Boneseed

Current management and control options for boneseed (*Chrysanthemoides monilifera* ssp. *monilifera*) in Australia

Weeds of National Significance

Australian Government

Department of Environment and Conservation NSW

National Parks & Wildlife Service NSW

National Bitou Bush & Boneseed management group

Boneseed management manual

Current management and control options for boneseed (*Chrysanthemoides monilifera* ssp. *monilifera*) in Australia

Edited by KJ Brougham, H Cherry & PO Downey

Weeds of National Significance

August 2006

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Boneseed management workshops

Workshops were held in South Australia, Victoria and Tasmania, and were attended by dedicated agency staff and community volunteers. These workshops provided valuable information on current boneseed management and control practices, much of which forms the basis of this manual. Thanks to all participants.

Diagram on page 30 by Norman Yeend, after original by Virginia Bear <www.weedsbluemountains.org.au>. Illustration on pages viii, 10, 22 and 50 by Dennis Morris.

Foreword

Boneseed is a South African plant that was introduced to gardens in Australia over 150 years ago. It has since 'jumped the garden fence' to become a serious invader of native bushland. Boneseed invades many vegetation types, and can form dense monocultures that smother and suppress native plants and prevent regeneration. If left unchecked, boneseed has the potential to invade much of southern Australia, endangering our native flora and fauna in its wake.

The National Bitou Bush and Boneseed Management Group recognises that a concerted effort is needed from all stakeholders to control boneseed and prevent it from invading more of Australia's native bushland. This can only be achieved through a coordinated effort between the community and all levels of government.

Boneseed is an environmental weed that mainly occurs on public land. Because the community appreciates the value of our natural environment, thousands of community volunteers work tirelessly to control boneseed. The success stories of just some of these invaluable volunteer groups are presented in case studies in this manual. These dedicated members of the community deserve continued support and recognition.

This manual compiles and evaluates best-practice management techniques currently being used by a range of community volunteers and land managers. It provides detailed information on effective boneseed control techniques in various situations, and advice on developing a comprehensive boneseed management plan. This information will help people choose the most appropriate control methods for their site.

For the last eight years, I have worked with a landcare group in Tasmania attempting to control boneseed, and I wish we had this manual when we started out. I hope that others who are striving to control boneseed will find this manual valuable in providing tips to improve their efficiency and effectiveness, and in turn reduce the impact of boneseed and its control on our natural environment.

I commend all those who contributed to this manual for their valuable input.

Peter McGlone
Chair
National Bitou Bush and Boneseed Management Group

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Introduction

A Weed of National Significance

Boneseed (*Chrysanthemoides monilifera* ssp. *monilifera*) is native to the Cape region of South Africa. Boneseed and the closely related bitou bush (*C. monilifera* ssp. *rotundata*) are collectively recognised in Australia as one of the twenty *Weeds of National Significance* (WONS) because of their invasiveness, potential for spread, and environmental and economic impacts (Thorp & Lynch 2000).

There are four other subspecies of *Chrysanthemoides monilifera* in South Africa (ssp. *canescens, ssp. pisifera,* ssp. *septentrionalis and* ssp. *subcanescens*), but fortunately they have not been introduced to Australia. The importation of any *Chrysanthemoides monilifera* subspecies is illegal under Australia's strict quarantine laws.

National management

A national strategy for *Chrysanthemoides monilifera* (boneseed and bitou bush) management was launched in 2000. Its vision is 'Working together to arrest the spread and minimise the impact of boneseed and bitou bush in natural ecosystems'.

The national strategy aims to deliver three outcomes:

- The further introduction and spread of boneseed and bitou bush is prevented
- The adverse impacts of boneseed and bitou bush on biodiversity are minimised
- The national commitment to the coordination and management of boneseed and bitou bush is maintained.

The implementation of the strategy is being guided by the National Bitou Bush and Boneseed Management Group (NBBBMG), composed of agency and community representatives from across Australia, and a national coordinator. The outcomes set out in the strategy are being achieved through a series of priority actions involving the community and all levels of government.

Although boneseed and bitou bush are declared as one WONS, they have different distributions, different growth habits, and exhibit different responses to control. Management strategies and guidelines published for bitou bush include the *NSW Bitou Bush Threat Abatement Plan* (DEC 2006) and the *Best Practice Guidelines for Aerial Spraying of Bitou Bush in New South Wales* (Broese van Groenou & Downey 2006). A priority for the NBBBMG was to consolidate information specifically on the management of boneseed. Thus, this manual deals only with boneseed management and control.

Using the manual

The control and management options presented in this manual are compiled from current best practice management, a series of boneseed control workshops, reviews by technical experts and previously published information.

This manual contains boneseed management strategies that may have been trialled only in particular regions or vegetation types, so they may not be relevant to all situations. Further research into boneseed management is needed so that best practice guidelines can be developed for all situations where boneseed is found.

This manual contains six sections:

Section 1 – The boneseed profile

This section contains information on the biology and ecology of boneseed, its impacts, the history of its introduction to Australia, and its national distribution. Information from previously published work has been referenced within the text in this section to assist readers who wish to learn more about, or conduct further research on boneseed.

Section 2 – Managing boneseed

Section 2 provides guidelines for developing a weed management plan. It also explains issues that need to be considered when managing boneseed in different land-use situations, and suggests the most appropriate control methods in these situations.

Section 3 – Control methods

This section describes each control method in detail, and gives examples of how to integrate control methods to achieve effective boneseed control.

Section 4 – Follow-up control, revegetation and monitoring

Section 4 explains the importance of follow-up control, and includes a short description of the differences between restoring native vegetation through natural regeneration, and revegetation. The importance of monitoring your progress is also discussed, along with information on various monitoring techniques.

Section 5 – Case studies

The case studies show different approaches taken by land managers and community groups, and present the findings of research on boneseed control. They give examples of different control methods and strategies for managing the weed in different situations, and with different management goals.

Section 6 – Further information

This section contains information on the declaration status of boneseed in Australia, details of legislation relevant to controlling boneseed in various situations, weed contacts across Australia, a glossary of terms used in the manual, and a list of references. Information for community groups on incorporation, insurance and funding opportunities is also provided.

Section One

The boneseed profile

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SECTION 1:

The boneseed profile

The impact of boneseed

Boneseed (*Chrysanthemoides monilifera* ssp. *monilifera*) was introduced to Australia from the Cape region of South Africa around 150 years ago. It has since become widely naturalised and has invaded a wide range of vegetation types across southern Australia. Based on its invasiveness, impacts on biodiversity, and potential for spread, boneseed is regarded as one of Australia's worst weeds. Boneseed and the closely related bitou bush (*C. monilifera* ssp. *rotundata*) are together recognised as one of the twenty *Weeds of National Significance* (WONS) (Thorp & Lynch 2000).

Boneseed has a number of traits that make it a successful invader of native bushland. Its vigorous growth is aided by the absence of natural enemies in Australia. Each plant produces large quantities of seed that is readily dispersed long distances by animals such as foxes, emus and other birds, allowing boneseed infestations to establish in undisturbed vegetation. It can grow in a range of habitats including dunes, mallee, open woodlands and sclerophyll forests. Once established, its rapid regeneration and ability to spread quickly after disturbance such as fire or clearing allows it to outcompete and displace native species. In contrast to its serious impacts on native bushland, boneseed does not impact on agricultural land because it does not persist when grazed or cultivated.

Boneseed endangers many threatened plant species and communities, including the brittle greenhood orchid in the You Yangs (south-west of Melbourne), the *Eucalyptus microcarpa* and *E. porosa* grassy woodlands in South Australia, the *E. ovata, E. viminalis* and *E. globulus* communities in Tasmania, and Eastern Suburbs Banksia Scrub in Sydney.

Nicole Zeoli

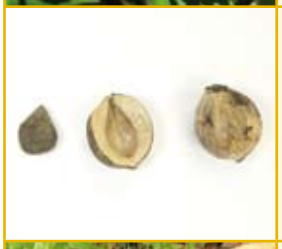
Each boneseed plant produces masses of flowers and fruits.

Description

- Boneseed is an erect perennial shrub in the Asteraceae (daisy family) that grows to 3 m high. It has branched upright woody stems, and a shallow but extensive root system. Old trunks can be up to 20 cm in diameter.
- The fleshy leaves are 3–9 cm long, and alternate along the stems. They have an elongated oval-shape that tapers towards the base, with irregularly toothed edges towards the tip. New growth is covered with white downy hairs that are shed as the leaves mature. Leaf shape and colour will change slightly depending on light availability and climate.
- The yellow daisy flowers are 2–3 cm in diameter with 4–8 'petals' (ray florets), and are clustered at the ends of branches.
- The round, fleshy fruits turn from green to black when mature, and contain a single seed (achene). The seed is hard, smooth and round, 6–7 mm in diameter, and is bone-coloured when dry – hence the name *boneseed*.

Boneseed can be confused with the closely related bitou bush. Bitou bush is mainly restricted to coastal habitats with summer rainfall, and infestations occur from Inskip Point in south-east Queensland to Mallacoota in north-east Victoria.

Distinguishing between boneseed and bitou bush

boneseed (ssp. *monilifera*)			bitou bush (ssp. *rotundata*)	
	erect shrub, up to 3 m high	**habit**	sprawling shrub, 1–2 m high	
	3–9 cm long, elongated oval shape, irregularly toothed edges	**leaves**	3–7 cm long, broader oval shape, smooth or only slightly toothed edges	
	4–8 ‘petals’ flowers from late winter to spring (mainland), to early summer (Tas)	**flowers**	11–13 ‘petals’ flowers year round with a peak from April to June	
	round fruit	**fruit**	egg-shaped fruit	
	round, smooth, bone-coloured	**seeds**	egg-shaped, rough, dark brown to black	
	leaves with toothed edges	**seedlings**	leaves with smooth edges	

SECTION 1:

The boneseed profile

Juvenile boneseed can be confused with seedlings of the native boobialla (*Myoporum insulare*). Boobialla is a coastal shrub that occurs in all southern states. Boneseed seedlings are covered in white downy hair while boobialla seedlings are not.

Hillary Cherry

Boneseed has yellow flowers, and irregularly toothed leaves.

Kerry Brougham

Native boobialla has a small white flower, sometimes with purple markings.

Margaret MacDonald

Mature boobialla has smaller and more regular teeth on the leaf margins.

Preferred habitat

Boneseed prefers winter rainfall regions, where it is found in a wide range of vegetation communities including coastal dunes, estuarine areas, heath, mallee, woodland, and dry and wet sclerophyll forest.

Boneseed occurs on a range of soil types, but does not tolerate water-logged soils (Muyt 2001). Most infestations are therefore in low to medium rainfall areas, or on free-draining soils in areas with higher rainfall (Lane 1985). Favouring sandy or medium-textured soils and tolerating saline conditions, boneseed thrives in coastal regions.

Nicole Zeoli

Boneseed infesting dunes in mallee, SA.

CSIRO

Boneseed invading open woodland, You Yangs, Vic.

Distribution

Early history of invasion

Boneseed is a native of southern areas of South Africa, predominantly in the south-west Cape region, and was introduced to Australia as a garden ornamental. With its masses of yellow flowers and hardy nature, boneseed was cultivated as a garden plant in most states, and many current infestations can be attributed to garden escapes. Self-sustaining populations established quickly, and it is thought that boneseed was naturalised in Australia by 1910 (Parsons & Cuthbertson 1992).

The first record of boneseed in Australia was from MacLeay's garden in Sydney in 1852 (Norlindh 1943). Boneseed was first recorded in Melbourne in 1858 (Parsons 1973), Adelaide at the West Terrace Cemetery in 1892, Ulverstone in Tasmania in 1931, and Armadale in Western Australia in 1948 (Gray 1976).

Just as bitou bush was planted to stabilise dunes along the NSW coast, there were deliberate plantings of boneseed to stabilise sand dunes between Nelson and Portland in western Victoria. Boneseed was also planted in the You Yangs region south-west of Melbourne to control erosion in the late 1950s and early 1960s. Major infestations occur in these regions today.

In an effort to halt their spread, boneseed and all other Weeds of National Significance have been banned from sale in all states and territories.

