether cultivars are sterile.

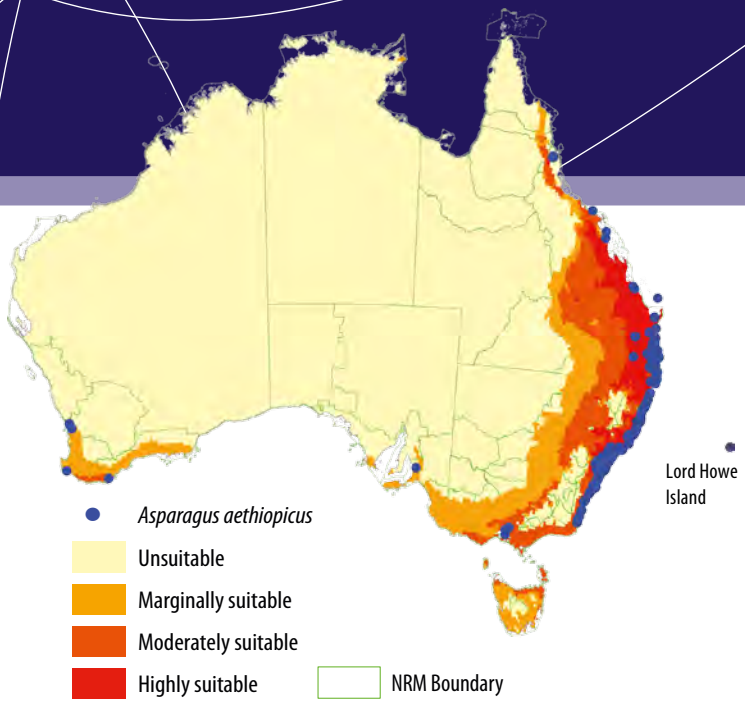
Origin and distribution

Asparagus aethiopicus was introduced to Australia from the Cape Province of South Africa and has been cultivated extensively as an ornamental plant. It has since escaped from gardens to become a major environmental weed in the south and east of Australia (including Lord Howe Island where it was introduced during the 1930s), New Zealand, Hawaii, Caribbean, Europe, parts of North America.

Climate modelling indicates that *A. aethiopicus* has the potential to spread more widely in coastal QLD, and infill coastal areas in New South Wales (NSW) (Scott and Batchelor 2006).

Habitat in Australia

Asparagus aethiopicus occurs in warm coastal regions with rainfall from 500–1500 mm. It is drought tolerant and can survive in hot, dry



Current and potential distribution (Scott and Batchelor 2006) of Asparagus aethiopicus

locations. While frost may damage the foliage, plants are quick to recover from the rhizomes. *Asparagus aethiopicus* occurs in a vast range of native habitats, including coastal headlands and sandy foredunes, littoral rainforests, heathlands, open woodlands, riparian areas and wetlands including estuarine edges, salt marshes and swamps. It can grow in the forks of trees, in birds nest ferns and amongst rocks or leaf-litter.

Environmental impacts

Asparagus aethiopicus creates vigorous thickets of foliage that forms dense spiny mats. It can quickly invade disturbed sites in open sun or partial shade. Plants can form monocultures that smother and displace native herbs and shrubs, and can form impenetrable root mats below the ground that may impede the growth of native seedlings. The above ground biomass can dominate the native ground and shrub layer. Large amounts of below ground biomass may allow the weed to persist in harsh conditions, while enabling strong competition with native species.

In south-eastern QLD, *A. aethiopicus* is ranked among the top 25 most invasive plant species and it is one of the most significant garden escapes invading coastal habitats (Batianoff and Butler 2002). In NSW, it is ranked 4th among 340 of the worst environmental weeds, based on its threat and impact on biodiversity (Downey *et al.* 2010).

Biology and threat

Hillary Cherry

Foredune invasion of Asparagus aethiopicus, Coffs Harbour, NSW

Hillary Cherry

Asparagus aethiopicus fruits and foliage

Biology and ecology

Asparagus aethiopicus is a low growing scrambler with prostrate, prickly stems that grow up to 2 m long, and arise from a central underground crown (cluster of short rhizomes; see page 4). The cladodes (leaves) are flattened and lance-shaped, growing in clusters of 2–5. Plants are perennial, retaining above ground foliage year round. Small, watery tubers form along the roots and act as storage organs, but these tubers are not capable of vegetative reproduction.

Spread is primarily by seed, but vegetative growth also occurs from the short rhizomes that comprise the central crown. Reproductive maturity occurs within the first two years, with staggered flowering occurring across plants from spring to autumn. Timings vary with climatic conditions and soil moisture. Peak fruit production occurs from autumn to winter, but plants may flower and fruit year round in favourable conditions. Seedlings can germinate at any time if water is available, but typically there is a major flush of germination in spring and a smaller one in autumn. Germination rates are higher than several other asparagus weeds (>98%), with a high mean seedling emergence (94.5%) (Vivian-Smith and Gosper 2010).

Although seed dormancy is rare, some seeds may survive for three or more years in the soil. Experiments have shown that seedlings can emerge for up to 1000 days after sowing (Vivian-Smith and Gosper 2010). Seeds are also viable while the fruit is still immature (i.e. green). Plants mature early (approx 1.5 years) and produce large numbers of flowering stems (average of 60 per plant) (Vivian-Smith and Gosper 2010). Under favourable environmental conditions, mature plants can produce a large amount of fruit (up to 600 mature fruits observed on one plant; Bowden and Rogers 1996).

The fruits are relatively large (to 9 mm), attractive and bright red when ripe and have a high mineral content that makes them desirable to animals**.** It is readily dispersed by birds and lizards. Birds help disperse the fruits long distances depositing them in undisturbed vegetation, where they can germinate and grow. *Asparagus aethiopicus* is also dispersed by humans, who spread rhizomes and fruits in dumped garden waste.

These characteristics provide considerable management challenges, such as dealing with rapid germination and emergence following bird dispersal to non-infested sites and its robust, underground storage capacity. In contrast, managers do not need to contend with a long-lived seed bank due to low dormancy in this species.

Seasonal patterns for *Asparagus aethiopicus*

	Summer			Autumn			Winter			Spring		
	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
Flowering	■	■	■	■	▒	▒	▒	▒	▒	■	■	■
Fruiting	▒	▒	▒	■	■	■	■	▒	▒	▒	▒	▒
Germination	■	■	■	■	■	▒	▒	▒	▒	■	■	■

■ Generally present

▒ Present in suitable conditions

Asparagus africanus

Asparagus africanus is most commonly known as climbing asparagus, but is also known as asparagus fern or ornamental asparagus. It was previously called *Protasparagus africanus* (Lam.) Oberm.

Origin and distribution

Asparagus africanus was introduced to Australia as a garden ornamental from southern Africa and has escaped from cultivation to become a major weed of natural vegetation. The earliest naturalised specimens were collected from the Ipswich area, west of Brisbane in the 1940s. The distribution of *A. africanus* extends from central west QLD and along the coast from northern QLD to central NSW. It is particularly common in coastal districts near settlements.

Current distribution of Asparagus africanus

Climate modelling indicates that *A. africanus* could expand its range in coastal regions from far north QLD to southern VIC, as well as coastal areas of SA and south-west Western Australia (WA), although there is low confidence in the current model and further work should be done (Scott and Batchelor 2006).

Habitat in Australia

Asparagus africanus occurs in a range of habitats, but is primarily a weed of sub-tropical to tropical forests, rainforest margins, littoral rainforests, hind dunes, open woodlands, riparian corridors, mangroves, brigalow scrub (*Acacia harpophylla*) and wet eucalypt forests. It also invades urban bushland and roadsides and is commonly found in ecotone areas (the transition area between two plant communities), disturbed bushland, parks and gardens. It is moderately tolerant to drought stress.

Environmental impacts

Asparagus africanus grows quickly and produces dense thickets of foliage that can climb and dominate the canopy layer, smother native herbs and shrubs and form monocultures, which in turn can alter the functioning of the native ecosystem.

Infestations are quick to expand, as the well developed root system enables rapid growth, even under harsh conditions such as drought or impoverished soils. The fibrous roots form dense mats just below the soil surface that may interfere with the germination and seedling survival of native plants (Navie and Adkins 2008).

In south-eastern QLD, *A. africanus* is ranked among the top ten most invasive plants, and extensive infestations of *A. africanus* threaten remnant brigalow scrub (Batianoff and Butler 2002) which is listed (Brigalow – *Acacia harpophylla* dominant and co-dominant) as an endangered ecological community under the EPBC Act.

Biology and ecology

Asparagus africanus is a long-lived climber or scrambling sub-shrub that can form woody stems. The stems grow in a twining fashion and develop large, sharp spines. Stems originate from a basal crown (up to 60 cm in diameter) consisting of short, fleshy rhizomes (see page 4 for root and stem structure). Plants are perennial, retaining above ground foliage year round. Unlike *A. aethiopicus*, the roots do not form distinct tubers but develop

thick swellings along the root structure. The root mass is thick and forms a fibrous mat below the soil.

Mature *A. africanus* plants can produce as many as 21,000 seeds per year and immature fruits can contain viable seed (Stanley 1994). In cultivation, plants reach reproductive maturity at 3–4 years of age (Vivian-Smith and Gosper 2010), but field observations indicate reproductive maturity can occur within 1–2 years. Seed survival is typically up to three years in the soil, but under favourable environmental conditions, seeds can survive longer (Stanley 1994). The round fruit contains a single seed (occasionally two) and fruit production peaks in summer, but fruit can often remain on the plant throughout the year. The fruit turns from green to orange to orange-red as it matures.

Asparagus africanus is readily dispersed by many birds, including silvereyes (*Zosterops lateralis*) and southern figbirds (*Sphecotheres viridis vieilloti*), but is also spread from rhizomes in dumped garden waste (Stanley 1994).

The only *Asparagus* species that is native to Australia is *A. racemosus* and its distribution overlaps with both *A. africanus* and *A. plumosus*.

Clear identification between the native and weedy asparagus species is imperative. See pages 7, 8 and 43 for photos and information on *A. racemosus*.

Kerinne Harvey

Invasion of Asparagus africanus, Tinchi Tamba Wetlands, Brisbane

Sheldon Navie

Asparagus africanus fruits and foliage

Seasonal patterns for *Asparagus africanus*

	Summer			Autumn			Winter			Spring		
	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
Flowering	■	■	■							■	■	■
Fruiting	■	■	■	■	■	■	■	■	■	■	■	■
Germination			■	■	■							

■ Generally present

■ Present in suitable conditions

Asparagus plumosus

Asparagus plumosus is most commonly known as climbing asparagus fern, but is also known as ferny asparagus. Previous scientific names have included *A. plumosus* var. *nanus* Hort. and *Protasparagus plumosus* (Baker) Oberm. It has been incorrectly called *A. setaceus* (Kunth) Jessop.

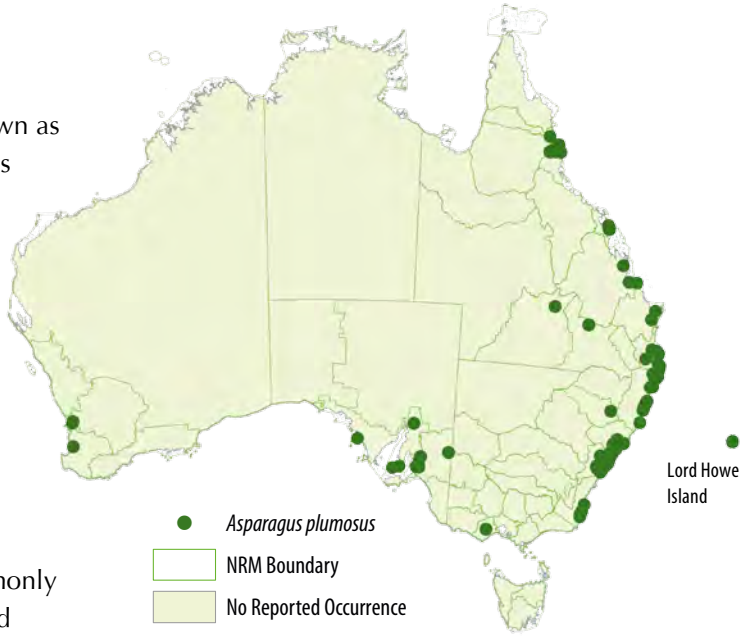
Origin and distribution

Asparagus plumosus is a native of southern and eastern Africa (Kenya, Zambia and South Africa), but is often cultivated elsewhere as an ornamental plant and commonly used in floral arrangements. It has naturalised in the southern United States of America (USA) (California and Florida), Puerto Rico and some Pacific Islands (Hawaii and Tonga). In Australia, it is mainly found in southern and eastern coastal regions, predominantly near major urban areas such as Brisbane, Sydney and Adelaide. It is also naturalised in other parts of NSW, south-west WA, southern VIC, north and central QLD, Lord Howe Island and Norfolk Island.

Climate modelling indicates that it is a potential threat to coastal regions of QLD, potentially extending north to Cape York, although there is low confidence in the current model and further work should be done (Scott and Batchelor 2006).

Habitat in Australia

Asparagus plumosus is found in fertile soils of tropical, sub-tropical and warm temperate region rainforests, littoral rainforests, *Casuarina* forests, forest margins, riparian areas, hind dune forests, urban bushland and open woodlands, generally in areas of 500–1500 mm annual rainfall. *Asparagus plumosus* tolerates low light and moist conditions, allowing it to invade rainforests. It also tolerates sandy soils and saline environments, such as saltmarsh communities. It is commonly found along roadsides and in disturbed sites, parks and gardens. Infestations are often isolated and may be the result of rhizomes spread by garden dumping rather than from seed.



Current distribution of Asparagus plumosus

Environmental impacts

Asparagus plumosus has the potential to significantly alter habitats by dominating and destroying the canopy layer. It can produce large rhizome clusters (crowns) that penetrate deeper into the soil as they grow, making them especially difficult to dig out. These large underground crowns and root systems may alter native regeneration. On Lord Howe Island, invasion of *A. plumosus* is potentially impacting the native habitat of the endangered woodhen (*Gallirallus sylvestris*).

Asparagus plumosus is ranked among the top 60 most invasive environmental weeds in south-east QLD (Batianoff and Butler 2002), where it is a particular concern in dry rainforests (Navie and Adkins 2008). It was also ranked among the top twenty environmental weeds during a survey conducted on the North Coast region of NSW (Navie and Adkins 2008).

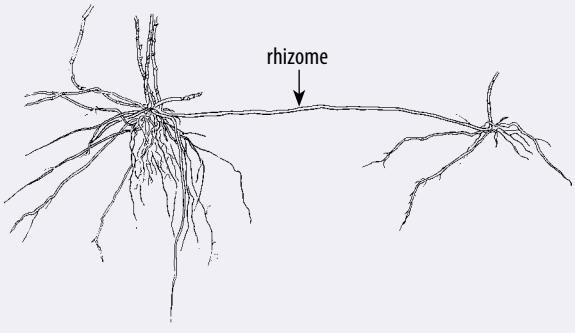
Biology and threat

Biology and ecology

Asparagus plumosus is a twining vine, with green to reddish-brown stems that become woody with age. Stems may have small, sharp recurved spines. Plants are perennial, retaining above ground foliage year round. The fibrous and fleshy roots branch from a rhizomatous crown at the base of stems. The roots do not form distinct tubers but may thicken along the root structure. The branches are arranged in a flat plane and have whorls of tiny, fine rounded cladodes, arranged in tight clusters of 8–15 per whorl, giving the plant a feathery appearance.

The flowers are small and greenish-white and occur singly or in pairs on branchlet tips. Flowers are produced from spring through to early autumn, but plants may not flower in the first year. Reproductive maturity generally occurs after two years and up to four years depending upon light availability. Fruits are black, fleshy berries that ripen from autumn to winter. Seeds germinate from autumn to spring and seedlings develop rapidly.

Seeds are primarily dispersed by birds, but are also spread in water and plants can spread vegetatively by rhizomes in garden refuse.



Drawing by Catherine Wardrop ©Royal Botanic Gardens and Domain Trust

Asparagus plumosus rhizome

Ian Hutton

Invasion of Asparagus plumosus, Lord Howe Island

Sheldon Navie

Asparagus plumosus fruits and foliage

Sheldon Navie

A. plumosus (left) with shorter, finer cladodes and A. africanus (right)

Seasonal patterns for *Asparagus plumosus*

	Summer			Autumn			Winter			Spring		
	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
Flowering	■	■	■	■						■	■	■
Fruiting				■	■	■	■	■	■			
Germination	▒	▒	▒	■	■	■	■	■	■	■	■	■

■ Generally present

▒ Present in suitable conditions

Asparagus scandens

Asparagus scandens is commonly known as asparagus fern, but is also known as climbing asparagus, climbing fern and snakefeather. The previous scientific name was *Myrsiphyllum scandens* (Thunb.) Oberm.

Origin and distribution

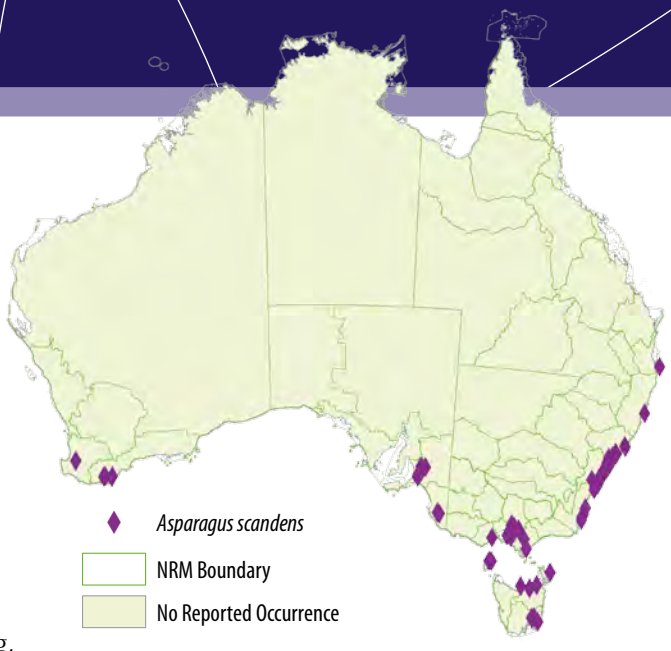
Asparagus scandens was introduced as a garden ornamental from southern Africa. Infestations are widely scattered within Australia but are increasing, particularly in southern VIC. Infestations also occur in northern Tasmania (TAS), SA (with emerging populations in the Adelaide Hills), around Sydney, and isolated infestations in south-west WA, near Denmark and Albany. At least 15 years ago, *A. scandens* was rampant on Lord Howe Island, but it is currently being controlled. It has also naturalised in New Zealand and Central America.

The distribution of *A. scandens* predominantly occurs in areas close to human habitation in Australia. But its invasive ability in climatically similar habitats of New Zealand suggests that *A. scandens* could seriously impact on Australia's biodiversity if not controlled.

Bioclimatic modelling indicates that *A. scandens* may spread north in coastal areas of central and southern QLD and expand across coastal regions of NSW, SA, TAS, VIC and south-west WA (Scott and Batchelor 2006).

Habitat in Australia

Asparagus scandens generally occurs in sub-tropical to temperate, high rainfall regions. It invades shaded woodland, heathland, sclerophyll forest, cool temperate rainforest, riparian and coastal habitats, and disturbed areas. Generally it is found in shady areas, but plants can also establish under moderate light. Plants appear to need moisture all year round and favour riparian habitats, but they can tolerate a range of conditions, from open sites to deep shade and damp to dry forest. *Asparagus scandens* is tolerant of fire and drought and may tolerate frosts. On Flinders Island (TAS) in Bass Strait, it has invaded native riparian habitats. In south-west WA, around Denmark and Albany, infestations occur in *Agonis* and *Banksia* woodlands and riparian areas.



Current distribution of Asparagus scandens

Environmental impacts

Asparagus scandens is a serious environmental weed threat to southern Australia. It is shade tolerant and competes with native plants for water, nutrients and space. The tuberous root system can form dense mats that impede native seedling germination, and the twining stems strangle or smother small seedlings and shrubs.

In New Zealand (NZ), it is the most damaging and widespread of all asparagus weeds. It can strangle or smother soft-barked plants and prevent the regeneration of native plants. On the North Island of NZ, *A. scandens* invades extensive areas of lowland broad-leaved and secondary forests. Following control of large infestations, the large amount of dead root biomass appears to impede the growth of other plants until the root mass decomposes (Timmins and Reid 2000).

In Australia, there is speculation that *A. scandens* may cause impacts on biodiversity similar to those caused by common bridal creeper (Lawrie 2004).

Biology and threat

Movement by humans is a major cause of spread. As a result, infestations are commonly found near towns. However, because *A. scandens* is both shade-tolerant and bird-dispersed, it can invade intact as well as disturbed native forest. Thus seedlings can be hard to find and areas need to be thoroughly searched to enable control (Timmins and Reid 2000). It can also grow as an epiphyte on tree ferns and in tree branch crooks.

Biology and ecology

Asparagus scandens is a creeping or climbing vine with thornless, wiry stems. Plants are perennial, and generally retain above ground foliage year round. The green, delicately-branching stems, that give the plant a fern-like appearance, arise from a crown at the base of stems. The dark green cladodes (leaves) are linear and often slightly curved (sickle-shaped). They occur in groups of three along fine branchlets.

Fibrous underground roots form small thin tubers that are predominantly for water storage. The root system can constitute up to 87–92% of mature plant biomass, allowing the plant to be extremely fire, drought and shade tolerant (Timmins and Reid 2000).

The fruit is a glossy, globe-shaped berry that ripens to orange-red when mature and usually contains one seed. Fruit appear in late spring and can remain on the plant until the following flowering season in wet years. An average of 64 fruit has been found on 1 m lengths of fruiting stems (Timmins and Reid 2000).

Denmark Weed Action Group

Invasion of Asparagus scandens

Shauna Potter

Asparagus scandens fruits and foliage

Reproductive maturity can occur after 12 months. Seedlings germinate from spring through to summer. The seeds are dispersed by birds and are likely dispersed by foxes and rabbits. *Asparagus scandens* is also spread by water and earth moving machinery, mud caught on vehicles and shoes, rhizomes in garden refuse and plant exchange through gardeners.

Seasonal patterns for *Asparagus scandens*

	Summer			Autumn			Winter			Spring		
	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
Flowering						■	■	■	■	■	■	
Fruiting	■	■	■	■	■	■	■	■	■	■	■	■
Germination	■	■	■							■	■	■
Foliage present	■	■	■	■	■	■	■	■	■	■	■	■

■ Generally present

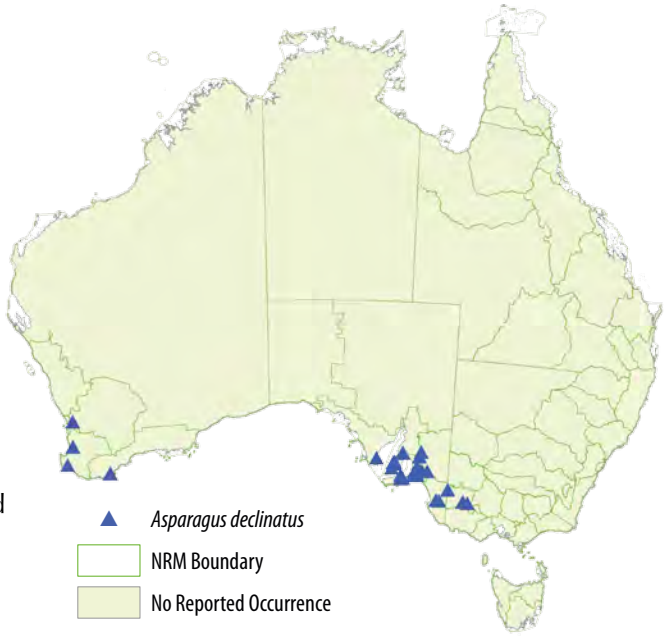
■ Present in suitable conditions

Asparagus declinatus

Asparagus declinatus is most commonly known as bridal veil, but is also referred to as asparagus fern. Previous scientific names include *A. crispus* Lam. and *Myrsiphyllum declinatum* (L.) Oberm.

Origin and distribution

Asparagus declinatus is native to the Western Cape region of South Africa. It has been present as an ornamental garden plant in Australia since 1870 (Pheloung and Scott 1996). Naturalised populations were first recorded on Kangaroo Island South Australia in 1954 (Weidenbach 1994). It has since become a highly invasive and aggressive environmental weed and has naturalised in coastal and inland regions of temperate SA (with severe infestations on Kangaroo Island) and to a very limited extent in south-west WA and VIC.



Current distribution of Asparagus declinatus

Bioclimatic modelling indicates that it has potential to invade across south-west WA and coastal regions SA, VIC and TAS (Scott and Batchelor 2006). Further work is needed to determine the full potential threat of *A. declinatus* as it may have similar invasive ability to bridal creeper.

Habitat in Australia

Asparagus declinatus grows in a wide variety of environments, including exposed rocky outcrops and pine forests to woodlands and coastal habitats. It grows well in shade and open sun and may occur in a variety of soil types, including sandy soils. It has a wide climate range and can tolerate cold winters and frosts, but does not persist in agricultural landscapes because it is grazed by stock.

Environmental impact

Asparagus declinatus biomass can dominate both the ground and shrub layer, leading to the displacement of native vegetation. Infestations can reduce recruitment of over-storey native species and lead to a decline in native groundcover. The dense, underground root mass can reduce regeneration of native species. The long-range dispersal capability of *A. declinatus* contributes to its invasive spread. For example, large frugivorous birds have been found to fly up to 10 km before regurgitating viable seeds, which potentially allows the weed to establish in undisturbed vegetation (Lawrie 2006).

In Australia, there is speculation that A. declinatus may cause impacts on biodiversity similar to those caused by common bridal creeper, as these two species are similar in their morphological and ecological characteristics (Lawrie 2004).

Biology and ecology

Asparagus declinatus is a scrambler, or weak climber, that shoots annually from an extensive rhizomatous, perennial root system. It shares a similar lifecycle and habit to the highly invasive bridal creeper.

Stems are smooth, wiry and twine. Shoots appear in autumn and dense foliage develops in winter. The leaves are densely arranged in whorls of 3 on short, fine branchlets that have a zig-zag pattern. Above ground plant material generally dies back

Biology and threat

Colin Wilson; Hilary Cherry (inset)

Asparagus declinatus fruits and foliage (inset: fruit and seeds)

Tim Parkinson

Invasion of Asparagus declinatus, Newland Hill, South Australia

during the summer and reappears with autumn rains, but in cool and wet areas fruit can stay on the plant through summer. There is little knowledge about its growth rate but it may be similar to bridal creeper.

Underground rhizomes radiate from the base of stems and run throughout the underground root system (see page 5 for root description). These underground rhizomes bear large, bulb-like, ridged tubers. The root mass generally occupies the top 15 cm of soil, though it has been found up to 1 m below the surface in sandy soil. The root mass in mature plants can account for 85% of the total plant mass (Leah 2001).

Flowering occurs from winter to mid-spring. The ovoid fruit is relatively large and begins green but ripens to pale, translucent or bluish-white. Fruits are present from late winter through to midsummer and are most prevalent on low growing (<0.5 m) plants. Fruit production ranges from 100–800 fruits per m^2 (Lawrie 2006) with each fruit usually containing 5–8 (but up to 14) black, round seeds. Under favourable conditions, it can produce up to 4800 seeds per m^2. Research indicates that higher rainfall regions have larger fruit with more seeds than lower rainfall areas (Lawrie 2006).

Dispersal distances may be greater than bridal creeper, as the larger fruit size attracts larger birds that can disperse seeds over a greater distance (i.e. distances up to 10 km). The grey currawong, Australian raven, magpie, red wattlebird and brush wattlebird have been identified as the most important bird dispersers (Bass and Lawrie 2003, Lawrie 2006). Other potential dispersers include brush-tail and ringtail possums, foxes, small rodents and lizards. Dispersal is also aided by water and humans. Humans can spread rhizomes with machinery, through soil disturbance and in dumped garden waste.

Seasonal patterns for *Asparagus declinatus*

	Summer			Autumn			Winter			Spring		
	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
Flowering								■	■	■	■	
Fruiting	▒	▒							■	■	■	■
Germination				■	■	■	■	■	■			
Foliage present	▒	▒	▒	■	■	■	■	■	■	■	■	▒

■ Generally present

▒ Present in suitable conditions

The two forms of bridal creeper (*Asparagus asparagoides*)

Common bridal creeper is widely distributed across southern Australia. Another form has also been recorded in South Australia and south-west Victoria. Both forms originate from South Africa.
In 2003, amateur botanist Kath Alcock of Naracoorte, SA, described and illustrated the Western Cape form of bridal creeper that was first discovered in the south-east of SA (Coles and Willing 2006). Further investigations revealed that this was a Western Cape form of bridal creeper, a form that is highly aggressive and apparently resistant to the bridal creeper rust fungus (*Puccinia myrsiphyllii*), a biological control agent that was introduced to help control the common form of bridal creeper. Western Cape bridal creeper could potentially reinfest vegetation where common bridal creeper has been suppressed by either the rust fungus or other control measures. It is suspected that Western Cape bridal creeper is a different species to common bridal creeper, but the scientific name *A. asparagoides* is currently used for both. Both forms are described below.

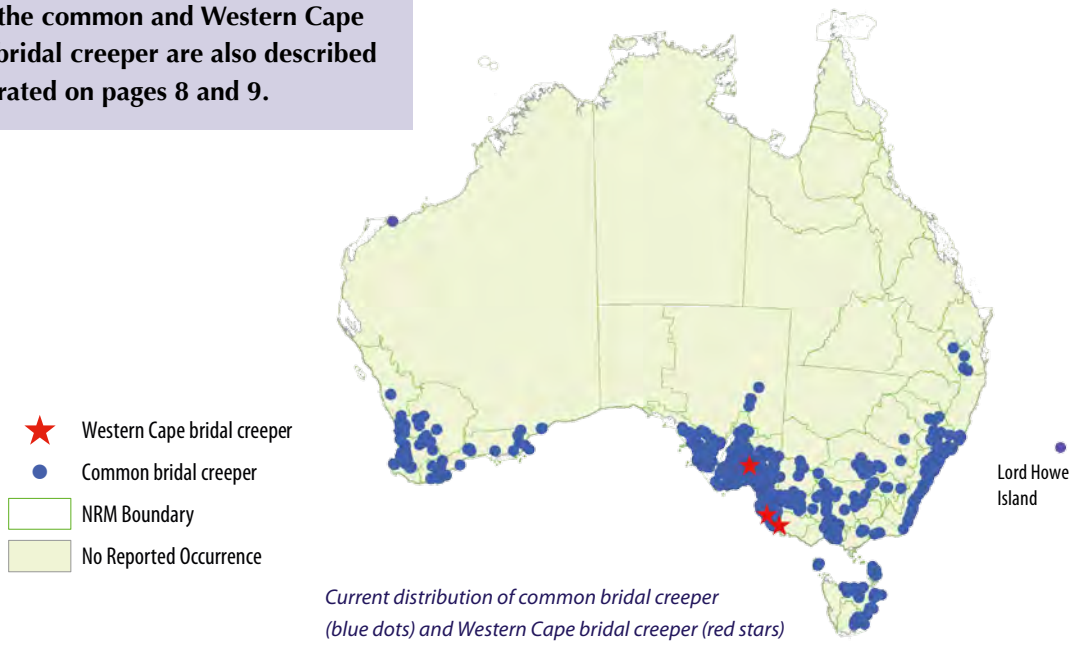
Please note: Distinguishing features between the common and Western Cape forms of bridal creeper are also described and illustrated on pages 8 and 9.

Western Cape bridal creeper (*Asparagus asparagoides* Western Cape form)

Origin and distribution

While little is known about the history of Western Cape bridal creeper it is suspected that it was introduced along with the common bridal creeper as an ornamental. The distribution of the Western Cape form in its native range of South Africa is restricted to the areas of 'winter rainfall' (where <20% of the annual average rainfall occurs between the months of December to February) and summer rainfall regions. Its distribution in southern Australia is climatically similar to its native distribution. In Australia, it currently exists in the 650 mm to 800 mm annual average rainfall regions in the south-east of SA and south-western VIC.

Predictive distribution models based on climatic data from its native range in South Africa indicate that Western Cape bridal creeper can grow along all Australian coastlines with a Mediterranean climate and may reach a similar distribution to the common form (Scott and Batchelor 2006).



Current distribution of common bridal creeper (blue dots) and Western Cape bridal creeper (red stars)

Biology and threat

Incursions of Western Cape bridal creeper in south-west Victoria and south-east South Australia are being contained, and local efforts are underway to eradicate a smaller infestation in the Adelaide Hills.

Habitat in Australia

Western Cape bridal creeper appears to favour higher rainfall regions and coastal areas. It is known to invade native bush corridors, roadsides, nature reserves and pine plantations, and infestations can be found growing among common bridal creeper. New infestations occur under bird perching areas such as tall trees and fence lines. Large numbers of seeds can germinate beneath the climbing plants.

Environmental impacts

Western Cape bridal creeper grows rapidly during autumn and winter and forms dense curtains of foliage that smother other plants. Although infestations are currently not extensive, it has the potential to spread further into most areas where common bridal creeper occurs throughout southern Australia. It can invade undisturbed habitats and is a major threat to most low shrubs and ground plants in mallee, dry sclerophyll forest and heath vegetation. Western Cape bridal creeper has a prolonged survival period over summer after common bridal creeper has died back, thereby demonstrating its vigorous nature compared to the common form.