Current distribution

Boneseed is widely distributed throughout southern Australia. In South Australia, extensive infestations occur around Adelaide, the Mount Lofty Ranges, and the Murray River region, and scattered infestations occur in the South-East and on the Eyre and Yorke Peninsulas.

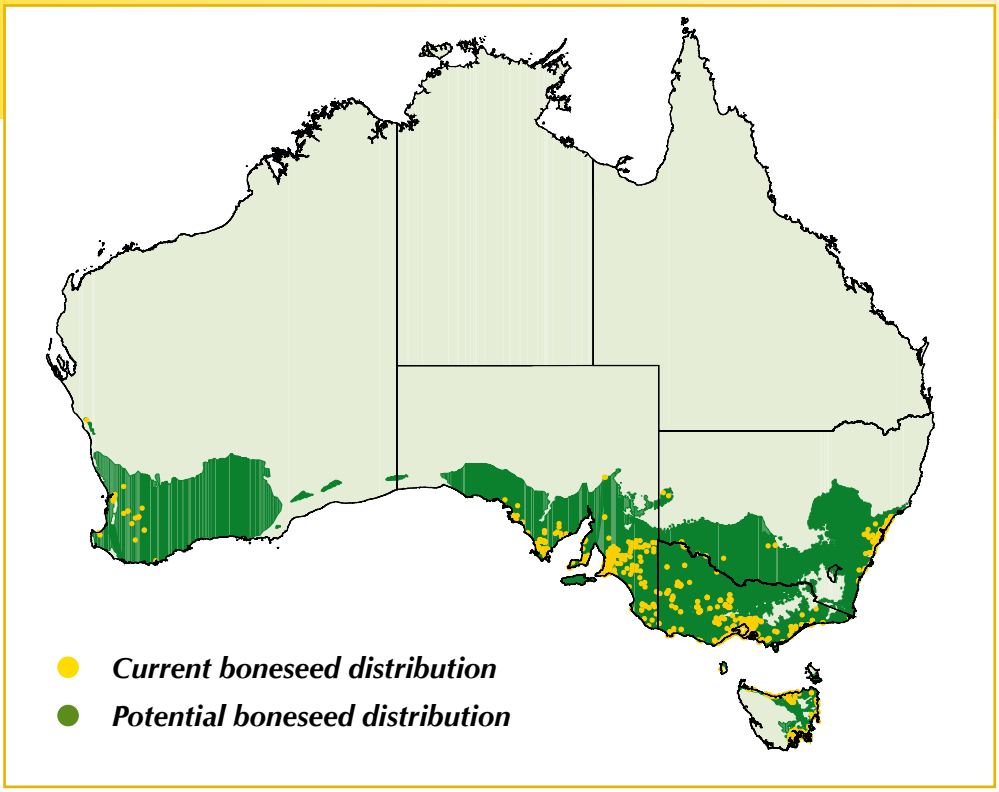
In Victoria, boneseed is widespread. Dense infestations occur around Melbourne, Portland, on the Mornington and Bellarine peninsulas, and in the You Yangs Regional Park south-west of Melbourne. Scattered populations occur throughout the western part of the state, along the Great Ocean Road, and in the Gippsland area.

The distribution of boneseed in Tasmania is concentrated around the fringes of inhabited areas, and is mainly restricted to coastal and estuarine areas. Boneseed occurs along the east and central-north coasts, and is common around Launceston. Extensive infestations occur along the Tamar River and the lower reaches of the Huon River, and around Hobart, Dodges Ferry, and Bicheno (Rudman 2001).

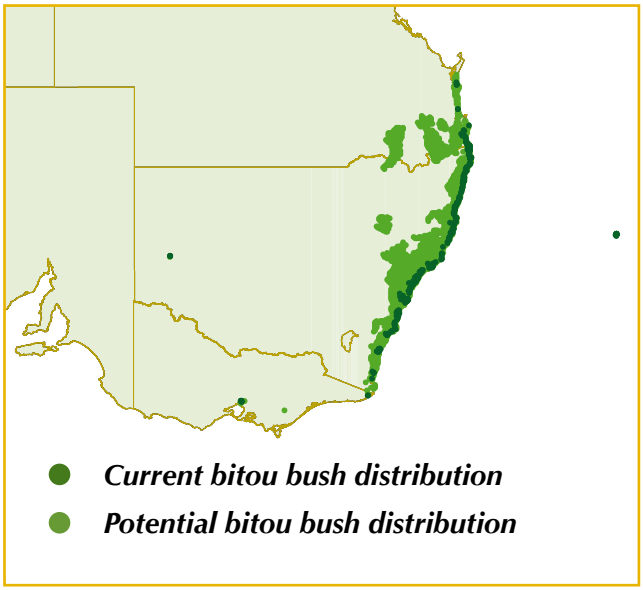
Peter McGlone

Clipped boneseed growing illegally in suburban garden, Hobart, Tas.

The boneseed profile



Current and potential boneseed distribution in Australia, August 2006 (potential distribution predicted by BIOCLIM model).



Current and potential bitou bush distribution in Australia, August 2006 (potential distribution predicted by BIOCLIM model).

Report all new boneseed infestations to your local government weeds officer.

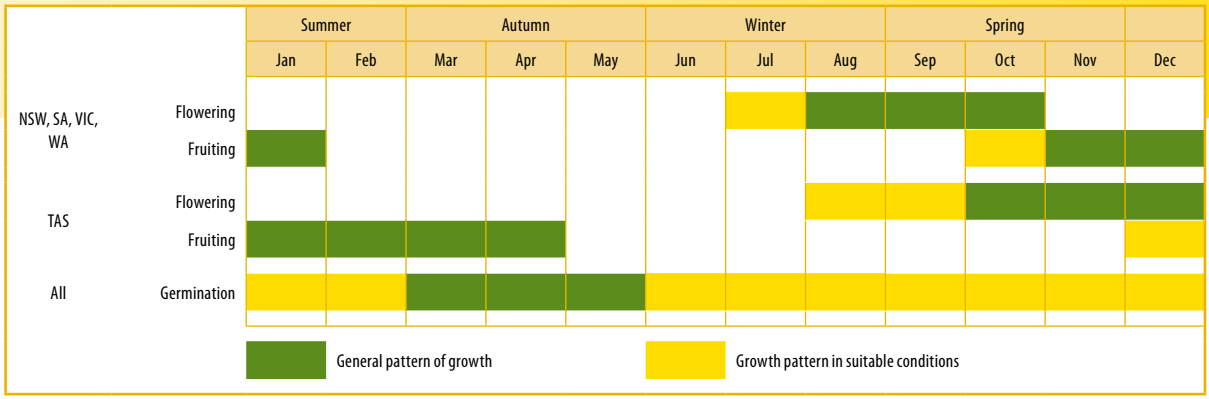
While boneseed has not spread in New South Wales to the same extent as bitou bush, scattered infestations are present along the coast from Newcastle on the Central Coast to Moruya in the south. The majority of infestations are in the Sydney region, extending west into the Blue Mountains. Isolated occurrences have also been recorded at Broken Hill in the far west of the state.

Only isolated infestations have been found in Western Australia, with the majority of records around Perth and Armadale. Outlier infestations have also been recorded near Albany and Geraldton.

Potential distribution

Boneseed has the potential to significantly expand its range, and also to become more abundant within its current range. Climate-based analysis using the BIOCLIM modelling process predicts that the potential distribution of boneseed extends across southern Australia, except for most of the Nullarbor Plain and extreme frost areas in Victoria, New South Wales, the Australian Capital Territory, and western Tasmania.

Seasonal growth pattern for boneseed



Reproduction and spread

The timing of growth, flowering, seed production and germination in boneseed is dependent on the regional climate. Thus, flowering and seed production begin earlier in warmer regions, and start later in the year in colder regions such as Tasmania. The chart above shows the average flowering, fruiting and germination times for boneseed in Australia.

Flowering and pollination

Boneseed plants do not normally flower until they are at least 18 months old. However, some plants may flower in their first year, particularly in burnt areas where there is little competition or in areas with high soil moisture and nutrient content. Plants growing in poor conditions may not flower until they are three years old.

Boneseed flowers, like other daisy flowers, are actually compound inflorescences made up of many small flowers called florets. The tiny disc florets make up the centre, and the large ray florets on the outer edge form the petal-like structures.

Flowers develop from late winter to spring on the mainland, extending into early summer in Tasmania. Bees are often observed visiting boneseed, but they are not required for pollination (Weiss *et al*. 1998).

Seed production

Each inflorescence produces 4–8 fruits (one per ray floret or 'petal'). The fleshy tissue of the fruit dries and flakes off with age, revealing a single, bone-coloured seed (achene). A single plant can produce up to 50,000 seeds per year, of which approximately 60 per cent are viable (Lane 1976). Seeds are shed in summer in most regions, extending into autumn in Tasmania due to the later flowering period.

Hillary Cherry

Boneseed flowers and fruits.

Peter Tucker

Masses of flowers produce thousands of fruits.

The boneseed profile

Seed dispersal

Boneseed does not reproduce vegetatively and so relies on its massive seed production for reproduction and spread. The fleshy fruits are attractive to a wide range of animals that spread the seeds, including foxes, rabbits, emus and a number of other bird species. The smooth round seeds also disperse from the parent plant by rolling down slopes, and the hard seed coat allows seeds to remain viable when transported via either fresh or salt water. Humans spread boneseed by dumping garden waste and soil, and by transporting seeds on machinery. Gravel carted from the You Yangs region near Melbourne has been a significant cause of boneseed spread.

DEC/K Gillett

Emus can disperse boneseed seeds long distances.

Kym Smith

Boneseed seeds in emu scats.

Grant Scurr

Boneseed 'seed rain' adjacent to infestation, Tas.

Seedbank longevity

Boneseed seeds can remain dormant in the soil if the seed coat remains intact. While the exact longevity of seeds is unknown, around 13 per cent remain viable after three years (Weiss 1984), and some seeds appear to remain viable for up to 10 years (Lane 1976).

Soil seedbank densities in the most heavily infested areas average around 2500 viable seeds per square metre, with up to 19,000 viable seeds per square metre (Melland in prep).

Germination and growth

Boneseed seeds can germinate at any time of the year if two requirements are met: the seed coat needs to have cracked, and there must be sufficient soil moisture (Lane 1976). The hard seed coat typically develops three cracks after exposure to the elements. Boneseed germination is not known to be limited by light or temperature.

Seedlings grow rapidly and will establish in the absence of disturbance, even in shade or infertile soil (Lane 1981). Fire and physical soil disturbance, however, can trigger mass germination events. The resulting increase in plant density can cause scattered populations to become dense infestations in a very short time (Lane 1976).

Kerry Brougham

Boneseed seedlings colonising open woodland in the Mount Lofty Ranges, SA.

Boneseed can grow in a range of conditions. Seedlings can tolerate shade (Thomas *et al*. 2005), and mature plants will grow in moderate shade to full sun (Muyt 2001). Boneseed grows throughout the year if moisture is sufficient, but growth is most rapid after autumn rains and in spring. Boneseed does not tolerate waterlogged conditions, and growth is inhibited by prolonged droughts and frosts. While the longevity of boneseed plants is unknown, plants are estimated to live for 10 to 20 years (Muyt 2001).

Peter Tucker

Round fleshy fruits.

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SECTION 2:

Managing boneseed

Kym Smith

Boneseed in native open woodland, SA.

Why planning is important

A management plan will help to identify the most appropriate boneseed control methods for your site, and the best time to use each control method. Planning in this way can save you time and money by directing limited resources to where they will be most effective. Following a plan helps you monitor the effectiveness of your control efforts, measure progress against objectives, and adapt to changing conditions. Management plans can also help to achieve consistency, which is important when the control program involves multiple stakeholders and spans several years. A good plan increases your chances of success.

Boneseed management occurs at a number of levels. For example, management plans 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 National Bitou Bush and Boneseed Strategy. You should consider these other strategies when developing your plan, as your actions benefit not just your site, but ultimately the national boneseed effort. Working in conjunction with other strategies will ensure your efforts are valuable, and may also help you to attract funding.