Biology and ecology

The growth habit of Western Cape bridal creeper is similar to the common form, but more robust. Western Cape bridal creeper is a climbing perennial plant (with annual foliage) that forms multiple twisting stems that climb to 3 m high on supporting vegetation and grow up to 6 m long. Its system of roots, rhizomes and tubers form a thick mat just below the soil surface. The tubers

Shauna Potter

Western Cape bridal creeper (left) growing among common bridal creeper (note rust fungus on common bridal creeper leaves giving them a yellowish appearance)

are different to those of common bridal creeper and are a distinguishing characteristic. They are large (40–75 mm long) and thick, and usually end in a fine root. They are arranged in a tight rosette around the short rhizomes that grow close to the ground surface.

The leaf-like flattened cladodes (leaves) are broad at the base and pointed at the tips. They are a dark blue-green, and leathery with a waxy feel and are thicker and larger than those of common bridal creeper.

When the common form is growing in ideal conditions, seedlings and leaves can appear similar, so it is important to look underground at the tubers to confirm identification.

Tracey Hardwicke

The underground tubers are the best defining characteristic of Western Cape bridal creeper; they grow to 7.5 cm long and form tight rosettes that grow close to the ground surface

Tracey Hardwicke

The leaves of Western Cape bridal creeper are generally larger, thicker and darker than the common form

Shoots appear after the first rains in early autumn. Germination appears to occur in the second winter after seed set, in contrast to common bridal creeper where seeds generally germinate in the first season.

Western Cape bridal creeper flowers two to three years after germination. Initial growth is rapid with white flowers first appearing in winter and fruit first appearing in late September. Berries are red and globe-shaped with three distinct lobes. With berry ripening, leaves yellow and fall, and stems begin to dry out and die back in late spring to early summer, but can survive throughout summer in areas with sufficient summer rainfall and shade. Plants produce thousands of black seeds (about 3.5 mm wide) each year and while viability is not confirmed up to 90% is suspected.

Like common bridal creeper, its main dispersal vectors are birds. Silvereyes, currawongs, black birds, wattle birds and emus readily consume fruits.

It also spreads vegetatively through rhizomes in dumped garden waste onto roadsides and into remnant bushland.

Correct identification is critical. Land managers should be on the lookout for Western Cape bridal creeper and report suspected infestations to local weed authorities.

Vigilance is required from all land managers to ensure that this form of bridal creeper is not growing on their property. Any findings must be reported to your local noxious weed management authority. An eradication program is currently underway in the Adelaide and Mount Lofty Ranges region of SA (see case study on page 95).

Seasonal patterns for Western Cape bridal creeper

	Summer			Autumn			Winter			Spring		
	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
Flowering							■	■	■	■		
Fruiting	■									■	■	■
Germination				■	■	■	■	■	■			
Foliage present	■	■	■	■	■	■	■	■	■	■	■	■

■ Generally present

■ Present in suitable conditions

Biology and threat

Common bridal creeper (*Asparagus asparagoides*)

Asparagus asparagoides is commonly known as bridal creeper. It was previously known as *Myrsiphyllum asparagoides* (L.) Willd., *A. medeoloides* (L.f.) Thunb., *Dracaena medeoloides* L.f., *Medeola asparagoides* L., *Elachanthera sewelliae* F.Muell. and *Luzariaga sewelliae* (F.Muell.) K.Krause. Other common names include bridal veil creeper, florist's smilax, baby smilax and false smilax, but it should not be confused with native plants in the genus *Smilax*.

Biosecurity SA

Infestation of common bridal creeper

Origin and distribution

Bridal creeper comes from a range of climatic regions in southern Africa, including areas with winter, summer and evenly distributed rainfall. It was first recorded in Australia in 1857 in a nursery catalogue and by the 1870s it was a common garden plant. Within 50 years after introduction, bridal creeper had become naturalised and widely distributed throughout southern WA, SA and VIC, with localised infestations in parts of NSW, QLD, Lord Howe Island and TAS. It is also a weed in New Zealand and South America.

Climate modelling indicates that the full extent of its range has not yet been reached. There is a risk of invasion in areas of rainfall greater than 350 mm, including central-northern and far south-eastern coasts of WA, far south-western coast and northern agricultural districts of SA, northern and south-western VIC, central and southern NSW, south-east QLD and northern and eastern TAS (Scott and Batchelor 2006).

Habitat in Australia

Bridal creeper invades a wide range of habitats throughout Australia, including coastal vegetation, wet and dry sclerophyll forests, heathlands, mallee shrublands and river banks. It prefers shaded or part-shaded situations, is found on most soil types and can tolerate a wide range of pH and climatic conditions. It thrives in nutrient-enhanced soils such as along drainage lines. It does not persist in pastures or most cropping situations due to grazing and cultivation.

Environmental impacts

Bridal creeper is very competitive. Its shoots form a dense canopy that shades out native shrubs, herbs and seedlings. The tuberous root mat forms a thick barrier just below the soil surface, which can limit the establishment of native seedlings by restricting access to soil moisture, nutrients, available space and light. This in turn can affect animals that depend on native plants.

Bridal creeper can cause significant economic losses by smothering trees and seedlings in forestry and plantation citrus orchards (Kwong 2006). It further reduces the productivity of orchards by shading trees (e.g. citrus and avocado trees) and interferes with fruit picking.

Bridal creeper is ranked as SA's most damaging environmental weed (Bass and Lawrie 2003).

Biology and ecology

Bridal creeper is a climbing plant with twisting stems that grow up to 3 m long and branch extensively. Plants have soft and shiny, broadly ovate, green leaf-like cladodes (leaves) that are 4–30 mm wide and 10–70 mm long. Leaves

occur alternately along the length of wiry green stems.

Annual shoots emerge in autumn from a perennial root system that consists of extensively branched rhizomes and numerous tubers. These rhizomes and tubers form thick root mats extending 10–20 cm below ground. Tubers range in size from 25 to 40 mm long and 8 to 20 mm wide. The perennial root mats make up at least 87% of the plant biomass and allow the weed to persist year round, withstand disturbance and outcompete native species (Raymond 1996).

Flowers are white and scented. They appear in late winter to early spring. Green pea-sized berries turn pink, then red or burgundy in late spring to early summer, and blacken upon maturity. Berries contain between 1 and 9 seeds. With berry ripening, leaves yellow and fall and stems begin to dry out and die back in late spring or early summer. However, stems can survive year round in areas with sufficient summer rainfall.

Seeds germinate readily under a wide range of environmental conditions (Willis *et al*. 2003). Vegetative reproduction commonly occurs from small sections of below-ground rhizomes. There have been no reports of regeneration from tubers alone but, as the tubers are attached to a rhizome that runs extensively underground, care must be taken to ensure rhizomes are completely removed, if manually removing this plant from the soil. The plant is able to persist mainly by way of the 'bud bank', with numerous shoot buds located along the rhizomes. Over 1000 berries per square metre may be produced. Viable seeds readily germinate from

Hillary Cherry

Common bridal creeper leaves

Biosecurity SA

Common bridal creeper root system

a depth of up to 10 cm and dry seeds can remain viable for at least three years (CRC 2004a).

Bridal creeper is capable of invading undisturbed sites, primarily through fruit-feeding birds (both introduced and native) that eat berries and excrete seeds a long distance away. Common bird dispersers include silvereyes, blackbirds, red wattlebirds, singing honeyeaters, common starlings, little crows, ringneck parrots and emus. Rabbits and foxes also eat fruit and disperse seeds, and berries may be carried by water along watercourses. Other methods of spread include dumping of garden rubbish and machines such as graders along road verges moving soil contaminated by seed or root mass.

Seasonal patterns for common bridal creeper

	Summer			Autumn			Winter			Spring		
	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
Flowering									■	■		
Fruiting											■	■
Germination				■	■	■	■	■	■			
Foliage present	▒	▒	▒	■	■	■	■	■	■	■	■	▒

■ Generally present
▒ Present in suitable conditions

New and emerging asparagus weeds

Species	*Asparagus falcatus* (sicklethorn)	*Asparagus retrofractus* (Ming asparagus fern)
Other names	*Protasparagus falcatus* (L.) Oberm.	*A. macowanii* Baker (pom pom asparagus or zig-zag asparagus)
Origin	Eastern and southern Africa	Southern Africa
Habit	Robust climber up to 6 m; capable of attaining large crown size (>300 mm diameter)  Sheldon Navie	Shrubby plant growing 1–2 m and occasionally 3 m tall  Sheldon Navie
Cladodes (leaves) and stems	Year round foliage; sickle-shape, shiny, dark green, elongated cladodes 30–60 mm long, 3–5 mm wide; stems with thorns that become woody with age  Sheldon Navie	Year round foliage; needle-like cladodes 7–45 mm long and produced in clusters of 20–30 along the stems; older stems are light grey and bear small spines  Sheldon Navie
Flowers	Small white flower clusters on elongated stalks  Sheldon Navie	Small, white or cream; dense clusters produced in large numbers on short stalks  Sheldon Navie
Fruits	Red rounded berry  Matt Sheehan	Rounded berries, initially green turning purple to pinkish-red or with bluish bloom to black as they mature  Matt Sheehan
Roots	Form swollen tubers	Form fleshy, tuberous roots  Glen Sanders
Current known distribution	Recorded in Sydney and Wyong region at Lake Cathie, Sancrox and Port Macquarie in NSW; growing in Littoral Rainforest, Wet Sclerophyll, Swamp Oak and Subtropical Rainforest ecological community types	Recorded in the Moreton and Wide Bay districts in south-eastern QLD, Coochiemudlo Island, Greenslopes and St Lucia in Brisbane and on the margins of a dry rainforest near Gympie; also observed growing in bushland at Ashgrove, Rochedale, Riverhills and Mount Coot-tha
Status and spread	Emerging environmental weed in south-eastern QLD and NSW coastal areas; spread by birds and other animals that eat its fruit	Emerging threat in south-eastern QLD in urban bushland and along waterways; often cultivated as a garden ornamental and spread by birds and other animals that eat its fruit
Habitat	Prefers moist, semi-shaded growing conditions; common in riparian areas near human habitation; can germinate in conditions from full sun to rainforest with >80% canopy closure	Potential weed of riparian vegetation, forest margins, open woodlands, urban bushland, coastal environs, roadsides and disturbed sites; most commonly found in the understorey of drier forests

Species	*Asparagus officinalis* (garden asparagus)	*Asparagus virgatus*
Other names	(edible asparagus)	*Protoasparagus virgatus* Baker (Oberm.)
Origin	Native to northern Africa, Europe, western Asia and Mongolia	Native to eastern and southern Africa and the Arabian Peninsula
Habit	Erect or scrambling multi-branched perennial herb to 1.5 m high  Rob Richardson	Erect herb, climber or shrub 0.4–0.8 m high; can attain very large and continuous infestations  Sheldon Navie
Cladodes (leaves) and stems	Foliage dies back annually; cladodes are fine and cylindrical, 5–30 mm long and 0.5–1 mm wide with a few in each axil  Rob Richardson	Year round foliage; cladodes and branches spirally arranged with 3–6 cladodes in each axil; each cladode 6–20 mm long and 0.5–1 mm wide, slightly tapering and hairless  Sheldon Navie
Flowers	Greenish-white and solitary in axils; spring to summer flowering  Rob Richardson	Greenish-white and solitary in axils; spring flowering  Sheldon Navie
Fruits	Globular berries to 10 mm diameter, red when mature; contain 1–9 seeds  Rob Richardson	Egg shaped berries, 4–6 mm diameter, bright orange when mature; contain 1 seed  Sheldon Navie
Roots	Form dense mat of rhizomes that arise from crowns	Fibrous forms an extensive rhizomatous root mass  Peter Michael
Current known distribution	Occasionally naturalised in southern and eastern Australia (i.e. in south-eastern QLD, eastern NSW, ACT, VIC, TAS, south-eastern SA and south-western WA); problematic in riparian areas	Naturalised in some parts of coastal and sub-coastal districts of south-eastern QLD and less common in the coastal districts of central NSW
Status and spread	Commonly grown vegetable plant that escapes cultivation and is an emerging weed of disturbed sites, wetlands and watercourses; an environmental weed in VIC and a potential environmental weed in WA, NSW, ACT, TAS and SA; spread by birds and rhizomes	Regarded as a minor environmental weed in eastern QLD and as a sleeper weed or potential weed in other parts of Australia (e.g. in north-eastern NSW); spread by birds and other animals that eat its fruit
Habitat	Occurs in disturbed areas and on roadsides and riverbanks and other wet areas; widely cultivated	Mainly found in riparian areas and near forest margins, or in disturbed sites near human habitation; can germinate in conditions from full sun to rainforest with >80% canopy closure

Other non-native *Asparagus* species to look out for and eradicate

The *Asparagus* species outlined in the previous table are emerging weeds in Australia. They are all naturalised in limited areas of Australia but have the potential to spread much further and negatively impact on a range of environments. If detected, these species should be immediately targeted for control, thereby reducing their chance of becoming major weeds in future.

We do not currently know the full distribution of these new and emerging asparagus weeds. If you see any of these species, they should be reported and targeted for eradication, if possible.

Emerging asparagus weed species *A. falcatus* and *A. virgatus*

Asparagus falcatus (sicklethorn) and *A. virgatus* are two emerging asparagus species in Australia that could become widespread weeds if they are not detected and controlled immediately. Both species can germinate in conditions from full sun to more than 80% canopy closure and can infest a range of coastal environments. Port Macquarie-Hastings Council in New South Wales is currently managing infestations of these weeds (see case study on page 106).

Sheldon Navie

Asparagus falcatus flowering

Peter Michael

Asparagus falcatus

Sheldon Navie

Asparagus retrofractus invasion

Sheldon Navie

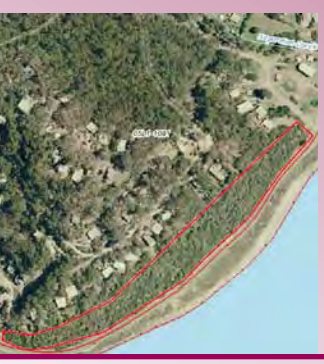
Asparagus virgatus invasion

Peter Michael

Asparagus virgatus

Section 2

Planning and pre-control considerations



Planning and pre-control considerations

Plan before you control

Good weed management is about good land management and, as with most management efforts, planning plays an important part. You may be tempted to 'jump straight in', but it is critical to plan your weed management program thoroughly before undertaking control activities. A well thought out plan that takes a strategic approach can:

- make weed management tasks easier and more achievable,
- help reduce the damage done by weeds or weed management activities,
- prevent re-invasion in the long-term, and
- save time, effort and money now and into the future.

Weed management is a long-term exercise, so the most systematic and effective way to deal with a weed problem is to create and implement a plan. Developing and following a weed management plan is important because:

- it will be an essential information and communication tool,
- data that is gathered will form the basis for informed decision making and adaptive management,
- it will help prioritise the use of limited resources,
- it will help identify the best means of control and, in turn,
- it will increase your chances of successfully managing the weed problem in the most effective way.

This section discusses some of the main issues that need to be considered when developing a management plan for your site. It includes information on where to start and a management checklist.

This information is based on the 'Introductory Weed Management Manual' published by the Cooperative Research Centre (CRC) for Australian Weed Management (2004b), which is available for internet download from www.environment.gov.au.

This manual is not the sole source of information and other texts should be referred to where appropriate.

Asparagus weed management plans should be:

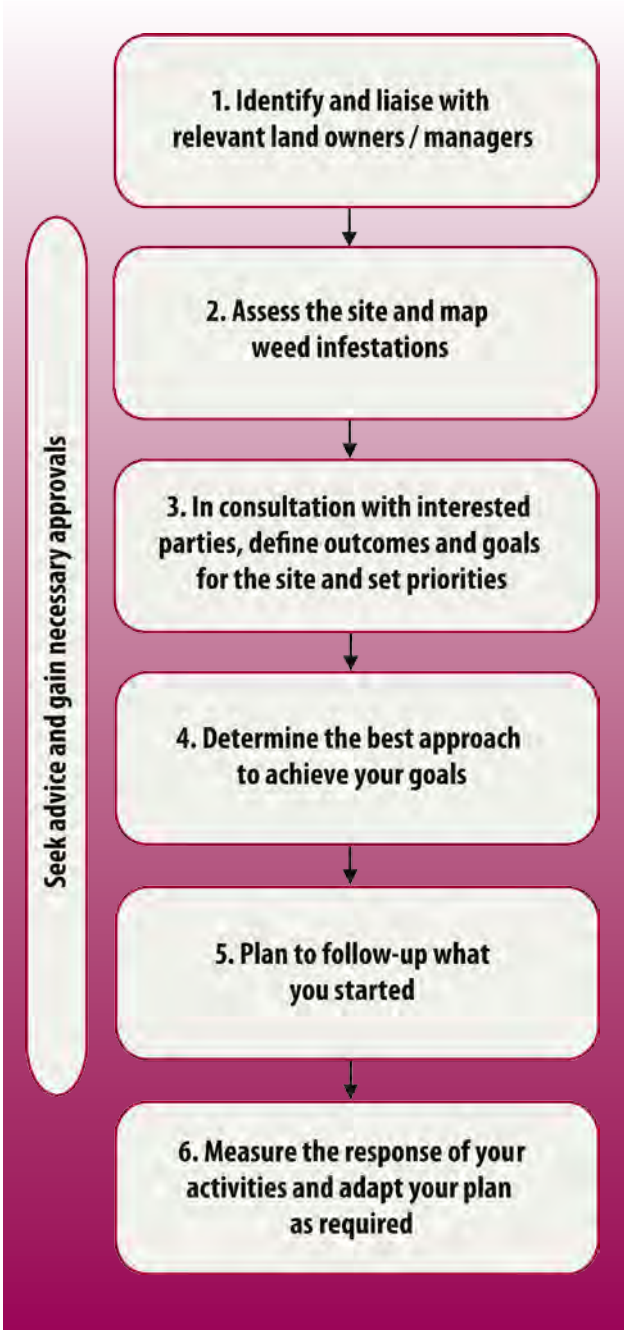
- ☑ Targeted to achieve both long-term and short-term objectives.
- ☑ Able to respond to changes in the environment (e.g. fires, storms and other weeds).
- ☑ Based on immediate site conditions with respect to the broader landscape (e.g. neighbouring weed and native populations and how they may affect your program).
- ☑ Consistent with existing strategies and plans.
- ☑ Informed by work already occurring in the community or region.
- ☑ Equipped with monitoring actions.

The planning process

Where to start

- **If you are concerned about asparagus weeds on public land in your area,** contact either the council or local parks office and discuss with them how to become involved. They may already be doing valuable work in your area, or there may be an active community group you can join. If not, and you obtain an agreement to start work at a new site on public land, your planning process should follow the flow chart and checklist of steps to develop a weed management plan below.
- **If you are a private landholder or custodian of public lands and want to start work on asparagus weeds,** you should also use the flow chart and checklist of steps below. In addition, it is important to talk with other landholders, custodians or groups working on asparagus weeds in your area to see what they have done and if you can complement existing programs.
- **If you become involved with an existing asparagus control program,** there should already be a plan in place, so the planning process outlined here is only for information purposes. If there is not a plan in place then you should discuss with the program leader the need for a plan using the flow chart and steps shown.
- **If your site contains threatened species,** you should contact the relevant threatened species officer in your state or territory. Please refer to Section 7 – Further Information for contact details.

Planning flow chart



Checklist of steps to develop a weed management plan

1. *Identify and liaise with relevant land owners or managers*

Permission is required to undertake activities on other peoples' land and weed management across multiple tenures may be required. Partnerships and cooperation across areas to be managed are a foundational component of strategic weed management efforts.

2. *Assess the site and map weed infestations*

The first step in any weed control activities is to identify areas for control and to prioritise areas that require treatment first.

To simplify this task, prepare a site information sheet (see Appendix 1 Site plan template in bitou bush management manual, Winkler *et al.* 2008) and weed management map (page 33). This will allow you to:

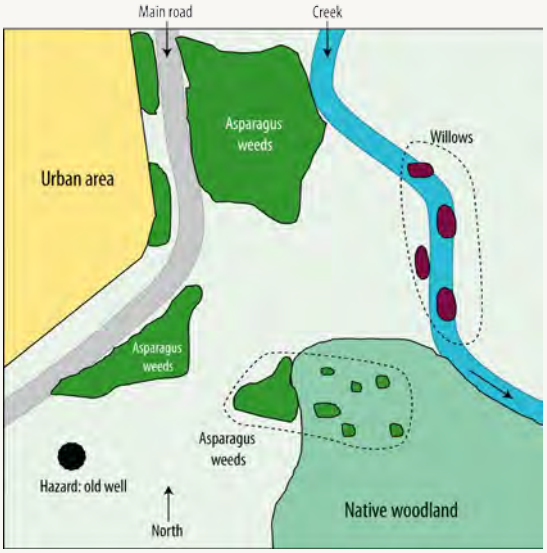
- ☑ **Identify and prioritise weeds on-site.** Often there are multiple weeds to deal with and it is important to assess their likely levels of impact and risk. Some weeds may not warrant control in the short-term, while others may require urgent attention.
- ☑ **Determine the extent of weed invasion.** This will help assess whether you can eradicate, contain or reduce impacts (see inset boxes 'Prevention', 'Eradication', 'Containment' and 'Asset-based protection' on pages 34–36).
- ☑ **Identify risks – deal with geomorphology first for long-term site stability.** This extends to dealing with risks associated with safety and access (steep or uneven terrain). Perform a safety assessment for your group and neighbouring residents.
- ☑ **Identify and record assets.** For example, the presence of animals and threatened plant species, sites consisting of geological and biological features that are highly sensitive to change (e.g. karst environments) and or cultural heritage sites. A valuable resource to consider is Ask First: a guide to respecting Indigenous heritage places and values (available at www.environment.gov.au). Also see Section 7 – Further Information.
- ☑ **Determine land-use and or management history.** Who are the stakeholders involved and are there historical factors that may influence management (e.g. recent fire, disturbance events, any recent revegetation or restoration works)? Mark these sites on your maps.
- ☑ **Research the target weed/s** to understand why the weeds are present and when they flower and set seed, as well as other weeds that may become problematic.
- ☑ **Allocate time and funds** extending to and including follow-up management.
- ☑ **Monitor the effectiveness of control outcomes** by having a baseline of where you started.


P. Watton

Identify risks, such as safety and access

Developing a weed management map

A local map of your site is a critical component of your plan and is the basis for recording information for your site assessment. It forms the basis for planning all control activities as it shows where control areas and significant environmental and cultural sites are located and sets the boundaries for your site. Your map can effectively demonstrate changes in weed location and density over time. Topographic maps or aerial photographs are a good basis to create a basic weed management map. Alternatively, for small sites, develop a mud map.



Example mud map with weed infestations and items of interest

When to map? The targeted weed species will determine the best time to map. For example, mapping of bridal creeper and *A. declinatus* during the mid-summer is ineffective as the foliage dies back during this period. Mapping of these species is best done during mid-winter to mid-spring when growth is vigorous. Other asparagus weeds may be mapped as late as mid-summer if there has been sufficient rain. For smaller weeds that are hard to distinguish, mapping is best done when they are in flower or fruit or at other distinctive life cycle stages.

See case study on page 39 about how Conserv-Action Environmental Services has used mapping to help improve their approach to management.

3. *In consultation with interested parties, define outcomes and goals for the site and set priorities*

Through your site assessment you can now determine your priorities and develop objectives and actions to address them. For example, what do you want to achieve? Is it to restore vegetation to original condition, eradicate a weed, prevent spread, contain a weed infestation, close canopy gaps or determine whether a site is worth investing in?

- Eradication and containment programs – are 'weed led' programs that focus management towards specific weed threats. High priority should be given to new infestations and isolated patches that have not set fruit or seed (to prevent dispersal).
- Asset-based protection programs – focus control of widespread weeds in areas of highest conservation value (those that contain threatened species) or for assets at immediate risk, and where success is most likely achieved. They adopt a 'site led' approach to management that requires a staged approach, guided by site-specific plans. To effectively protect the asset, it is still worth incorporating a weed-led component that considers and manages, where possible, the most likely weed sources. Consult experts (see Section 7 – Further Information).

Prevention, eradication, containment or asset protection can be in response to a specific or local situation, or used to describe broader weed management at a regional, state or national scale (see boxes below). Your intended outcomes should consider different scales of management and where your site fits within broader plans. Different weed management strategies and legislation can be applied to each of these approaches depending upon the situation. For example, see the WoNS asparagus weeds strategic plan that is endorsed by all states and territories www.weeds.org.au/WoNS/asparagusweeds/.

Who to talk to

People that you can consult or talk to about your site intentions include:

- Local council officers (weeds, bushland, biodiversity or environmental).
- Community Support Officers (CMA / NRM).
- Local Aboriginal communities.
- Local and regional community groups, including Landcare, Bushcare or Coastcare groups.
- Local weeds authority or biosecurity officers.
- National Parks rangers.

Some contact details can be obtained from Section 7 – Further Information.

What to aim for? Prevention, eradication, containment or asset-based protection

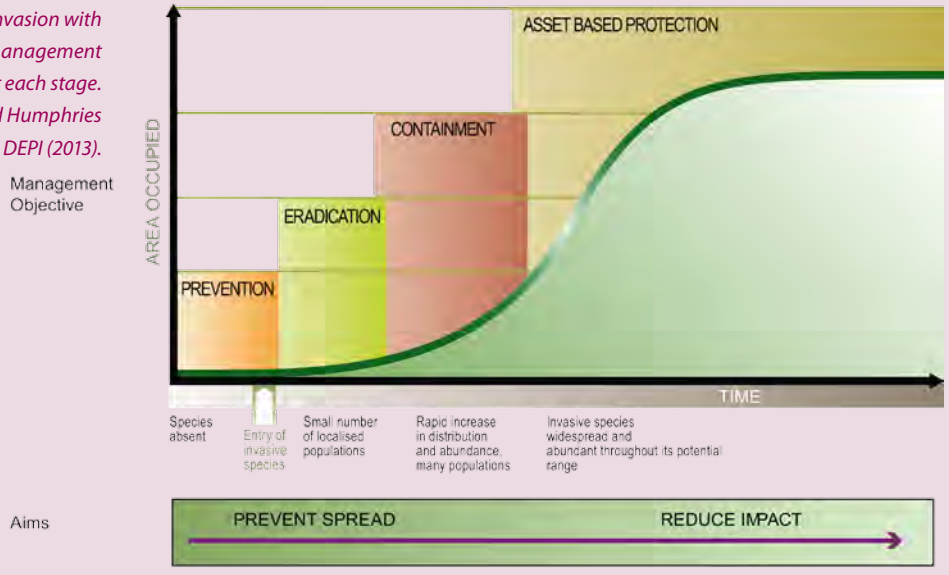
Prevention

Aims to prevent new weeds from establishing in your site (see Table 1 Summary of current legislation status for asparagus weeds on page 110). At site level, prevention of asparagus weed infestations is achieved through:

- Assessing areas on a regular basis that are free from infestation but at a high risk of asparagus invasion.
- Controlling potential vectors such as foxes or stock if they have access to bushland.
- Treating isolated plants if found and before they set fruit.
- Thoroughly inspecting and cleaning machinery and vehicles if they have been used in known infestations before moving them to other locations.
- Raising awareness and ability to identify new asparagus weeds.
- Directing people to report any discoveries to an authorised officer who can assist with mapping the infestations and identifying control options.

Prevention and early intervention provides a high return on investment.

Stages of weed invasion with corresponding goals, management objectives and actions at each stage. Modified from Hobbs and Humphries (1995) and DEPI (2013).



Eradication

Aims to eliminate all plants and seeds from an area where there is limited or no potential for re-invasion. Eradication of weed infestations should only be adopted after due consideration of whether the outcome is achievable. Generally, eradication is only possible when:

- The weed is in the early stages of establishment.
- The distribution and abundance is low across the general area.
- All infested areas are known.
- The chance of re-invasion from adjacent areas is unlikely.
- Infestations can be detected before plants set fruit.
- There is low potential for a persistent soil-stored seed bank, and newly emerged plants are detected before seeds are released.
- Resources are ample for regular survey, control and ongoing management.

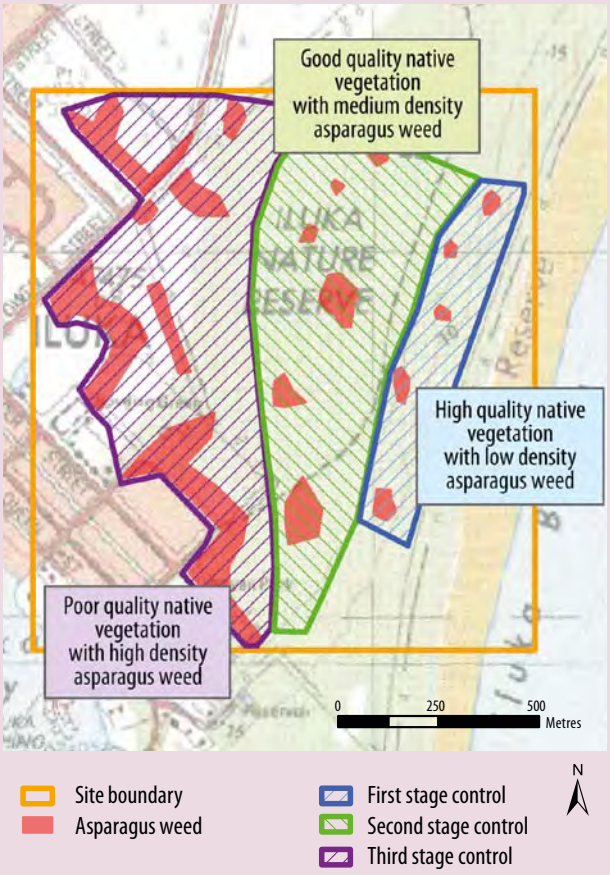
Note: Although asparagus weeds do not have a long-lived seed bank, dispersal of asparagus weeds by birds and some mammals presents a considerable management challenge (e.g. some birds can spread seeds up to 10 km). Early detection of newly emerged populations is as important as post control site monitoring.

Containment

Aims to prevent the further spread of a high-risk weed that cannot be eradicated. Containment involves the management of outlying or satellite infestations and prevents the spread of the weed species beyond the boundaries of core infestations that are deemed too large and well established to eradicate.

Regeneration of native plants in adjacent bushland helps maintain containment lines. Where core infestations occur, work from the edges of the infestation toward the middle, allowing native plant establishment to determine the rate of weed removal.

Unlike eradication, the costs of containment will continue indefinitely. The possibility of long distance dispersal via birds is high, thus land managers will need to work together to maintain containment lines. Containment programs require an accurate knowledge of the boundaries of current infestations. See case study on page 39 to read about a containment program for *A. scandens*.

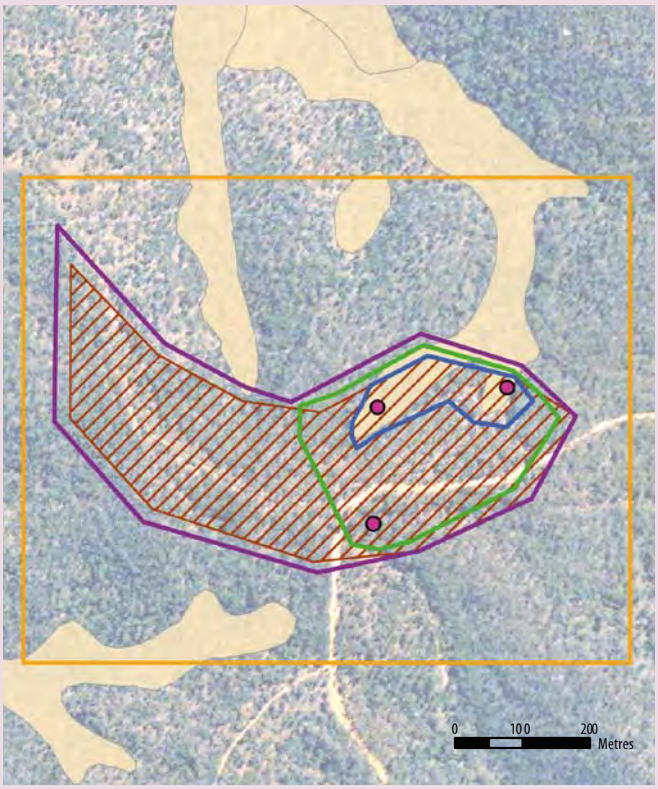


Site management map for containment-based control

Asset-based protection

Aims to reduce the adverse effects of a widespread invasive weed by achieving protection and restoration outcomes for highly valued assets. Management within core infestations may include the protection of high value assets and site regeneration (i.e. to safeguard an asset under immediate impact).

Asset-based management is targeted at invasive species when they have become so widespread that eradication and containment lines would not be feasible. Assets may be defined as biophysical or physical elements of the environment you are trying to protect (i.e. environmental, primary production or community – human health or cultural). Assets can be prioritised at the state, regional or sub-regional level (e.g. threatened species populations, endangered ecological communities) or on a site basis. Protecting specific assets requires using a staged approach to control whereby you work outwards from an asset as opposed to working from outliers to stop spread (see Bitou Bush Management Manual available at www.weeds.org.au/wons/bitoubush).



Site management map for asset-based control

Note: Obtaining a high degree of support from stakeholders is a prerequisite to the success of any long-term containment or asset-based protection program.

4. Determine the best approach to achieve your goals

Determine the best asparagus weed control methods for your site by assessing:

☑ **Need for integrated control methods.** Often the most successful and cost-effective approach to controlling weeds is to combine or integrate several control methods over time (termed 'integrated weed management'). A variety of methods can be used to target vulnerable aspects of a weed, its lifecycle or its environment. For example, mature plants may be treated with herbicide, while subsequent seedling germination may be controlled by hand pulling. Integrated control can:

- reduce the impact of control on the surrounding vegetation (see Iluka Nature Reserve case study on page 93),

- reduce the chance that weeds will adapt to control techniques (e.g. build up resistance to a herbicide), and
- achieve successful weed management using limited resources in the most effective way.

☑ **What 'assets' are found at your site.** For asset protection programs, is there a weed control method available with minimal adverse impacts on the asset that you are aiming to protect (e.g. minimising off-target damage)? Are there other important assets, such as threatened species, that your management may impact?

☑ **The impact of weed removal.** Are the native plants resilient and is regeneration likely, or is there a possibility of other high impact weeds replacing asparagus weeds once they are controlled? Some major weeds that may invade after asparagus weed control are listed in Section 4. If restoration is required (see Section 5), plan for this at the outset to ensure resources will be available.

☑ **Whether you need cooperation from several landholders.** Weeds do not recognise property boundaries. There may be socioeconomic factors that may affect weed management. Communication with adjacent landholders will help align landscape priorities.

☑ **Whether control methods can be applied to more than one type of weed?** See Section 4 – Holistic Management.

☑ **What is causing the problem and can you manage this cause?** For example, asparagus weeds can be spread by birds and other animals or by humans, who still plant them, transport them unintentionally with machinery or dump them in garden waste.

☑ **What are your resources?** Do you have the skilled personnel, funds (or financial plan) and equipment needed to complete the work? See Section 6 – Case Studies for examples on how different groups and organisations have balanced their resources and or sought additional resources.

☑ **Establish your long-term plan.** Schedule a control plan that is at least 3 years, but longer if possible, that includes follow-up activities (see Section 3 – Control) and time for monitoring.

Andrew Storrie

Glory lily (Gloriosa superba)

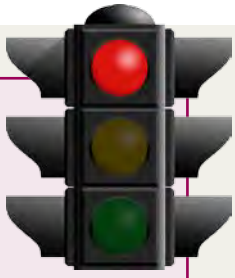
Hillary Cherry

Bitou bush (Chrysanthemoides monilifera)

5. *Plan to follow-up what you started*

Is your management adhering to your priorities and goals? The key to successful control is a commitment to an appropriate follow-up control program. Follow-up is essential because:

- soil-stored asparagus seeds may continue to germinate for another 2–3 years, or longer,
- seeds or rhizomes may continue to spread in from other areas and form new plants, and
- large, dense infestations may take many years to contain.



CAUTION! An often-made mistake is to conduct initial control activities across too large an area for follow-up monitoring and control to realistically be maintained. It can take a minimum of 3 years and more than 5 years at some sites to successfully control asparagus weed infestations. It is important to remember that:

- **Several applications of herbicides may be required to completely kill the rhizomes in some asparagus weeds.**
- **It can also take many years for plants to be removed by hand grubbing.**
- **Biological control agents are very long-term measures that will only ever suppress the weed, so they must be integrated with other management techniques if long-term control is to be achieved.**
- **Potential ongoing reinfestation through bird dispersal from neighbouring, untreated infestations needs to be considered.**

You may need to stop plants from flowering in nearby areas to prevent their spread into your controlled site. This effort may need to be maintained over a long period, until you have the resources to control these nearby infestations.

Early detection of newly emerged populations is as important as post control site monitoring in **eradication and containment programs**.

For **asset-based protection programs,** a staged approach to management is required and promoted by site led management plans to reduce the impact of **all** weeds on highly valued specific site assets.

6. *Measure the response to your activities and adapt your plan as required*

Establish a monitoring and evaluation program (refer to Section 5 – Follow up, Restoration and Monitoring). Monitoring is an essential component of any weed management program and sufficient resources need to be incorporated as a part of your control program. Monitoring allows you to:

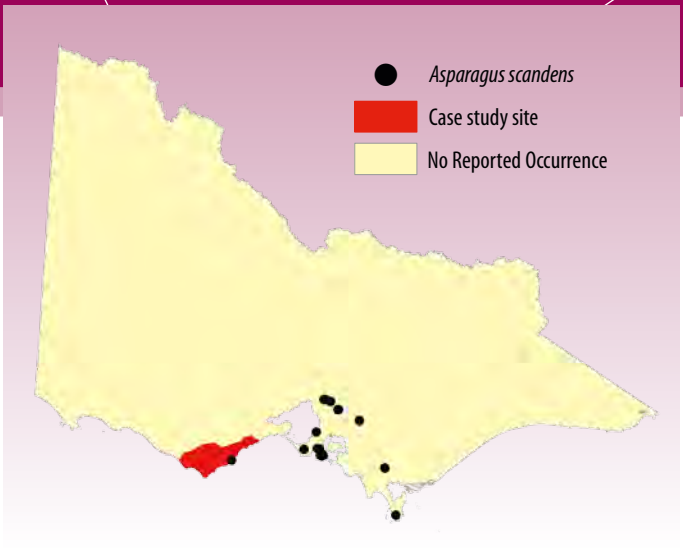
- ☑ Assess the effectiveness of your control program.
- ☑ Assess the rate of establishment of native regeneration if applicable.
- ☑ Identify any new weed infestations or issues that may affect the success of your control program.
- ☑ Demonstrate progress to your group or funding body.
- ☑ Raise awareness for group momentum and general public education.

Andrew Meiklejon

Monitoring A. africanus before control

Andrew Meiklejon

Monitoring A. africanus after control



Case study

Mapping and containing *Asparagus scandens* in a difficult to access environment

Robert Hanna, Conserv-Action Environmental Services

Parks Victoria engaged Conserv-Action Environmental Services to control *Asparagus scandens* among blue and manna gum forest in the Great Otway National Park at Wye River. Parks Victoria is providing funding to tackle *A. scandens* at this site through the Otway Eden pest plant project. The moist mild climate, solid overhead canopy and abundant vertical structure are ideal conditions for *A. scandens* to thrive.

Asparagus scandens infestations were so dense and the ground so steep that Robert and his team initially experienced difficulty penetrating the infestation to estimate its extent, let alone accessing it to conduct control. After several seasons of attempting to control the weed with limited results, they observed that the drier, more open forest acted as a natural barrier to *A. scandens*, which prefers moist, shaded areas to grow. This allowed them to access infestations through open forest areas, establish its extent and map it onto an aerial photograph using GPS coordinates, which showed the infestation covered about 8 hectares. Once they were able to access and map the infestation, they then developed an effective control plan to tackle the infestation 'from the outside in'. Conserv-Action Environmental Services adapted its tactics to achieve maximum results within a limited budget and adopted a containment approach.

***'We found where it wasn't, mapped it, and started to push it back from there.'* Robert Hanna, Conserv-Action Environmental Services.**

Different chemical sprays were trialled in the area. Initially the perimeter of the infestation was treated with metsulfuron-methyl plus the adjuvant Pulse®.

While the kill rate was effective it was slow. A mix of 10 mL of glyphosate + 10 g of metsulfuron-methyl per 100 L water plus Pulse® adjuvant had a more successful kill rate, but fluroxypyr-based products (e.g. Starane®) ultimately proved to be the most effective on *A. scandens* at this site.

'You're always looking for ways to improve what you're doing.'

Although the optimal season to treat *A. scandens* is spring, the site was wet at this time, making access dangerous. Instead, the team chose to conduct treatment in mid-summer, when there were drier conditions and the plant was still healthy. To contain the infestation, they walked the site with knapsacks, spraying the infestation from the perimeter inward.

Because *A. scandens* thrives in these habitats, follow-up control is necessary twice a year, ideally in May–June before rain again prevents access. To monitor progress, the site perimeter was marked with flagging tape, before and after photographs taken and weed coverage estimated. Progressive mapping shows that after two years the infestation is steadily reducing. Site resilience is high. Hardy ground cover like *Goodenia* spp. and bracken regenerate quickly once the weed is removed: *'It comes back as good as new'*.

More recently, the Department of Sustainability and Environment engaged Conserv-Action Environmental Services to control *A. scandens* in a recreational reserve in Wye River township,

along a popular walk called Paddy's Path. Applying experience gained at the other site, asparagus weed coverage has been reduced by 80% after two years. Robert is very positive after his experiences on these sites.

'Asparagus scandens is very gettable. If you can access it, you can eradicate it. If you've got a serious infestation, just follow-up, follow-up, follow-up. Once you've identified a site, get other people involved. And get enthusiastic about it.'

Mapping the infestations: (above) 8 ha of the Great Otway National Park (GPS mapping of infestation and aerial overlay was conducted by Peter Hay, Ranger from Parks Victoria) and (below) 0.45 ha area along Paddy's Path, Wye River, Victoria

Before (above) and after (below) foliar spraying of A. scandens infestation at Paddy's Path, Wye River, Victoria

Section 3

Control methods

Choosing a control method

Identify the methods most suitable for your species in the table below. Then, read in the following pages about how to apply each method and compare their advantages before deciding.

Species	Hand pulling	Crowning[A]	Digging / grubbing[B]	Slashing stems / leaves*	Cut-paint / gouge-paint
Page	44	44	47	48	60
A. aethiopicus	Y	Y	N/A	Y	Y
A. africanus	Y	Y	N/A	Y	Y
A. plumosus	Y	Y	N/A	Y	Y
A. scandens	Y	Y	N/A	Y	Y
A. declinatus	Y	N/A	Y	Y	N
Bridal creeper	Y	N/A	Y	Y	N
WC bridal creeper	Y	N/A	Y	N	N
Infestation size	Small / Seedlings	Small / Dense (sensitive habitat)	Small / Dense (sensitive habitat)	Large / Dense	Small

Species	Basal bark spray	Foliar spot spraying	Fire*	Grazing*	Biological control
Page	62	62	65	65	65
A. aethiopicus	N	Y	+	Y	N/A
A. africanus	Y	Y	+	Y	N/A
A. plumosus	Y	Y	+	Y	N/A
A. scandens	N	Y	+	Y	N/A
A. declinatus	N	Y	+	Y	N/A
Bridal creeper	N	Y	Y	Y	Y
WC bridal creeper	N	Y	N	N	N/A
Infestation size	Medium / Large	Small / Large	Large	Large	Large

[A] Crowning involves removal of the central rhizome. [B] Grubbing involves removal of all branching rhizomes.

* Slashing, grazing or use of fire as a management technique will deplete but not kill the weed and must be integrated with other techniques.

Y = Yes. N = Not recommended.

+ Further research is needed to determine effectiveness of method.

Native species that can be confused with asparagus weeds

The list below was created from a combination of research literature and stakeholder consultation.

Asparagus racemosus – native asparagus is distinguished from A. africanus and A. plumosus by having red fruit when mature and longer leaflets (cladodes) (10–30 mm long). See A. racemosus distribution map on page 8.

Sheldon Navie

Asparagus racemosus (native asparagus)

Sheldon Navie

A. plumosus (left) and A. africanus (right); note short leaflets (to 15 mm)

Sheldon Navie

Asparagus racemosus: note long leaflets (to 30 mm) compared to A. plumosus and A. africanus in the photo above

Native species	Common name	Habit	Asparagus look-a-like
Adiantum aethiopicum	Common maidenhair	Small fern	*A. plumosus* (foliage)
Asparagus racemosus	Native asparagus fern	Vine / shrub	*A. africanus* and *A. plumosus*
Baloskion tetraphyllum	Plume rush, Australian reed	Rush	*A. aethiopicus* (foliage) *A. virgatus* (prior to formation of inflorescence)
Billardiera scandens	Common apple berry	Shrub	*A. asparagoides*
***Callitris* spp.**	Pines	Shrub / tree	*A. aethiopicus* (seedlings)
Clematis microphylla	Old mans beard	Vine	*A. asparagoides*
Eustrephus latifolius	Wombat berry	Vine	*A. asparagoides*
Geitonoplesium cymosum	Scrambling lily	Vine	*A. asparagoides* and *A. falcatus*
***Lycopodium* spp.**	Clubmoss	Small primitive plant	*A. africanus* (foliage)
Morinda jasminoides	Sweet morinda	Woody climber / scrambling shrub	*A. falcatus* (seedlings)
***Muehlenbeckia* spp.**			*A. asparagoides*
Podocarpus elatus	Plum pine	Tree	*A. falcatus* (seedlings)
Pteridium esculentum	Common bracken	Perennial fern	*A. plumosus* (foliage)
Selaginella uliginosa	Swamp selaginella	Small primitive plant	*A. africanus* (foliage)
***Smilax* spp.**		Climbers	*A. asparagoides*

Note: This list is not exhaustive and there may be other native species that resemble asparagus weeds – please use caution.

Detailed overview of control methods

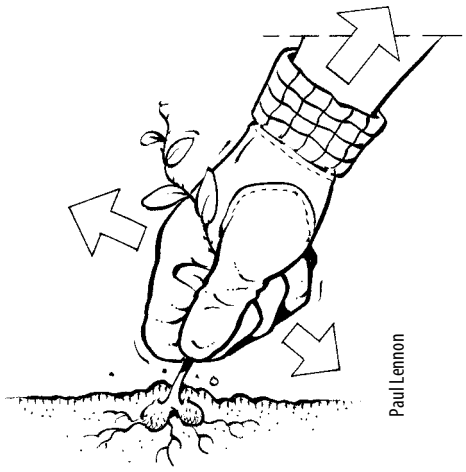
Manual control

Manual control methods use physical or mechanical means to remove plants, and may include the use of hand tools. Methods include hand pulling, digging / grubbing, crowning, and slashing. For asparagus weeds, these are only recommended for seedlings or small plants, in small to medium-sized infestations, or when working in high-value native vegetation or around cultural or geological assets.

Hand pulling

Applying the method:

- Hold the plant stem/s as close as possible to the base of the plant.



Hand pulling – grasp the stem close to the ground

- Gently tug the plant and rock from side to side. This will loosen the soil and allow the roots and tubers (if any) to come free.
- If the stems are breaking off from the rhizome, use a knife or trowel to help free the roots as they are being pulled out. The entire root system, including rhizome must be removed.
- Remove the roots and tubers shaking off any soil, bag them and dispose of properly.

Crowning

Crowning is the removal of the underground growing points (or the central crown) of the plant, thus preventing regeneration (see Section 1 – Biology and Threat for description of the root systems).

Applying the method:

- Grasp the base of the stems where they attach to the underground crown, so that the base of the plant is visible. Thick gloves (e.g. leather) are highly recommended due to thorns or prickles.
- Cut away large stems or foliage to gain access to the crown.
- Use a knife or sharp trowel to cut away all roots leading from the crown.
- Extract the crown by inserting a peter lever, mattock or trowel under the base of the crown and lever it up.
- Remove the crown, shaking and removing as much soil as possible, and dispose of in an appropriate manner (see 'Disposal' page 48). Taking excess soil from the site could: a) inadvertently remove native seeds that might

Hand pulling

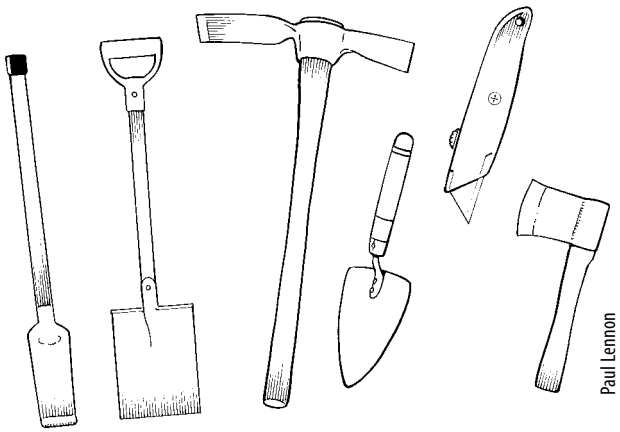
Recommended for:	Caution!	Advantages	Disadvantages	Timing
▪ Seedlings or small plants in light infestations or as a follow-up control option after mature plant control ▪ Soft soil, such as sand or loam ▪ Use on all asparagus weeds	▪ **If part of the crown is left in the soil, it will likely re-sprout** ▪ **Plants can regrow from any sections of rhizome that are left in the ground**	▪ Whole plant removed (no regrowth) ▪ No chemicals or equipment required ▪ Minimises risk of off-target damage to native flora	▪ Time consuming and labour intensive ▪ Not practical for extensive infestations or mature plants, as stems will break free of the crown ▪ Will not work in hard or compacted soils, such as dry clay	Anytime

otherwise naturally regenerate, and b) increase the amount of green waste that needs to be transported off-site.

- Remove and bag fruits or fruiting stems in areas of isolated infestations and/or low density to reduce the chance of reinfestation. In high density infestations, it is not necessary to remove fruits, as it is time consuming and any new seedlings can be controlled during follow-up.

Which tools to use?

For small crowns: Use a plaster cutter ('gyprock' saw), sharp knife or trowel. As knives and plaster cutters can go blunt quickly when used in soil, it is helpful to have one dedicated for use on asparagus crowns only.



Paul Lennon

Tools for manual control

Pittwater Council

Peter lever: can be used for crowning

For larger crowns: Use a peter lever, mattock or sharp spade. Hand mattocks are useful on large plants in open areas but are awkward for use in shrubby and rocky ground (e.g. coastal heath), where peter levers are more effective.

Note: ***There may be situations where removal of the entire underground root mat is desirable to allow native regeneration. For example, root mats of A. aethiopicus in temperate climates do not decompose rapidly therefore removal of the root mat may allow additional light penetration to assist germination from the native seed bank. This is only recommended when working in plant communities that have a resilient seed bank and where some level of soil disturbance is acceptable. Follow-up control will be necessary.***

Crowning

Recommended for:	Caution!	Advantages	Disadvantages	Timing
▪ Large, well-established asparagus weeds that do not form extensive rhizome networks under ground ▪ Weeds that grow from a central point at ground level or below the surface of the ground, including crown forming asparagus weeds e.g. *A. aethiopicus, A. africanus, A. plumosus, A. scandens* and *A. falcatus*	▪ **Do not leave the crown in contact with soil, as it can re-shoot** ▪ **The tubers and or thickened roots of the crown forming asparagus weeds are not reproductive and do not need to be removed from the soil** ▪ **Do not dig up entire root mats unnecessarily as it is labour intensive and creates a high level of disturbance**	▪ All reproductive parts removed via crown removal (no regrowth) ▪ No herbicides required ▪ Minimises risk to native flora if care taken ▪ Minimal soil disturbance ▪ Effective for plants of all sizes	▪ Time consuming and labour intensive ▪ May not be practical for extensive infestations ▪ Rhizomes must be completely removed ▪ Creates soil disturbance which may promote weed germination ▪ Not effective for *A. declinatus, A. virgatus* and *A. asparagoides*, as they form extensive, rhizomatous root mats (see Digging / grubbing method instead)	Anytime but pre-flowering / fruiting is best

Control methods

Should I remove all plant material off-site after 'crowning'?

Many people hang *A. aethiopicus* plants and root mats in tree forks, but be aware that if the tubers, which are water holding sacs, are still attached to the rhizome, plants can continue to grow, develop fruit and set seed. If the plant is fruiting, the fruits should be removed and disposed of properly.

Leaving crowns on-site is only used in:

- remote areas where removal of large amounts of refuse is a problem,
- large infestations, and
- areas where follow-up treatment will occur.

When crowning, leave the tubers and as much of the soil as possible in the ground. If you are leaving plant material on-site, leave the foliage attached to the crown to assist the plant in drying out.

Andrew Meiklejohn

Asparagus aethiopicus drying out in tree fork

Kerinne Harvey

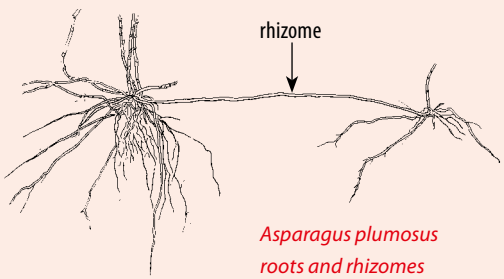
Asparagus africanus crown

Pittwater Council

Asparagus aethiopicus crown removal

Be careful of suckering and layering when crowning Asparagus plumosus

Asparagus plumosus crowns are capable of sending out creeping, underground stems or runners. These stems can be greater than 2 m long and produce more climbing stems from nodes along their length. Be aware, and search for creeping stems and new crowns that can form along these runners, particularly where infestations run under logs or other objects. Rooting from the nodes may also occur when climbing stems come in contact with the ground, such as when pulled down by a tree fall. These underground stems form new crowns, which must also be removed.



Asparagus plumosus roots and rhizomes

Drawing by Catherine Wardrop ©Royal Botanic Gardens and Domain Trust

Digging out plants / grubbing

Digging, sometimes referred to as grubbing, involves the physical removal (by digging) of the entire root system including underground rhizomes. This contrasts with crowning, which only removes the central crown and not the rest of the root system.

Applying the method:

- Prepare the area by removing as much surrounding ground debris (e.g. mulch, leaves, etc.) as possible.
- Using a small trowel, dig a narrow channel next to and around the base of the stems until you reach the rhizomatous root mass. Dig out the root mass and remove from site, with any fruit or fruiting fronds/foliage. Shake as much soil off the roots as possible.
- Check the soil for any adjoining or loose rhizomes. Although the tubers do not regenerate in these species, the tubers are densely arranged along branching rhizomes. If a tuber breaks off from the rhizome, a small part of the rhizome may still be attached to the tuber and therefore regenerate. Best practice management is to remove both tubers and rhizomes in these species (i.e. non-crowning species).

Biosecurity SA

Tubers and branching rhizomes of A. declinatus (above) and Western Cape bridal creeper (below)

- After the plant is removed, it is best to replace soil and leaf litter to minimise the effect of disturbance.
- Remove plant material and dispose of in an appropriate manner (see 'Disposal' page 48).
- Follow-up control is required in subsequent years to treat seedlings that emerge after primary control.

Digging out plants / grubbing

Recommended for:	Caution!	Advantages	Disadvantages	Timing
▪ Isolated infestations or after several years of herbicide treatment on larger infestations ▪ Effective on species with extensive, rhizomatous root mats (*A. declinatus*, *A. asparagoides* and *A. virgatus*)	▪ **Once the rhizomes and roots have been removed, it is best to replace the soil and leaf litter to prevent erosion** ▪ **Rhizomes cannot be dug out separately; the whole root system needs to be removed from the soil, as vegetative growth can occur from broken off pieces of rhizomes**	▪ Whole plant removed (no regrowth) ▪ No herbicides required ▪ Very precise with potential for little or no off-target damage	▪ Time consuming and labour intensive ▪ Not practical for extensive infestations ▪ Rhizomes and tubers must be completely removed ▪ Creates extensive soil disturbance which may promote weed germination ▪ Not appropriate for *A. aethiopicus*, *A. africanus*, *A. plumosus*, *A. scandens* and *A. falcatus* (see Crowning method instead)	▪ Autumn and winter when soils are moist ▪ Pre-flowering / fruiting is best ▪ When plants have foliage on them

Slashing or pulling off above ground foliage

Slashing weeds involves the cutting back of above ground foliage to ground level. This can be done using either hand slashing or tractor drawn equipment on all asparagus weeds.

Slashing or pulling off above ground foliage

Recommended for:	Caution!	Advantages	Disadvantages	Time
▪ Dense infestation of asparagus weeds ▪ Will assist in improving access for follow up treatment ▪ Use on all asparagus weeds ▪ Not recommended for Western Cape bridal creeper because any infestations of this weed are to be eradicated or fully controlled	▪ **To prevent seed set, the foliage should be slashed before the plant flowers** ▪ **While slashing should usually be conducted six months prior to spraying, an established bridal creeper infestation that was slashed during flowering has been observed to re-sprout and flower again within just one month** ▪ **Green fruits can be viable and set seed even if stems are cut**	▪ May prevent fruit production and slowly deplete tubers of energy over time ▪ Improves access to dense infestations for further treatment ▪ New shoots easier to treat with herbicides	▪ Will not kill plants ▪ Not suitable in natural areas	▪ Pre-flowering, around six months prior to spraying ▪ When plants have sufficient foliage

Disposal

Off-site disposal

Shake as much soil off the roots as possible. Place plant material in a strong bag and remove from site. Rhizomes and other reproductive material should be disposed of in strong plastic bags and buried (>1 m depth) or disposed of at the tip. Do not include reproductive material in green waste.

Composting and mulching

If composting or mulching material on-site, be aware that crowns and rhizome fragments can re-shoot. Compost maintenance through routine turning, spot spraying and covering with black plastic is required to break the material down. Use compost bins that have an open bottom to allow soil organisms to assist in decomposition. Routine turning allows new material to be buried and aerates the pile, which further assists with decomposition. On occasion, spot spray re-shooting foliage prior to turning. When bins are full, a few months on average are required before new material can be added. Every 18–24 months, remove compost and leave in full sun on a hard surface to dry and lighten material before taking to landfill.

Peter Tuggart

Compost bins

Solarisation

Material can be transferred into a black plastic bag and left out in the sun to 'cook' (solarise) the tubers and rhizomes until they are no longer viable. This process takes about 2–3 months, depending on weather conditions, after which time the bag can be disposed of off-site or composted on-site.

Chemical control

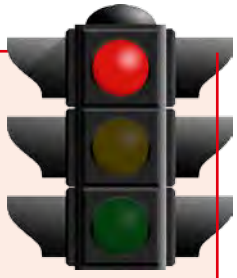
When used as part of an integrated management plan, the use of chemicals (herbicides) can be an efficient way of controlling asparagus weeds. Herbicide applications are recommended for medium to large infestations or where infestations are present on steep slopes where erosion may occur if roots and/or crowns are removed. To avoid off-target damage, care must be taken when applying herbicide in areas of native vegetation. Herbicide application on asparagus weeds is only effective with correct application methods and with appropriate chemicals. Herbicides should only be applied when plants are actively growing with sufficient above ground foliage. Plants may yellow off and re-sprout if treated with herbicide outside the active growing period or if the plant is stressed. Currently herbicide use is only registered for *A. asparagoides* but some herbicides are permitted under minor use (or off-label) permits for other asparagus weeds. Herbicide application methods used on asparagus weeds include:

- cut and paint or gouge and paint,
- basal bark spray, and
- foliar spot spraying.

These methods are discussed in detail later in this section.

Watch out!

Green fruits in asparagus weeds can be viable. Plants may still set seed after being sprayed with herbicide. Follow-up is important.



Stop and Think!

Site-specific management is important

Sites vary and what is appropriate for one site may not be suitable for another.

Follow-up, follow-up, follow-up!

Follow up is paramount for successful weed control and should be included as part of an integrated management plan (e.g. foliar spraying followed by hand removal and site monitoring). Although the seed bank for most asparagus weeds is thought to be relatively short-lived (approximately 3–5 years), many years of control may be required for dense infestations to be contained. It takes a minimum of 3 years per site, but more than 5 years at some sites, to control asparagus weed infestations.

Bird dispersal of asparagus weeds presents a considerable management challenge. Early detection and control of newly emerged populations is as important as post control site monitoring. See Section 2 for more information on planning.

Herbicide labels and legislation

The Australian Pesticides and Veterinary Medicines Authority (APVMA) controls and regulates the use of all pesticides (this includes herbicides). The APVMA approves the use of a herbicide to control a weed and sets the label recommendations. APVMA also issues permits for herbicide applications that are not otherwise registered and are referred to as 'off-label' permits. Various off-label permits for asparagus weed control are held by government departments and individuals and can be used by other individuals or groups with permission from the permit holder. As new chemical products are registered on a regular basis and existing chemicals are reviewed routinely,

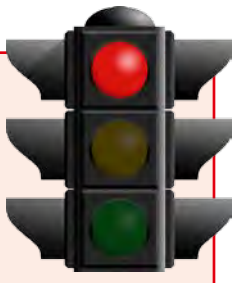
Weed control contacts

	Department	Phone	Email	Website
ACT	Environment and Sustainable Development Directorate	132 281	environment@act.gov.au	www.environment.act.gov.au/environment
NSW	Biosecurity NSW, NSW Dept. of Primary Industries	1800 680 244	weeds@dpi.nsw.gov.au	www.dpi.nsw.gov.au/agriculture/pests-weeds/weeds
NT	Dept. of Land Resource Management	(08) 8999 4567 Katherine and the Gulf (08) 8973 8857 Alice Springs (08) 8951 9210	weedinfo@nt.gov.au	www.lrm.nt.gov.au/weeds2
QLD	Biosecurity Queensland, Dept. of Agriculture, Fisheries and Forestry	132523	callweb@daff.qld.gov.au	www.daff.qld.gov.au/4790_8331.htm
SA	Biosecurity SA, Primary Industries and Regions SA	(08) 8303 9620	nrmbiosecurity@sa.gov.au	www.pir.sa.gov.au/biosecuritysa/nrm_biosecurity/weeds
TAS	Dept. of Primary Industries, Parks, Water and Environment	North (03) 6336 5429 North-west (03) 6421 7654 South (03) 6233 3650	invasivespecies@dpipwe.tas.gov.au	www.dpipwe.tas.gov.au/inter.nsf/ThemeNodes/SSKA-52J2K4?open
VIC	Dept. of Environment and Primary Industries	136 186	customer.service@dpi.vic.gov.au	www.dpi.vic.gov.au/agriculture/pests-diseases-and-weeds/weeds
WA	Dept. of Agriculture and Food	(08) 9368 3333	enquiries@agric.wa.gov.au	www.agric.wa.gov.au
National	Australian Pesticides and Veterinary Medicines Authority	(02) 6210 4701	contact@apvma.gov.au	www.apvma.gov.au

check the APVMA website (www.apvma.gov.au) each time you use a herbicide off-label to ensure you are not breaching any laws.

Herbicides must be stored in properly labelled containers, preferably in the original container and in a locked cabinet. Only chemicals that are registered for use in aquatic situations may be used in and around aquatic areas.

Stop and Think!



Be aware of legislation in your state regarding herbicide use. For example, some herbicides are restricted in certain states or in specific areas of the state.

For up-to-date registration details and current permits visit the Australian Pesticides and Veterinary Medicines Authority (APVMA) website: **www.apvma.gov.au** and refer to weed control contacts in your state (see table above).

Safety and training

Personal protective equipment (such as protective clothing, eye or face shields, and respiratory protection) must be used in accordance with the recommendations stated on the herbicide label or permit. **Herbicide use training is highly recommended** and is required for people using herbicides as part of their job or business. Training is recommended for community groups and may be required if working on public land. Training courses are run by ChemCert and TAFE in each state. Other training courses may be available through state agencies (e.g. AgTrain in Victoria, SMARTtrain in New South Wales, and AgForce in Queensland), local councils or non-government organisations. See Section 7 for contact information.

By law, you must read the label (or have it read to you) before using any herbicide product. Always follow the label instructions. The same applies for off-label permits.

Registered herbicides

Before using a herbicide it is important to check that each herbicide product is registered in *your* state or territory for the particular application method you are planning to use or that the use is allowed by a relevant permit. The use of certain chemicals off-label is permitted in specific circumstances in Victoria, as explained in the 'Guide to using Agricultural Chemicals in Victoria', which can be found at www.dpi.vic.gov.au/agriculture/farming-management/chemical-use/publications/a-guide-to-using-agricultural-chemicals-in-victoria.

It may be beneficial to choose herbicides that can treat multiple weeds at one time. For information on which herbicide may be most appropriate in your patch, contact your local weeds or biosecurity officer.

The most commonly used herbicides on asparagus weeds are glyphosate, metsulfuron-methyl, fluroxypyr, 2,4-D, picloram and triclopyr. Neat diesel is also registered in QLD only for use on environmental weeds. Some of these chemicals are used for all asparagus weeds, while others are species specific or used in combination. The characteristics of the most commonly used herbicides are described below. This information is not necessarily comprehensive and does not imply any recommendation of a specific herbicide. Individual site requirements must be considered when choosing a herbicide. See Section 6 – Case Studies for examples of where managers have considered their specific situation before applying chemicals. Many other herbicides containing these active ingredients, but not mentioned in this manual, may also be registered for use on asparagus weeds.

Glyphosate is a non-selective herbicide used against many annual and perennial broadleaf weeds and grasses. It is not residual, meaning it only kills existing plants and is inactivated on contact with the soil. Glyphosate enters a plant through its foliage and the speed of entry depends on the species and where it is applied to the plant. It is absorbed by the leaves and stems and is translocated throughout the plant and into the root system. Glyphosate inhibits an enzyme required for the production of amino acids used in protein synthesis, hence plant growth. On annual weeds, it may only take between 3 and 7 days to see visible impacts but, on perennial plants, it can take over 2 weeks. On asparagus weeds, it can take 3–4 weeks to see visible impacts. Visible effects of control may be delayed by cool or cloudy weather. Only healthy and actively growing weeds should be sprayed, as translocation is dependent upon the sugar transport system (phloem) within the plant being active. Most transportation within the phloem to the plant's growing points occurs within 4 hours and slows thereafter, stopping by 48 hours. Other factors such as plant stress, dust and extreme weather can affect glyphosate uptake in plants. Asparagus weeds often grow closely among native vegetation and the use of non-selective herbicides can lead to unacceptable off-target damage unless the application is very carefully targeted. For example, *Themeda* grasslands, a community commonly threatened by asparagus weeds, are particularly vulnerable to even low amounts of glyphosate.