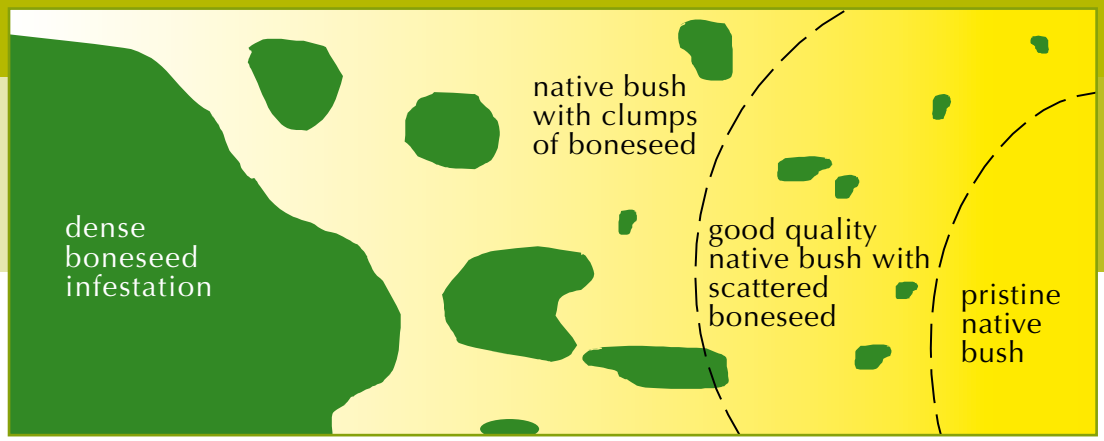
This section of the manual discusses some of the main issues you should consider when developing a weed management plan. Firstly, you should decide whether you are trying to eradicate or contain the boneseed infestation. Then you must consider the many issues related to your particular land-use situation (e.g. natural areas, pastures, vacant land). Using this information, you can then develop a management plan, considering your goals and the resources required. Finally, you need to monitor the success of your management program (some simple monitoring methods are presented in Section 4).

Eradication or containment?

Ideally, the goal of all weed management programs would be the total eradication of all weeds from an area. Eradication over a small, local scale is achievable in many situations. With a long-term commitment to follow-up control and the resources to carry it out, you can eradicate boneseed from your site. However, for widespread weeds such as boneseed, eradication over a large (e.g. regional) scale is not always achievable due to a lack of resources, and containment of weed populations may be a more appropriate goal.

Containment means restricting a boneseed infestation to its current boundaries. This is a more realistic goal than eradication if the infestation is widespread and well established. Containment protects areas of native vegetation, reduces the number of new weed infestations and reduces the need for future control. The main objective is to reduce infestations to a level that does not negatively impact the natural ecology of the site.

Containing a boneseed infestation in the short-term will increase the chance of successfully eradicating the infestation in the future if more resources (funding and people) become available. Containment should also involve restoration of treated areas through native regeneration or revegetation (see Section 4).



Grades of boneseed invasion: dense infestation, patches of boneseed in native bush, good quality native bush with only scattered boneseed plants, and pristine native bush with no boneseed.

Eradication programs

Eradication of boneseed is possible when:

- the boneseed infestation only covers a small area
- the extent of the infested area is known and accessible
- the chance of reinvasion from adjoining areas is low
- the infestation is detected before seeds are released

  or
- resources are available for regular surveying and control for the lifespan of the seedbank
- new seedlings are controlled before more seeds are produced.

Eradication is most often attempted in areas of relatively good native bushland, as these areas have a greater potential for natural regeneration of native species, and may provide more resistance to further weed invasion.

A priority for eradication programs is to reduce the size of the boneseed seedbank, and to prevent fresh seed fall. This generally requires eradication programs to be more intensive (i.e. they require more resources) in the short- to medium-term, so *all* boneseed seedlings can be controlled before they mature and set seed.

Follow-up control of seedlings is critical in the first few years, but it is just as important that you maintain your commitment over the longer-term. It only takes a few plants to establish and set seed for all your hard work to be undone. Seedlings will continue to emerge from the seedbank (perhaps for up to 10 years), or seeds may be dispersed into the area, so you need to ensure for many years that all seedlings are controlled before they set seed (i.e. annually). Only through sustained effort will you be able to achieve eradication.

A long-established boneseed infestation will be difficult to eradicate due to the large, persistent seedbank. The seedbank needs to be depleted, and this can be accomplished quickly by stimulating the seeds to germinate. Mass seedling germination can occur after fire (see case study on page 60), or after soil disturbance.

Containment programs

The key to successful containment is to focus efforts on isolated or scattered plants, and prevent boneseed spreading beyond the edges of the main, dense infestation. Once control of isolated plants is achieved, you can begin to reduce the size and impact of the main infestation. Where dense patches of boneseed border native bush, work from the edges of the boneseed infestation towards the middle of the infestation. This allows natives to regenerate from propagules in the adjacent bush. Let native plant establishment determine the rate of weed removal. That is, completely remove weeds from small areas at a time, and don't move on to the next area until enough native species have established to inhibit weed invasion.

Remember to monitor the area outside the main infestation for new boneseed seedlings. These must be controlled before they set seed for your containment strategy to be successful.

Managing boneseed in different situations

Natural ecosystems

Many types of native vegetation are invaded by boneseed, but there are general management principles that apply to them all. Boneseed invades coastal dunes, grasslands, heath, riparian and estuarine vegetation, woodland, dry and wet sclerophyll forest, and mallee. In all these natural ecosystems control measures must be adopted that minimise damage to desirable vegetation, minimise soil disturbance, and encourage native regeneration (see Section 3 for details of control methods discussed below).

Hand removal and chemical control methods are the best choice in natural areas. Hand pulling, cutting (without herbicide), cutting-and-swabbing, and stem injection are preferred over foliar spraying, which may cause off-target herbicide damage to native vegetation.

Native ground cover species can be killed by off-target spraying, and this opens up areas to further invasion by boneseed and other weeds. Although foliar spraying may be a more efficient initial herbicide treatment than cutting-and-swabbing or stem injection, follow-up control can take far longer if many more weeds have colonised the bare ground.

Clearing a dense boneseed infestation can allow other weeds to spread rapidly by reducing competition for light, water, nutrients and space. Before removing boneseed, take note of what other weed species are growing under and around the boneseed. Other weeds may need to be treated at the same time to prevent scattered weed populations expanding after boneseed is removed. To resist further weed invasion, remove the boneseed at the same rate that native species establish and (re)colonise the area.

Kerry Brougham

Boneseed invading native eucalypt woodland.

Kym Smith

Cut-and-swab can be done close to native plants (herbicide with blue dye applied to boneseed stump on right).

Kym Smith

Overclearing of mature boneseed. Note lack of native regeneration, and numerous boneseed seedlings.

Native animals using boneseed

Boneseed may provide shelter and food for native animals in the absence of native vegetation. Keep this in mind when removing boneseed from large areas, and clear the infestation in stages to allow native plants to re-establish and to give animals time to find new habitat. Large boneseed plants can be killed by stem injection, so that the dead plants are left standing and can continue to provide some shelter.

Herbivores inhibiting native regeneration

Dense boneseed infestations may restrict herbivores such as feral deer, rabbits and kangaroos from grazing on native grasses, ground covers and seedlings. Removing large areas of mature boneseed can allow herbivores access to an area, and their grazing can prevent the establishment of native seedlings. It may be preferable to thin the cover of boneseed using hand pulling or the cut-and-swab technique, to allow native shrubs to recover before clearing the remaining boneseed. This will help restrict grazing of native ground covers, and allow native shrubs and trees to regenerate.

Disposing of boneseed plants

Removing whole boneseed plants by pulling or cutting results in a large amount of dead plant material. Dragging large boneseed plants through the bush can damage native vegetation and spread seed (if plants are fruiting), so it is recommended that dead plants be left on site to decay. To prevent re-establishment, ensure that roots are not in contact with the soil. Seeds can be destroyed on site by fire (if permitted), or can be bagged and disposed of carefully off-site by fire or in suitable land-fill.

Gillian Baker

Dead boneseed left to decay on site.

Dead boneseed plants appear to rot quickly in damp areas, but may decay more slowly in dry areas. Mulching the plants will improve the aesthetics of the site and help control erosion. Cut the plants into small pieces (about 30 cm long) and spread evenly over the ground. Be careful, however, not to lay the cuttings so thickly that you create a deep mulch that prevents native regeneration.

Mulching the boneseed cuttings on site will increase nutrient levels in the soil. This can have adverse impacts on native vegetation adapted to low nutrient soils (such as heath), by favouring weeds that thrive on high nutrient loads. Be careful where you use boneseed as mulch, so you don't provide a competitive advantage to the weeds!

Managing boneseed

Hillary Cherry

Boneseed (in foreground) invading riparian vegetation, Tamar River, Tas.

Cultural heritage sites

Weed control around Indigenous and historic heritage sites needs to be managed carefully. Before starting any activities at your site, find out if the site holds any historical or cultural significance. Asking locals is a good place to start, and be sure to contact the local council. All stakeholders who have an association with, or interest in the site need to be involved in planning the weed management program.

Many states require that assessments be done before beginning restoration work in areas that hold cultural significance. Initially, contact your local government or NRM authority; they will be able to inform you of any issues and advise you on how to proceed.

Riparian areas

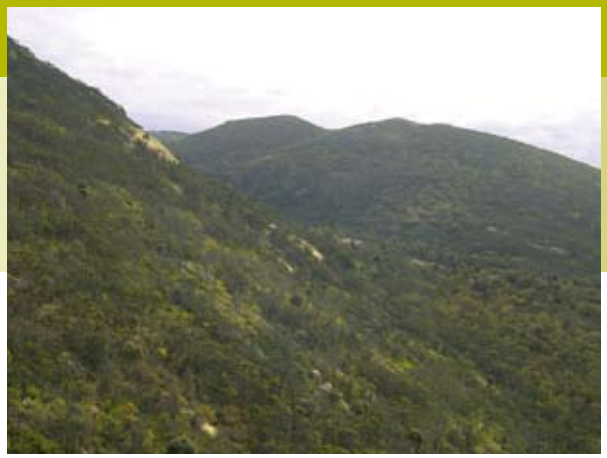
When controlling weeds along watercourses you need to use control methods that minimise bank erosion. Treat small areas one at a time to allow native plants to regenerate and stabilise the bank. In addition, try to prevent large amounts of plant material falling into pooled water, as the breakdown of organic matter can kill aquatic organisms by depleting oxygen levels. For these reasons, mechanical control methods should be avoided in riparian areas.

Cut-and-swab is the most appropriate method to use, and the cut plants should be removed from the water's edge. Cutting-and-swabbing leaves the roots in the ground, which decreases the chance of bank erosion, and removes the foliage, which prevents dead leaves from falling into the water.

Some herbicides contain surfactants that are toxic to aquatic organisms such as frogs. Use only herbicides registered for use in aquatic situations, and follow all label directions. See Section 3 for information on herbicides.

Steep and inaccessible areas

Terrain can greatly influence the choice of control methods, and in some circumstances even prevent control. Boneseed on cliff faces, steep slopes, remote areas, and at the water's edge may be inaccessible. It is important to identify inaccessible and difficult-to-access areas in your management plan, as you may need to engage trained contractors or government agency staff to control boneseed in such areas. People with the appropriate training and experience can control boneseed on cliff faces and steep slopes using safety equipment such as harnesses and ropes. You should always consider occupational health and safety guidelines when planning to control boneseed in difficult to access areas.



CSIRO

Flowering boneseed in steep country, You Yangs, Vic.

Erosion

Boneseed control on steep slopes can result in erosion, so use control methods that limit soil disturbance, and do not leave areas of bare ground. Chemical control methods are the most suitable as the roots are left in the ground and soil is not disturbed. Manual control may be used on small infestations, although hand pulling should only be performed when the soil is moist or loose to prevent erosion.

Take into account drainage patterns, and always work from the top of a slope to the bottom to prevent boneseed spreading by seed movement down slopes and watercourses. If possible, remove boneseed from the edge of watercourses to prevent seeds being carried downstream.

Pastures and grazing lands

Boneseed is not considered an agricultural weed as it is palatable to stock, and does not persist when grazed or cultivated. For this reason, many landholders do not consider boneseed to be a problem on their properties. However, good land management is important to prevent the spread of boneseed around your property and onto neighbouring properties and native bushland.