Note: Do not use surfactants when working in an aquatic situation and only use herbicide formulations registered for use in aquatic situations.

Metsulfuron-methyl is a selective herbicide for use on broad-leaved plants and some annual grasses. The residual activity of this herbicide is dependent upon environmental conditions and can vary with soil type, soil pH, temperature, moisture and organic matter. Soil residual activity may be reduced in the presence of high carbon levels following fire. Half-life estimates for metsulfuron-methyl in soil are wide ranging from 14–180 days, with an overall average of 30 days. The residual activity dissipates faster in acidic soil and in soils with higher moisture contents, temperatures, and

increased microbial activity. Metsulfuron-methyl is absorbed both through roots and leaves, and is generally applied in solution to the leaves. It is transported through the plant rapidly, but can be slow acting. Metsulfuron-methyl blocks a key enzyme system required for the production of amino acids necessary for plant cell division.

Be aware of the importance of conducting small scale trials in your specific situation before broadscale spraying of residual herbicides. For example, the Narrawallee Foreshore and Reserves Bushcare Group in NSW conducted a small scale trial that found too much off-target damage from metsulfuron-methyl in their situation (see Narrawallee Beach Dunes case study on page 103). In contrast, the use of metsulfuron-methyl has worked effectively in a number of situations in SA (see South Australian Indigenous Flora case study on page 97).

Important notes on metsulfuron-methyl

- **Mixing metsulfuron-methyl with other chemicals:** before using any herbicide mixes, it is important to check that they are registered in *your* state or territory for the particular application method you are planning to use.
  - ***Penetrants (e.g. Pulse®) are required*** when using metsulfuron-methyl on asparagus weeds.
  - ***Spot-spraying metsulfuron-methyl + penetrant*** on asparagus weeds may take up to 12 months or more to see an effective kill. Asparagus weeds with crowns can have persistent, dormant crown 'buds' that can sprout even after other parts of the crown are dead, thus follow-up is required.
  - ***Spot spraying 'hotmix', a mixture of metsulfuron-methyl (600 g a.i./kg) + glyphosate (360 g a.i./L) + penetrant: Where hotmix is permitted or registered for use,*** 1.5 g metsulfuron-methyl + up to 200 mL glyphosate per 10 L water + label rates of penetrant is suggested to provide good kill of *A. aethiopicus*, *A. plumosus*, *A. scandens*, *A. declinatus* and *A. asparagoides*. This chemical mix is situation specific and can be used with a range of other weeds (e.g. weedy grasses like *Ehrharta erecta*). This mix should never be used for broadscale spraying – be careful to avoid off-target damage, particularly from glyphosate on native grasses.
  - ***Cut and paint or gouge-paint applications of 'hotmix'*** can be used on *A. aethiopicus, A. africanus, A. plumosus* and *A. scandens*.
- **Using lower rates:** some land managers have indicated that using lower rates of metsulfuron-methyl (i.e. 0.5 g per 10 L of water) may give a slower, but more effective kill of some asparagus weeds (e.g. *A. asparagoides, A. virgatus*). These lower rates, however, may limit the suite of other weeds that can be controlled at the same time. Further research is needed and this technique may be best suited only to certain asparagus weeds. Refer to the emerging asparagus weeds case study on page 106.
- **Off-target damage:** several native monocots, such as *Dianella* species, commonly co-exist with *A. aethiopicus* and are sensitive to off-target damage by metsulfuron-methyl. Do not apply where the roots of desirable non-target species are present. Similarly, *Eucalyptus* and *Leptospermum* species are particularly vulnerable to off-target damage from metsulfuron-methyl. Preparing an area for spraying is imperative to prevent off-target damage. Alternatively, manual control methods can be used in sensitive situations.

Herbicides and bridal creeper

From late autumn through winter, common bridal creeper is susceptible to very low rates (i.e. 0.5 g per 10 L of water) of metsulfuron-methyl + penetrant as a foliar spray, with little off-target damage to grasses, established trees and shrubs. When flowering (between mid-winter and early spring) glyphosate plus a penetrant is more commonly used. Be careful to avoid off-target damage when using glyphosate as a foliar spray. For greater selectivity when using glyphosate, wipe directly onto leaves using a stick type weed wiper, brush or sponge. Look for a weed wiper that has a narrow or controlled release reservoir. Wipe over leaves, working from the inner plants outwards. Apply yearly to prevent seed set and to exhaust the tubers.

2,4-D (present as dimethylamine and diethanolamine salts) is a selective, foliar-absorbed, translocated herbicide for use on broad-leaved plants. 2,4-D disrupts plant cell growth. Half-life estimates for 2,4-D in soil are approximately 6 days. 2,4-D can provide good control of asparagus seedlings, but may not be effective on mature asparagus plants. Like most herbicides detailed in this manual, it is useful for helping to defoliate asparagus weeds to assist with crown access in dense infestations.

2,4-D has been used successfully with concurrent management of *Ipomoea cairica* (see Boondall Wetlands case study on page 100).

Diesel is often mixed, in varying proportions, with various herbicides to facilitate their penetration into plant vascular tissue, thus allowing the movement of herbicide throughout the plant. It is a less desirable chemical for operators and for the environment than selective herbicides, due to possible off-target damage and petrochemical residue in the soil leading to long-term site contamination issues. It is usually only added for use when basal barking. However, neat diesel can give good control of some asparagus weeds if stems are cut near the ground and central crowns are sprayed or painted to the point of runoff (only permitted for use in QLD). Careful application will ensure minimal risk to adjacent non-target plants.

Fluroxypyr is a selective, foliar-absorbed, translocated herbicide used in the control of broad-leaved weeds. It has little residual activity. Fluroxypyr disrupts plant cell growth. It is an oil-soluble, water emulsifiable chemical. That is, it can mix with oil-based liquids (e.g. diesel), but isn't very soluble in water and turns a milky white colour. Fluroxypyr generally remains within the top 30 cm of soil if any reaches the ground, where it is then broken down by soil organisms.

Picloram is a selective herbicide targeted for use on broadleaf plants. It affects the synthesis of proteins and disrupts cell growth. It is absorbed through the roots and cut stems and translocates throughout the plant. While not widely used on asparagus weeds, it can be applied to rhizomatous plants as a thickened gel to cut stems or as a gouge and paint technique to the crowns. It is slow acting, signs of damage may take over 2 months and total death may take from 6 months to 2 growing seasons after application. The herbicide is highly residual and can remain active within the soil for more than a year and within the plant for up to 2 years.

Triclopyr is a systemic foliar-applied herbicide used to control a range of broadleaf weeds. It does not have a long residual activity in the soil. Half-life estimates for triclopyr range between 30 and 90 days. Once absorbed, it is rapidly transported throughout the plant. Triclopyr disrupts plant cell growth. While not widely used on asparagus weeds, it may be used as part of an integrated management program.

Herbicides for use on asparagus weeds

The herbicides listed in the next table are currently permitted to be used in the listed situations. Before using any herbicide, always read the label carefully. All herbicides must be applied strictly in accordance with the label directions and the conditions in the APVMA permit. This table is only a guide. Do not rely on it, only rely on current label or permit directions. Check permit or label before application to ensure it is still valid. Commercial products listed here are examples only, and many other products containing these active ingredients may be registered, visit www.apvma.gov.au/permits/search.php. To search registered chemical products visit services.apvma.gov.au/PubcrisWebClient/welcome.do.

Herbicides for use on asparagus weeds

	Application method	Active ingredient	**Commercial product/s** See additional information at PUBCRIS	Rate	**Situation as per label or permit** See additional information at PUBCRIS	Species suitability	**Label or Permit (APVMA) requirements (at June 2013)**	Comments
All states	Spot spray	Metsulfuron-methyl 600 g/kg	Please refer to PUBCRIS for labels Chemtura Metsulfuron 600 WG Herbicide FMC, Metsulfuron-methyl 600 Herbicide Rygel 600 Metsulfuron WG Agro-Essence Metsulfuron-methyl 600 Herbicide	5 g per 100 L	Native pastures, rights of way, commercial and industrial areas	*A. asparagoides*	As per label instructions	Apply from mid-June to late August. To achieve complete control follow-up applications over at least 2 seasons are required. To minimise damage to native vegetation, water volumes of 500–800 L/ha are recommended.
	Cut and paint or gouge and paint	Picloram 43 g/kg	Vigilant* Herbicide gel	Undiluted (gel form)	Native vegetation, conservation area, gullies, reserves and parks	*A. aethiopicus* *A. africanus* *A. plumosus* *A. scandens*	As per label instructions	Avoid use over or near desirable plants, or in areas where their roots may extend or where the chemical may be washed or moved to their roots. Do not use if rain is likely to fall within 12 hours of application.
New South Wales	Spot spray	Glyphosate 360 g/L	All registered products	1 part glyphosate to 50 parts water + surfactant	Urban bushland and forests Coastal reserves	*A. aethiopicus* *A. africanus* *A. plumosus*	PER11916 expires 31/3/2020	Do not allow spray to drift onto sensitive areas including but not limited to natural streams, rivers, wetland waterways and non-target species. The latter is particularly important when using a surfactant or penetrant
				1:75 + surfactant		*A. asparagoides*		August to September only
	Spot spray	Glyphosate 360 g/L	Roundup®, Weedmaster® Duo and Roundup® Biactive™	Up to 1 part glyphosate to 50 parts water	Areas of native vegetation (e.g. subtropical rainforest remnants, littoral rainforest and other bushland reserves) Lands controlled by the Botanic Gardens Trust Non cropland areas	*A. aethiopicus* *A. africanus* *A. plumosus* *A. scandens* *A. asparagoides*	PER9907 expires 31/3/2020	
	Spot Spray	Metsulfuron-methyl 600 g/kg	Brush-off®	5 g per 100 L of water + surfactant	Urban bushland and forests Coastal reserves	*A. asparagoides*	PER11916 expires 31/3/2020	Do not allow spray to drift onto sensitive areas including but not limited to natural streams, rivers, wetland waterways and non-target species. The latter is particularly important when using a surfactant or penetrant. August to September only

	Application method	Active ingredient	**Commercial product/s** See additional information at PUBCRIS	Rate	**Situation as per label or permit** See additional information at PUBCRIS	Species suitability	**Label or Permit (APVMA) requirements (at June 2013)**	Comments
New South Wales continued	Spot spray	Metsulfuron-methyl 600 g/kg	Associate®, Brush-off®, Bushwacker®	10–20 g per 100 L water plus surfactant	Areas of native vegetation (e.g. subtropical rainforest remnants, littoral rainforest and other bushland reserves) Lands controlled by the Botanic Gardens Trust Non cropland areas	*A. aethiopicus* *A. africanus* *A. plumosus* *A. scandens* *A. asparagoides*	PER9907 expires 31/3/2020	
	Spot spray	Glyphosate 360 g/L and metsulfuron-methyl 600 g/kg	All registered products	Tank mix of up to 2 L glyphosate + 15 g metsulfuron-methyl per 100 L water	Areas of native vegetation (e.g. subtropical rainforest remnants, littoral rainforest and other bushland reserves) Lands controlled by the Botanic Gardens Trust Non cropland areas	*A. aethiopicus* *A. africanus* *A. plumosus* *A. scandens* *A. asparagoides*	PER9907 expires 31/3/2020	
	Spot spray	Fluroxypyr 333 g/L	Starane Advanced	300–600 mL per 100 L water; or 3–6 L per ha; or label rate for specific weed	Non-agricultural areas, bushland, forests, wetlands, coastal and adjacent areas	*A. aethiopicus* *A. africanus* *A. plumosus* *A. scandens* *A. asparagoides*	PER9907 expires 31/3/2020	
		Fluroxypyr 200 g/L	Nufarm Comet 200	500 mL per 100 L water; or 5–10 L per ha; or label rate for specific weed				
	Splatter gun	Glyphosate 360 g/L	Roundup®	Rates of up to 1:9 with water	Non-agricultural areas, bushland, forests, wetlands, coastal and adjacent areas	*A. aethiopicus* Needs further investigation	PER9907 expires 31/3/2020	
	Wipe onto leaves	Glyphosate 360 g/L	Roundup®	1:20 with water to undiluted herbicide	Areas of native vegetation (e.g. subtropical rainforest remnants, littoral rainforest and other bushland reserves) Lands controlled by the Botanic Gardens Trust Non cropland areas	*A. asparagoides*	PER9907 expires 31/3/2020	
	Cut stump	Glyphosate 360 g/L	All registered products	Undiluted	Urban bushland and forests, coastal reserves	*A. aethiopicus* *A. africanus* *A. plumosus*	PER11916 expires 31/3/2020	Do not allow spray to drift onto sensitive areas including but not limited to natural streams, rivers, wetland waterways and non-target species. The latter is particularly important when using a surfactant or penetrant

	Application method	Active ingredient	**Commercial product/s** See additional information at PUBCRIS	Rate	**Situation as per label or permit** See additional information at PUBCRIS	Species suitability	**Label or Permit (APVMA) requirements (at June 2013)**	Comments
New South Wales continued	Cut stump, basal bark spray or cut and paint	Glyphosate 360 g/L	All registered products	1:1.5 with water to undiluted herbicide	Areas of native vegetation (e.g. subtropical rainforest remnants, littoral rainforest and other bushland reserves) Lands controlled by the Botanic Gardens Trust Non cropland areas	*A. aethiopicus* *A. africanus* *A. plumosus* *A. scandens*	PER9907 expires 31/3/2020	
	Cut and paint	Glyphosate 360 g/L and metsulfuron-methyl 600 g/kg	All registered products	Tank mix of 1:1.5 glyphosate + 1 g metsulfuron-methyl per 1 L water	Areas of native vegetation (e.g. subtropical rainforest remnants, littoral rainforest and other bushland reserves) Lands controlled by the Botanic Gardens Trust Non cropland areas	*A. aethiopicus* *A. africanus* *A. plumosus* *A. scandens*	PER9907 expires 31/3/2020	
	Basal bark spray	Fluroxypyr 333 g/L	Starane Advanced	21 mL per 1 L diesel/ kerosene	Areas of native vegetation (e.g. subtropical rainforest remnants, littoral rainforest and other bushland reserves) Lands controlled by the Botanic Gardens Trust Non cropland areas	*A. africanus* *A. plumosus*	PER9907 expires 31/3/2020	
Queensland	Spot spray	Glyphosate 360 g/L Products registered for use in aquatic situations	Roundup® Biactive™, Weedmaster Duo	1 L per 100 L water; or 10 L per ha. Boom or label rate for specific weed	Non-agricultural areas, bushland, forests, wetlands, coastal and adjacent areas	*A. aethiopicus* *A. africanus* *A. plumosus*	PER11463, expires 30/6/2014	Spot spray in aquatic and wetland areas
	Spot spray	Glyphosate 360 g/L	Roundup®	1 L per 100 L water; or 10 L per ha. Boom or label rate for specific weed	Non-agricultural areas, bushland, forests, wetlands, coastal and adjacent areas	*A. aethiopicus* *A. africanus* *A. plumosus*	PER11463, expires 30/6/2014	Spot spray in dry land areas
	Spot spray	Metsulfuron-methyl 600 g/kg	Brush-off®, Alley	10 g per 100 L water plus wetting agent; or 100 g per ha plus wetting agent	Non-agricultural areas, bushland, forests, wetlands, coastal and adjacent areas	*A. aethiopicus* *A. africanus* *A. plumosus*	PER11463, expires 30/6/2014	
	Spot spray	Fluroxypyr 200 g/L	Starane 200	500 mL to 1 L per 100 L water; or 5–10 L per ha; or label rate for specific weed	Non-agricultural areas, bushland, forests, wetlands, coastal and adjacent areas	*A. africanus* *A. plumosus*	PER11463, expires 30/6/2014	

	Application method	Active ingredient	**Commercial product/s** See additional information at PUBCRIS	Rate	**Situation as per label or permit** See additional information at PUBCRIS	Species suitability	**Label or Permit (APVMA) requirements (at June 2013)**	Comments
Queensland continued	Spot spray	2,4-D 625 g/L	Amicide® 625	3 mL per 1 L water; or 3 L per ha	Non-agricultural areas, bushland, forests, wetlands, coastal and adjacent areas	*A. africanus* *A. plumosus*	PER11463, expires 30/6/2014	
	Spot spray	Triclopyr 600 g/L	Garlon™ 600	33 mL per 10 L water Or label rate for specific weed	Non-agricultural areas, bushland, forests, wetlands, coastal and adjacent areas	*A. plumosus* Needs further investigation	PER11463, expires 30/6/2014	
	Paint or spot spray crowns	Diesel	All registered products	Neat	Non-agricultural areas, bushland, forests, wetlands, coastal and adjacent areas	*A. aethiopicus* *A. africanus* *A. plumosus*	PER11463, expires 30/6/2014	
	Cut stump	Glyphosate 360 g/L	Roundup®	1 part product to 2 parts water (e.g. 10 mL in 20 mL water)	Non-agricultural areas, bushland, forests, wetlands, coastal and adjacent areas	*A. africanus* *A. plumosus*	PER11463, expires 30/6/2014	
	Basal bark spray	Fluroxypyr 200 g/L	Starane 200	35 mL per 1 L diesel/ kerosene	Non-agricultural areas, bushland, forests, wetlands, coastal and adjacent areas	*A. africanus* *A. plumosus*	PER11463, expires 30/6/2014	
Western Australia	Spot spray	Glyphosate 360 g/L	Roundup®	1 L per 100 L water; or 10 L per ha; or label rate for specific weed	Non-agricultural areas bushland and forests, wetlands, roadsides, industrial areas	*A. aethiopicus* *A. plumosus* *A. scandens* *A. declinatus* *A. asparagoides*	PER1333 expires 31/3/2017	Spot spraying in dry land areas
	Spot spray	Glyphosate 360 g/L where product has an aquatic registration	Roundup® Biactive™	1 L per 100 L water; or 10 L per ha; or label rate for specific weed	Non-agricultural areas bushland and forests, wetlands, roadsides, industrial areas	*A. aethiopicus* *A. plumosus* *A. scandens* *A. declinatus* *A. asparagoides*	PER1333 expires 31/3/2017	Spot spraying in aquatic and wetland areas
	Spot spray	Metsulfuron-methyl 600 g/kg	Brush-off®, Alley	10 g per 100 L plus wetting agent or spray oil; or 100 g per ha plus wetting agent or spray oil; or label rate for specific weed	Non-agricultural areas bushland and forests, wetlands, roadsides, industrial areas	*A. aethiopicus* *A. plumosus* *A. scandens* *A. declinatus* *A. asparagoides*	PER1333 expires 31/3/2017	
	Mister or hand held spray	Metsulfuron-methyl 600 g/kg	All registered products	0.5 g per 10 L of water registered + wetting agent e.g. Pulse at 2 mL per L	Crop and non-crop areas as specified on the label. Apply up to maximum registered label rates in accordance with Dept of Ag WA advice for the control of Declared Plants	*A. asparagoides*	PER13236 expires 31/12/2016	Lower rates are also recommended for bushland treatment (see permit) Mid-June to late August Follow-up treatment required for a couple of seasons.

Herbicides for use on asparagus weeds continued

	Application method	Active ingredient	Commercial product/s See additional information at PUBCRIS	Rate	Situation as per label or permit See additional information at PUBCRIS	Species suitability	Label or Permit (APVMA) requirements (at June 2013)	Comments
Western Australia continued	Spot spray	Metsulfuron-methyl 600 g/kg	Apparent Metsulfuron 600 WG	5 g per 100 L	Native pastures, rights of way, commercial and industrial areas – ground application	*A. asparagoides*	As per label instructions	Apply during mid-June to late August. Follow-up applications over at least 2 seasons will be required for complete control. Water volumes of 500–800 L/ha are recommended to minimise the risk of damage to native vegetation.
	Wipe onto leaves	Glyphosate 360 g/L	Roundup®	Undiluted to 1 L per 5 L water	Non-agricultural areas bushland and forests, wetlands, roadsides, industrial areas	*A. asparagoides*	PER1333 expires 31/3/2017	Apply directly to plant using a sponge glove. Retreatment necessary.
			All registered products	1:2 parts with water	Crop and non-crop areas as specified for WA on the approved label. Apply up to maximum registered label rates and in accordance with Dept of Ag WA advice for the control of Declared Plants		PER13236 expires 31/12/2016	
South Australia	Spot spray	Glyphosate 360 g/L	Roundup®, Roundup® Biactive™	1 L per 100 L water surfactant or spray oil may be added	Non-crop areas, rights of way, roadsides and easements, forest and conservation areas	*A. aethiopicus* *A. plumosus* *A. scandens* *A. declinatus* *A. asparagoides*	PER13371 expires 31/3/2017	
	Spot spray	Metsulfuron-methyl 600 g/kg	Brush-off®	10 g per 100 L water + surfactant	Non-crop areas, rights of way, roadsides and easements, forest and conservation areas	*A. aethiopicus* *A. plumosus* *A. scandens* *A. declinatus*	PER13371 expires 31/3/2017	
	Spot spray	Glyphosate 360 g/L and metsulfuron-methyl 600 g/kg	Weedmaster® Duo Roundup® Biactive™ Brush-off®	(Roundup 1 L + Brush-off 3 g) per 100 L water + surfactant	Non-crop areas, rights of way, roadsides and easements, forest and conservation areas	*A. aethiopicus* *A. declinatus* *A. asparagoides*	PER13371 expires 31/3/2017	
	Spot spray	Metsulfuron-methyl 600 g/kg	Please refer to PUBCRIS for labels	5 g per 100L water	Native pastures, rights of way, commercial and industrial areas – ground application	*A. asparagoides*	As per label instructions	Apply during mid-June to late August. Follow-up applications over at least 2 seasons will be required for complete control. Water volumes of 500–800 L/ha are recommended to minimise the risk of damage to native vegetation.
			Brush-off®	1.5 g per 100 L water + surfactant	Non-crop areas, rights of way, roadsides and easements, Forest and conservation areas		PER13371 expires 31/3/2017	

	Application method	Active ingredient	**Commercial product/s** See additional information at PUBCRIS	Rate	**Situation as per label or permit** See additional information at PUBCRIS	Species suitability	**Label or Permit (APVMA) requirements (at June 2013)**	Comments
South Australia continued	Spot spray	Triclopyr 75 g/L and metsulfuron-methyl 28 g/L	Ultimate Brush Weed Herbicide	125 mL per 100 L water + surfactant	Native pastures, rights of way, commercial and industrial areas	*A. asparagoides*	As per label instructions	Spray from mid-June to late August. One spray is unlikely to give complete control and follow-up sprays will be necessary. Avoid excessive wetting and run-off to minimize damage to native vegetation.
	Cut and swab	Glyphosate 360 g/L	Nufarm Weedmaster® Duo	10–50 mL per L water	Non-crop areas, rights of way, roadsides and easements. Forest and conservation areas	*A. plumosus* *A. scandens*	PER13371 expires 31/31/2017	
	Weed wiper sponge or brush	Glyphosate 360 g/L	Roundup®, Roundup® Biactive™	1 L per 3 L water surfactant may be added	Non-crop areas, rights of way, roadsides and easements. Forest and conservation areas	*A. asparagoides*	PER13371 expires 31/31/2017	
Tasmania	Spot spray	Glyphosate 360 g/L where product has an aquatic registration	Roundup® Biactive™	10–13 mL per L plus adjuvants ONLY in accordance with label as required	Non-cropping and bushland (native vegetation both forested and non forest, including urban bushland reserves)	*A. scandens* *A. asparagoides*	PER13160 expires 31/3/2017	
	Spot spray	Glyphosate 360 g/L where product has an aquatic registration	Sickle™ 540 plus other registered herbicides	7 mL per L plus adjuvants ONLY in accordance with label as required	Non-cropping and bushland (native vegetation both forested and non forest, including urban bushland reserves)	*A. scandens* *A. asparagoides*	PER13160 expires 31/3/2017	
	Spot spray	Metsulfuron-methyl 600 g/kg	Nufarm Associate®, Brush-off®, Lynx WG	As per existing registrations or if weed not recorded on label 10–15 g per 100 L	Non-cropping and bushland (native vegetation both forested and non forest, including urban bushland reserves)	*A. scandens* *A. asparagoides*	PER13160 expires 31/31/2017	

Note: Starane 200 (Fluroxypyr 200 g/L) has/will be phased out and be replaced by Starane Advanced (Fluroxypyr 333 g/L). There are a number of companies that produce a generic formulation of Fluroxypyr 200 g/L, namely Fluroxypyr, Fluroxypyr 200, Floxor 200EC, Restrain 200, Neon 200, Rockstar 200, Acclaim, Dozer, Prostar, Flagship 200, Staroxy 200, Trample 200 and Uni-Rane 200. APVMA permits will be updated to reflect changes upon their expiry.

Products may be registered for use on asparagus weeds in all states and territories (shown as 'All') or only in the specific states and territories listed.

Please note that this is not a full list of herbicides and applications for use on asparagus weeds. Seek further advise from APVMA or your local weed authority.

Application methods

Cut and paint / gouge and paint

Cut and paint (also known as cut-stump, cut-swab or snip and drip) and gouge and paint are treatments used to apply herbicide to the stems and/or crowns of asparagus weeds.

Applying the method

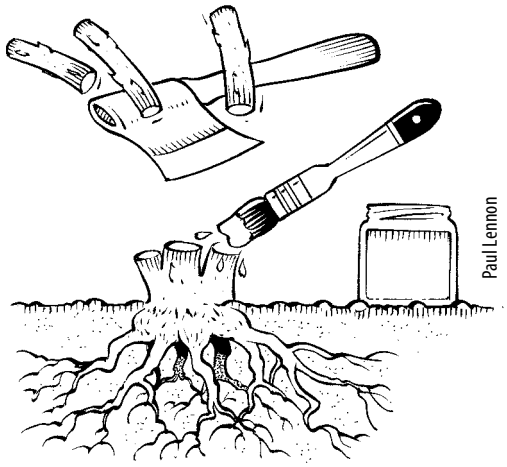
For stem treatments: cut the stem close to the ground and apply herbicide immediately (within 10 seconds) to the cut surface.

For crown treatments: gouge out sections of the fleshy base (crown) with a knife (cut the stems to improve access) and apply herbicide immediately with a low-pressure sprayer, paint brush or applicator bottle.

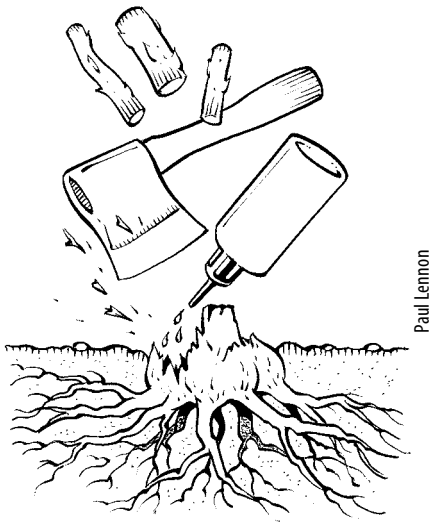
For the canopy climbers: a tomahawk is a handy tool to gouge into *A. africanus* after the canes are cut. Paint herbicide to gouged section of the crown immediately.

For *A. plumosus*: use the same technique as above but, as the crowns are generally smaller, loppers or secateurs can be used to gouge into the crown.

Be aware that bringing down climbing asparagus foliage is a lot of work and can potentially damage trees.



Cut and paint method



Gouge and paint method

Cut and paint / gouge and paint

Recommended for:	Caution!	Advantages	Disadvantages	Timing
▪ Asparagus weeds that do not form extensive rhizome networks underground ▪ Suitable for *A. aethiopicus, A. africanus, A. plumosus* and *A. scandens*	**It is imperative that the herbicide is applied as soon as possible after the stem is severed or crown is gouged (within 10 seconds)**	▪ Stem and crown treatments can minimize off-target damage ▪ Less labour intensive than manual methods ▪ Useful when crowns are difficult to dig out (e.g. in hard and rocky ground) ▪ Limits soil disturbance	▪ More labour intensive than foliar spray	▪ When plants are actively growing, as herbicide is rapidly transported through the plant ▪ Immediately after cutting

Case study

Dealing with hazardous weedy climbers in Queensland rainforests

Alan Carter, *Strategic Weed Control and Vegetation Management, Queensland*

Climbing vines can be a hazard when doing weed control. A pole hedge trimmer is a useful tool to cut vines away from trees and is much faster than using a machete or secateurs. Low branches or other obstructing vegetation can be trimmed back quickly to give safe access to your site and reduce the number of anchor points available for climbers to attach to.

Cut vines as high as possible and let long vines drop to the ground for later spraying. In the case of climbing asparagus weeds, the crowns can then be readily accessed and treated by gouge and paint methods or basal barking. For other weedy vines, follow-up using a selective herbicide to help ferns, grasses, sedges, palms and other monocots re-establish while you continue to control any regrowth. Plants including *Commelina diffusa*, *Poa labillardieri* and species of *Oplismenus* and *Ottochloa* establish readily and keep some annual weeds at bay between follow-up treatments.

Techniques for glyphosate that can reduce off-target damage include:

- trimming the trigger on the spray bottle to prevent it getting caught on things and squirting accidently, and
- applying thread tape to the nozzle screw, preventing drips onto the trigger. This also allows a nice straight laminar jet that can reach the crown or stump without having to get on your hands and knees. But always squirt gently, as close as possible and using only as much chemical as the stump or crown will absorb.

This technique can also be readily used for all other woody weeds that are encountered on a site.

For most vines (except Madeira vine *Anredera cordifolia*), laboriously cutting and treating large individual stems with herbicide is usually less work in the long run rather than repeatedly spraying regrowth of untreated cut stems.

Alan Carter

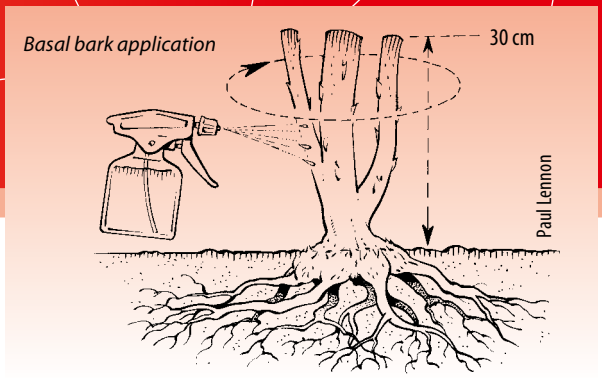
Cutting back vines using a pole hedge trimmer

'I nearly always carry hand secateurs and a modified 500 mL trigger spray on a belt holster when I'm working.'

Alan Carter

Trigger spray and belt holder

Control methods



Basal bark spray

This method involves mixing an oil-soluble herbicide in diesel or other carriers and spraying (or painting) the circumference of the plant stems and or crown. Diesel enables the penetration of the vascular tissue of the plant, allowing the movement of herbicide throughout the plant.

Applying the method:

- Basal barking can be done with plants entire (vertical stems not chopped) or chop stems out of the way to avoid prickles and entanglement.
- Prepare herbicide mix as per label directions.
- Apply herbicide mix to the outer tissue of the base of the crown and remaining stems (to a height of 10–30 cm) with either a paint brush or a hand-held sprayer, ensuring that the whole circumference of every stem is saturated.
- Refer to the product label for further information. Check that the herbicide and application is listed for use in your state and seek advice from local weed authorities.

Basal barking

Recommended for:	Caution!	Advantages	Disadvantages	Timing
Canopy climbers (i.e. *A. africanus* or *A. plumosus*) when foliar spraying cannot get effective cover and or when the weed is intertwined with native host plants	**To achieve maximum efficiency, ensure that the full circumference of every stem arising from the ground (to a height up to 30 cm) is saturated including the crown**	Saves on 'hands and knees' time required for primary control compared with physically removing the crown	Labour intensive	Only when stems are dry and free of charring from fire – stems that are wet with rain or dew repel the oil-based spray and charcoal deactivates the chemical

Foliar spot spraying

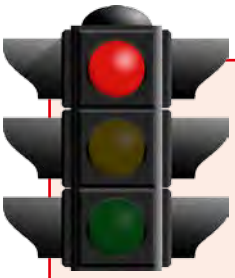
Foliar spot spraying is the use of herbicide diluted with water (or other carrier) at a specific rate and applied to the leaves and stems of a plant in the form of a fine spray. A range of other chemicals may be added (e.g. penetrants, adjuvants, surfactants, wetting agents).

Applying the method:

- Effective foliar spraying requires that **all** foliage be wetted with herbicide.
- There are several techniques available and the choice of which technique to use depends on the plant size and growth form, density of infestation, habitat, site specifications and the availability of resources, including trained contractors.
- The application rate, volume and concentration of herbicide in water vary with the application used. Foliar spray application techniques used to control asparagus weeds include:
  - Backpack/knapsack – for low pressure spraying and used for spot spraying large or small infestations.
  - Hand held spray bottles – for small areas or around native vegetation.
  - Vehicle-based sprayers – for high pressure spraying using a hose with handgun.

Foliar spot spraying

Recommended for:	Caution!	Advantages	Disadvantages	Timing
▪ All asparagus weeds ▪ Large infestations	▪ **Follow-up control is required to treat subsequent seedlings that emerge after primary control** ▪ **Herbicides should not be applied when the plant is under stress or during hot, dry conditions**	▪ Efficiency ▪ Can cover large areas	▪ Potential for spray drift and off-target damage ▪ Several asparagus weeds have fine or waxy foliage that may impede herbicide uptake ▪ All foliage must be wetted with herbicide to be effective	When plants are actively growing and prior to fruit set – ideally when plants are just starting to flower



Stop and Think!

Site-specific management: minimising spray drift and off-target damage

In areas where there is a good ground cover of native plants, some land managers have found that some off-target damage may be prevented and herbicide coverage improved if they bundle up and tie asparagus stems prior to foliar spraying.

Wendy Midgley

Asparagus aethiopicus bundled prior to spraying

Alternatively, if asparagus is growing over native shrubs, the climbing branches can be quickly cut off to get the asparagus foliage onto the ground for spraying. This assists in targeting herbicide spray to asparagus foliage and saves time in untangling asparagus from native plants.

Foliar spot spraying of A. plumosus regrowth after initially cutting vines has been used effectively in Iluka Nature Reserve (see case study on page 93).

***Asparagus declinatus* does not readily absorb sprayed herbicide due to its waxy foliage. To overcome this problem, practitioners should add a penetrant or spray oil to their spray mixture. Best results for spot spraying occur when the plant is flowering in late winter. Follow-up control is required to treat subsequent seedlings that emerge after primary control.**

Splatter gun

Splatter guns are not widely used on asparagus weeds, but may be effective, so this technique warrants further investigation. This technique is widely used on lantana and bitou bush. The method involves applying a low volume of concentrated herbicide mix to foliage. A specialized nozzle produces a solid stream of large droplets of herbicide that can be applied from a distance of 6–10 m away. Only a small portion of the foliage needs to be sprayed, thus non-target damage can be minimized. This technique is useful in difficult to access areas and for specifically targeting the herbicide to the plant. The use of a marker dye is recommended to identify treated plants.

Hillary Cherry

Splatter gun equipment

Case study

A potential new technique for treating *Asparagus aethiopicus* in hard-to-access locations

Sue Bower, Lord Howe Island Board and Stuart McDonald, Byron Shire Council, NSW

Weed managers on Lord Howe Island are faced with controlling infestations of *Asparagus aethiopicus* growing in remote, hard to access cliff locations. They are currently trialling the splatter gun to control mature stands of *A. aethiopicus*, with some success.

The splatter gun is a relatively new tool that is commonly used on lantana and bitou bush. Herbicide concentrations for splatter guns differ from that of normal foliar spray guns, and technique is extremely important. Further information on splatter guns can be found at your local weeds authority or rural supplies store (or in the lantana and bitou bush management manuals at www.weeds.org.au).

***'Trial the technique in an accessible location first as you want to make sure you get it right before you use it remotely.'* Sue Bower, Lord Howe Island Board.**

For *A. aethiopicus*, the trick is to be sure that each 'frond' gets a good 'splatter' of herbicide. Weed managers are using a 'cross hatch' pattern or linear splat that ensures that each frond gets an appropriate cover of herbicide (for further information and contact details, see Section 7).

Suitability of method

- Use on mature and dense *A. aethiopicus* stands of similar age.
- Apply at least a 20% herbicide cover on each plant.
- Ensure a good 'splat' of herbicide hits each asparagus frond (stem).
- Apply herbicide in a cross-hatch pattern by using long arching strips, or a strip along each frond for individual plants.
- Apply when the weed is actively growing and not under stress.

Sue Bower

Hayden Denmeade from The Good Bush People demonstrating the use of the splatter gun – as you traverse a cliff, it is best to spray down from above, or from the side

Splatter gun

Advantages	Disadvantages
▪ Great for use in hard to access locations with low weed density (e.g. cliff faces, areas of low water availability). ▪ Splatter gun is lightweight and portable. ▪ Requires minimal use of water. ▪ Good response with mature age stands (i.e. thick, mature ground cover of asparagus). ▪ Can achieve targeted control. ▪ Minimal soil disturbance.	▪ Only suitable for use in dense, mature-aged stands (e.g. monocultures). ▪ If used in the wrong way, off-target damage can be amplified because of the concentrated nature of this technique. ▪ If you are using the technique in hard to access locations, you want to make sure your technique is right! Consult with others who have experience using the splatter gun. ▪ Not recommended for use on multi-aged stands of asparagus (i.e. where there are young plants that may not be exposed to herbicide; or where there is a high concentration of seedlings).

For an example of how a community group is effectively using a splatter gun in coastal environments please refer to Pittwater Eco Warriors YouTube videos, e.g. 'The how and why of splatter guns' www.youtube.com/watch?v=LozAyJcghck.

Other methods

Fire

Using fire as a tool to manage asparagus weeds has only been investigated for bridal creeper, and further research is required to determine the feasibility of fire to manage other asparagus weeds. Fire can be used in bridal creeper management but must be part of an integrated control strategy. Fire assists with removing understorey vegetation to improve access and promote weed regrowth for later herbicide treatment. Fire is not likely to kill bridal creeper, but has the potential to help deplete the seed bank and the dense, rhizomatous root mat. Burning must be followed up with other control methods, including physical removal or herbicide application.

Pre-planning is paramount to a successful integrated asparagus weed management plan that utilises fire. Asparagus weeds will usually re-sprout from the rhizome unless the fire is very intense and the rhizomes are shallow (less than 5 cm deep) or over rock. As high intensity fires in planned burns are not desirable, best practice management is to treat asparagus weeds with herbicide prior to a prescribed burn. All weeds that are unlikely to be killed by fire and/or that may be fire resistant should be considered for treatment in the months prior to the burn. Crowned rhizomes or rhizomes that have been dug out can be left suspended in the low shrub or herb layer. Retaining the foliage on the hanging rhizome assists in removing moisture from the rhizome and adds to the fuel load. Foliage that has been sprayed prior to fire also adds to the fuel load. Untreated asparagus weeds have a high moisture content, making burning difficult.

Great care is needed when using fire. Appropriate conditions, equipment and experienced personnel are essential. The landowner is responsible for ensuring that all planned burning is conducted in a safe manner. Prior to undertaking any planned burn, the landowner must inform all relevant authorities and obtain all relevant permits.

Consultation with vegetation specialists is also recommended as fire can have both positive and negative effects on native vegetation. For example, fire raises soil pH and can increase the persistence of herbicides used after fire, so there may be greater off-target damage.

Follow-up actions are required after sites are burned. Infestations post-fire should be monitored regularly and over several years because of the high probability of regrowth from remnants of the root system. New seedlings or regrowth need to be carefully removed or treated with herbicide to limit above ground growth and further reduce the stored root reserves. For new or small infestations, hand digging of roots may be an appropriate follow-up technique.

Grazing

Grazing may assist in exhausting the tubers and may assist in managing some asparagus weeds. Tamar wallabies on Garden Island in Western Australia have been found to eat bridal creeper. Similarly, sheep are known to eat bridal creeper and *A. declinatus*, keeping the plants at low levels in grazed areas. As sheep grazing can also damage native understorey plants and tree seedlings, it is not suitable for conservation reserves. Do not allow grazing when asparagus weeds are fruiting, as seed can be consumed and spread by animals.

Bridal creeper biological control

Three natural enemies specific to bridal creeper have been released in Australia: the bridal creeper leafhopper (an undescribed Erythroneurini formerly referred to as *Zygina* sp.) was first released in 1999, the rust fungus (*Puccinia myrsiphylli*) in 2000 and a leaf beetle (*Crioceris* sp.) in 2002. The rust fungus and leafhopper have caused the most impacts. In good years, these agents can stop plants flowering and fruiting. Many more years of impacts by the agents are required to deplete the nutrient reserves stored in underground tubers and stop regrowth.

Control methods

Since they were introduced, the leafhopper and rust fungus have been widely released across southern Australia. They have most likely colonised all areas suitable for their development. Redistribution of these agents is mainly done to accelerate development at specific sites in some years by increasing their population at the beginning of the growing season.

The leaf beetle has established poorly, so there is currently no scope to redistribute it.

Note: The Western Cape form of bridal creeper, which is found in limited areas of South Australia and south-west Victoria, is not impacted by the bridal creeper rust fungus.

Shauna Potter, Biosecurity SA

Western Cape bridal creeper (left) stands out among rust infected common bridal creeper (right)

Bridal creeper biocontrol agents

Agent	Appearance	Damage	Life cycle	Status
Leafhopper	White, 2–3 mm long, living on underside of bridal creeper leaves.	Sap-sucking insect that feeds on the photosynthetic leaf cells (visible as silver patterning on the leaves). Adults and juvenile stages feed on the leaves, causing them to turn white and, in severe cases, fall off. Continued damage over several years reduces new tuber production, making bridal creeper less competitive.	Lays about 200 eggs over 6 weeks, and has multiple generations each year.	Widely established across Australia. By 2008, released at close to 900 sites. Used in Weed Warriors program as educational tool (see page 67).
Rust fungus	Yellow pustules surrounded by yellowing tissue on the underside of leaves.	Attacks leaves and stems, diverting nutrients away from healthy plant tissue. Can have a major impact on the level of reserves normally stored in tuber. In severe cases, leaves die off.	Complicated, with 5 spore stages including one that survives over summer when bridal creeper has senesced. Many generations per year, and produces large amounts of wind-dispersed spores.	Widely established across Australia. By 2008, released at more than 2100 sites. Spreads within and between bridal creeper infestations efficiently.
Leaf beetle		Adults and larvae feed exclusively on bridal creeper's young, expanding tissues. Larvae strip shoots and leaves and prevent plants from climbing, thereby reducing fruit production.	Active in autumn and early winter (February to July) and does not compete directly with above agents for resources. From early winter, adult females lay eggs on expanding shoots and leaves, either singly or in groups of up to 10.	Poorly established. By 2008, released at 82 sites across southern Australia (except TAS) but confirmed established at only three sites, possibly due to predation or parasitism.

Redistribution of the leafhopper and rust fungus

The leafhopper and rust fungus can be sourced from sites where they have been released and have established.

- For a list of sites where the leafhopper and rust fungus had been released up to 2008 see: www.csiro.au/en/Outcomes/Safeguarding-Australia/Agent-Release-Sites.aspx.
- For a list of some sites where they are established see: www.root.ala.org.au/bdrs-core/wbiocont/home.htm. If bridal creeper rust is established at sites in your area please consider adding location details for these sites to this national website.
- For regionally specific information on bridal creeper biocontrol redistribution, contact your local weeds officer.
- Search the web for information related to the Weed Warriors program which engages school children in the rearing and release of biocontrol agents (see Section 7 – Further Information).

Leafhopper redistribution method

University of Adelaide

Bridal creeper leafhopper

Harvest:

- Cut a large bunch of heavily infested foliage and put into large plastic bag. Seal bag and keep it out of the sun. Do this in the early morning when cool.

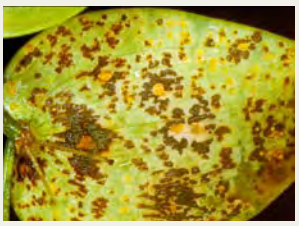
Redistribute:

1. Tease apart foliage and spread thinly over resident bridal creeper infestations while pushing infected foliage into infestation.
2. Invert bag and shake out any insects into common bridal creeper infestations.

For more detail see:
www.csiro.au/Outcomes/Safeguarding-Australia/BridalCreeperLeafhopper.aspx#a3.

More information can also be found by searching the internet for 'Weed Warriors'.

Rust fungus redistribution methods



Louise Morin

Rust pustules on common bridal creeper

The rust spores are not toxic but may cause irritation to people who are hypersensitive to pollens. As a precaution when handling rust-infected foliage, wear safety equipment, including:

- goggles,
- a respiratory mask, and
- gloves.

The rust fungus does not spread internally throughout the plant and must reinfect bridal creeper every growing season to be effective.

There are two methods currently available for the redistribution of the rust fungus (see page 68).

First signs of rust appear in autumn. Redistribution is more effective when spore production is at its peak, usually between July and September when plants are flowering and fruiting. Infection is dependent upon seasonal conditions.

See 'A guide to weed biological control in South Australia' for more photos and information on bridal creeper agents: www.pir.sa.gov.au/biosecuritySA/nrm_biosecurity/weeds.

Rust fungus redistribution methods

Method 1 (developed by CSIRO to establish nursery sites)

1. Cut approximately a dozen, 30 cm long, infected stems of bridal creeper that have well-developed sporulating pustules and place in a paper bag to move to the new release site.
2. A dozen infected stems are required to inoculate a one to two metre square bridal creeper infestation on either the ground, or the equivalent amount of foliage climbing up a bush or tree.
3. Releases should be made at the end of the day to avoid hot temperatures.
4. Rub infected foliage onto healthy foliage in the field by sliding infected foliage back and forth to dislodge spores from pustules to be deposited on the under surface of healthy leaves.
5. After inoculation, mist inoculated field plants with water.
6. Cover the area with a sheet of clear plastic held in place with sticky tape, rocks or pegs to provide a humid environment for 16–24 hours, or overnight.
7. If the site is in full sun, the plastic sheet should be removed the next morning to prevent plants heating up or burning.

For more detail see: www.csiro.au/Outcomes/Safeguarding-Australia/Bridal-Creeper-Rust-Fungus.aspx

Method 2 – **'spore water' method** (developed by a community group on Kangaroo Island, SA)

1. Rinse rust-infected bridal creeper leaves in rainwater. One plastic shopping bag of infected leaves makes approximately 15 L of spore water or use 4 kg of leaf to 100 L of rainwater. Water should turn brown.
2. Strain spore water from bucket into a clean spray unit (e.g. quick spray or backpack sprayer).
3. Using a fine mist, spray out resulting slurry as soon as possible by starting at top of infestation and work downwards. Spray until run-off, paying particular attention to underside of leaves. Try to keep solution agitated while in tank to minimise spores sticking to tank. There is no threat of off-target damage.
4. Spray spore water solution as soon as possible after mixing, as the spores will die the longer they are kept in solution.

- **Note:** It is important to use rainwater only, as mains water and minerals in bore water may adversely affect the rust spores. Clean spray units, and a clean spray gun must be used.

Following up after spraying spore water

Follow-up monitoring of the release sites should take place a month after initial spraying with spore water. If no sign of the rust is seen within two months, another dose of spore water will be required.

Please remember that the spore water technique does not work in all areas. Repeated failure to establish the rust fungus may indicate that a different application technique is required for the area or that conditions are unsuitable for rust establishment. Monitoring and recording activities at the spray site is important so that work is not unnecessarily duplicated.

For more detail: on how to make spore water view the Power Point file www.weeds.org.au/docs/BC_How_to_make_spore_water.ppt

Section 4

Holistic management of invasive vines and scramblers

Holistic management of invasive vines and scramblers

A holistic approach to management

It is important to consider weed management in conjunction with other land management priorities and site based threats, including secondary weed invasion. Weed management needs will vary with the asset or value that is impacted, the habitat, the characteristics of the weeds and the size of the weed invasion. A holistic approach to management will assist in achieving optimal, long-term outcomes (refer to Section 2 – Planning and Pre-control Considerations). Holistic management is a decision making and planning framework whereby you consider all elements of your system, including ecological, economic and social aspects, and how your management actions might interact with that system.

This section provides information on key factors to consider when undertaking weed control in habitats commonly invaded by asparagus weeds, and identifies some key weeds that are commonly managed in conjunction with asparagus weeds.

Note: The information below is for example purposes only and does not include all weed threats or habitats.

Asparagus weeds must be managed holistically, in association with other site-based threats, to avoid secondary invasion by other weeds and reduce other threats to native system recovery. It is essential to develop your control strategy to target co-existing weeds and successional weeds (i.e. weeds that quickly colonise) that can have ongoing negative impacts.

Managing other weeds in conjunction with asparagus weeds

It is important to be aware of the threats posed by co-existing weeds and likely secondary invaders when planning and undertaking asparagus weed management. For example:

- *Gloriosa superba* (glory lily) commonly invades sites following asparagus weed control in coastal environments in eastern Australia. This weed can pose significant threats to native species and, in some cases, is more difficult to control (see case study page 72 in this section and on page 90).
- *Asparagus aethiopicus* is a frequent invader in areas where other weeds have been removed (e.g. bitou bush – *Chrysanthemoides monilifera* ssp. *rotundata*).
- Western Cape bridal creeper and *A. declinatus* can invade sites where common bridal creeper has been controlled and can be more difficult to control. Because Western Cape bridal creeper

Shauna Potter

Asparagus declinatus (with small white flowers) and common bridal creeper are often found together

is not affected by the bridal creeper rust fungus (*Puccinia myrsiphylli*, a biocontrol agent which is highly effective at suppressing the common form), it could be more difficult to manage over the long-term. See case study on page 72 on the importance of timing in holistic management.

Holistic planning and actions that target a suite of weeds and other threats will provide more effective, long-term outcomes. A list of some major weeds that are known to co-occur with asparagus weeds is provided below to assist with holistic management. Recognition of these and other weedy species and their potential effects on your management program will assist in gauging resource commitments and ensuring use of appropriate control measures. Many of these weeds are difficult to control, so it is important to consult your local weeds officer for best practice management advice.

Some major weeds occurring with asparagus weeds

List created through discussion and stakeholder consultation at national asparagus weeds workshops in 2012/2013.

Scientific name	Common name/s
Vines and scramblers	
Acetosa sagittata	Turkey rhubarb
Anredera cordifolia	Madeira vine
Aristolochia elegans	Calico flower, dutchman's pipe
Araujia sericifera	Moth vine
Cardiospermum grandiflorum	Balloon vine
Delairia odorata	Cape ivy
Dolichandra unguis-cati	Cat's claw creeper
Ipomoea alba	Moonflower, coastal morning glory, mile-a-minute
Lonicera japonica	Japanese honeysuckle
Passiflora spp.	Corky passionfruit, passionfruit
Solanum seaforthianum	Climbing nightshade
Thunbergia alata	Black-eyed Susan
Herbs	
Ageratina spp.	Crofton weed, mistflower
Ageratum houstonianum	Billy goat weed
Crocosmia × *crocosmiiflora*	Montbretia
Chasmanthe floribunda	African cornflag
Euphorbia paralias	Sea spurge
Gloriosa superba	Glory lily
Lilium formosanum	Formosan lily
Moraea spp.	Cape tulips
Sphagneticola trilobata	Singapore daisy
Tradescantia fluminensis	Trad
Vinca major	Blue periwinkle
Watsonia meriana var. *bulbillifera*	Wild watsonia, bugle lily

Scientific name	Common name/s
Grasses	
Elymus repens	English couch
Ehrharta spp.	Veldtgrass
Melinis minutiflora (pasture grass)	Molasses grass
Paspalum spp. (pasture grasses)	
Shrubs	
Chrysanthemoides monilifera	Boneseed and bitou bush
Genista monspessulana	Montpellier broom
Lantana camara	Lantana
Lycium ferocissimum	African boxthorn
Nicotiana glauca	Tree tobacco
Ochna serrulata	Mickey mouse plant
Ricinus communis	Castor oil plant
Rubus fruticosus agg.	Blackberry
Senna pendula	Cassia
Solanum mauritianum	Wild tobacco bush
Sorghum halepense	Johnson grass
Trees	
Cinnamomum camphora	Camphor laurel
Celtis spp.	
Schinus terebinthifolius	Broad-leaf pepper tree

Case study

A focus on main weed invaders after *Asparagus aethiopicus* control on the east coast of Australia

As determined by stakeholder consultation at national asparagus weeds workshops held from south-east Queensland to southern New South Wales in 2013.

Herbs *Gloriosa superba* (glory lily) and ***Watsonia meriana* var. *bulbillifera*** (wild watsonia)

- *Gloriosa superba* is a perennial herb that rapidly moves in where both *A. aethiopicus* and *Chrysanthemoides monilifera* ssp. *rotundata* (bitou bush) have been removed, forming a dense understorey (up to 70 stems per m^2) in coastal dune environments. It is extremely difficult to control. For an example of where glory lily and *A. aethiopicus* are being holistically managed see case study on page 90.
- *Watsonia meriana* var. *bulbillifera* (wild watsonia) is an erect perennial herb that forms large clumps of underground corms. It is a successful competitor of native vegetation forming dense stands that exclude other vegetation.

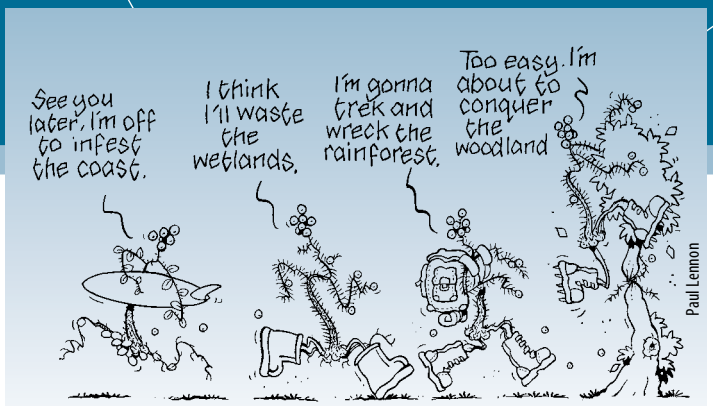
Climber *Acetosa sagittata* (turkey rhubarb)

- *Acetosa sagittata* is a perennial climber with thick underground tubers. It is an aggressive weed that can completely smother native ground plants and small shrubs. It rapidly invades after asparagus weed management particularly in coastal riparian environments. Control of this species is difficult because it is a prolific seeder and regenerates from hard-to-find underground tubers.

Climbers *Ipomoea cairica* (coastal morning glory), ***Passiflora suberosa*** (corky passionflower) and ***Cardiospermum grandiflorum*** (balloon vine)

- *Ipomoea cairica* is a rampant, perennial groundcover or climber. It rapidly invades after asparagus weed management, most commonly in riparian areas, littoral rainforest and coastal environs. When *A. aethiopicus* is removed, a successional cycle of coastal morning glory can occur, often followed shortly by glory lily invasion.
- *Cardiospermum grandiflorum* and *Passiflora* species are also problematic secondary invaders post *A. aethiopicus* control.
- *Cardiospermum grandiflorum* is a long-lived perennial climber that is commonly found growing (to 8 m high) over vegetation lining creeks and rivers. *Passiflora suberosa* is a slender vine with a climbing or creeping habit that develops corky bark at the base of older stems.

Note: After spraying *A. aethiopicus* with metsulfuron-methyl in dune systems, generally good regeneration of native grasses and sedges can occur. Corky passionflower (*Passiflora suberosa*) commonly trails over *A. aethiopicus* in these systems. To control both of these species you may need to control corky passionflower first with glyphosate before tackling *A. aethiopicus* with metsulfuron-methyl. Corky passionflower is not sensitive to metsulfuron-methyl. Spraying corky passionflower that is trailing over *A. aethiopicus* provides an opportunity for glyphosate off-target damage to be only directed at *A. aethiopicus*, thus allowing good regeneration of native grasses and sedges.



There's an asparagus weed for every habitat!

Management considerations in natural habitats invaded by asparagus weeds

Asparagus weeds invade a range of native habitats across Australia. Available control options vary according to different habitat types. Some methods that are effective in certain environments can be unsuitable in other environments. In all native habitats, control and management must:

- minimise damage to desirable vegetation,
- minimise soil disturbance,
- address other weed species invading the environment,
- encourage native plant regeneration, and
- treat asparagus invasion at a rate that allows for effective long-term control and natural regeneration or restoration processes to occur, or at least at a rate that allows effective follow-up.

For canopy climbing asparagus weeds, initial treatment often needs to be undertaken rapidly to reduce pressure on host trees.

Key management considerations in some natural habitats invaded by asparagus weeds

Habitat type		Asparagus weeds most commonly found in habitat type	Key management considerations
Coastal	 Hillary Cherry	*A. aethiopicus* invades all coastal habitats, while common bridal creeper, *A. declinatus* and *A. scandens* thrive in the sandy soils of coastal environs	Minimise erosion See text later in this section for further details
Tropical, sub-tropical, littoral and temperate rainforests (closed forest)	 Mark Hamilton	*A. africanus* and *A. plumosus* are common invaders of rainforest, *A. aethiopicus* is an invader of littoral rainforest and *A. scandens* invades a variety of rainforest habitats including littoral, wet sclerophyll and cool temperate rainforests	Protect vulnerable, small, disturbed remnants and patches of rainforest vegetation; limited control methods available due to high densities of sensitive species and difficulty of access See text later in this section for further details
Wetlands and riparian zones	 Kerinne Harvey	*A. aethiopicus* is a common weed of estuarine edges, saltmarshes and swamps; similarly, both *A. africanus* and *A. plumosus* are found in saline environments including mangroves and saltmarsh plant communities *A. aethiopicus*, common bridal creeper and *A. scandens* are common invaders of riparian zones	Minimise stream bank erosion and weed spread by water and prevent re-invasion, as these areas are particularly vulnerable to this See text later in this section for further details
Woodlands	 Deb Stevenson	All asparagus WoNS can occur in woodland habitats	Integrated management is particularly important in modified habitats (e.g. stock and fire management) See text later in this section for further details
Shrublands / heathlands		*A. asparagoides* invades mallee shrublands and heathlands; *A. aethiopicus* and *A. scandens* can occur in heathlands	Minimise soil disturbance to prevent erosion
Dry and wet sclerophyll forests (open forest)	 Mark Hamilton	*A. africanus*, *A. scandens*, *A. declinatus* and *A. asparagoides* commonly invade sclerophyll forests	Minimise changes to fire regimes

Holistic management

Site assessment is crucial. The actions required to achieve ecosystem rehabilitation are always site-specific, and weed management plans must be tailored based on environmental factors and the relevant management objectives (See Section 2 – Planning and Pre-control Considerations).

The remainder of this section describes some natural habitats invaded by asparagus weeds, along with corresponding management considerations. This information is best used in conjunction with control methods outlined in Section 3 and restoration options in Section 5.

Key management considerations

Minimise erosion

Erosion is a primary concern in environments that are characterised by unstable substrates. To reduce the chance of erosion during control work you can:

- Remove asparagus infestations in stages. The rate of removal depends upon the rate of native plant regeneration and level of site disturbance (i.e. whether or not natives are present in sufficient numbers to provide soil stabilisation).
- Revegetate with a diverse range of plants. Contact local professionals (e.g. Landcare coordinators or local government officers) in your area for region-specific native species lists and advice (see Section 5, Restoration page 79; Section 7 – Further Information).
- Use mulch, to protect young native plants and reduce new weed incursions.
- Avoid applying residual herbicide where there is the potential for roots of desirable non-target species to be present. Be aware that herbicides can leach through sandy substrates at a greater rate than in other habitats.
- Consider using manual techniques or more selective herbicide application methods (e.g. gouge-paint techniques rather than foliar spraying) to reduce the persistence of herbicides and limit off-target damage.

In warmer wetter regions, good native regeneration can occur through dead *A. aethiopicus* root mats which can decay within 6 months after death of plants. In well established infestations in more temperate regions, it may be necessary to remove some or all of the root mat to allow native regeneration, as root mats may take many years to decay.

Mark Hamilton

Asparagus aethiopicus forms thick root mats

Protect vulnerable rainforest remnants

Small, disturbed remnants and patches of rainforest vegetation are particularly vulnerable to weed invasion:

- High priority sites should be regularly monitored for new incursions.
- Where applicable, buffer zones (e.g. plantings of pioneer natives) could be established around the perimeter and at vulnerable edges to provide a physical barrier to disturbance and reduce rates of weed incursion.

Rainforest weeds can be hard to delimit as they can occur in relatively intact, highly complex systems, and search and control efforts are difficult.

Natural regeneration is likely to occur in areas that have a good canopy cover.

Kerinne Harvey

Asparagus africanus invading coastal forest

Due to high densities of sensitive species and access difficulties, control methods should be chosen carefully:

- Control operations should be conducted using low impact methods (e.g. hand removal).
- In most instances, herbicide management should be targeted e.g. cut-stump, gouge-paint or, in some circumstances, splatter-gun.
- Restoration activities that help increase the resilience of the environment to future invasion are of critical importance.

Natives flourish quickly when weedy vines are cut to relieve canopy pressure.

- The risk of damage to micro-organisms such as mycorrhizal fungi (essential for plant nutrition and growth) is lowest with non-residual herbicides.
- When using a residual herbicide such as metsulfuron-methyl, great care must be exercised to avoid herbicide reaching the soil. Frequent repeated use of herbicides in any areas should be avoided.
- Low impact control options should be considered for sensitive areas, particularly riparian zones where there is a risk of herbicide entering the water. 'Frog friendly' formulations of glyphosate registered for use around waterways should be used in rainforests.

Minimise weed spread by water and prevent re-invasion

A well designed weed management program can achieve positive outcomes to minimise weed spread in wetland and riparian areas and assist in preventing re-invasion. Basic principles include:

- Identify and assess threats to any assets in the system being managed (e.g. water quality, threatened species, bank stability).
- Minimise stream bank erosion and prevent sediment and nutrients from entering waterways and impacting on aquatic organisms. Treat small areas, one at a time, to allow native plants to regenerate and stabilise the bank.
- Mechanical control such as slashing should be avoided in riparian areas.
- Initiate management of water and wind dispersed weeds in the upper part of the catchment first to prevent infestations downstream; remove weeds from edge of watercourse to prevent seeds and rhizomes moving downstream.
- Anticipate likely replacement species establishing after primary weed management, as these areas are particularly vulnerable to re-invasion.
- Replanting may be required to provide rapid bank stabilisation and protect vulnerable areas from re-invasion.
- Determine priority species for control, as complete removal of all weed species may not be realistic in areas where multiple weed species invade.

An example of a group successfully managing *A. africanus* in a wetland habitat can be found in the case study on page 100.

Integrated management in modified habitats

Habitats that have undergone chemical and structural modification associated with agricultural land use can favour non-native weed invasion to the detriment of natives. For example, elevated nutrients (e.g. nitrogen, phosphorus) are a common problem in modified woodland habitats because of the addition of fertilisers to soil, deposition of livestock dung, rubbish dumping and stormwater

runoff from urban areas. Basic management principles include:

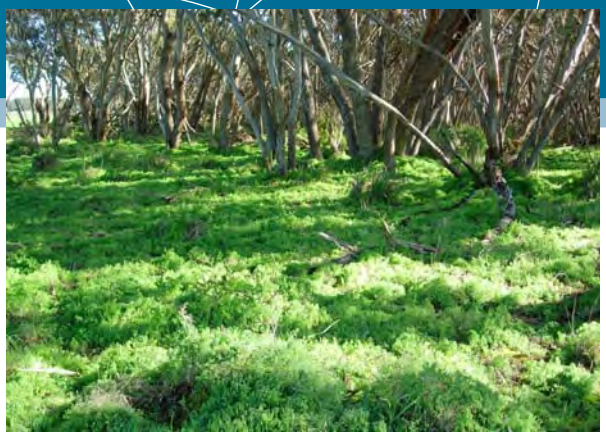
- Manage site to improve native species diversity.
- Keep soil carbon levels high (e.g. establish native perennials to reduce nitrate levels). The addition of carbon and burning can reduce inorganic nitrogen and may reduce the growth of non-native ground layer species relative to native species.
- Maintain ground cover – don't create opportunities for weed invasion, but some bare ground is needed to allow native forbs to establish.
- Prevent grazing of native seedlings and sensitive species.
- Use herbicide sparingly.

Stock management can be an important consideration in modified environments:

- Intermittent grazing regimes can maintain or improve condition of grassy woodland ecosystems without causing too much compaction of the soil.
- Time grazing periods to avoid native flowering and seed set (regionally specific).
- Grazing pressure can support asparagus weed management. For example, sheep will graze common bridal creeper and *A. declinatus* keeping the plants at low levels in grazed areas.

Integrated fire and herbicide control may be effective in managing asparagus weeds in modified environments:

- Geophytes (perennial plants with underground storage organs, such as *Asparagus* spp.) are reasonably fire tolerant due to their habit of dying back to the storage organ during summer. However, following a summer fire, these weeds will often emerge in autumn, prior to regeneration of native vegetation, making herbicide control easier and more effective.
- Control of established populations and prevention of seed production can be achievable under these conditions.



Shauna Potter

Asparagus declinatus dominating understorey vegetation

Note: For many asparagus species the seed will germinate or decay within two years and vegetative material (rhizomes) can often have greater persistence in the soil than seed. Fire is the major disturbance in the Mediterranean ecosystems of South Africa where 95% of Australia's geophyte weeds originate. Consequently many have evolved life history traits that are strongly tied to recurrent fire. Dying back to an underground storage organ over the long dry summer is an extremely effective way of surviving fire. When dormant in summer, most geophyte weeds will probably survive all but the very hottest fires.

Herbicide selection and application approach is important in woodland environments:

- Glyphosate (a non-selective herbicide) is useful for removing dense weed monocultures in disturbed environments.
- Where asparagus weeds are growing closely amongst native vegetation, non-selective herbicides can cause unacceptable levels of off-target damage unless targeted application techniques are used (e.g. cut-paint, gouge-paint).
- Residual herbicides, such as metsulfuron-methyl, can cause native plant death at very low concentrations and can remain active in the soil for several months following application.

See case study for managing Western Cape bridal creeper in modified eucalypt woodland of the Mount Lofty Ranges on page 95.