Boneseed is especially palatable to sheep and can be controlled by grazing. However, stock should not be used to graze fruiting boneseed plants as they can spread the seed in their faeces. If they have ingested fruits, quarantine stock in holding facilities before moving them into 'clean' areas.

Ros Gibson

Boneseed flowering along the Great Ocean Road, Vic.

Gillian Baker

Care needs to be taken when controlling boneseed on slopes.

Be aware of the effect of removing stock from paddocks containing boneseed. When stock graze emerging boneseed seedlings they prevent the young plants from establishing and fruiting. If stock are removed, the boneseed seedlings can mature and produce seed, and the boneseed population will expand rapidly. If you are fencing off areas of previously grazed land to promote native regeneration, you will need to control the boneseed (and other weed) seedlings as they emerge.

Mechanical control using heavy machinery may be appropriate on agricultural land. Small excavators can be used to pull mature boneseed plants from the ground. To minimise soil disturbance, mechanical pulling should only be done in sandy or loose soils so that the root mass comes out of the ground more cleanly. Slashing or grooming attachments on tractors or excavators can also be used to fell and shred boneseed plants. However, this will not kill all boneseed plants, and the regrowth will need to be treated.

Nicole Zeoli

Boneseed plants clustered around dead paddock tree. Birds deposit seeds while roosting.

All machinery and vehicles will cause soil disturbance and compaction, and this needs to be carefully balanced against the time-saving benefits of using machinery. Revegetation with local native species will usually be needed after mechanical slashing and grooming to prevent further weed invasion.

Road, utility and railway corridors, and vacant land

Boneseed often occurs along road, utility and railway corridors, which are managed by local councils, state governments, utility providers and transport operators. Although these areas are often degraded, roadsides and utility corridors can contain the only remnants of native bush left in an area. If this is the case, these areas do have conservation value, and weed control methods should be chosen that minimise disturbance to desirable vegetation and soil (e.g. hand pulling or cut-and-swab).

Vacant land, such as land awaiting development, is often unmanaged. Weed infestations on such land can easily spread to neighbouring properties and native bushland. At a minimum, boneseed infestations should be managed to prevent seeding and spread to other areas. On heavily degraded land, this can be achieved by slashing (mechanical slashing or with a brush-cutter) at least once a year before flowering. Alternatively, foliar spraying from a vehicle-based spray unit at least once a year will also prevent seeding, and should kill all boneseed plants. These control methods can be carried out cost-effectively by land managers or contractors.

Legislation exists in most states and territories that requires landholders to control boneseed on their land (see Section 6 for declaration details). Cooperation between all landholders in an area is essential for successful control, as boneseed will quickly spread from an unmanaged property to (re)invade neighbouring properties.

Developing a management plan

Presented below are the steps involved in developing a weed management plan. A good resource with more detailed information on planning and monitoring is the *Introductory weed management manual*, published by the Cooperative Research Centre (CRC) for Australian Weed Management (2004) and available free in hard copy or by download from the CRC's website <www.weeds.crc.org.au>.

Hillary Cherry

Boneseed invading degraded vacant land, Tas.

Richard Holloway

Boneseed in ungrazed pasture, Droughty Point, Tas.

Step 1: site assessment

To help you plan your weed control activities, carry out a site assessment. Preparing a site information sheet and a weed management map will help to:

- accurately target weed control activities
- allocate time and funds
- monitor the effectiveness of control treatments
- identify other important issues (safety, access etc.).

Site information sheets

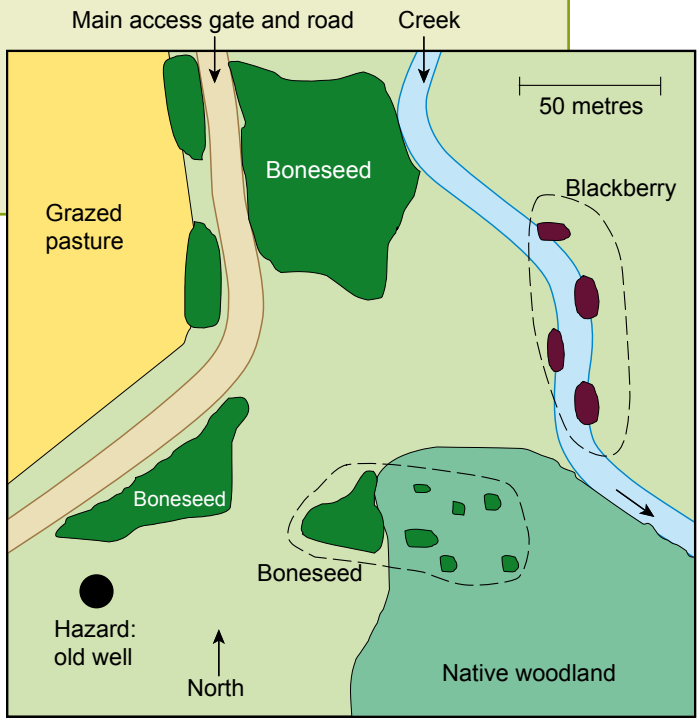
A site information sheet should include:

- site location (latitude and longitude, GPS or map coordinates) and a site map
- date surveyed
- stakeholders – who owns the land, who uses the area, or who has an interest in or association with it?
- site conditions (e.g. vegetation communities, soil type)
- weed species present, their origins and reinvasion pathways (if possible)
- animals or threatened plant species present
- land-use and/or management history of the site
- disturbance history of the site
- safety hazards such as water, steep or uneven terrain
- management issues such as accessibility, gates, cultural heritage assets.

Weed management maps

Topographic maps or aerial photographs (available from your local council or library) are a good base on which to create your weed management map. Use separate transparent overlays and coloured markers to record natural features, native vegetation and weed infestations. This will make the map easier to interpret. Make sure you include a map legend, north orientation, and a scale.

A mud-map (below) is a simple alternative. Use different colours for different weed species.



Managing boneseed

Wendy Andrew

H&A Wapstra

Above: Volunteers control boneseed to protect the rare Woolly New Holland Daisy (inset).

Step 2: set goals

Set realistic goals that focus on what you are trying to protect or restore, rather than on weed control alone. For example, your goal may be to:

- restore a native open woodland community by eradicating a recent boneseed infestation
- protect a threatened plant species by controlling the boneseed

  or
- contain an extensive boneseed infestation to its current area in the short term by controlling isolated plants, and in the long term restore the site by gradually controlling sections of the main infestation.

Step 3: prioritise

Prioritise areas for control beginning with areas of highest conservation value (e.g. areas containing threatened species). High priority should also be given to new boneseed infestations and isolated plants that have not set seed, to prevent a seedbank forming that will require extensive follow-up control.

Focus control efforts where success is most likely, such as areas that are easily accessible, have relatively intact native bushland (or good agricultural land), and are important to the community (so long-term management is maintained). Highly degraded areas that have a high chance of invasion by other weeds following boneseed control may be a lower priority.

Where possible you should consult local experts, council weed officers, NRM board officers or CMA officers to help you prioritise areas for control.

Always work from the best areas to the worst.

Step 4: develop a control plan

Determine the best boneseed control methods for your site for initial and follow-up treatments by assessing:

- the appropriateness of each method (based on land-use situation, terrain, and the size, density and age of the boneseed infestation)
- your goals (are you trying to eradicate or contain the infestation?)
- your resources (people, funding and equipment).

Establish a long-term plan (i.e. more than three years), and schedule control and follow-up activities at the time of year they will be most effective (see Section 3 for details on control methods). Include time for monitoring in your annual timetable.

People required

Assess how many 'people-hours' will be required to complete the planned control program. Also consider what skills, training and experience are needed to carry out each control method and monitoring technique. If labour is likely to be a limited resource, focus your control efforts on a manageable area – it is better to completely control boneseed over a small area than to expend resources on a large area that cannot be followed-up or maintained.

Trevor Wyniatt

Boneseed is easily spread along road corridors (along roadside, Mt Burr, SA).

Financial plan

Compare the costs associated with each control method, and develop a financial plan. There are obvious costs associated with each technique such as herbicide, spray equipment, machinery, and labour; but do not forget the less obvious expenses such as protective gear, lockable storage for herbicides, and training. It is important to budget over the long term, and allow for follow-up work and monitoring.

To save costs, check if you can borrow equipment from councils, landcare organisations, and catchment authorities. If you are working on public land, councils or state agencies may also supply herbicides and even trained operators to assist you. See Section 6 for information on funding opportunities.

Step 5: monitor your progress

Monitoring allows you to:

- assess the effectiveness of your control measures
- assess the rate of establishment of desirable vegetation
- identify new weed infestations
- identify any new issues that will affect your control program
- demonstrate your progress to your group or funding body.

Monitoring is an extremely important part of a boneseed control plan. Information gathered through the monitoring process will allow you to adjust your weed management plan to adapt to changes at your site, and improve future outcomes. Collecting meaningful monitoring data ensures your results can be used to develop and improve best-practice guidelines for management. See Section 4 for further details on monitoring.

Section Three

Control methods

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Key points

Follow-up what you started

The key to successful boneseed control is sustained follow-up work over a number of years. Removal of mature plants promotes seedling germination from the long-lived seedbank, and these seedlings must be controlled before they establish and set seed. Seedlings will continue to emerge from the seedbank (perhaps for up to 10 years), or seeds may be dispersed into the area. Annual removal of these seedlings will be necessary for many years.

Integrate methods

Often the most successful and cost-effective way to control weeds is to combine or integrate different control methods (known as integrated weed management). An integrated approach does not need to be complicated. It may be as simple as using different techniques for initial and follow-up control – for example, mature plants might be treated by herbicide application, and the seedlings hand pulled in following years.

Choose methods based on the ecosystem, terrain, available resources and the size and density of the boneseed infestation. Target the timing of each treatment to coincide with the most vulnerable growth stage or season.

The following examples illustrate how methods can be integrated through the various stages of control in different situations. The control methods listed are the best options available for each situation. Detailed information on each of these control methods is presented later in this section.

Example 1 – Scattered boneseed plants in native bushland

Key points Use minimal disturbance techniques, and remove mature plants before they fruit (or you will have to dispose of the seeds). Many seedlings will die in their first summer, so follow-up seedling control should be done after summer to save unnecessary effort. If you wish to eradicate boneseed from the area, you will need to conduct annual surveys and remove all seedlings for many years.

Stages of control and appropriate methods:

- initial control to remove all boneseed plants by:
  ✔ hand pulling, cut-and-swab, or stem injection (for large plants)
- follow-up control of seedlings and any overlooked mature plants by:
  ✔ hand pulling, cut-and-swab
- natural native regeneration
- follow-up control of seedlings by:
  ✔ hand pulling

Example 2 – Dense boneseed infestation in native bushland

Key points Same as for Example 1. In addition, remove isolated plants first. Dense infestation can then be controlled in stages. Remove boneseed from small areas, or thin out the infestation, to allow native groundcovers to regenerate and resist further weed invasion. This approach also restricts herbivores from grazing on newly emerging native seedlings, and allows native animals to gradually adjust to changes in the habitat.

Stages of control and appropriate methods:

- initial control to remove isolated boneseed plants and thin out main infestation by:
  ✔ hand pulling, cut-and-swab, or stem injection (for large plants)
- natural native regeneration
- further control to remove all mature boneseed plants and new seedlings by:
  ✔ hand pulling, cut-and-swab, or stem injection (for large plants)
- natural native regeneration
- follow-up control of seedlings by:
  ✔ hand pulling

Example 3 – A planned hazard reduction burn by local fire authorities in an area containing boneseed

Key points Mature boneseed may not be killed by a low intensity prescribed burn, and soil temperatures may not be high enough to affect the seedbank. By slashing or hand pulling mature plants a few weeks or months prior to the burn you can increase boneseed mortality and fuel loads at ground level. The higher soil temperatures generated should also kill many seeds and stimulate mass seedling germination. Wait until just before the seedlings flower to control them, as they will thin out naturally through competition (they may flower in the first year after a fire).