Section 5

Follow-up, restoration and monitoring

Follow-up, restoration and monitoring

Follow-up

Follow-up weeding, maintenance, restoration and monitoring are critical to the success of weed management efforts. Provision for these activities should be integrated in your asparagus weeds management plan from inception (see Section 2 – Planning and Pre-control Considerations). Follow-up asparagus weed control needs to be done for at least three years – more than five years at some sites – to ensure time, effort and resources invested in initial weed control are not wasted.

An understanding of the ecology of your site will help you plan and manage follow-up control and restoration. It will also help you utilise processes such as natural regeneration, not only to save time and effort, but also achieve more complete restoration.

The key to successful and systematic follow-up is careful monitoring:

- Plan your monitoring program and determine exactly what changes you want to monitor.
- Visit sites at appropriate times of the year, for example after rain, during the active growing season or at flowering times.
- Visit sites regularly.
- Monitor for regrowth of target weeds as well as new and emerging weeds.
- Monitor the natural regeneration of indigenous plant species.
- Treat regrowth of target weeds using appropriate control methods (see Section 3).

Things to watch out for with asparagus weeds

☑ Asparagus weeds develop dense root systems containing rhizomes. It is unlikely that initial works will remove every asparagus rhizome from the soil, so these can re-shoot.

☑ The dense tuberous root mats can inhibit regrowth of native plants. However, removal of these mats will create high levels of disturbance. This disturbance could stimulate either new weed growth or, in highly resilient areas, native plant germination. By monitoring the response to disturbance on your site you will be able to determine the most appropriate approach.

☑ Disturbed ground should be carefully restored and closely monitored. In warmer areas, holes can be dug into dead asparagus root mats and seeds or tube stock can be planted directly into the mat, which will ultimately decay. Or simply monitor and wait for the mats to break down. In temperate regions, root mats tend to take much longer to break down, so leaving them may mean slower regeneration rates.

☑ If removed, root mats are sometimes left to dry onsite. Care should be taken to monitor these mats as any root fragments may contain rhizomes that can re-shoot.

☑ Areas where plants containing fruits are bagged up for disposal should be carefully monitored. Paths and tracks used to access the site should also be checked for weed outbreaks.

☑ Sites sprayed with herbicide should be monitored and treated again during the following growing seasons. Assess effectiveness on treated plants and watch for new shoots from plants that were missed during the last herbicide application.

Identifying new outbreaks of asparagus weeds and acting quickly to control them ensures that extensive root mats are prevented from establishing.

Case study: Dog walkers unite! Tackling *Asparagus aethiopicus* and other weeds on the dunes at Sunshine Beach, Queensland

At Sunshine Beach, regular follow-up control of *Asparagus aethiopicus* is critically important as seed continues to spread in from nearby suburbia. New asparagus seedlings are easiest to remove when they are less than 12 months old. The community group revisits each weeded site one month after weeding, then twice per year, to remove any new weed seedlings and monitor natural regeneration.

For more on this case study, see Section 6 page 90.

Case study: Protecting rare and endangered species through the control of *Asparagus declinatus* and *Asparagus asparagoides* across South Australia

In this region, there is only a brief window of opportunity to control *A. declinatus* and *A. asparagoides* when many sensitive native plants are dormant and the asparagus weeds are still active. Many native annuals such as orchids, lilies and ferns withdraw into their rootstock for a period of summer dormancy with the onset of hotter, drier conditions in mid to late spring. The asparagus weeds, with their larger tuber and rhizome systems, persist a few weeks longer on the surface. During this time they can be sprayed without impacting the dormant native plants. It is important to revisit the site during the same window of opportunity the following year to control seedlings and regrowth.

For more on this case study, see Section 6 page 97.

Jeff Thomas

Planting to reduce erosion on coastal dunes

Restoration

Restoring ecosystem health and function is a difficult task, not only because the impact of weeds might be extensive, but also because natural ecosystems are very complex. Identify the long-term outcome for your site. If patches of similar, less degraded remnant vegetation can be found nearby, they can provide a good benchmark for the type and diversity of species at your site. Healthy, functioning ecosystems are dynamic and can have a high level of resistance to invasion by weeds. Restoring species diversity and structure may help to restore the benefits of resilience and reduce the need for intensive ongoing management.

Once a weed infestation is effectively controlled it may leave a gap in the structure of the site's vegetation. This gap will naturally be filled with either opportunistic indigenous species or another suite of weed species. In many cases, it is advisable to wait and see what naturally fills the gap before proceeding with revegetation. You must be prepared to control any new weeds that emerge.

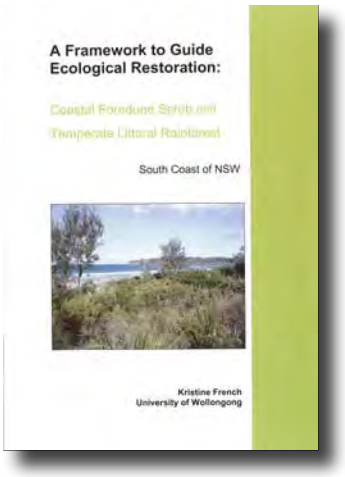
Barry Hart

Site restoration

Follow-up

'We find the more native cover we can maintain, the better the defence against weed invasion.' Kieran Brewer, South Australian Indigenous Flora.

A five-step approach to ecological restoration following weed management has been developed for Coastal Foredune Shrub and Temperate Littoral Rainforest (French 2010) available at www.weeds.org.au/WoNS/bitoubush. This approach can be used as a template for many vegetation types.



Five-step approach to ecological restoration (from French 2010)

Step 1	Make a species list containing all the plants that would have historically been present at the site; define your project goal based on this.
Step 2	Commence weed management according to your site management plan.
Step 3	Allow natural regeneration to occur and monitor regrowth.
Step 4	Reassess the site and make species list of plants that are now growing there; compare this list with the pre-disturbance list to determine which species are missing.
Step 5	Propagate and plant missing species that do not return from seed bank or via natural dispersal. Allow sufficient time for natural regeneration.

Wait before commencing replanting activities unless urgently required. Natural regeneration of some species can occur, saving resources. Some native species can take up to 2 years to emerge as a response to disturbance. Due to the difficulty in propagating many common native species the only chance for their recovery on site is through natural regeneration.

Natural regeneration

The ability of a site to regenerate naturally depends on its resilience. In many sites, at least some of the plant species present before disturbance will regenerate naturally. Natural regeneration takes place in successional stages. The cycle of natural succession begins after a major disturbance event, such as weed control or fire. The first plants to appear are generally fast growing plants that can quickly germinate, grow and produce a new crop of seeds. These can often be weeds.

It can pay to wait and see what emerges over several years of natural regeneration, but be prepared to closely monitor and control any new weeds that emerge.

Natural regeneration can make important contributions to site restoration:

- It ensures plants of local provenance regenerate.
- Success rates of naturally regenerated plants are generally higher than planted seedlings.
- It is the most economical form of restoration.
- It saves time and effort planting species that are going to regenerate anyway, allowing targeting of *missing* species for propagation and replanting.
- It allows important ecosystem processes to occur, for example the mass germination of seedlings followed by natural thinning out until just a few strong individual plants remain to grow to maturity.

Andrew Meiklejohn

Before (above) and after (below) A. africanus control

Site resilience

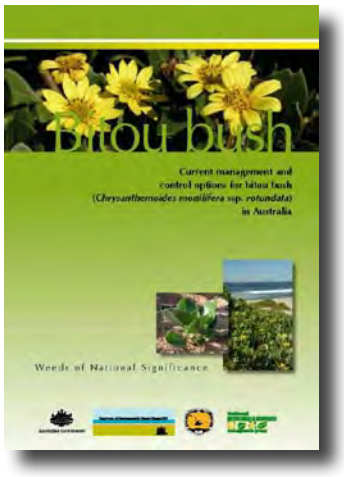
Assessing your site's resilience will help you understand how much natural regeneration is likely to occur. On most sites, resilience will be determined by:

- The seed bank in the soil.
- The amount and quality of surviving remnant vegetation.
- Distance from less disturbed sites that can act as native seed source.
- The severity and time span of disturbance (including the severity and length of time of the weed invasion).
- The presence of other degrading factors such as feral animals, erosion and nutrient enriched stormwater.
- The presence of ecosystem elements such as native animals that disperse seed or help cycle nutrients through digging the soil.

The composition of native species growing in some habitats is not always reflected in the soil-borne seed bank. For instance, 74% of plant species growing on undisturbed secondary dunes along the NSW south coast are not present in the seed bank (French 2010). For example, *Banksia* species that store their seeds in cones have no propagules in the soil-stored seed bank. Sites that are heavily infested with weeds for many years are likely to have a severely depleted and less diverse native seed bank. Even if seeds are present, some species may require a fire or other disturbance event for germination to occur. Understanding the ecology of the vegetation type you are working in is very important.

Indicative guide to site resilience based on age of weed infestation (*adapted from Bitou Bush Management Manual 2008*)

⇦ LOW | resilience | HIGH ⇨
Newly colonised by weeds; rich native seed bank; broad range of native plant species growing; many adult native plants available to flower and seed.
Weed infestation for up to five years; strong native seed bank; some native plants growing; some adult plants available for flowering and seeding.
Established weed infestation; native seed bank persisting and viable but only apparent over time; few native plants growing and available for flowering and seeding (monitor and assess).
Long established weed infestation; denuded seed bank and few seeding adults (monitor and assess).



Seed dispersal

Seed dispersal is a natural mechanism that contributes to site resilience. Seeds disperse in a variety of ways:

- Fall at the base of the parent plant or are propelled to adjacent areas.
- Carried short distances by insects or water.
- Carried longer distances by birds or mammals.
- Blown by the wind or transported in water, sometimes over great distances.

Seeds that arrive at your site from long distances are particularly important. They enable natural regeneration of plant species that disperse from less disturbed remnants nearby. For this reason, isolated 'oasis' sites that do not have good quality remnant vegetation nearby are disadvantaged and may require more intensive revegetation works.

Many of our most invasive weed species disperse seeds over long distances. Regular monitoring is important to identify any new weeds that disperse into your site, and control them promptly and appropriately.

Propagation, replanting and seeding

Once weeds have been removed it is important that they are replaced with native species, otherwise more weeds may emerge to fill the gap. It is possible that natural regeneration will not result in plant diversity equivalent to that present before disturbance, even in sites that have high levels of resilience.

If natural regeneration does not occur at a sufficient rate (e.g. in sites prone to erosion) or some of the desired species are not able to regenerate naturally (e.g. from seed bank or via dispersal) and plants are still missing from the site, some level of revegetation may be needed. Planting and seeding activities should be carefully integrated into your overall weeding and restoration plan. Most revegetation projects can be divided into a six-step process.

Six-step approach to revegetation

Step 1	Develop a revegetation plan; incorporate into your weed management plan – see Section 2.
Step 2	Select a revegetation method.
Step 3	Undertake site preparation (e.g. spot spraying, safety assessment).
Step 4	Order seeds or seedlings and other supplies well in advance of planting time, organise labour, contractors, volunteers etc.
Step 5	Undertake revegetation activity; plant seedlings, broadcast seed.
Step 6	Monitor revegetation and undertake maintenance activities such as watering and weed control.

Considerations when developing a revegetation plan

- Which native plant species are you going to use? Comparing the pre-disturbance and actual plant lists from your sites is a good starting point, but establishing a comprehensive pre-disturbance list is difficult. Use your reference point or site as a guide. The final list will always be dictated by what is available. Consult your suppliers and be realistic about what plant species can be sourced. Contact your natural resource management agency or local council bushcare officer for guidance. Plant lists and guides to plant communities may be available for your area. Some useful resources are listed in Section 7 – Further Information.
- What is the availability of seed or tube-stock seedlings for the species you have chosen to plant? Can the local native nursery be engaged to propagate species they do not currently stock or does your group have the ability to do so? Many species of native plants will not

be available due to difficulties in collecting or propagating from seed. What is the time lag between placing an order with the nursery and availability of viable seedlings? This can easily take over 12 months depending on the species.

- You may need to consider how important local provenance is to your project or site. Local provenance is generally less important for species with seed that is naturally dispersed long distances. With very rare or localised plants, local provenance may be more important. However, advice should be sought from local plant experts or natural resource management officer.
- If you decide to gather seed and propagate seedlings, this requires appropriate permits and knowledge of native plant species, as well as knowledge of when and where to gather seed and propagation techniques such as seed scarifying. Propagation from cuttings or tissue cloning can be done but consideration for genetic diversity is required. See Florabank for guidelines on seed collection for revegetation www.florabank.org.au.
- Rare and cryptic species are often overlooked during restoration programs. It is important to ensure recovery of these species to improve plant community resilience. If you decide to include these species in revegetation efforts, be aware that they are often difficult to propagate, probably occur naturally at low densities, and may require specific habitat of very high quality to survive. If working with threatened plant species, always contact the relevant natural resource management or conservation agency to obtain permits and find out who is working on that species' recovery. You may be able to help each other.

When choosing native plant species to replant, it is preferable to use locally endemic species. You can ensure local provenance by sourcing seeds from nearby bushland. Try to include rare and cryptic species in your list to restore healthy biodiversity.

Importance of hygiene

Revegetation projects can increase the risk of spreading nursery weeds and soil-borne pathogens (e.g. *Phytophthera* spp.). Be aware and follow correct hygiene protocols.

Seed collection will usually require a permit and should be collected according to Florabank guidelines.

More information on revegetation methods can be found in the Border Rivers-Gwydir CMA vegetation management guide (see Section 7 – Further Information).

Site rehabilitation in erosion-prone, dry or impoverished soils

When planting at sites prone to erosion, excessively dry sites or those with impoverished soil, mulching with woodchips may be useful to support revegetation work. See Section 3 page 48 for important information on composting or mulching asparagus weeds on site.

Mulching helps control surface erosion and retain soil moisture, provides habitat for many animals, and can improve aesthetics of a site and reduce the fire risk.

Mulch will eventually decompose, so may need to be topped up regularly until the site is sufficiently regenerated.

Mulch also increases nutrient levels in the soil as it decomposes. **Beware! While this may be beneficial in some instances, higher nutrient levels can have adverse effects on native plants adapted to low nutrient soils (e.g. heath). Many weeds thrive in high nutrient soils, so they may gain a competitive advantage over native plants.**

As mulch can introduce weed seed, be careful where mulch is sourced.

Monitoring

One of the first activities to conduct at your site is monitoring. It will establish a historical summary of the *before* against which you can compare the *after*. In other words, it will provide a benchmark to assess the progress at the site. To ensure that sufficient time and resources are allocated, monitoring should be included in your asparagus weed management plan (see section 2). Many funding bodies require that some form of monitoring be incorporated into your project. Monitoring results will inform project reports and provide quality information for promoting your restoration activities and allowing adaptive management.

Monitoring is the systematic gathering of information or data to answer specific questions. It is used to evaluate the progress and effectiveness of your project by comparing information you gather with your goals and objectives. If done regularly, it will help keep track of progress, show what is working and what is not, help you fine tune your methods and motivate you as it highlights successes. If you set out clear, achievable and quantifiable goals at the beginning of your project, monitoring will be a relatively straightforward and rewarding activity.

Monitoring made easy

Monitoring can be simple and achievable. Every time you visit, you will most likely mentally monitor some aspect of your site. Monitoring is observing the vegetation cover, changes since last visit, progress of a weed control activity, how many seedlings have survived or how big they have grown. The trick is to record these observations in a systematic way that enables measurements and comparisons to be made.

Some tips for good monitoring

- Keep a site diary to record your observations.
- Use simple, consistent methods.
- Make note of any recording methods you develop, use or change.
- Make a series of observations at the same or similar times of year.
- Monitor before and after weed control and restoration activities.
- Collect and record data as you go; for example, estimate of the number of plants removed during hand weeding.
- Collect data from similar but less degraded sites nearby for comparison and reference.
- If monitoring methods are simple and clearly documented, it should not matter who does the monitoring. However, if one person is usually responsible for monitoring, consider doing it with another person or mentoring another person for long-term continuity.
- Seek technical advice before you begin monitoring.

Designing your monitoring questions

Knowing what changes you want to monitor and what questions you want answered is the most important part of any monitoring program. It will determine what data to collect, how to collect it and how often. Monitoring questions need not be complex but they must be specific, measurable and clearly defined.

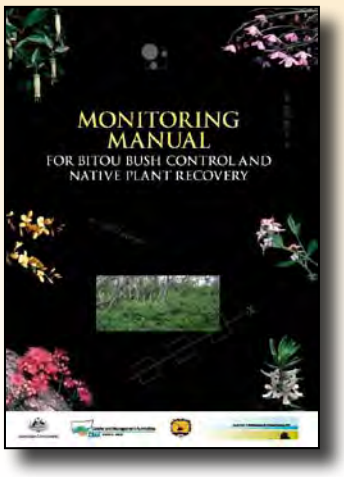
Some possible monitoring questions include:

- **Has the density of the asparagus weed reduced?** This could be monitored by measuring the density of the asparagus weed at a specific point at the same time of season over several years.

- **Has the coverage or density of native vegetation increased?** This could be measured at the same time as measuring the density of asparagus and other weeds.
- **Which control method is most effective?** To answer this question, monitor areas where different control methods are applied and compare results. Make sure your monitoring method is consistent across the different sites.

Bitou bush monitoring manual

The Bitou Bush Monitoring Manual – Hughes *et al.* (2009) outlines a three-tiered approach to monitoring with techniques ranging from simple qualitative assessments to robust research studies, allowing managers to adopt the level most suitable to their objectives and desired outcomes, skills and resources. Available at www.environment.nsw.gov.au/bitouTAP/monitoring.htm.



Selecting monitoring locations

Here are some basic principles for choosing locations to make observations:

- Monitoring locations should be easy and safe to access.
- Establish set monitoring points so that you can return to make your observations from exactly the same spot year after year.
- Mark your monitoring points using GPS or map coordinates, a physical marker such as a stake, or flagging tape tied around a tree or a prominent and permanent feature such as a large boulder, a fence corner post, the junction of walking tracks. It pays to mark your point using more than one of these methods and to record the location with a photograph and entry in your site diary.

Photopoints

This is a very simple but effective method of documenting change and progress. *Photopoints* are a series of photographs recording any activity or feature of your site taken from fixed locations over time. A picture will indeed speak a thousand words to members of your group, the wider community and funding bodies. But it is not as simple as that. There are limitations to photographic records of vegetation. It is often difficult to interpret images of green on green, so photopoints should always be accompanied by observational information or detailed monitoring data such as the density of plants. Photopoints are particularly useful for recording the results of weed control on a large weed infestation over time.

Using photopoints requires preparation and a systematic method, supported by meticulous written documentation:

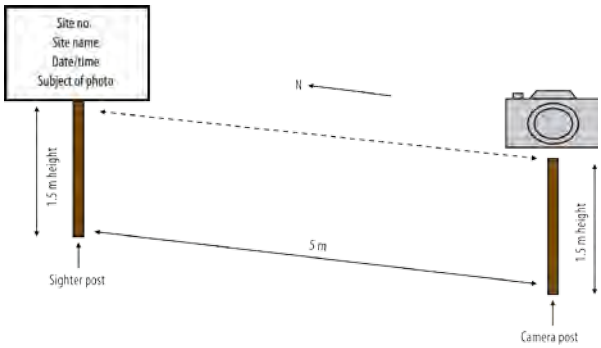
- Establish and record your photopoint locations; GPS coordinates, compass bearings, post markers (see *selecting monitoring* locations). Give each photopoint a unique number or name.
- Return to the same photopoints to record changes over time. It is important to use exactly the same location, face the same direction with the camera at the same height, at the same time of day, so that images are comparable. If possible, use the same camera and lens. Always consider where the sun is and try not to take a photo into the sun.

Follow-up

- A simplified photopoint method is to use two permanently installed posts. Rest your camera on top of one post and place the other post in the centre of the frame. Include an object of known size in the photo for scale. If possible include an identification label for the site. By repeating the same method each time, your photograph will always be taken from the same spot at the same height in the same direction with the post for reference.

Andew Meiklejohn

Install a permanent monitoring marker



Suggested photopoint marker specifications

- Take lots of photos; digital files are cheap – the moment is lost forever. Make sure you have a digital filing system that matches your field notes so you can easily locate and cross-reference images for years to come. Make backups and make sure others have access to this priceless archive.

Things to consider with photopoints

For wider shots, include a reference point (or several) in the camera frame for orientation and scale; a rocky outcrop, the horizon, the edge of a path, or one of your marker posts.

Select a location that dissects the subject vegetation to show its profile; a cutting, a creek, a path. But remember, vegetation develops unique characteristics along fringes.

For detail shots, remember your subject will grow and change over time, so think about multiple close, middle and far distance points.

Observe which direction gives the best lighting conditions and note the time of day; hint: low sunlight angles in early morning or late afternoon can offer ideal lighting conditions for many bush locations.

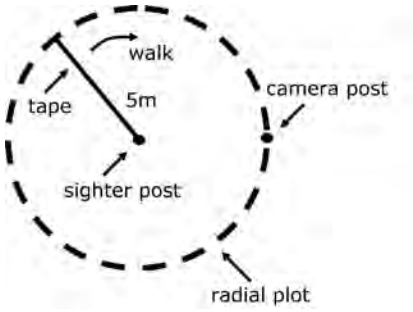
Mark Hamilton

Include a site label in your photographs

Supporting photopoints with observational data

The locations you chose for photopoints can also be used as reference points or quadrats for collecting observational data that will help interpret the images and add new and useful information.

- At a photopoint location marker, use a tape measure or line to permanently mark a circular or rectangular plot (quadrat).



Circular photopoint and monitoring plot

- Make a list of key species to observe, including weedy species.
- Note frequency, density, coverage or other features from the list below.
- A useful feature to note is the age of plants (e.g. seedlings, juveniles, saplings, adults) to record recruitment over time.

The Bitou Bush Monitoring Manual has instructions on how to set up and collect supporting data on plant species abundance.

Site diary

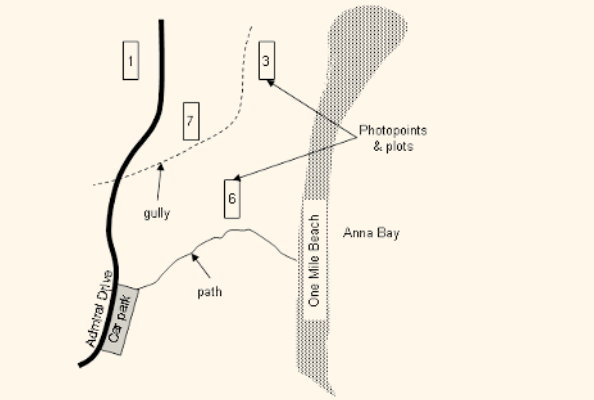
A site diary is indispensible for recording details about activities conducted at your site and observations before and after each activity. It can include species lists, animal sightings, observations about seasonal changes and climatic conditions. To be most effective, ensure that all site and weed management activities are recorded. Make your observations and descriptions as consistent as possible, so they can be compared across the site and over time.

Site map

Drawing and maintaining a map (or series of maps) of your site is an effective way to help you understand your site and is a useful adjunct to the site diary. It is also a key element to developing a good site management plan (see Section 2). If done systematically, maps can chart the dynamics of your site and successes of your control program. Mapping can be an appealing way to employ the more creative members of your group and engage with young people.

A process for mapping your site:

- Start with a base map showing boundaries, basic topography and a few key physical features such as tracks and waterways.
- Each element of your site and control program can be recorded onto different traces or layers to create overlay maps. This can be done using tracing paper, overhead projector sheets or by using computer graphics software.
- Record more detailed information on separate layers super-imposed over the base map, such as distribution of vegetation types, weed infestations, weed control activities and plantings.
- Maps (or layers) can be redrawn and dated regularly or at important stages of your project, then presented in series to show changes.
- Monitoring points, photopoints and sampling areas can be recorded on maps.



Site mud map representing locations of photopoint markers

A set of national core attributes to collect when mapping weeds can be accessed online at www.weeds.org.au/docs/National_Core_Attributes_for_Weed_Mapping.pdf

At a minimum, information should be collected for each of these national core attributes when monitoring and reporting at regional, state or national levels. This will allow your data collection to be consistent and feed into other monitoring efforts.

Other monitoring methods

There are a variety of other methods you can use to monitor changes at your site. Some sampling methods including quadrat and transect monitoring. Details on how to implement these methods can be found in the Bitou Bush Monitoring Manual.

Although this level of monitoring may seem highly technical, it is worth the effort. Enlist the advice of someone versed in environmental survey methods, get some training, and see what level of monitoring can be implemented on your site.

Terry Hemmingway

Transect monitoring

Section 6

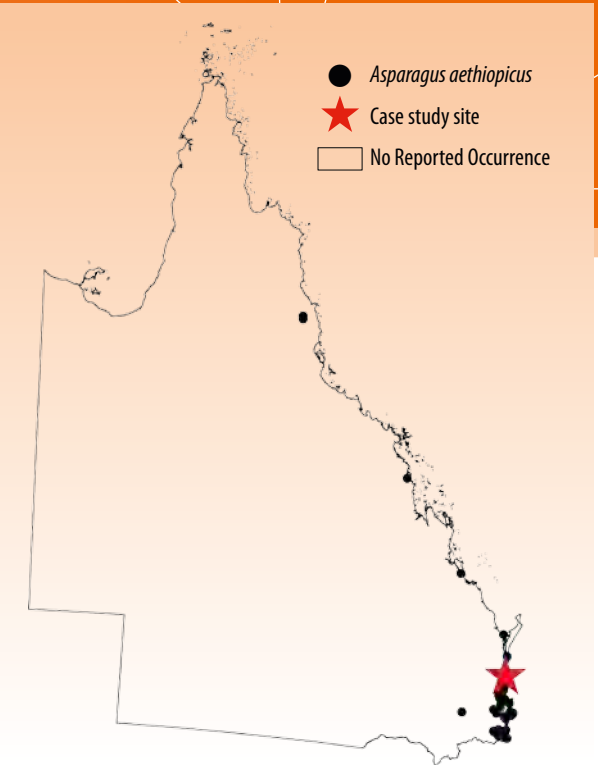
Case studies

First hand experiences in managing different asparagus weeds

Case study 1

Dog walkers unite! Tackling *Asparagus aethiopicus* and other weeds on the dunes at Sunshine Beach, Queensland

Jill Campbell, Sunshine Beach Bushland Care



'A group of local dog owners/walkers watched the native plants disappear from the increasingly weed infested Foreshore Reserve and said to one another, "Somebody should do something", finally realising that the "somebody" was ourselves. So we do.' **Jill Campbell, Sunshine Beach Bushland Care.**

Sunshine Beach Bushland Care was formed by a group of local residents concerned about the degrading dune system where they regularly walk their dogs. The group began working in the dunes in 2004 with support from Noosa Shire Council. Their long-term aim is to eradicate invasive environmental weeds from Sunshine Beach. In the shorter term, however, containment is more realistic, so instead they are aiming for a resilient landscape.

Why is Sunshine Beach important?

Sunshine Beach sits in an environmentally sensitive area. A permanent creek, spring fed from perched lakes, links Noosa National Park to the dunal wildlife habitat corridor. In the 1960s to 70s, the dunes were sand mined and all vegetation stripped. Later, the dunes were replanted with casuarinas and *Sphagneticola trilobata* (L.) Pruski (Singapore daisy), a recommended planting at the time. A range of hardy garden plants also spread in from nearby holiday beach cottages, the major ones being *Asparagus aethiopicus* (ground asparagus) and *Gloriosa superba* (glory lily). Eventually, the foreshore and dunes, parks, reserves and verges were totally weed-infested. Few native ground cover and understorey plants remained. Nearby homes still harbour large numbers of weeds that continue to spread into the reserve.

Killing the weeds: easier said than done

As there was no 'least degraded area' to start with, the group decided to confine their initial weeding to a 10,000 m^2 area. Contractors were initially employed to spray impenetrable swathes of *A. aethiopicus* on the dunes, but this later became a last resort. The problems with spraying included:

- Being unable to work in the area until long after spraying had occurred, as the brittle, sharp, dead asparagus fronds were hazardous.
- Asparagus crowns were often so large that spraying would merely give them a shock and respraying could not be done effectively until months afterwards.
- When the overburden of asparagus was removed, *G. superba* flourished, and the spiky dead asparagus fronds made removing *G. superba* difficult.

Instead of spraying, the group decided that crowning was their preferred control method. 'Asparagus crowning' was pioneered by one of

Controlling Asparagus aethiopicus at Sunshine Beach Foreshore Reserve

After asparagus crowning, native seedlings are planted into the remaining asparagus root mats

their group members a decade earlier. Although crowning is slower, it:

- enabled them to remove fallen *G. superba* seed, as well as other weeds and their seeds,
- had minimal impact on the little remaining native vegetation and minimised erosion, and
- enhanced natural regeneration as the remaining root mats help to retain moisture.

As *A. aethiopicus* does not generally flower until about 2–3 years after germination and control is easier when the seedlings are older, the volunteers have a grace period to monitor and control the weed. *Gloriosa superba* is the other most problematic weed and it does not have a grace period, flowering soon after germination. Constant surveillance is therefore needed to ensure a holistic management outcome. The constant presence of group members at the site has been crucial to stay on top of these threatening weeds.

'The weed problem is so huge that we realize it won't be beaten in our lifetime, but we are pragmatic. We have made a great start and continue with rehabilitation, also trying to increase public awareness and involvement on many levels.'
Jill Campbell, Sunshine Beach Bushland Care.

Gaining additional financial support: community grants

With so many seeds spreading into the reserve, the job seemed too big a task for the group to tackle alone. Discovering they could apply for grants was a great windfall. In 2008, the group received an Australian Government Envirofund grant, which enabled them to employ weed control contractors and to raise community awareness. Since then, they have secured many other grants, via the Australian Government Caring for our Country Program and from local and State government. These grants have accelerated the rehabilitation program, and substantially improved group morale and motivation.

Revegetating using local provenance seed

Given the degraded state of the reserve, revegetation was necessary as soon as possible. However, planting too soon meant that follow-up weeding became a major burden. Hence, the group monitored the rate of natural regeneration and responded where needed.

For dune stability, and biodiversity resilience, it is critical to revegetate with a diverse range of plants. Many plants were not available so they grew their own using local provenance seeds and seedlings. The advantage of propagating their own plants was that it only required the group's labour, and allowed them to use grant money to employ weed contractors and produce community awareness materials.

Adding mulch to weeded sites proved futile as the scrub turkeys would scrape it away. Instead, dead asparagus was left to act as mulch to help protect young plants and prevent new weed incursions. With a recent Caring for our Country grant, the group is trialling a technique whereby water saturated, folded squares of jute mat (400 × 400 mm) are inserted vertically into the front of the

Once smothered by A. aethiopicus, ground cover plants now grow beneath old casuarinas and trees are starting to regenerate

Sunshine Beach Bushland Care volunteers working to restore the degraded dunes at Sunshine Beach

planting hole to act as a dam wall. The aim is to insulate the roots and give the plant stability by trapping sand. A temporary jute mesh is also being used to hold the dune structure.

Follow-up monitoring and control: make the effort worthwhile

Follow-up weeding is critically important as seed continues to spread from nearby suburbia. The group revisits each site a month after weeding, then twice per year, to remove any new weed seedlings and monitor natural regeneration. They also revisit specifically at flowering times. To minimise future spread, the group collects any asparagus seed laden fronds and *G. superba* seed pods they find in adjoining areas.

'Be patient. If you look for quick results, you'll be disappointed.'

Raising community awareness and understanding

Grants also enabled the group to develop community awareness products. Volunteers applied 1000 weed identification stickers to each wheelie bin in Sunshine Beach and these have only been removed from two known bins to date. The Noosa Shire Council considered the wheelie bin stickers to be so successful that they have printed 2000 more stickers and provided them to other community groups across the region.

The group also erected weed identification signs at the reserve entrances and they wear T-shirts identifying their group when they are working in the reserve. They stop and talk to garden contractors working in nearby residences and people walking in the reserve and generally receive a positive response. They also deliver newsletters to keep the community informed and have produced a informational DVD.

Since the program began, many new people have volunteered their time to help, including school groups looking to provide community services. With a committed, core group of about 15 people, and another 50 or so less frequent volunteers, they are able to keep a close eye on the site and rapidly respond to emerging weeds or other issues.

'The only way it's going to get done is with community volunteers.'

Taking a step back to see what they've achieved!

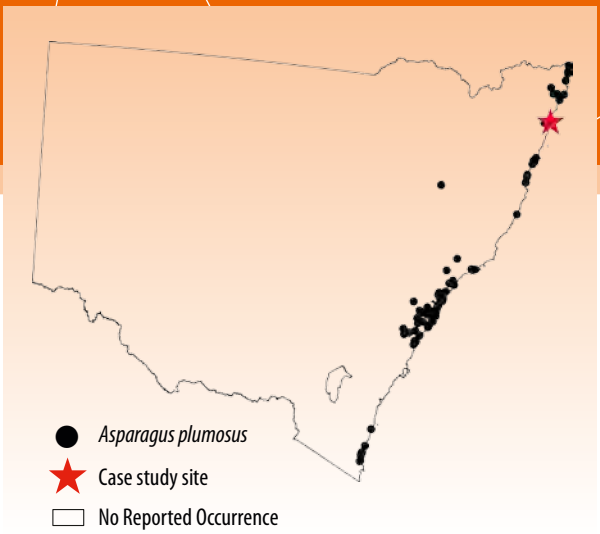
While they acknowledge that management is a very long-term process, the group is already being rewarded with positive results. The project provides them with good exercise, good camaraderie and a sense of worth in doing something for the community and for environmental resilience.

'…when the sand goannas, skinks and coucal pheasants return and move through the previously impenetrable areas it is very satisfying. When the wrens and finches chatter in the grasses and understorey it makes you smile, but when the black cockatoos can eat banksias and casuarina nuts from trees we have grown from seed… it makes your heart glad.' **Jill Campbell, Sunshine Beach Bushland Care.**

Case study 2

Protecting a World Heritage Area from the impacts of *Asparagus plumosus* and other weeds – the Iluka Nature Reserve story

Jeff Thomas *and* ***Steve Hodgson,*** *National Parks and Wildlife Service, New South Wales*
Martyn Swain, *Clarence Valley Council*
Kay Jeffery, *Iluka Landcare Group*



Since 1996, the Iluka Landcare Group with support from NSW National Parks and Wildlife Service (NPWS) have been controlling *Asparagus plumosus* and other weeds within Iluka Nature Reserve as part of an 800 ha landscape restoration project. Iluka Nature Reserve contains 90 ha of Littoral Rainforest, the largest remaining remnant of this endangered community in NSW. The nature reserve is of such high conservation value that it is listed as a World Heritage Area as part of the Gondwana Rainforests of Australia.

Site history

For many years, the Iluka Landcare Group and NPWS were concerned about the ever-increasing degradation of the reserve's natural values which was primarily caused by multi-species weed invasion and disturbance from previous land uses. By the mid-1990s, the problem was at a stage where the reserve was being considered for removal of its World Heritage Area status. Local resources were vastly inadequate to deal with the extent and severity of the problems.

Weed invasion had altered the structural and floristic composition of the rainforest and nearby vegetation and was preventing natural regeneration. Weeds such as *Asparagus plumosus*, bitou bush and lantana were extremely prevalent. Infestations of other potentially devastating weeds such as Madeira vine, *A. aethiopicus* and *Aristolochia elegans* also occurred. Regrowth of *Leptospermum laevigatum*, an Australian species not native to the area that was planted after sandmining, was preventing the regeneration of prime koala habitat on the reserve edge.

Asparagus plumosus was the major threat to the rainforest, with dense infestations covering the ground and climbing up trees. In 1988 15 ha were infested, with 8 ha containing density levels of 50%–100% ground cover. By early 1997 the infestation had increased to 30 ha, with half containing dense infestations and the remainder consisting of many outlying scattered infestations of individual plants and small clumps.

In December 1996, the Iluka Landcare Group with support from NPWS was successful in gaining $79,700 in funding from the NSW Government's Environmental Trust for a bush regeneration project centred on Iluka Nature Reserve.

Setting priorities and developing a plan

Revised mapping of all weeds conducted in 1997 outlined the extent and severity of the infestations. Even with the large grant received, the group would be unable to deal fully with the scale of the problems, so priorities had to be set.

These priorities considered: 1) threats posed by weed infestation; 2) area, species and level of infestation; 3) resources available; 4) ability, enthusiasm, expertise and interests of participants; and 5) requirements for follow-up work after project conclusion.

Asparagus plumosus is the priority weed being managed within Iluka Nature Reserve

Bitou bush (above) and many other weeds are being managed as part of a holistic management program

Asparagus plumosus vines were cut at head height, then at ground level, and regrowth sprayed

A plan was developed by NPWS and the Iluka Landcare Group which allocated resources and responsibilities. As envisaged, the majority of the funds were for a bush regeneration contract which focused on the arduous and technically demanding job of controlling the *A. plumosus* infestations in the reserve and the multi-species infestations on the reserve margins fronting the urban areas.

Due to the existing and potential impact of *A. plumosus*, it was targeted as the major priority for contract work. The approach was for all treatment areas to receive an initial and two follow-up treatments with specific targets to be met. The purpose was to undertake as thorough a treatment as possible to reduce the threat to the rainforest and bush and minimise follow-up.

The method adopted was to initially cut the vines at head height, which were climbing into the canopy, and to recut the vines at ground level and then spray the regrowth. This initial treatment was extremely time consuming. Vines were cut over a 3–4 month period commencing in winter 1997 and then sprayed the following autumn-winter when regrowth was 10–15 cm high. A 1:50 glyphosate:water mixture with the additive Li-700® was used to minimise off-target damage and the volume of herbicide used. Many plants were also crowned, hand removed and hung to dry.

Follow-up monitoring and control

After two years, the asparagus infestations were less than 5% of their original densities and regeneration of rainforest seedlings was abundant. Follow-up occurred annually over the next 5 years and concentrated where the densest infestations originally existed. Plants missed previously and newly emerged seedlings were targeted.

Over the last 8 years, work has continued as needed at intervals of 1–4 years. Small amounts of new asparagus seedlings or juvenile plants have been treated, often by Iluka Landcare Group members. Other features of the project included training the community group in bush regeneration techniques, creating awareness and support in the local and broader community and involving volunteer groups to support the Iluka Landcare Group's work on multiple sites.

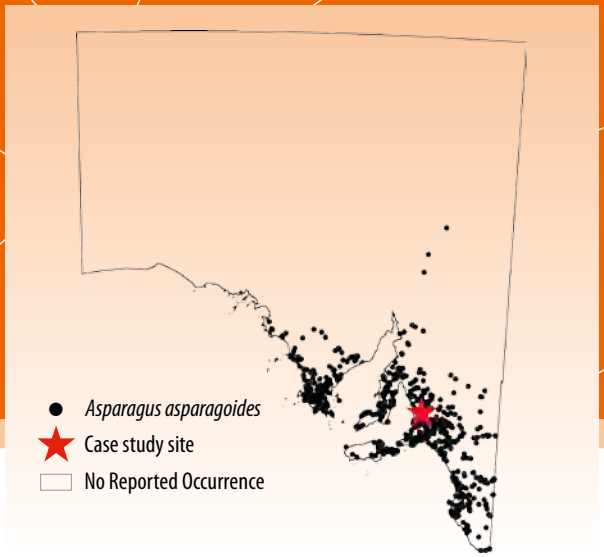
Success

Asparagus plumosus infestations are less than 1% of original infestation levels in the Iluka Nature Reserve. The program has expanded to treat weed infestations on nearby public land, in cooperation with Clarence Valley Council, and a successful pilot program was run to provide free weed control for private residences. This project is part of a wider landscape restoration project spanning 800 ha of heavily weed-infested area that includes Iluka Nature Reserve, Bundjalung National Park and public lands managed by Clarence Valley Council. Restoration has now been implemented over approximately 80% of the 800 ha project area by all three levels of government, Iluka Landcare Group, and other volunteers. A long-term, systematic and persistent effort is essential to achieving restoration aims.

Case study 3

Western Cape bridal creeper: a threat to natural ecosystems in the Adelaide and Mount Lofty Ranges

Tracey Hardwicke, *Natural Resources AMLR, Department of Environment, Water and Natural Resources, Adelaide and Mount Lofty Ranges*



Bridal creeper is well known as a plant that smothers native vegetation, affecting both the canopy and understorey. The common form is widespread throughout the Adelaide and Mount Lofty Ranges (AMLR) region. Biocontrols such as the rust fungus (*Puccinia myrsiphylli*) are very useful in reducing the impacts of the common bridal creeper.

The Western Cape form of bridal creeper is larger and more vigorous than the common form.

Unfortunately the rust fungus does not affect the Western Cape form and it may replace common bridal creeper, undoing years of successful control.

Natural Resources AMLR helps protect the region's parks, reserves and bushlands through programs that target weed threats to natural ecosystems. One of the highest priorities is the eradication program for Western Cape bridal creeper.

The underground tubers are the best defining characteristic of Western Cape bridal creeper, forming a tight rosette around the rhizomes that grow close to the ground surface

An eradication target

The Western Cape form is not widespread in the AMLR region. It currently affects a small area in the region's north, infesting public and private lands. This is one of only two areas in Australia affected by Western Cape bridal creeper, with the other spanning the South Australian-Victorian border. Due to the threat, impacts and small size of the infestation, Western Cape bridal creeper has been an eradication target in the AMLR region since 2007.

Western Cape bridal creeper plants were initially identified in Angove Conservation Park in Tea Tree Gully in 2006. A survey of the broader area was undertaken in 2007 and control initiated. The main infested areas were Anstey Hill Recreation Park and properties along Range Road. The area is generally covered with low eucalypt woodland with either a heath or grassy understorey. The terrain is hilly with steep rocky gullies and several old quarries. This makes conditions treacherous for contractors and requires the use of safety harnesses. Affected

The leaves of Western Cape bridal creeper are generally larger, thicker and darker than the common form

Grubbing became the preferred method for controlling mature Western Cape bridal creeper

One of many dense infestations of Western Cape bridal creeper growing in the AMLR region, prior to control

areas are also sometimes infested with gorse or blackberry, prickly weeds that create difficult conditions for the detailed searching required.

Approach to management

Trials were undertaken early to identify the best control approach. Grubbing was selected to control mature plants, as it was a far more effective than spraying. While plants were suppressed and prevented from fruiting the following season, the herbicide did not kill these plants and they eventually re-established. Seedlings were successfully controlled using glyphosate (450 g/kg) at a rate of 1:100 water, plus wetting agent.

The initial cost for grubbing is expensive but it is far more efficient in the longer term. Masses of seedlings germinate after removal of mature tubers and these are spot sprayed. This combination of grubbing mature plants and spot spraying seedlings is a more targeted approach that reduces the risk of off-target damage to native lilies and orchids, which are active at the same time of year as the control program. To further manage this risk, specialised bushcare contractors are engaged.

Natural Resources AMLR works closely with the City of Tea Tree Gully and Adelaide Hills Councils. Many volunteer groups, such as the Friends of Anstey Hill and North East Hills Environmental Conservation Association, also contribute significantly to control in public areas. The AMLR NRM Board successfully secured funding via the Australian Government Caring for our Country initiative for Natural Resources AMLR staff to implement this high priority program. These funds were used to employ specialised contractors to conduct on-ground works. Public awareness activities are also part of the program and are very important for private landholders.

'It is vital to have community input and support and a committee has been formed to facilitate this.'

Key challenges and successes

Occasional new outlying plants are still being located, but these are usually single plants rather than established sites.

In this region, Western Cape bridal creeper threatens an area of 1400 ha and over 150 private properties. Natural Resources AMLR surveys the area annually and controls all plants. Due to the eradication status of this weed, and the importance of finding and removing every plant, these services are offered to landowners free of charge. Liaison with landowners to gain access and carry out on-ground works is intensive.

In 2007, 15 tonnes of tubers were grubbed from the area and disposed of by deep burial. In 2011 and 2012, close to two tonnes of tubers were removed, as the thickest, densest and easiest to find infestations were removed early in the program.

'Remaining plants are now harder to find and much more on-ground searching is involved, especially in the more difficult to access terrain.'

The program is clearly getting closer to eradicating Western Cape bridal creeper from the AMLR region, but a continued, long-term effort must be sustained.

Case study 4

Protecting rare and endangered species through the control of *Asparagus declinatus* and *Asparagus asparagoides* in South Australia

Kieran Brewer, *South Australian Indigenous Flora*

Adelaide based bushcare company South Australian Indigenous Flora (SAIF) has extensive experience in controlling asparagus weeds in sensitive bushland areas across SA. Their focus of management is on the preservation of rare species and building the resilience of native vegetation, with the surgical removal of weeds being one means to achieve this. The company has worked with Parks SA, natural resource management boards, local councils, community groups and increasingly on private property. Numerous projects have involved the control of common bridal creeper (*Asparagus asparagoides*), which is widespread across the State, and to a lesser extent *A. declinatus*, which has a more restricted distribution in the Fleurieu Peninsula and other southern areas of SA.

'We think the best way is to come from an environmental perspective, not a weed control one.'

A holistic approach

SAIF conducts weed control from an ecological perspective, minimising ground disturbance and reducing the risk of further weed invasion. Sites are first carefully surveyed. If new populations of rare plants are found, they are recorded and seeds gathered for cultivation and later planting back into the site. Management techniques are adapted to work around native plants.

'We identify every rare plant and use a lot of markers. We don't spray anywhere near them to make sure there's no off-target damage. We'll either cut and swab or do delicate hand pulling.'

On the most sensitive sites, only the most experienced staff are assigned in order to avoid compromising the native plants.

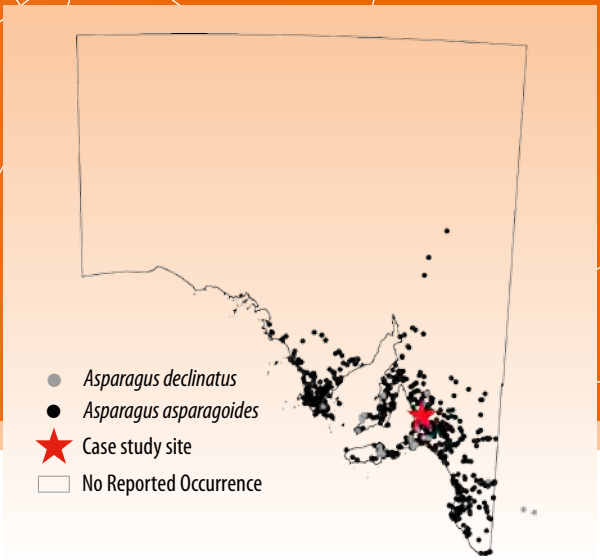
'Really good spray operators are not born, they're made. It's about concentration. It can't wane in the afternoon. You've got to be right on it all day. You only get good by thinking about it and working at it for many years.'

Experience has shown that weed control projects are best conducted on a landscape scale to achieve long-term success, generally over an area of at least three to five hundred hectares. This sometimes encompasses 20–25 different properties, requiring a lot of coordination to get everyone involved and finding ways of working around those that decline. Another lesson learned is that project time frames need to be at least four years for weeds like *A. declinatus* and much longer for broom and gorse.

'If you're not in it for the long haul you're wasting your time. There's not enough money to do what needs to be done. That means we have to spend every cent effectively if we're to make a difference.'

A narrow window of opportunity

There is only a brief window of opportunity to control *A. declinatus* and *A. asparagoides* when many sensitive native plants are dormant and the asparagus weeds are still active. SAIF has developed a specialised technique tailored to managing *A. declinatus* and *A. asparagoides* that



requires detailed understanding of plant life cycles, soil types and climatic conditions.

In the Adelaide Hills and Fleurieu Peninsula regions, many native annuals such as orchids, lilies and ferns withdraw into their rootstock for a period of summer dormancy with the onset of hotter, drier conditions in mid to late spring. The asparagus weeds, with their larger tuber and rhizome systems, persist a few weeks longer on the surface. During this time they can be sprayed without impacting the dormant native plants.

Spraying with a strong solution at this stage of their cycle has proven particularly effective, as the herbicide is drawn down into the rootstock. However, younger seedlings fade earlier in the season and are likely to be missed. It is important to revisit the site during the same window of opportunity the following year to manage seedlings.

'If the project runs for three to four years, you've got a good chance of picking up all the weeds.'

Refining the technique

Knapsack foliar spraying using metsulfuron-methyl at 5–7 g per 100 L is the preferred application. A surfactant is added, which makes the herbicide go further and helps penetrate the waxy asparagus foliage. Fine spray nozzles are used on the very fine foliage of *A. declinatus* which enables the operator to apply small hits onto little patches and avoid overspray. Dye is used to keep careful track of applications.

'Metsulfuron-methyl is very effective on A. declinatus and A. asparagoides. Glyphosate will work but it is less selective and can do a lot of off-target damage.'

Instead, glyphosate is used to treat watsonia (*Watsonia meriana* var. *bulbillifera*) and African cornflag (*Chasmanthe floribunda* (Salisb.) N.E.Br.) using similar principles to those for asparagus weeds.

Reading the sites – timing is key

There is a lot of variation from site to site, so each must be assessed individually and its conditions understood. During the brief window of opportunity, usually in October to early November, the work is intensive. As rainfall and temperature vary from year to year, so does the timing. This makes it difficult to forward plan and cover multiple, dispersed sites. For example, plants will dry off earlier at sites with a northerly aspect or on exposed heights and will linger longer at sites with a southerly aspect or in sheltered valleys where it is cooler and wetter.

Soil type and weather conditions affect how long metsulfuron-methyl has a residual activity in the soil. When to control must be carefully planned around predicted weather conditions to limit damage to off-target plants. Typically, there is a two-week dry spell after spring rain events, giving sufficient time for the herbicide to become inert.

Asparagus asparagoides before treatment in grey box grassy woodland, Belair National Park, Mount Lofty Ranges, SA

Grey box grassy woodland, Belair National Park, Mount Lofty Ranges, South Australia

Additional time is needed in acid soils as the chemical is more persistent. Soils rich in organic matter tie up the chemical and prevent it from affecting other plants.

There is a high level of knowledge and expertise required to use metsulfuron-methyl effectively in bushland settings. Excessively high rates, heavy applications, wet conditions and limited understanding of soil types and native ecology can lead to devastating off-target damage.

Making bushcare everyone's business

SAIF director, Kieran Brewer, sees bushcare projects as an opportunity to share knowledge about native plants, ecology and weed management.

'You work with people who really know their plants. Volunteers have got a strong connection with their conservation site, their heart's in it, they've got intimate knowledge and they're great to work with.'

A project running in the Mt Lofty Ranges demonstrates that working closely with a community group can disseminate skills, build long-term capacity and manage fragile species. The Woodcutters Road Environmental Protection Association, formed to conserve natural heritage values across their adjoining properties, which contain some high-value bushland, manages the project. A spectrum of weeds is present including *A. asparagoides*. Weed control by contractors is into its fourth year. Populations of nationally endangered pink-lipped spider-orchids (*Caladenia behrii* Schltdl.) and stiff white spider-orchids (*Caladenia rigida* R.S.Rogers) are carefully managed. An integral contribution is being made by a community member who was mentored by a NRM Officer, received training and now monitors the progress of every single plant, recording population, flower count and seed set.

Achieving success

Maintaining focus on the core outcomes of preserving rare species and building the resilience of native vegetation has been the key to success with SAIF's projects. Weed management is always conducted within this context and control techniques are carefully selected and timed to limit damage to existing native vegetation.

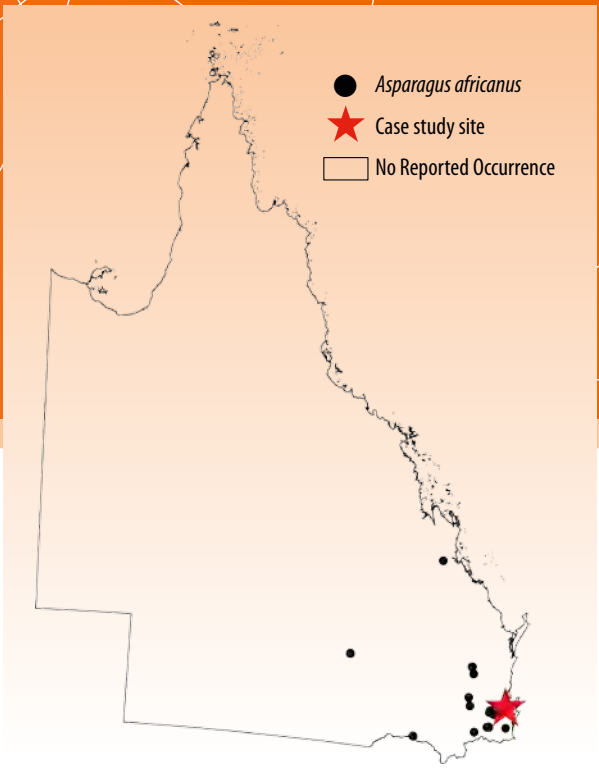
Over the course of weed management, sites are carefully monitored and documented, using multiple photopoints, mapping, written reports each season and site visits with clients to discuss progress. After sufficient time has passed to show weed control objectives have been met, a final inspection with the client usually concludes the sign-off process. Long-term monitoring and maintenance is then continued by the client, often by a dedicated community group.

'Instead of weeds you see all the native plant cover you'd ever want.'

Case study 5

Protecting a Ramsar-listed wetland from the impacts of *Asparagus africanus*

Brisbane City Council



Brisbane City Council (BCC) has been controlling *Asparagus africanus* (climbing asparagus) for the past 5 years within the Boondall Wetlands to protect these valuable coastal wetlands from total canopy destruction. Having largely contained the problem, they are now shifting their focus to reducing the volume of asparagus within the Reserve.

Faced with a suite of over 450 potential or present weed species and an area of 8000 ha of natural areas to manage, BCC must prioritise weed management activities to specific weed species and areas. *Asparagus africanus* has most recently been declared a class C or widespread pest that is to be controlled when within or adjacent to natural areas under the Brisbane Invasive Species Management Plan 2013–2017.

Asparagus africanus is recognised as a serious threat to ecosystem function within the Boondall Wetlands Reserve and is targeted more aggressively as a result.

The Boondall Wetlands lie at the edge of the Moreton Bay Ramsar Site, which is one of Australia's largest Ramsar sites and is internationally important to migratory shorebirds. The Wetlands are extremely diverse, with over 1000 ha of tidal flats, mangroves, salt marshes, melaleuca swamps, casuarina forests, grasslands, open eucalypt forests and woodlands. This diverse landscape supports a huge variety of plants and animals, many of which are rare and endangered.

What is the problem?

In the past, a range of weeds (most notably groundsel bush – *Baccharis halimifolia* L.) have disturbed the Wetlands and been managed through a species-led approach. During the most recent period of drought, *A. africanus* expanded rapidly, threatening the structure and integrity of the established canopy. By the time this was recognised, *A. africanus* had heavily infested an estimated 100 ha of the reserve. Infestations occurred predominantly within the melaleuca swamps and casuarina forests, where entire curtains of the weed were forming and creating impenetrable barriers. The weed was also colonising the neighbouring eucalypt woodland areas at a rapid rate.

'The wetlands are extremely sensitive to disturbance and have limited access options. Control activities therefore needed to strike a balance between reducing weed species vigour and limiting disturbance.'

This was never more evident than when BCC attempted to use large groups of workers, working in lines, to manually remove asparagus crowns by hand in Boondall Wetlands. Though this chemical free approach was effective in suppressing weeds, there was an unfortunate unintended consequence of damage being caused to regenerating and

The problem: entire curtains of Asparagus africanus have formed and created impenetrable barriers

A range of methods were used to control Asparagus africanus in different situations

remnant native plants from the volume of people moving through this fragile ecosystem. This incident highlighted the advantages of small-team operations in such a sensitive area.

Access and control options are limited in this area. The wetlands are greatly influenced by tidal inflows limiting the location and extend of chemical use to avoid water pollution. Matching management techniques to appropriate tide and location within the landscape is crucial to maintaining this internationally significant natural area.

Selecting the right management methods

In recent years, it has become apparent that effective management of *A. africanus* requires a commitment of at least 5–10 years when dealing with a mature infestation. Focused attempts to control it within this site commenced in 2008.

Brisbane City Council has tried a range of control methods in different situations, working out what does and does not work. They have found that no one method is best for all situations and often a combination of techniques is required for any particular site.

1. Working out what doesn't work

The first priority was to free the native canopy of the dense curtains of *A. africanus*. Early attempts to either spray *in situ* or hand remove the aerial infestation created additional disturbance either through off-target herbicide damage, increased light infiltration or, in many cases, both. Attempts to remove the entire root system from the ground also disturbed the soil. These disturbances resulted in damage to some nearby native plants and provided gaps for other weeds to colonise.

2. Severing the aerial stems at the crown

It was quickly realised that the best way to limit disturbance was to sever all aerial stems directly at the crown and leave the aerial component *in situ*, where it could continue to restrict light availability to the canopy floor as it gradually died off. Unfortunately, severing the aerial stems without controlling the root system has resulted in robust ground infestations that were suppressing grass and native seedling recruitment, so chemical control methods were selected to control these.

3. Chemical spray only in specific areas

Early attempts to use glyphosate-based products were found to be destructive even though they were largely selected for their suitability for use in aquatic situations. Glyphosate killed desirable plant species as readily as it did the weeds and it actually seemed to enhance the ability of *A. africanus* to take over. On this basis, spray treatment was suspended in wet areas altogether and fluroxypyr-based products substituted as a selective spray, where grass cover was adequate and native broad-leaf seedling recruitment limited.

4. Crowning in areas where chemicals cannot be applied

In other areas, where the above techniques could not be applied, the crowning method was used. Although time consuming, this method

After Asparagus africanus control it looks like the weed is gone, but follow-up monitoring and control is now critical to ensure that it stays that way

was considered to be very effective at killing *A. africanus* with little damage to other plants. Crowning involves either cutting and removing the crown directly from the adjoining root system or cutting into the crown and applying herbicide. Initially, fluroxypyr or glyphosate was used but, more recently, fluroxypyr has been abandoned as it was considered to be no more effective than glyphosate for this purpose.

5. Managing other invasive vines

Ipomoea cairica (mile a minute) is the other invasive vine in these areas that requires aggressive management. It is managed in the same way as *A. africanus* except that 2,4-D-based products are used as they are considered to be more effective than fluroxypyr-based chemicals.

Follow-up monitoring: making the effort worthwhile

Until 2010, there were only anecdotal indicators of any real success. After this, new assessment and monitoring practices were implemented. Within the reserves, the exact frequency and volume of treatment to be undertaken varies. However, history indicates that a minimum of four individual interventions per growing season are required to ensure positive success. Since 2008, a clear trend towards better recruitment of native plant species and a reduction in *A. africanus* density has been observed. Annual site evaluations are conducted to assess the overall increase or reduction in weed densities as well as other outcomes such as disturbance created through treatment and weed hygiene management practices.

Photo-monitoring is used at these locations, but with limited success to date due to:

- seasonal variation causing difficulty distinguishing between weeds and desirable vegetation in photos,
- symptoms of recent herbicide damage demonstrating short-term weed suppression in photos that may not necessarily translate to long-term management,
- difficulty in observing species succession from a landscape photograph, and
- pickets or other markers used to guide the photographer back to the same location often being moved or stolen.

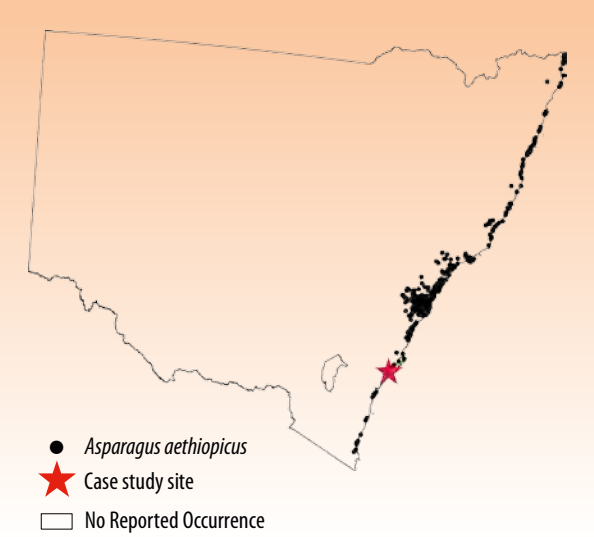
To enhance monitoring efforts, steps are now underway to set up mounted time-lapse cameras and permanent transects.

Brisbane City Council has also commenced a proactive weed survey program that employs contractors to assemble a complete inventory of priority weeds within core reserves to develop a strategic framework for their management and provide a baseline measurements. Boondall Reserve was a pilot site for this activity in 2011 and was monitored again in 2013. The 2013 survey indicated that, since 2011, there was a 20% reduction of *A. africanus* in most parts of the site and limited to no increase in infestations in adjoining areas. The aim set by Brisbane City Council to contain and gradually reduce *A. africanus* within these areas is clearly being realised.

Case study 6

Regenerating the Narrawallee Beach Dunes: controlling *Asparagus aethiopicus* to restore an Endangered Ecological Community – Bangalay Sand Forest

Alasdair Stratton *and* ***Kerry Thompson,*** *Shoalhaven City Council;* ***Wendy Fuller,*** *Narrawallee Bushcare Group, New South Wales*



The Narrawallee Foreshore and Reserves Bushcare Group have been managing *Asparagus aethiopicus* within the local dunes since 2005 to protect the dunes from further degradation by this weed. The group's long-term aim is to encourage regeneration of the native understorey, improve local biodiversity and increase the resilience of the dunes.

Narrawallee Beach dunes are located along the south coast of New South Wales and sit just south of the 880 ha Narrawallee Creek Nature Reserve. The fore-dune vegetation consists primarily of Coastal Foredune Scrub. The hind-dune area is dominated by Bangalay Sand Forest, which is listed as an Endangered Ecological Community under the New South Wales *Threatened Species Conservation Act 1995*.

What is the problem and how are they managing it?

The dunes were heavily disturbed during the early residential sub-division of Narrawallee Beach township and the vegetation was degraded as a result. Over time, large areas of the Bangalay Sand Forest understorey had been invaded by dense infestations of *A. aethiopicus*, up to 90% of the understorey in some sections. *Asparagus aethiopicus* had reached such a high density that it was completely suppressing regeneration of germinating native species, which was causing the Bangalay Sand Forest to senesce. This prompted the Narrawallee Foreshore and Reserves Bushcare Group to act.

Gain financial support

The Narrawallee Foreshore and Reserves Bushcare Group, with support from Shoalhaven City Council, applied for funding and received two successive Australian Government Envirofund grants. The grant funding was used to pay professional contractors to conduct initial control activities in areas of high weed density which were beyond the capacity of the volunteers. This was a great help, as the group had limited labour resources to draw upon.

Control the weed and encourage native plant regeneration

To encourage native plant regeneration and increase resilience at the site, the group undertook two phases of control. Primary control focused on removing *A. aethiopicus* from a contained 7.5 ha area of the foredune and hind dune zones. Of this area, about 2.3 ha had high density infestations of *A. aethiopicus* and the remaining area had medium to light density infestations.

Contractors were employed to manually control the 2.3 ha of dense infestation. They did this by removing the crown and leaving the root mat and tubers in the ground. The group insisted that

In 2005, Asparagus aethiopicus dominated the Bangalay Sand Forest understorey

Working together, the volunteers and contractors removed many truckloads of Asparagus aethiopicus

only hand removal was to be undertaken for two main reasons: spraying would lead to hectares of dry, dead fronds that could be a fire hazard and removing the crowns would allow maximum natural regeneration.

Despite being more resource intensive, manual control techniques were selected by preference, as the group considered these methods would better encourage native plant regeneration in the area.

As a trial, they also chemically treated a small 20 × 10 m zone using metsulfuron-methyl. They found that this method was effective in controlling *A. aethiopicus*, but asparagus seedlings continued to germinate from the soil-stored seed bank and there was little to no regeneration of native seedlings. The number and diversity of native seedlings that naturally regenerated over the next 5 years was substantially less in this area compared with where they had manually controlled the weed. It should be noted that spraying of the trial area was undertaken in the middle of a prolonged dry period of 10 years, with lower than average rainfall occurring. Although metsulfuron-methyl has been used successfully to control asparagus weeds in other environments, the fact that it caused such detrimental impacts here highlighted the importance of conducting a small-scale trial under these specific climatic and ecological conditions, before attempting to use it more broadly.

'There was almost no regeneration of endemics (where A. aethiopicus was sprayed) until the present very wet season, yet there was amazing natural regeneration everywhere else in the immediate vicinity.' **Wendy Fuller, Narrawallee Foreshore and Reserves Bushcare Group.**

Follow-up monitor and control for many years to come

Following primary control efforts, the group continued to look for and manually remove any new seedlings over the next 2 to 5 years. This proved to be an exercise in patience and perseverance, with seedlings continually germinating from the vast seed bank. For ease of control, they waited until the leaves had formed before removing the seedlings, since research indicated that they would not set flower and fruit within the first 2 years. This meant they could concentrate on removing only larger seedlings during each sweep of the site, but checking to ensure that no seedlings were allowed to flower.

'Trying to remove the smallest seedlings wasted time and effort as more often than not the small fronds would break off and, with the high likelihood that they would re-shoot, we'd have to return to remove them a season or two later. We used our available time on the greatest threat.' **Wendy Fuller, Narrawallee Foreshore and Reserves Bushcare Group.**

To remove asparagus seedlings during these secondary control and maintenance stages, the group used a simple 3-pronged garden hand fork with the outside prongs ground off, turning it into a type of hook. They found it created minimal

By 2012, the densest infestations of Asparagus aethiopicus have been removed and native plants are regenerating in the once degraded Narrawallee Beach Dunes

disturbance and made their work faster, easier and safer than using a knife or folding saw. It is no good for removing large plants, however.

Control efforts were conducted during a long period of drought, which may have influenced the effectiveness of different control techniques and the rate of native plant regeneration. Since the drought broke in 2011, the group has observed an increase in the number and diversity of native plant species that have germinated.

Although no formal before and after monitoring has been conducted, members of the Narrawallee Bushcare Group have maintained a constant presence on the site since they commenced control, and have watched the site change over time. Casual observations from the group indicate that the percentage and abundance of ground cover species has increased on the dunes, with various species of terrestrial orchids being observed germinating for the first time.

Deal with other weed incursions

In the same area, *Pittosporum undulatum* Vent. (sweet pittosporum) had become dominant in the lower and mid-storey, and appeared to be altering the diversity of the Bangalay Sand Forest. Although native to Australia, *P. undulatum* is a semi-rainforest pioneer that may be responding to changes in soil moisture and fire regimes.