Stages of control and appropriate methods:

- pre-treatment to dry out foliage before a hazard reduction burn by:
  ✔ hand pulling, slashing (with an axe or brush-cutter)
- hazard reduction burn
- follow-up control of post-burn seedlings just before they flower by:
  ✔ hand pulling or foliar spraying
- natural native regeneration
- follow-up control of seedlings by:
  ✔ hand pulling

Hillary Cherry

Grasp the stem close to the ground.

Manual control

Manual control is performed using no tools or hand tools only, and methods include hand pulling and cutting without herbicide (see box on page 26). Manual control methods cause minimal soil disturbance and minimal damage to desirable vegetation, thus reducing the risk of erosion and limiting the germination of weed seeds. Consequently, manual control is useful for tackling infestations in quality native bushland and in dunes or other areas prone to erosion.

Hand pulling

Because boneseed has a relatively shallow root system with no taproot, seedlings and young plants can be pulled out by hand. It is also possible to hand pull mature plants in sandy or moist soil, and hand tools are available that use leverage to help pull larger plants out of the ground (e.g. the 'Tree Popper'). Hand pulling mature plants is more difficult in heavier soils such as clay unless the soil is moist.

Method

For small seedlings, take hold of the stem at ground level and pull out vertically. Larger plants should be rocked backwards and forwards gently until they come away cleanly, or use a leverage tool. It's important to replace any disturbed soil and leaf litter as you go to reduce erosion and encourage regeneration of native seedlings.

Plants may be left to decay on site, provided the roots are not left in contact with the soil (otherwise they may re-establish).

Timing

This method can be used at any time of the year, but in areas with heavier soils you may need to wait until the soil is moist. Young plants must be removed before they first flower and set seed. Adult plants should ideally be removed when they are not in fruit in order to prevent the spread of seeds.

Treatment	Advantages	Disadvantages
Hand pulling	• Low impact on natural environment • Whole plant removed (no regrowth) • Selective (boneseed can be removed when growing close to desirable vegetation) • No costly chemicals or equipment required • Low level of soil disturbance if done carefully	• Time-consuming and labour-intensive • Not practical for extensive infestations • Can be difficult in heavier soils or with large plants

Cutting without herbicide

Trees For Life in South Australia have had success killing boneseed with a technique they call 'cutting' – this involves simply cutting off the stem close to the ground, without applying herbicide. This method is used for boneseed plants that are too big to pull by hand, or when soil erosion is an issue, such as in steep areas and gullies.

Cutting is used successfully in the Adelaide Hills and around the Barossa Reservoir, although boneseed in the adjoining Para Wirra Recreation Park has been found to resprout. Success may depend on light availability, soil type, soil moisture or season. On the Eyre Peninsula, resprouting is minimal in late summer and autumn, when soil moisture is lowest.

For a successful kill, the stem needs to be cut very close to the ground, and preferably slightly below ground level if possible. If more than two centimetres of the trunk is left above the ground, boneseed is likely to resprout. After cutting, any exposed roots should be re-covered with soil to prevent resprouting.

Bush saws are ideal for larger plants, while smaller plants can be cut with long-handled loppers. Brush-cutters fitted with a steel blade are very useful for stems up to about 3 cm in diameter. Chainsaws are not suitable as it is not possible to obtain the very low cut required without blunting the equipment.

Cutting without herbicide must be trialled to test its suitability to your particular area before it is used on a large scale. If successful, cutting is a very ecologically sensitive approach to boneseed control, as it causes minimal soil disturbance and requires no chemicals.

Kym Smith

If stumps are cut too high when cutting without herbicide, regrowth may occur.

Chemical control

When used as part of an integrated management strategy, the use of chemicals (herbicides) can be a practical and efficient way of controlling boneseed. Four herbicide application methods are currently registered for use on boneseed:

- cut-and-swab (where herbicide is applied to the stump of a felled plant)
- stem injection (where herbicide is injected into the sapwood of the plant)
- foliar spraying (where the leaves of the plant are sprayed with a herbicide solution)
- splatter gun application (also spraying with herbicide).

These four methods are discussed in detail later in the section.

Herbicide labels and legislation

The Australian Pesticides and Veterinary Medicines Authority (APVMA; formerly known as the National Registrations Authority) controls and regulates the use of all pesticides, which includes herbicides. Herbicides are registered with the APVMA for specific applications as stated on the label. By law, only herbicides registered for boneseed control can be used on boneseed, and only in the manner specified on the label. APVMA also issues permits for herbicide applications that are not otherwise registered, and these are often referred to as 'Off-label' permits. See the APVMA website for more information <www.apvma.gov.au>.

Be aware of legislation in your state regarding herbicide use – for example, some chemicals are restricted in certain states or in specific areas of the state. Only chemicals that are registered for use in aquatic situations may be used in and around aquatic areas. Herbicides must be stored in properly labelled containers, preferably in the original container, and in a locked cabinet.

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. Chemical use training 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), local councils or non-government organisations. See Section 6 for contact information.

Registered herbicides

There are many different herbicide products registered for use on boneseed. 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. The active ingredients in herbicide products registered for use on boneseed are glyphosate, metsulfuron-methyl, 2,4-D amine, picloram and bromoxynil, in various concentrations. The APVMA has issued permits for the use of triclopyr ester in some states.

Table 1 lists the herbicides registered for use on boneseed, and the states in which these registrations apply. Herbicides that are not registered for use on boneseed but which have Off-label permits covering their use are also shown. Check the APVMA website for current registration and permit information <www.apvma.gov.au>, and always check the label for the correct application rate.

Table 1.
Summary of registered herbicides for boneseed (as of June 2006). 'PERXXXX' denotes permit number.

Application method	Active ingredient	Commercial product examples[1]	State or Territory[2]	Rate	Situation in which the herbicide is registered	Comments
cut-and-swab	2,4-D amine[3] 500 g/L	Smash	VIC, SA	undiluted	pastures, rights of way and industrial areas.	Apply to cut stump at any time of year.
	picloram 75 g/L + 2,4-D 300 g/L	Tordon™ 75-D	QLD, NSW, VIC, SA, WA	1 L/10 L water	pastures, rights of way, commercial and industrial areas.	Apply to cut stump at any time of year.
	glyphosate[3] 360 g/L	Roundup®, Roundup® Biactive™, Weedmaster® Duo, Nuturf Razor, Biochoice™ 360	NSW	1:1.5 with water	urban bushland and forests, and coastal reserves.	PER9158
			SA	1:1 with water	nature reserves and other native vegetation, roadsides, urban open spaces and forests.	PER8865
			TAS	undiluted to 1:5 with water	bushland and non-cropping situations.	PER8949
			WA	undiluted to 1:5 with water	non-agricultural areas, bushland, forests and wetlands.	PER4984
	triclopyr 600 g/L	Garlon™ 600	TAS	1:60 with diesel	bushland and non-cropping situations.	PER8949
	triclopyr 240 g/L + picloram 120 g/L	Access™	TAS	1:60 with diesel	bushland and non-cropping situations.	PER8949
			WA	1:60 with diesel	non-agricultural areas, bushland, forests and wetlands.	PER4984
	triclopyr 300 g/L+ picloram 100 g/L	Grazon™ DS	SA	undiluted	non-cropping situations.	PER7869 – Persons under direction of Animal & Plant Control Commission in SA.
	picloram 43 g/kg	Vigilant®	All	undiluted (gel form)	native vegetation, conservation areas, gullies, reserves and parks.	Apply 3–5 mm layer of herbicide gel to cut stump from 'brushbottle' supplied.

[1] Commercial products listed here are examples only, and many other products containing these active ingredients are registered for use on boneseed visit <www.apvma.gov.au>.

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

[3] Products containing different concentrations of the active ingredients 2,4-D amine and glyphosate are also registered for use on boneseed in various states, visit <www.apvma.gov.au>.

[4] Some manufacturers specify using a higher rate on plants over 1.5 m high.

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

Mick Richards, photo courtesy of DNRMW, QLD

Wear personal protective equipment when using herbicides.

Application method	Active ingredient	Commercial product examples[1]	State or Territory[2]	Rate	Situation in which the herbicide is registered	Comments
stem injection	glyphosate[3] 360 g/L	Roundup®, Roundup® Biactive™, Weedmaster® Duo, Nuturf Razor, Biochoice™ 360	TAS	2 mL undiluted per hole	bushland and non-cropping situations.	PER8949
			WA	2 mL undiluted per hole	non-agricultural areas, bushland, forests and wetlands.	PER4984
	triclopyr 300 g/L+ picloram 100 g/L	Grazon™ DS	SA	undiluted	non-crop situations.	PER7869 – Persons under direction of Animal & Plant Control Commission in SA.
foliar spray	glyphosate[3] 360 g/L	Roundup®, Roundup® Biactive™	QLD, NSW, VIC, TAS	5 or 10 mL/ 1 L water	all situations.	Best results achieved when treated at peak flowering during winter. Use higher rate on plants over 1.5 m high[4].
		Weedmaster® Duo, Nuturf Razor, Biochoice™ 360	All	5 or 10 mL/ 1 L water		
	2,4-D amine[3] 500 g/L	Smash	VIC, SA	100 mL/ 10 L water	pastures, rights of way and industrial areas.	Spot spray when in flower. Thoroughly wet all foliage.
	metsulfuron-methyl 600 g/kg	Brushmaster	All	10 g/ 100 L water	native pastures, rights of way, commercial and industrial areas.	Spray thoroughly to wet all foliage.
		Brushkiller™ 600, Brush-Off®	QLD, NSW, VIC, SA,	10 g/ 100 L water		
		All products	TAS	10 g/ 100 L water	bushland and non-cropping situations.	Permitted in TAS under PER8949. Spot spray using backpack.
	glyphosate 760.5 g/ kg + metsulfuron-methyl 63.2 g/kg	Cut-Out®	QLD, NSW, VIC, SA, ACT	95 g/ 100 L water	pastures, rights of way, commercial and industrial areas.	Spray thoroughly to wet all foliage.
			TAS	95 g/ 100 L water	bushland and non-cropping situations.	Permitted in TAS under PER8949. Spot spray using backpack.
	picloram 75 g/L + 2,4-D 300 g/L	Tordon™ 75-D	QLD, NSW, VIC, SA, WA	650 mL/ 100 L water	pastures, rights of way, commercial and industrial areas.	Spot spray when flowering or fruiting.
	bromoxynil 200 g/L	Bronco 200, Bromo 200	VIC, TAS	160 mL/ 100 L water	pastures, roadsides and rights of way.	Spot spray for young seedlings.
	triclopyr 300 g/L+ picloram 100 g/L	Grazon™ DS	TAS	350-500 mL/ 100 L water	bushland and non-cropping situations.	Permitted in TAS under PER8949. Spot spray using backpack.
	triclopyr 600 g/L	Garlon™ 600	TAS	170 mL/ 100 L water	bushland and non-cropping situations.	Permitted in TAS under PER8949. Spot spray using backpack.
splatter gun	glyphosate[3] 360 g/L	Roundup®, Roundup® Biactive™	QLD, NSW, VIC, TAS	1:29 or 1:19 with water	all situations.	Use higher rate (1:19) on bushes over 1.5 m high[4].
		Weedmaster® Duo	All	1:29 or 1:19 with water		

Cut-and-swab (cut-stump, cut-and-paint)

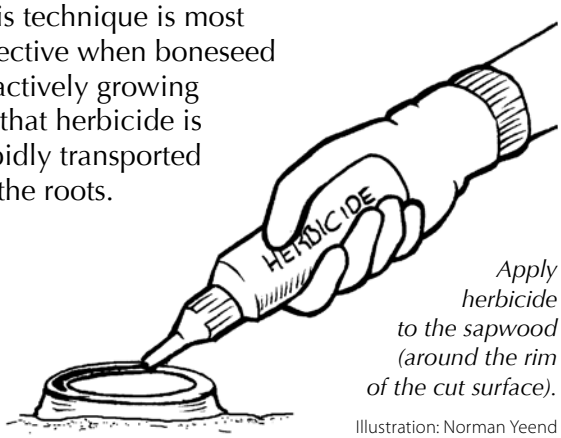
Also called cut-stump or cut-and-paint, the cut-and-swab method involves cutting the plant off at the base of the stem then immediately applying herbicide to the stump. Use this method for all boneseed plants that are too large to hand pull, or when soil disturbance should be avoided, such as in steep areas and gullies. Cut-and-swab is an ideal technique for use in native bushland, as there is little chance of off-target herbicide damage if done correctly.

Method

Cut through the stem horizontally as close to the ground as possible with a bush saw, secateurs, loppers, chainsaw or brush-cutter. Immediately (within 15 seconds) apply herbicide to the cut surface of the stump, before the plant cells close up and inhibit entry of the herbicide. This method works best when done by a two-person team – one person cutting and one person applying the herbicide. Herbicide can be applied using a squeeze bottle, sponge-tipped bottle or spray bottle. On larger stems, apply the herbicide to the outer sapwood (cambium layer) only, as only the sapwood will transport the herbicide to the roots.

Timing

This technique is most effective when boneseed is actively growing so that herbicide is rapidly transported to the roots.



Apply herbicide to the sapwood (around the rim of the cut surface).

Illustration: Norman Yeend

Peter Tucker

Use two people to cut-and-swab.

Kerry Brougham

Cut stem horizontally and as close to the ground as possible, to avoid leaving sharp stumps.

Read and follow all directions on the herbicide label. Usage restrictions are explained on the label (e.g. use is often restricted in wet weather).

Have you tried cutting without herbicide in your area? See box on page 26.

Left: Squirt bottle to apply herbicide. Below: Sponge-tipped bottle to apply herbicide.

Images: Trees For Life

Mick Richards, photo courtesy of DNRMW, QLD

Cut stem with loppers as close to the ground as possible.

Stem injection

Stem injection (also called drill-and-fill) delivers herbicide directly to the sapwood. Stem injection is an ideal technique for use in native bushland, as it causes minimal soil disturbance, and there is little chance of off-target herbicide damage if done correctly. This method is especially useful for large boneseed plants, as plants are left standing and can continue to provide shelter and habitat for native animals.

Kym Smith

Stem injection or drill-and-fill. Blue dye in herbicide shows that this plant has already been treated.

Method

Use a cordless drill to drill holes around the base of the trunk, no more than 50 mm apart. Holes do not need to go deeper than the sapwood layer, as the heartwood layer will not transport herbicide around the plant. Drilling holes at an angle of 45° will aid herbicide retention and increase absorption by the plant. Inject the herbicide within 15 seconds of drilling the hole, using a squeeze bottle or plastic syringe. Do not overfill the holes as excess herbicide is wasted and can contaminate the environment. Injection guns are available that can drill the hole and deliver a precise amount of herbicide.

Timing

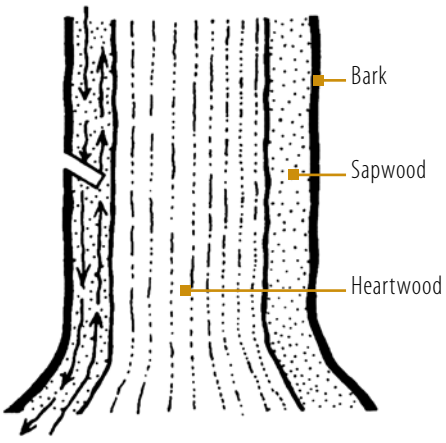
This technique is best used when boneseed is actively growing so that herbicide is rapidly transported around the plant.

Success using glyphosate

Trees For Life is a non-government organisation committed to the revegetation and protection of South Australia's native bushland. *Bush For Life* is its bushcare program, and volunteer bushcarers are trained in minimal disturbance bush regeneration techniques. Their preferred methods for controlling woody weeds in native bushland are hand pulling, cut-and-swab and stem injection.

They have had particular success in controlling boneseed using the cut-and-swab and stem injection methods with glyphosate herbicide. 'Many people don't realise that glyphosate is very effective on a range of woody weeds', says Peter Tucker, Technical Officer for Bush For Life. 'Glyphosate has few restrictions on its use, is cost-effective and requires less safety training, making it ideal for use by community bushcare groups'.

Peter has found that glyphosate is as good as any other herbicide at killing boneseed, with total mortality achieved when the cut-and-swab or stem injection methods are done properly.



Drill into sapwood not heartwood

Foliar spraying

Foliar spraying is the application of herbicide solution to leaves in the form of a fine spray. Foliar spraying can be used to treat plants of all ages. It is especially effective for treatment of dense 'carpets' of boneseed seedlings because large areas can be treated quickly. Foliar spraying is useful for treating infestations in steep terrain where erosion is an issue. It is also practical when few workers are available because it can be done relatively quickly by one person. 'Spot spraying' refers to the foliar spraying of individual plants or clumps of plants, and is used on small infestations or isolated plants.

No boneseed-selective herbicide currently exists, so care needs to be taken not to damage desirable vegetation by off-target spraying, over-spraying or spray drift. Desirable vegetation includes both native vegetation and horticultural crops and vines.

Method

Foliar spraying of boneseed is usually done using a spray gun and backpack or vehicle-based spray unit; a small boom attachment is useful for spraying a dense cover of seedlings. Spray units connected to a tank and pump mounted on a vehicle are very useful when treating large areas. Plants must be sprayed thoroughly, wetting all foliage.

Timing

This technique must be used when boneseed plants are actively growing, and not stressed by hot, dry, cold, wet or other extreme conditions. It is during active growth that the herbicide is most readily absorbed through the leaves. Mature plants should ideally be treated either in winter or when in flower, depending on the herbicide used (see Table 1 on page 28). Scattered plants are also easiest to locate and identify when flowering.

Phil Maughan

Spot spraying from a backpack sprayer.

Rachel Melland

Spraying boneseed seedlings using a boom extension.

Foliar spraying should be avoided on windy days, to limit spray drift, and when rain is forecast. Read and follow all label directions regarding method and timing of application.

Splatter gun

Splatter guns administer large droplets of herbicide solution, and are used with more concentrated herbicide solutions than other foliar applications. Although splatter guns were developed over thirty years ago, they have not been used widely. Recent trials on lantana have shown splatter guns to be particularly effective in controlling this weed when the spray is applied in straight lines approximately one metre apart. This technique uses a much lower volume of spray mixture than standard foliar spraying, and the larger droplets are less likely to drift. While splatter guns are

not widely used on boneseed, they may be effective for mature boneseed control. They are not recommended for use on seedlings.

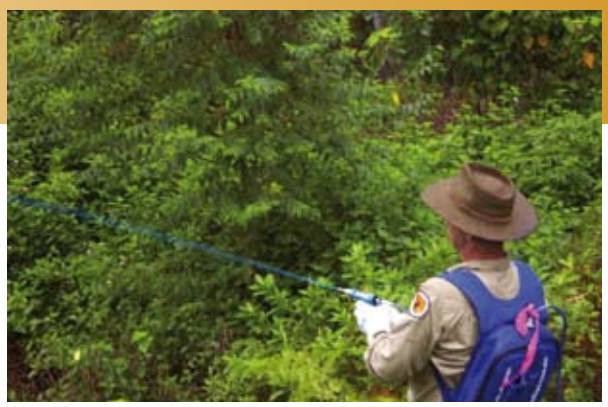
Method

Splatter guns are usually used with a backpack spray unit. Check the label to ensure the herbicide is registered for application by splatter gun, and read and follow all label directions.

Timing

As with foliar spraying, this technique must be used when boneseed is actively growing (and the plants are not stressed by extreme conditions) so that the herbicide is taken up by the plant. Mature plants should ideally be treated either in winter or when in flower, depending on the herbicide used (see Table 1 on page 28). Scattered plants are also easiest to locate and identify when flowering.

Splatter gun application should be avoided on windy days, to limit spray drift, and when rain is forecast. Read and follow all label directions regarding method and timing of application.



Daniel Stock, Photo courtesy of DNRMW, QLD

Applying herbicide with a splatter gun, using dye to mark areas already sprayed.

Treatment	*Advantages*	*Disadvantages*
Cut-and-swab, and Stem injection	• Very high kill rate • Selective • Uses less herbicide than foliar spraying • Minimal soil disturbance	• Labour-intensive and time-consuming when dealing with large infestations • Cannot be used in wet weather • May require training
Foliar spraying	• Very high kill rate • Large areas can be treated quickly • Can be used in steep terrain or erosion prone areas • Minimal soil disturbance	• High risk of off-target damage when treating large areas • Dense seedlings may cover one another leading to incomplete spray coverage • Cost may be prohibitive for large infestations • Cost of spray equipment • Cannot be used in wet weather • May require training
Splatter gun	• Very high kill rate for mature plants • Large areas can be treated quickly • Lower risk of off-target damage than with foliar spraying • Can be used in steep terrain or erosion prone areas • Minimal soil disturbance	• Cost may be prohibitive for large infestations • Cost of spray equipment • Cannot be used in wet weather • May require training

Mechanical control

Mechanical control involves the use of heavy machinery such as tractors and excavators. Fitted with a claw attachment, these machines can remove mature boneseed plants by pulling them from the ground. Tractors or excavators fitted with slashing or grooming attachments can be used to simultaneously fell and shred boneseed plants.

Due to the high level of disturbance caused to soil and desirable vegetation, mechanical control methods are not suitable in natural areas.

Mechanical pulling

Mechanical pulling can be used to clear large boneseed plants from degraded areas, pastures and grazing lands. Because of boneseed's shallow but extensive root mass, pulling large plants can lead to soil disturbance. This may promote the germination of boneseed and other weed seedlings. This method is performed successfully in areas of South Australia with fairly sandy soil, using a small excavator.

Method

Using a compact excavator or tractor with a modified claw attachment, it is possible to remove very large boneseed plants with the root mass intact. The claw grips the boneseed plant around the stem close to the ground, and the mechanical arm is lifted to pull the plant out of the ground.

Timing

This method can be used at any time of the year, but preferably before the plants set seed. This will prevent an increase in the boneseed seedbank; it also prevents machinery becoming contaminated with, and spreading boneseed seeds. On heavy soils such as clay, mechanical pulling may need to be done when the soil is moist.

Hillary Cherry

Boneseed has an extensive but shallow root system, with no tap root.

Tony Zwar

Mechanical puller - a claw attached to an excavator.

Hillary Cherry

The claw grasps the stem close to the base.

Craig Bray

Mechanically grooming boneseed monoculture, You Yangs, Vic.

Craig Bray

Results of mechanical grooming. Regrowth and seedlings will require treatment.

Mechanical slashing and grooming

Mechanical slashing and grooming can be used to stop flowering boneseed plants setting seed and increasing the size of the seedbank. This method is usually only appropriate in non-natural areas, such as vacant land awaiting development. Many stumps will resprout, although the regrowth can be treated by spraying. This is more economical than spraying an entire large infestation, and therefore the high machinery costs may be balanced against reduced herbicide costs.

Method

Heavy duty slashing (mowing) attachments simultaneously fell boneseed plants and cut them into pieces, while grooming heads fell plants and shred them into a fine mulch. Either attachment can be attached to a tractor, which is driven over the infestation. Alternatively, grooming heads can be attached to excavator arms to treat infestations in hard to access areas, as they can reach around objects to fell and shred boneseed.

Timing

This method can be used at any time of the year, but preferably before the plants set seed. This will prevent an increase in the boneseed seedbank; it also prevents machinery becoming contaminated with, and spreading boneseed seeds.

Treatment	*Advantages*	*Disadvantages*
Mechanical pulling	• Whole plant removed (no regrowth) • Targeted – minimal damage to surrounding trees • Less labour intensive than manual or chemical control methods • Can treat large infestations relatively quickly	• Potentially high levels of soil disturbance and compaction • Risk of damage (crushing) to desirable shrubs and grasses • Disturbance may promote germination of weed seeds • Weed seeds can be spread on machinery • Requires access for machinery • High machinery costs • Training required for machinery operator
Mechanical slashing and grooming	• Less labour-intensive than manual or chemical control for large infestations • Can be cost-effective for large infestations • If foliar spraying regrowth, less chemicals are required than if spraying entire plants	• Many plants resprout • Damages desirable vegetation • Potentially high levels of soil compaction • Weed seeds can be spread on machinery • Requires access for machinery • High machinery costs • Training required for machinery operator

Boneseed and fire

Fire plays an integral role in the functioning of many natural ecosystems in Australia, and bushfires and prescribed burns should therefore be taken into account when formulating a weed management plan. Prescribed burns are carried out for either hazard (fuel) reduction purposes or to trigger the regeneration of native vegetation. The main consideration with boneseed is the need for follow-up seedling control after fire, as fire stimulates the germination of boneseed seeds.