As a result of this, Shoalhaven City Council prepared a Review of Environmental Factors (REF) into the possibility of undertaking a staged control program of *P. undulatum* at Narrawallee. The REF suggested using a combination of controlled burns, manual control and cut paint or direct injection using neat glyphosate. They are also replanting 10% of the eucalypts each year to augment natural regeneration.

Some secondary weed invasion, mainly from *Lilium formosanum* A.Wallace (Formosan lily), has also occurred where *A. aethiopicus* has been controlled. Narrawallee Foreshore and Reserves Bushcare Group are controlling this using a snip-drip method with neat glyphosate and it has taken 5 years to reach a point where *L. formosanum* infestations have been significantly reduced to less than 20% of the original population.

Enjoy the success, but keep a watchful eye

Within 7 years, the group has achieved its initial aim of removing the densest infestations of *A. aethiopicus*, and is maintaining the effort by monitoring the site annually to ensure that it does not re-establish again. Native plant regeneration is already occurring in the once degraded parts of the foredune vegetation as well as the Bangalay Sand Forest Endangered Ecological Community. This will help build resilience against future invasion of this or other weeds.

***'Natural regeneration has surpassed all our expectations and we are also witnessing the return of several species of ground orchid and small birds.'* Wendy Fuller, Narrawallee Foreshore and Reserves Bushcare Group.**

Case study 7

Managing emerging asparagus weeds on the mid-north coast of New South Wales – *Asparagus virgatus* and *Asparagus falcatus*

Peter Michael, Port Macquarie-Hastings Council

Asparagus falcatus (sicklethorn) and *A. virgatus* are two emerging asparagus weeds that are currently being managed by Port Macquarie-Hastings Council. Whilst they are in low abundance relative to other vines and scramblers, the Council is working to ensure they remain '[two] less transforming vine weeds they have to worry about'.

For *A. falcatus*, Council's objective is to eradicate the weed in all instances. It is in the early phase of establishment (sparse, isolated infestations, largely not yet naturalised) and eradication of these infestations is feasible and desirable based on the potential impact if left unmanaged. By comparison, *A. virgatus* is more widespread and more difficult to control than *A. falcatus*. Therefore, Council aims instead to protect priority areas from this weed (i.e. areas of high conservation value), and in so doing, target resources systematically (e.g. locate, map, control, monitor) to prevent further spread and gradually reduce local infestations.

What is the problem?

Asparagus falcatus displaces native vines and scramblers in a range of ecological communities, is tolerant of a wide range of site conditions (e.g. coastal wind, salt water near the root zone, full sun to deep shade, variable substrata) and is spread by birds and other animals. It, therefore, has the potential to spread widely and invade a range of coastal environments, including cliffs and headlands, littoral rainforest and wet sclerophyll forest. Infestations usually consist of an established 'parent' plant (founder) with diffuse cohorts spread up to 150 m away, but it is likely that the range of bird dispersal is much further. Although *A. falcatus* is quite distinct at maturity, at the seedling stage its sickle-shaped cladodes can be mistaken for other native seedlings such as *Morinda jasminoides* A.Cunn. or *Podocarpus elatus* R.Br. ex Endl.

Asparagus virgatus causes impacts to native ground cover and understorey plants. It is capable of invading almost all ecological communities that occur along coasts and coastal plains. It forms a dense mat of water-hogging roots that can prevent the germination and establishment of other species. The root systems and foliage often co-mingle with desirable vegetation, making access for digging and off-target damage from foliar spraying problematic. The fine, fern-like foliage provides little surface area on which to apply chemicals. Infestations can spread beneath tree roots, rocks and logs, making physical removal very difficult.

Both species grow in a range of coastal environments and can germinate in conditions from full sun to more than 80% canopy closure.

How are they managing the problem?

Port Macquarie-Hastings Council is actively managing these two weeds in public bushland,

This A. virgatus has recovered from a recent flood that covered it in silt and water. As its roots are heavily mingled with rainforest tree roots, digging is not feasible, so foliar spray will initially be applied

Asparagus falcatus growing in marginal Casuarina glauca forest near Lake Cathie, New South Wales

road reserves and Asset Protection Zones and on private land by way of landholder engagement and education. Given the biological differences between the two species, the approach to management has also differed.

Asparagus falcatus

To date, all located individuals of *A. falcatus* have been accessible and able to be treated. When detected, a first attempt is made to locate the infestation source by ground-based inspection of the surrounding area. This is easier in bushland areas, but much more difficult in urban and peri-urban areas. Delimiting infestations of new and emerging weeds remains extremely resource-constrained and surveys may under estimate the true extent of the weed. Consideration is given to factors such as the likely vector(s) of dispersal, proximity-to-patch (the 'pull factor') and possible corridors and stepping-stones for seed dispersal at the sub-landscape level. When located, records are mapped into a GIS layer to make later treatment easier as well as increase the understanding of possible sub-landscape level distribution patterns.

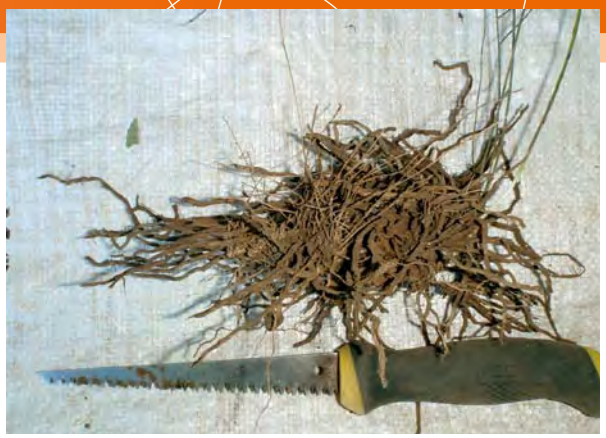
For a given infestation, all cohorts are treated within 12 months of detection. Plants are typically treated by using the 'crowning' method (crown removal) and removing as much fruit as practicable. Stems are left hanging out of contact with the soil. If resource constraints do not allow for removal in the first instance, foliar application of herbicide may be used to retard growth (and kill off some individuals) and limit further impact.

Although more time consuming, Council has found that crowning is entirely effective and preferable when working in marginal swamp oak and riparian areas, when herbicide application may be unsuitable or undesirable.

After an initial treatment, sites are usually revisited within 1 to 6 months for any necessary retreatment. Ongoing monitoring is implemented and the site treated annually to remove any new individuals and – in bushland areas – facilitate natural regeneration.

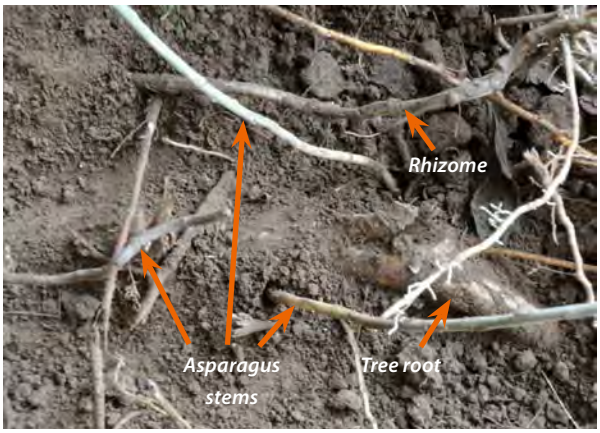
To date, only small infestations of *A. falcatus* have been found and 'best practice' methods are being used to locate, map, control, and monitor all sites. If the situation were to get 'worse' (i.e. increase in abundance and/or impact) and many dense infestations were found, council would revise weed risk assessments and adopt a different approach to management that focuses on protecting priority areas. This may mean the focus shifts from a solely eradication-centred technique being applied in *all* cases (labour intensive crowning and removal) to a combination of techniques that reflect the dual objectives of targeted eradication on some sites (typically outliers and new infestations) and suppression/gradual reduction on others (large/founder populations). These integrated techniques may include crowning, basal barking and foliar spraying. However, eradication remains the goal at present.

Asparagus virgatus single crown separated from running rhizome
Note: crowning knife is approximately 300 mm long



Asparagus virgatus crowns connected

Asparagus virgatus two crowns, connected by rhizome



Asparagus virgatus stems and rhizomes running beneath tree root

Asparagus virgatus

Physical removal of this weed is often very difficult, due to the way in which its root system can spread beneath the roots of nearby vegetation as well as other objects such as rocks, logs and other structures (e.g. fences). Most infestations are therefore being suppressed using foliar spray treatments with hand gun application of 5–15 g metsulfuron-methyl per 100 L water plus the adjuvant Pulse®. While the lower rate gives a slower, but higher percentage kill, it can limit the suite of other weeds that can be controlled. Therefore, under average conditions where a range of weeds may be targeted (e.g. other asparagus weeds, *Lantana camara*, *Chrysanthemoides monilifera* (bitou bush), *Nephrolepis cordifolia* (L.) Presl (fishbone fern), *Ageratina adenophora* (Spreng.) R.M.King & H.Rob. (crofton weed), and *Rubus fruticosus* aggregate (blackberry)), 10–15 g rates are usually applied.

The treatment is monitored for efficacy and thoroughness and, within 6–12 months after initial control, follow-up foliar spraying or grubbing (where appropriate) is undertaken. With this approach, the council is gradually reducing the extent of each patch and preventing plants from flowering and setting seed.

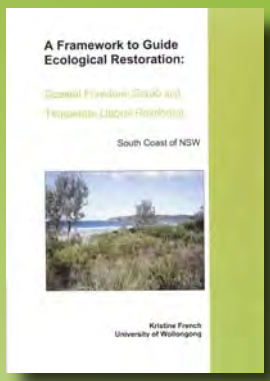
Two less weeds to worry about

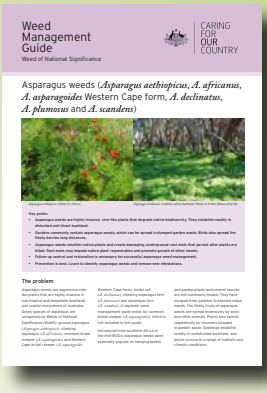
Port Macquarie-Hastings Council uses GIS to help map and monitor the reduction in the extent and abundance of these two weeds.

'In every instance we approach the management of Asparagus falcatus and A. virgatus from the same perspective – that is, we weigh up the cost of managing a small problem now versus a large problem later.' **Peter Michael, Port Macquarie-Hastings Council.**

Section 7

Further information





Declaration status of WoNS asparagus weeds in Australia

Entry into Australia of the WoNS asparagus weeds is prohibited. These species are declared weeds in some states or territories and may be restricted from sale and/or require control. Asparagus weed control work that potentially impacts on native vegetation may also be regulated by legislation (see Safety section page 112).

It is still legal to trade many *Asparagus* species in some jurisdictions, and specimens are sold in markets or traded among gardeners.

Legislation and declaration status of asparagus weeds in all states and territories is summarised in Table 1.

Table 1. Summary of current legislation status for asparagus weeds as at 2013

	Relevant legislation	*Asparagus aethiopicus*	*Asparagus africanus*	*Asparagus asparagoides*
ACT	*Pest Plants and Animals Act 2005*	Not declared	Not declared	Must not be sold or traded
NSW	*Noxious Weeds Act 1993*	The growth of the plant must be managed in a manner that reduces its numbers spread and incidence and continuously inhibits its reproduction and the plant must not be sold propagated or knowingly distributed (14 Local Government Areas)	Not declared	The plant must not be sold, propagated or knowingly distributed (state wide) The growth of the plant must be managed in a manner that reduces its numbers spread and incidence and continuously inhibits its reproduction and the plant must not be sold, propagated or knowingly distributed (11 Local Government Areas)
NT	*Weeds Management Act 2001*	Not declared	Not declared	To be eradicated and not to be introduced.
QLD	*Land Protection (Pest and Stock Route Management) Act 2002*	May not be sold or supplied May require landholder removal if adjacent to environmentally significant areas	May not be sold or supplied May require landholder removal if adjacent to environmentally significant areas	May not be introduced, kept or supplied Subject to eradication Landowners required to control
SA	*Natural Resource Management Act 2004*	Not declared	Not declared	Movement and sale prohibited Landholders are required to control
TAS	*Weed Management Act 1999*	Not declared	Not declared	Importation, movement and sale prohibited Landholders may be required to control Zone A municipalities required to eradicate
	Plant Quarantine Act 1997	Not declared	Not declared	The importation of this species into Tasmania is restricted
VIC	*Catchment and Land Protection Act 1994*	Not declared	Not declared	Trade in these weeds and their propagules, either as plants, seeds or contaminants in other materials is prohibited
WA	*Agricultural and Related Resources Protection Act 1976* *Biosecurity and Agriculture Management Act 2007*	Not declared	Not declared	Introduction of the plant into, or movement of the plant within, an area is prohibited (state wide)

Table 1 continued

	Relevant legislation	*Asparagus declinatus*	*Asparagus plumosus*	*Asparagus scandens*
ACT	*Pest Plants and Animals Act 2005*	Not declared	Not declared	Not declared
NSW	*Noxious Weeds Act 1993*	Not declared	The growth of the plant must be managed in a manner that reduces its numbers, spread and incidence and continuously inhibits its reproduction and the plant must not be sold, propagated or knowingly distributed (13 Local Government Areas)	Not declared
NT	*Weeds Management Act 2001*	Not declared	Not declared	Not declared
QLD	*Land Protection (Pest and Stock Route Management) Act 2002*	Not declared	May not be sold or supplied May require landholder removal if adjacent to environmentally significant areas	Not declared
SA	*Natural Resource Management Act 2004*	Movement and sale prohibited Landholders required to control	Not declared	Not declared
TAS	*Weed Management Act 1999*	Not declared	Not declared	Importation, movement and sale prohibited Landholders may be required to control Zone A municipalities required to eradicate.
	Plant Quarantine Act 1997	Not declared	Not declared	The importation of this species into Tasmania is restricted
VIC	*Catchment and Land Protection Act 1994*	Not declared	Not declared	Not declared
WA	*Agricultural and Related Resources Protection Act 1976 Biosecurity and Agriculture Management Act 2007*	Not declared	Not declared	Not declared

Table 2. Threatened species legislation relevant to asparagus weeds

	Relevant legislation	Relevant Key Threatening Process
Commonwealth	*Environment Protection and Biodiversity Conservation Act 1999*	Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants
NSW	*Threatened Species Conservation Act 1995*	Invasion and establishment of exotic vines and scramblers (in Schedule 3 of the Act) Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants (in Schedule 3 of the Act)
VIC	*Flora and Fauna Guarantee Act 1988*	Invasion of native vegetation by 'environmental weeds'

Safety, native vegetation and cultural heritage information

Safety

All weed control activities involve risk, so personal safety must be prioritised. Regulations regarding the safe use of herbicides and machinery must be followed and personal protective equipment such as gloves, respiratory equipment, eye and ear protection should be worn as appropriate. Training may also be required for handling herbicides and operating machinery.

New Commonwealth Occupational Health and Safety (OH&S) legislation, regulations and codes of practice were introduced in 2011. The ACT, NSW, Queensland and Northern Territory harmonised their Work Health and Safety (WHS) laws with the Commonwealth in 2012. Other states have updated their own workplace safety structures accordingly.

In some states, areas where restoration work is carried out are classified *work places*. Here, participating volunteers are classified as *workers* subject to the same health and safety regulations as managing agency employees. Guidance, information and fact sheets for working with volunteers are available from Safe Work Australia at www.safeworkaustralia.gov.au, and relevant authority websites in each state.

A risk management tool called *Running the Risk?* is available from Volunteering Australia at www.volunteeringaustralia.org. Contact your local council or natural resource management agency for more information about safety and weed management.

Protection of native vegetation and threatened species

Restoration works can impact on native vegetation and threatened species. This includes herbs and grasses as well as trees and shrubs. Before commencing works, familiarity with relevant legislation governing weed control activities in your state is essential. Working near threatened species, impacting threatened species or propagating threatened species may require a permit.

Contact natural resource management officers or local government authorities for advice before commencing any weed control activities. They will provide advice on state and federal legislation, as well as any local laws governing weed control activities in natural areas or near waterways. The following tables outline main federal and state agency contacts.

Rare or threatened species and vegetation of conservation significance should be identified in your asparagus weeds management plan (see Section 2 – Planning and Pre-control Considerations).

Hillary Cherry

Asparagus aethiopicus fruits and foliage

Table 3. Native vegetation and threatened species contacts

	Native vegetation contacts	Threatened species contacts
ACT	Department of Territory and Municipal Services 132 281 www.tams.act.gov.au/parks-recreation/plants_and_animals *Nature Conservation Act 1980*	Department of Territory and Municipal Services 132 281 www.tams.act.gov.au/parks-recreation/plants_and_animals *Nature Conservation Act 1980*
NSW	Office of Environment and Heritage 131 555 www.environment.nsw.gov.au/vegetation *The Native Vegetation Act 2003* *Native Vegetation Regulation 2005*	Office of Environment and Heritage 131 555 www.environment.nsw.gov.au/threatenedspecies *Threatened Species Conservation Act 1995*
NT	Department of Land Resource Management (08) 8995 5001 www.lrm.nt.gov.au/natveg *Planning Act 2009* *Pastoral Lands Act 1992*	Department of Land Resource Management (08) 8995 5001 www.lrm.nt.gov.au/corporate/contacts *Territory Parks and Wildlife Conservation Act 2000*
QLD	Department of Natural Resources and Mines Phone numbers for each region at: www.nrm.qld.gov.au/vegetation/bioregions.html *Vegetation Management Framework Amendment Bill 2013* (pending)	Department of Environment and Heritage Protection 137 468 www.ehp.qld.gov.au/wildlife/threatened-species/endangered/index.html *Nature Conservation Act 1992 (NCA)* *Nature Conservation (Wildlife) Regulation 2006*
SA	Department of Water, Land and Natural Resources (08) 8204 1910 www.environment.sa.gov.au/Conservation/Native_vegetation *Native Vegetation Act 1991* *Native Vegetation Regulations 2003*	Department of Water, Land and Natural Resources (08) 8204 1910 www.environment.sa.gov.au/Plants_Animals/Threatened_species_ecological_communities South Australia's *National Parks and Wildlife Act 1972*
TAS	Department of Primary Industries, Parks, Water and Environment 1300 368 550 or (03) 6233 3295 www.dpiw.tas.gov.au/inter.nsf/themenodes/bhan-54746e?open *Forest Practices Act 1985* *Land Use Planning and Approvals Act 1993*	Department of Primary Industries, Parks, Water and Environment 1300 368 550 or (03) 6233 8759 www.dpiw.tas.gov.au/inter.nsf/ThemeNodes/RLIG-53KUPV?open *Threatened Species Protection Act 1995*
VIC	Department of Environment and Primary Industries 136 186 www.dse.vic.gov.au/land-management/land/native-vegetation-home *Catchment and Land Protection Act 1994*	Department of Environment and Primary Industries 136 186 www.dse.vic.gov.au/plants-and-animals/native-plants-and-animals/threatened-species-and-communities *The Flora and Fauna Guarantee Act 1988*
WA	Department of Parks and Wildlife (08) 6467 5000 www.dec.wa.gov.au/management-and-protection/plants/native-vegetation.html *Environmental Protection Act 1986*	Department of Parks and Wildlife (08) 9334 0455 www.dec.wa.gov.au/management-and-protection/threatened-species.html *Wildlife Conservation Act 1950*
Federal	Department of Sustainability, Environment, Water, Population and Communities (02) 6274 1111 www.environment.gov.au/land/vegetation/index.html *Environment Protection and Biodiversity Conservation Act 1999*	Department of Sustainability, Environment, Water, Population and Communities (02) 6274 1111 www.environment.gov.au/biodiversity/threatened *Environment Protection and Biodiversity Conservation Act 1999*

Cultural heritage

Before beginning restoration work in areas that may hold cultural significance, it is appropriate and respectful to assess all issues. Some states and territories require this. Contact your local government or natural resource management authority for information about appropriate procedures. Copies of the laws summarised in Table 4 are available online from Australasian Legal Information Institute at www.austlii.edu.au.

The Australian Heritage Database contains information for over 20,000 natural, historic and indigenous places. Searching by local government area provides a list of heritage places in each locality. The database is accessible online from Department of Sustainability, Environment, Water, Population and Communities at www.environment.gov.au/heritage/ahdb. It should be noted that this is not be a comprehensive register of culturally significant places.

Previously unknown sites of Indigenous cultural significance are frequently revealed during the course of on-ground works. A useful introduction to identification, consultation and management of new sites titled *Ask First: A guide to respecting Indigenous heritage places and values* is available online from the Australian Heritage Council www.environment.gov.au/heritage/ahc/publications/commission/books/ask-first.html.

A guide for protecting and conserving Aboriginal landscapes called *Bushcare With Care Guide* is available online from Sydney Metropolitan Catchment Management Authority at http://sydney.cma.nsw.gov.au/content/view/68/32/.

Natural resource management officers can help with questions about Aboriginal heritage. State, territory and regional contacts are available online from Caring for our Country at www.nrm.gov.au and search for 'contacts'.

Most states and territories maintain Indigenous heritage site registers. Because of the sensitive and vulnerable nature of many sites, access to some information may be restricted and require an application process. As well as accessing information, it is equally important to report previously unknown sites for entry into the databases. For more information, contact the government agency responsible for managing each register.

Table 4. Cultural heritage legislation and information

	Act	Register and managing agency	Website
ACT	*Heritage Act 2004* *Heritage Objects Act 1991*	Heritage Register Environment and Sustainable Development Directorate	www.environment.act.gov.au/heritage/heritage_register
NSW	*Heritage Act 1977* *National Parks and Wildlife Amendment (Aboriginal Ownership) Act 1996*	State Heritage Register Office of Environment and Heritage	www.environment.nsw.gov.au/heritageapp/heritagesearch.aspx
NT	*Aboriginal Sacred Sites Act 1989* *Heritage Conservation Act 1991*	Register of Sacred Sites Aboriginal Areas Protection Authority	www.aapant.org.au/
QLD	*Aboriginal Cultural Heritage Act 2003* *Torres Strait Islander Cultural Heritage Act 2003* *Queensland Heritage Act 1992*	Aboriginal and Torres Strait Islander Cultural Heritage Register Department of Aboriginal and Torres Strait Islander and Multicultural Affairs	www.datsima.qld.gov.au/atsis/aboriginal-torres-strait-islander-peoples/indigenous-cultural-heritage
SA	*Aboriginal Heritage Act 1988* *Heritage Act 1994*	Heritage Sites Database Department of Planning, Transport and Infrastructure	www.planning.sa.gov.au/go/heritagesearch
TAS	*Aboriginal Relics Act 1975* *Historic Cultural Heritage Act 1995*	Tasmanian Aboriginal Site Index Department of Primary Industries, Parks, Water and Environment	http://www.aboriginalheritage.tas.gov.au/tasmanian-aboriginal-site-index-(tasi)
VIC	*Aboriginal Heritage Act 2006* *Heritage Act 1994*	Victorian Aboriginal Heritage Register Department of Planning and Community Development	www.dpcd.vic.gov.au/heritage/victorian-heritage-register/Victorian-aboriginal-heritage-register
WA	*Aboriginal Heritage Act 1972* *Heritage of Western Australia Act 1990*	Register of Aboriginal Sites Department of Indigenous Affairs	www.dia.wa.gov.au/en/Site-Search/Register-of-Aboriginal-sites/
Federal	*Aboriginal and Torres Strait Islander Heritage Protection Act 1984* *Environment Protection and Biodiversity Conservation Act 1999* *Australian Heritage Commission Act 1975*		

Further information and contacts

Information for volunteers

Incorporating a volunteer group is a straightforward and inexpensive process that is highly recommended. Incorporation is required for government grants and funding applications. An alternative is for your group to join a large organisation that acts as an *umbrella body*. Regional Landcare groups often have multiple member groups covered by their incorporation and provide funds management and insurance cover. Information for setting up and running a volunteer group is summarised in Table 5.

Table 5. Selected funding, organisational and training resources for volunteer groups

Entity	Information	Website
Australian Association of Bush Regenerators	Bushcare Volunteer Training and Professional Support materials – VCN Manual 2012 and 'Bushcare Booster' Training Modules	www.aabr.org.au/index.php?option=com_content&view=article&id=51:vcn
Caring for our Country	Funding; natural resource management facilitators and contacts	www.nrm.gov.au
Central Coast (NSW) Community Environment Networks	Workshops and events	www.cen.org.au
Coastcare	Community coast care groups	www.coastcare.com.au
Conservation Volunteers	Volunteer recruitment for environmental and wildlife conservation projects	www.conservationvolunteers.com.au
Dept. of Sustainability, Environment, Water, Population and Communities	Government grants	www.environment.gov.au/biodiversity/invasive/weeds/government/index.html
Greening Australia	Vegetation management and community engagement	www.greeningaustralia.org.au
Landcare Australia	Community land care groups	www.landcareonline.com.au
Landcare Tasmania	Volunteer recruitment, training, incorporation and insurance	www.landcaretas.org.au
Natural Resource Management knowledge online	Digital online archive for information about natural resource management activities	nrmonline.nrm.gov.au/
National Volunteer Skills Centre	Skills, training and education resources for volunteers, managers of volunteers, trainers and not-for-profit organisations	www.volunteeringaustralia.org/Skills-and-Training/-For-volunteers/Skills-and-training-for-volunteers.asp
School of Volunteer Management	Volunteer management education and training activities	www.svm.edu.au
Training.gov.au (TGA)	Vocational education and training in Australia; formerly The National Training Information Service and Australian National Training Authority	training.gov.au/
Victorian Landcare Gateway	Volunteer recruitment, training, incorporation and insurance	www.landcarevic.net.au/
Volunteering Australia	Nationally recognised qualifications, training resources and materials for volunteers and volunteer managers	www.volunteeringaustralia.org/Skills-and-Training/-Training-skills-resources.asp
Volunteering WA	Useful range of volunteering resources	www.volunteeringwa.org.au/resources.aspx

Further information

There are many funding opportunities for weed management. These may be included in applications that have wider scope than just weeding activities, such as projects for restoration of native vegetation. Grants are available from federal and state government sources, catchment management authorities, natural resource management boards, local councils and non-government organisations. Information about federal government grants is available from Department of Sustainability, Environment, Water, Population and Communities (see Table 6).

As you begin planning, consult with:

- **the land manager of your site,**
- **local council, and**
- **catchment management or natural resource management board officer. A well prepared management plan will not only make filling out funding applications a straightforward task, but also increase your chances of success (see Section 2 – Planning and Pre-control Considerations).**

Useful contacts and resources

Table 6. Where to find further information, contacts and weed management resources

	Organisation	Website	Information available
NATIONAL	**Weeds Australia**	www.weeds.org.au/WoNS www.weeds.org.au/WoNS/asparagusweeds	Weed identification Funding Legislation Contacts and web links
	Department of Agriculture, Fisheries and Forestry	www.daff.gov.au www.aqis.gov.au/icon32/asp/ex_querycontent.asp	Web links Funding National Biosecurity Import conditions database (icon)
	Department of Sustainability, Environment, Water, Population and Communities	www.environment.gov.au/biodiversity/invasive www.environment.gov.au/epbc/protect www.environment.gov.au/heritage	Threatened species legislation Heritage Weed identification Funding opportunities
	Australian Association of Bush Regenerators	www.aabr.org.au	Bush regeneration
	Australian Pesticides and Veterinary Medicines Authority	www.apvma.gov.au www.apvma.gov.au/permits/search.php services.apvma.gov.au/PubcrisWebClient/welcome.do	Herbicide permits, labels and registrations Safe herbicide use
	ChemCert Australia	www.chemcert.com.au	Chemical handling, training and certification
	Smart Train	www.smarttrain.com.au	Herbicide training and manuals
	Safe Work Australia	www.safeworkaustralia.gov.au	OH&S
	Drum Muster	www.drummuster.com.au	Recycling chemical containers
ACT	**Environment and Sustainable Development Directorate**	www.environment.act.gov.au/environment	Weed control Natural resource management Environmental protection

	Organisation	Website	Information available
NEW SOUTH WALES	**Department of Primary Industries (Biosecurity NSW)**	www.dpi.nsw.gov.au www.dpi.nsw.gov.au/__data/assets/pdf_file/0017/123317/Noxious-and-environmental-weed-control-handbook.pdf www.dpi.nsw.gov.au/agriculture/pests-weeds/weeds www.dpi.nsw.gov.au/biosecurity	Weed management Noxious weeds Funding opportunities Legislation Education and awareness Weed control handbook Biosecurity
	Office of Environment and Heritage, NSW National Parks and Wildlife Service	www.environment.nsw.gov.au/ www.nationalparks.nsw.gov.au www.environment.nsw.gov.au/cpp/ConservationPartners.htm www.environment.nsw.gov.au/epa	Bitou bush management and monitoring manual Weed management for biodiveristy Threatened species legislation Conservation partnerships program Cultural awareness Environment Protection Authority
	Catchment Management Authorities (Local Land Services)	www.cma.nsw.gov.au	NSW CMAs Regional community support officers Regional weed plans
	Pittwater EcoWarriors	www.youtube.com/watch?v=105jsllbk4l	Videos on use of splatter gun and *A. aethiopicus* management
NT	**Department of Land Resource Management**	www.lrm.nt.gov.au/	Weed management Natural resource management
QUEENSLAND	**Queensland Department of Agriculture, Fisheries and Forestry (Biosecurity Queensland)**	www.daff.qld.gov.au www.daff.qld.gov.au/4690_8331.htm	Control methods Declared plants legislation Biosecurity
	SEQ Fire and Biodiversity Consortium	www.fireandbiodiversity.org.au	Fire management for biodiversity
	Advancing Rural Queensland	www.agforceqld.org.au	Land management chemical accreditation
	Qld Regional NRM Groups Collective	www.rgc.org.au	Natural resource management
	Weeds of Southern Queensland HD – The Weed Society of Queensland	itunes.apple.com/au/app/weeds-southern-queensland/id597804971?mt=8 www.wsq.org.au	iTunes app for weed identification and control methods
SOUTH AUSTRALIA	**Natural Resources Management**	www.nrm.sa.gov.au	Natural resource management Weed control advice Legislation Community grants
	Primary Industries and Regions SA (PIRSA)	www.pir.sa.gov.au www.pir.sa.gov.au/biosecuritysa/nrm_biosecurity/weeds	Legislation Biosecurity and Policy
	Adelaide and Mount Lofty Ranges NRM Board	www.youtube.com/watch?v=105jsllbk4l www.amlrnrm.sa.gov.au/	Video on how to control bridal creeper
VICTORIA	**Department of Environment and Primary Industry**	www.depi.vic.gov.au/	Noxious weeds Chemical use Biological control Legislation Catchment management
	Weeds of Murrindindi – Victorian Government	www.vic.gov.au/social-media/mobile-apps/weeds-of-murrindindi.html	iPhone app for weed identification and control methods
WA	**Department of Agriculture and Food**	www.agric.wa.gov.au/PC_92313.html?s=0	Weed management advice Biosecurity Legislation
	Department of Parks and Wildlife	www.dec.wa.gov.au	Natural resource management
	Natural Resource Management	www.nrm.wa.gov.au/	Natural resource management

Further information

Glossary

Annual	A plant that germinates, flowers and dies in one year or less
Axil	The angle between the upper side of the stem and a leaf, branch, or petiole
Bush regeneration	Restore or maintain ecosystem function by encouraging natural regeneration of indigenous flora and limiting the impact of weeds and other degrading processes
Control	The treatment or management of weeds to reduce or prevent their further impact
Crown	A compressed group of underground rhizomes (stem mass)
Cryptic species	Species that are difficult to distinguish but are genetically distinct
Dispersal	Process of transporting propagules via a vector, such as wind, water, birds or other animals
Evaluate	Analyse information (data) to assess change and/or effectiveness of an intervention
Geophyte	Perennial plants with underground storage organs
Grubbing	Dig out whole plants, roots and all
Indigenous	A plant naturally occurring in particular area or region within Australia
Monitor	Gather information (data) about a site in a systematic way to answer predetermined monitoring questions
Native	A plant naturally occurring within Australia
Natural regeneration	The germination of indigenous plants from seeds or other propagules without human intervention
Nodes	Point in stem or rhizome containing buds from which stems or leaves arise
Perennial	A plant that remains growing year round
Propagule	Any part of a plant that can become detached to produce a new plant, e.g. bud, sucker, seed, spore
Provenance	The geographical and genetic source of a particular plant or seed
Rehabilitation	Repairing landform elements of a site, such as soil health and erosion
Resilience	The ability of native vegetation to recover from disturbance events such as fire, clearing or suppression by weeds
Restoration	Return ecosystem health and function to a degraded ecological community
Revegetation	Planting and direct seeding of indigenous plants
Rhizome	An underground stem capable of growing shoots or roots from its nodes
Roots	Underground plant organs used for nutrient and water uptake (not reproductive) and that may assist to anchor rhizomes, tubers or other underground parts. Often fibrous in asparagus weeds
Senesce	Process of drying and withering in period between maturity and death of a plant, or part of a plant, e.g. leaves on a deciduous plant; the natural end of a plant or vegetation community's lifespan
Succession	The natural progression of vegetation from one type to another, e.g. the first flush of species to colonise a disturbed area, then replacement by other suites of species over time as a community establishes and matures
Tubers	Bulbous underground storage organs (not reproductive in asparagus weeds)
Vegetative growth	New individuals arise without process of sexual reproduction (e.g. seeds); occurs when new individual growing buds (e.g. rhizomes) become detached and root as independent plants

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