Effect of fire on boneseed

If boneseed plants are entirely scorched in a fire they are unlikely to survive (unlike bitou bush which will often resprout after fire). Fire kills many seeds and stimulates mass germination from the seedbank, resulting in a dense 'carpet' of boneseed seedlings. If seedlings are controlled before they set seed, a fire can effectively reduce the number of years required for follow-up control by depleting the seedbank (see case study on page 60). If seedlings are not controlled they will out-compete native seedlings, exhausting the native soil seedbank. The boneseed population can then expand and quickly re-establish a massive seedbank (see case study on page 65). Although boneseed plants are usually at least 18 months old before first seeding, post-fire seedlings grow rapidly and can often set seed around 12 months after a fire, depending on climate conditions (Melland in prep).

Boneseed does not burn as easily as many native shrubs, in part due to the fleshy nature of the leaves. Dense boneseed infestations can shade out native grasses and herbs that would otherwise provide ground-level fuel for a fire, so a low intensity fire will not carry well through a boneseed monoculture (Melland in prep).

Rachel Melland

Prescribed burn in boneseed infestation, You Yangs, Vic.

To increase boneseed mortality during a prescribed burn, mature plants should be slashed or pulled out prior to the burn. The plant material should be left to dry on the ground where felled (not in piles). This fuel at ground level will help to carry a fire, and thus heat the soil, stimulating the boneseed seedbank to germinate. Ideally, plant material should be left to dry for several months, depending on weather conditions (Melland in prep). However, this extra fuel can increase the risk of bushfires. Consult local fire authorities regarding the suitability of this technique for your area.

High intensity fires (such as bushfires) can heat the soil to extreme temperatures, which can destroy the boneseed seedbank. However, follow-up control is still needed as fires are usually patchy, and it is unlikely that all seeds will be killed over large areas. Follow-up seedling control will be necessary in areas of

Rachel Melland

No boneseed seed was found in the soil three days after the January 1997 wildfire, Arthurs Seat, Vic.

low intensity, near water sources, and where seeds have dispersed into the burnt area from unburnt sections of the population (Melland in prep).

If you are in a bushfire-prone area make sure you have an 'emergency' follow-up control plan in place. This way you can respond quickly after a bushfire and take advantage of the opportunity to control the boneseed infestation, by eliminating any seedlings before they flower and replenish the seedbank. The massive seedling recruitment is advantageous if you have the resources to control the seedlings, because it rapidly depletes the seedbank. A concerted effort after a fire can reduce the intensity and duration of your boneseed control program (Melland in prep).

Rachel Melland

No boneseed emerged in areas burned by intense wildfires in Arthurs Seat, Vic.

Boneseed in the You Yangs Regional Park

Fire triggers mass boneseed germination and if seedlings are not controlled they will out-compete native seedlings, exhausting the native seedbank. The boneseed population can expand as it quickly re-establishes a massive seedbank.

Boneseed expanded its range rapidly after bushfires in 1985 in the You Yangs Regional Park, south-west of Melbourne. Before the fires, boneseed was scattered throughout the park. The fires were widespread, burning 85 per cent of the park, and they triggered the mass germination of huge numbers of boneseed seedlings. Within three years of the fire, the boneseed infestation became dense and widespread in the You Yangs, and now impacts upon 1300 hectares of the 2000 hectare park. Boneseed now dominates the middle-storey vegetation in the areas that were burned.

The park is now missing a lot of indigenous middle-storey plants, as they were out-competed by fast-growing boneseed seedlings after the fire. The loss of native plants has had a huge detrimental impact on the numbers of native birds and animals that relied upon them for food and shelter.

There are simply not enough resources to control all the boneseed in the park, so management is strategically targeted to some 40 hectares where boneseed threatens high conservation values, such as around the rare brittle greenhood orchid. For more details on boneseed in the You Yangs see the case study on page 65.

Boneseed seedbank and fire

Laboratory experiments by Lane and Shaw (1978) showed that exposing boneseed seeds with cracked seed coats to temperatures of 100 °C for 30 seconds induced the seeds to germinate. They also showed that temperatures over 250 °C killed the seeds after two minutes. Seeds with uncracked seed coats would not germinate at all.

Field experiments by Melland (in prep) revealed that peak soil surface temperatures of 250 to 300 °C are required to substantially deplete the boneseed seedbank. During a controlled burn at Arthurs Seat State Park, the soil surface temperature remained over 100 °C for just over 5 minutes, and the temperature 2 cm below the soil surface remained over 50 °C for more than 30 minutes. This burn eliminated the boneseed seedbank at this site via seed death and stimulation of germination.

An even burn is required to eliminate as many boneseed seeds from the seedbank as possible. A patchy burn will lead to an increase in weed control time and labour costs in the post-burn years, as seeds surviving the fire continue to germinate. Brush-cutting boneseed and leaving it to dry on the ground prior to burning will increase the fuel load and enable fires to be carried throughout the boneseed infestations (Melland in prep). For more details of these experiments see the case study on page 60.

Talk to local fire authorities

Keep in contact with local fire authorities and the land managers of your site. Alert them to the effect fire can have on boneseed populations and its implications for control. By having input into fire management plans, you can better plan your weed control activities. For instance, before a prescribed hazard reduction burn, you can pull or slash mature boneseed to improve mortality rates during the fire; you can also arrange follow-up seedling control for after the fire.

Community input into fire management plans

In the Meehan Ranges outside of Hobart, the Flagstaff Gully Landcare Group was concerned about the rapid spread of boneseed after fire – particularly when the fire was hot enough to remove the native understorey plants, and good rain followed the fire. The group and other members of the community encouraged the Clarence City Council in south-east Tasmania to include boneseed in the local fire management plan. The council has now introduced a simple notification process to advise when they will carry out hazard reduction burns in their bushland reserves. The council writes to landcare groups and land owners in spring to notify them of burns planned for autumn. This gives all stakeholders an opportunity to raise concerns and provide input into the fire management process, as well as plan for post-burn weed control.

Last spring, the council fire crew hand pulled around 1500 boneseed plants from the area cared for by the Flagstaff Gully Landcare Group, prior to a planned burn. This improved mature boneseed mortality rates, and helped promote an even burn, stimulating seed germination. The landcare group then focused its efforts on the burnt areas in winter, where they removed the mass of seedlings that emerged after the fire. Thus, the planned hazard reduction burn assisted the landcare group's boneseed removal program by rapidly depleting the seedbank.

Tom Morely

Lacy-winged seed fly pupa and maggot in boneseed fruit.

Biological control

Biological control (biocontrol) is the use of a weed's natural enemies (biocontrol agents) to suppress a weed population. The agents used on boneseed come from its native range in South Africa. The aim of biological control is to:

- suppress plant vigour
- reduce seed production
- slow plant growth
- reduce the density of the weed infestation.

For more information on biological control see the CRC for Australian Weed Management website <www.weeds.crc.org.au/weed_management/biological_control.html>.

Brief history

A biological control program to combat boneseed and bitou bush was established in 1987. To date, four of the six insect species released on bitou bush have established, with the bitou tip moth (*Comostolopsis germana*) and bitou seed fly (*Mesoclanis polana*) now widely distributed in New South Wales. In contrast, none of the six insect species released for boneseed control has established. The reasons for the failure of these agents to establish in the field are not known, although they are thought to be related to the predation of the biocontrol insects by ants, mites and spiders.

Tom Morely

Adam Magennis, Parks Victoria ranger releasing the lacy-winged seed fly onto boneseed, Arthurs Seat, Vic.

Tom Morely

Lacy-winged seed fly.

The lacy-winged seed fly, first released in 1998, has so far failed to establish on boneseed, probably due to boneseed's flowering period being too short to sustain seed fly populations from one season to the next. In an effort to establish a self-sustaining population, the seed fly was released onto bitou bush (which flowers year-round) on the south coast of New South Wales in August 2005. If establishment is successful, large quantities of seed flies will then be released onto boneseed. The seed fly was also re-released onto boneseed at two sites at Arthurs Seat in Victoria.

For a detailed review of the *Chrysanthemoides monilifera* biological control program see Downey *et al*. (in press).

Hillary Cherry

Park rangers are raising biocontrol agents for boneseed in this greenhouse. School students will release these agents in the You Yangs as part of a weed awareness program.

Engaging the community in biological control

Parks Victoria staff at the You Yangs Regional Park have been running their own biological control program for boneseed since 2004. This is an innovative community engagement program aimed at increasing awareness and involvement in local weed issues. The program engages school students in weed management through a series of practical hands-on experiences based on biological control.

Park rangers, with the assistance of Norlane High School, northern Geelong, have been breeding the boneseed leaf-rolling moth (*Tortrix* sp.) in specially constructed greenhouses. Norlane High School has also constructed a greenhouse on the school grounds where students monitor the breeding success of the moths. The students then release the moths in the You Yangs Regional Park. Students have also been studying the effects of different control methods on boneseed in trial plots at the park.

Recently, North Shore Primary School (also in northern Geelong) built a greenhouse to breed the boneseed leaf-rolling moth. The school also has plans to incorporate observations of the moth's life cycle and results from post-release distribution surveys at the park into their science curriculum.

As well as making a valuable contribution to on-ground weed control, this program allows students to gain knowledge and awareness of environmental issues, and a sense of empowerment because they are actually contributing to weed control.

Similar work on other weeds is being done through the *Weed Warriors* program, a joint initiative between the CRC for Australian Weed Management and state agencies <www.weedwarriors.net.au>.

Future directions in biological control

Despite the lack of success in establishing biocontrol agents on boneseed to date, there are still promising agents yet to be released.

The boneseed leaf buckle mite (*Aceria sp.*) has been approved for release in Australia, and mass-rearing techniques are currently being developed to ensure large numbers of mites are available for release. A distribution network is also being formed, with releases planned for Victoria, South Australia and Tasmania. The leaf buckle mite induces the formation of felt-like leaf galls (or erinea). The photosynthetic efficiency of boneseed plants is reduced, resulting in less vigorous growth and reduced reproductive capacity.

Another promising biocontrol agent for boneseed (and potentially bitou bush) is the boneseed rust fungus (*Endophyllum osteospermi*). The rust affects the entire plant, and the infection is retained until the death of the plant. Host-specificity testing is partially completed.

Two undescribed insects have been identified as possible agents – the tip wilt pyralid moth (family Pyralidae), and the stem-galling cecidomyiid (family Cecidomyiidae) – but are yet to be formally identified or tested for suitability.

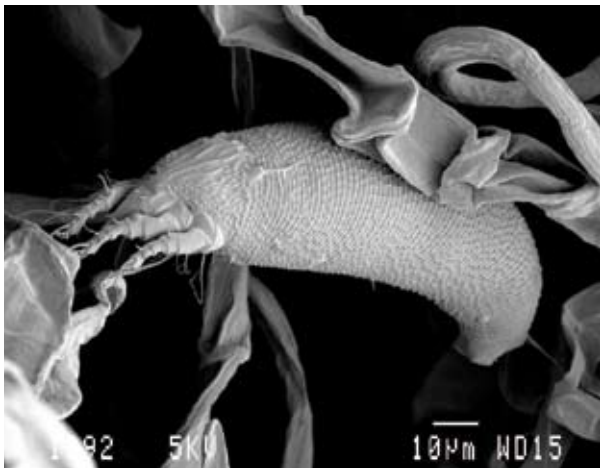
Table 2, on page 42, lists biocontrol agents that have been released for boneseed control, and those that are being considered for future releases.

Tom Morely

Rust-affected boneseed, Cape Town, South Africa.

Tom Morely

Damage caused by boneseed leaf buckle mite.



Charnie Craemer

Scanning electron micrograph of boneseed leaf buckle mite.

Table 2 – Boneseed biological control history

Biological control agent	Years released	Establishment summary	Current status
bitou tip moth *Comostolopsis germana*	1989–1998	Did not establish – possibly due to predation.	
black boneseed leaf beetle *Chrysolina scotti*	1989–1996	Did not establish – possibly due to predation.	
blotched boneseed leaf beetle *Chrysolina picturata*	1992–1995	Did not establish – possibly due to predation.	
painted boneseed beetle *Chrysolina oberprieleri*	1994–1995	Did not establish – possibly due to predation.	
lacy-winged seed fly *Mesoclanis magnipalpis*	1998–2000 2005 (onto bitou bush and boneseed)	Did not establish – short flowering period of boneseed may not allow fly to survive from one season to the next.	Released onto bitou bush (which flowers year-round). If it establishes, will then release large quantities of seed flies onto boneseed.
boneseed leaf-rolling moth *Tortrix* sp.	2000–2004	Did not establish – possibly due to predation.	The bitou leaf-rolling moth (a different *Tortrix* sp.) to be released onto boneseed in Victoria.
leaf buckle mite *Aceria* sp.	Approval for release granted in March 2005		Mass-rearing techniques being developed.
boneseed rust fungus *Endophyllum osteospermi*	Host-specificity testing underway		Host-specificity testing under way.
tip wilt pyralid moth Pyralidae family	Untested		
stem-galling cecidomyiid Cecidomyiidae family	Untested		

Section Four

Follow-up control, revegetation and monitoring

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Follow-up control

There are three stages to achieving successful weed control:

- **primary treatment** – removal of mature boneseed plants and existing seedlings
- **secondary treatment** – intensive control of the seedlings that emerge after removal of mature boneseed plants, and control of resprouting mature plants
- **maintenance weeding** – ongoing removal of boneseed seedlings that establish from the seedbank or from seeds imported to the area by birds or other sources.

Follow-up control (i.e. secondary treatment and maintenance weeding) is crucial because boneseed seedlings can continue to germinate from the long-lived seedbank, possibly for up to 10 years.

For effective follow-up control you should:

- Inspect treated areas within 6 to 12 months of primary control, and remove boneseed seedlings by hand pulling or foliar spraying before they flower and set seed.
- Inspect treated areas where boneseed roots have been left in the ground (i.e. after foliar spraying, cutting-and-swabbing, or cutting without herbicide treatment) for regrowth and control if necessary.
- Conduct maintenance inspections at least every 12 months and remove any new boneseed seedlings by hand. The extent of follow-up control required will decrease each year and inspections can be as simple as an annual walk and hand pulling day.
- Survey regularly for new infestations, especially if there are other infestations of boneseed nearby.

Nicole Zeoli

Removing boneseed in the Murray Mallee region, SA.

- Pay close attention to areas where seeds might be dispersed, such as under trees and along fence lines where birds perch.
- Combine yearly progress monitoring with follow-up control, and record weeds as you remove them.

The extent of follow-up control required will depend on the density of the infestation and how long it had been established. The larger the boneseed seedbank, the more resources that will be required for follow-up work.

Numerous boneseed seedlings will germinate after mature plants are removed. However, many will die during summer. As boneseed rarely flowers in the first year, this first flush of seedlings can be left to thin out naturally, and the remaining young plants pulled up or cut-and-swabbed in autumn. The juvenile plants will also be easier to spot than the small seedlings, making control more efficient.

Peter Tucker

Native acacia seedling growing amongst boneseed seeds.

Follow-up after a fire

After a fire, a protective crust is formed on the soil surface. This crust reduces erosion and retains soil moisture. Working in a newly burnt area can disturb the protective crust and cause soil compaction. In the initial stages after a burn a cover of weed seedlings may help to conserve moisture and protect native seedlings. It can be beneficial to allow the site at least six months to regenerate naturally before carrying out follow-up weed removal. Of course, boneseed seedlings do need to be controlled before they set seed.

Other weeds invading after boneseed control

The control of boneseed often leads to invasion by other weed species, which may have been present in only small numbers before boneseed was treated. Your management plan must address this issue, as your efforts in controlling boneseed will be negated if another weed spreads and requires intensive control. For example, weeds such as bridal creeper, montpellier broom, gorse and non-native grasses have been reported to invade after boneseed is removed, and can often be harder to control than boneseed.

Ensure that your weed management plan addresses all weeds present at your site. Multiple weeds may need to be removed from a particular area at the same time.

Restoring native vegetation

Natural regeneration

The aim of bush regeneration is to encourage native plants to regenerate from the existing seedbank. Allowing native bush to re-establish through natural regeneration is preferable to revegetation for three reasons:

- native plants establish that are adapted specifically to the site (these are known as 'local provenance' species)
- local biodiversity is conserved
- natural regeneration is far more cost-effective than revegetation.

Removing mature boneseed plants can promote substantial regeneration of native seedlings, provided a native seedbank still exists. Natural regeneration will be more successful where native vegetation is intact and the boneseed infestation is recent. Where dense patches of boneseed border native bush, work from the edges of the boneseed infestation towards the middle of the infestation. This allows natives to regenerate from propagules dispersed from the adjacent bush.

Revegetation

Revegetation by planting tube-stock or direct seeding is useful when:

- a site has limited or no potential for natural regeneration (e.g. if the boneseed infestation was long established and a native seedbank is no longer present)
- key species are missing and cannot be naturally recruited to an area.

Use only locally indigenous species in your revegetation project, preferably propagated using material sourced from the bushland area to be planted (local provenance species). This ensures that the plant community you are attempting to establish is appropriate for the habitat you are working in. For example, you want to ensure that a natural grassland community is not replanted with trees and shrubs.

Timing is important when establishing native vegetation from direct seeding or tube-stock. Include revegetation in your boneseed management plan, and try to schedule your weed-control activities to coincide with the best time to revegetate.

For detailed information on revegetation see *Bush Regeneration: Recovering Australian Landscapes* by Robin Buchanan (1989).

Whether through natural regeneration or revegetation, rehabilitation of bushland is a long-term process that requires a commitment to extended monitoring and follow-up.

Monitoring your progress

You can monitor your progress using many different methods, including site maps, photopoints, or quantitative measures such as density or cover. The most suitable method depends on the resources available, the expertise of the people carrying out the monitoring, the questions you want to answer, and the intended audience. For example, if you wish to demonstrate the native regeneration following boneseed control at your site to the wider community, photopoints are ideal. Or, if you need to present quantitative data on the results of your control activities to your funding body, you could monitor the numbers of boneseed plants and native species using plot transects.

To make valid comparisons, monitoring needs to be done at a similar time of year, at least once each year, and in a consistent manner. Incorporate monitoring into your yearly activity timetable. Monitoring can be combined with follow-up control – pull up any seedlings as you survey the area.

A site diary is useful for documenting activities undertaken, as well as observations about seasonal conditions or other factors that may influence the results of your control program. Recording the cost of control (both in labour and dollars) is important for evaluating the cost-effectiveness of different methods and helps you stay within budget.

Photopoints

Photopoints are a photographic record of changes occurring over time at your site, taken from the same point each time. They are an excellent tool for demonstrating progress to members of community groups, the public, and funding bodies.

Kym Smith

Dense boneseed infestation before control.

Setting up a photopoint

- Choose sites that will best represent the work undertaken at your site, such as an area with significant ecological values, or a heavily infested area.
- Place a permanent marker such as a stake at the point from where you will take the photo each time.
- Label an A4 card with the date and photopoint location, and attach to another stake approximately 10 metres from the camera position.
- Stand at the marker, face the labelling card, and take your photo.

Tips

- Align markers north to south to avoid excessive sun or shadow, and to make it easy to remember which direction to take the photo if the markers are removed.
- Try to include a distinctive object in each photo, such as a tree or fence post, that will be there each time.
- Use the same camera and film type (or the same settings on a digital camera), and take the photos from the same height (rest the camera on the stake), with the same zoom settings.
- Take photos as frequently as required to reflect changes at the site, but ensure you have photos taken at the same time each year to make valid comparisons.
- Label each photo with the date, location, and the reason for taking the photo (e.g. annual monitoring, before and after weed removal).

Kym Smith

Native regeneration after partial and gradual boneseed removal.

Measuring density

Density is defined as the number of individual plants per unit area – for example 100 boneseed plants per hectare. Density is a good measure of boneseed population size, as boneseed populations will respond to most control treatments by a change in the number of individuals (of various age classes), rather than a change in vigour or plant size.

Density is the most appropriate population measure for scattered boneseed infestations. Measuring the density of thick boneseed infestations is difficult, as it can be time-consuming to determine how many individual plants are present in a clump. For dense thickets it is more appropriate to measure cover (see page 49).

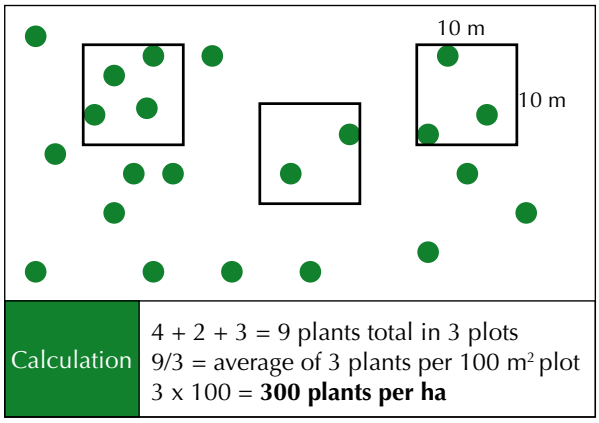
Measuring density in age classes will more accurately reflect the changes caused by the control treatments. It is a good idea to determine the density of juvenile and mature plants separately, as the removal of mature boneseed plants is generally followed by the germination of many boneseed seedlings. Juvenile plants could be defined as those under 50 cm tall, or, if measured when the population is in flower, juvenile plants could be those that are not flowering.

For example, before treatment, the density may be 500 mature plants and 100 juveniles (total 600 plants) per hectare. Six months after the initial treatment, the density may be 50 mature plants and 650 juveniles (total 700 plants)

per hectare. Follow-up control is carried out 12 months after the initial control. After 18 months, the density may have dropped to 0 mature plants and 300 juveniles (total 300 plants) per hectare. If only total numbers of boneseed plants were counted, the dramatic effect of the initial treatment on the boneseed population would not have been captured.

Plot counts

Boneseed density can be measured simply, by marking out three or more plots ('quadrats') of 10 m x 10 m (100 square metres). The plots should be randomly located over the site, and the more plots you have, the more precise the results will be. Count the number of boneseed plants (in each age class) in each plot, and determine the average. Multiply the average number of plants per 10 m x 10 m plot by 100 to get the number per hectare (one hectare is 10,000 square metres). For plants straddling the boundaries of the plot, count all individuals along two contiguous sides, and do not count the individuals that straddle the other two sides.

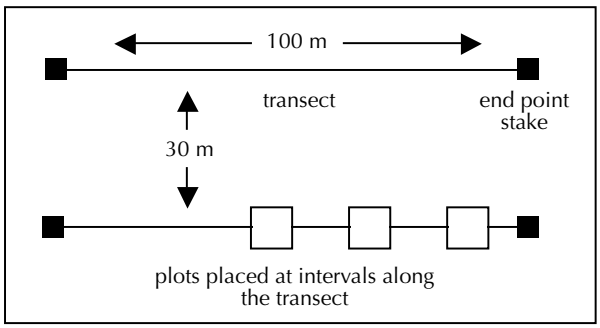


Calculating density using plot counts.

Plot transects

Plots are often placed along sample lines called transects. Transects are commonly 100 m long, and are placed 10–50 m apart, parallel to each other. Using multiple transects will give you results that are more representative of your entire site. Plot size will depend on the species being measured. For shrubs such as boneseed, 2 m x 2 m plots may be appropriate. Smaller plots (50 cm x 50 cm) would be needed if you were measuring native seedling regeneration. Keep the plots the same size on each subsequent monitoring occasion, so that results are comparable.

If you wish to monitor native regeneration, you can count all species in each plot. Or, you may choose one or two key native species as the target species to be monitored. Record the number of individuals of the target species within each plot. Average the number of individuals of each species in each plot (over all transects), and convert to a density measure (i.e. individuals per square metre or individuals per hectare).



Calculating density using plot transects.

Rachel Melland

Post control monitoring using a 2 m x 2 m plot frame.

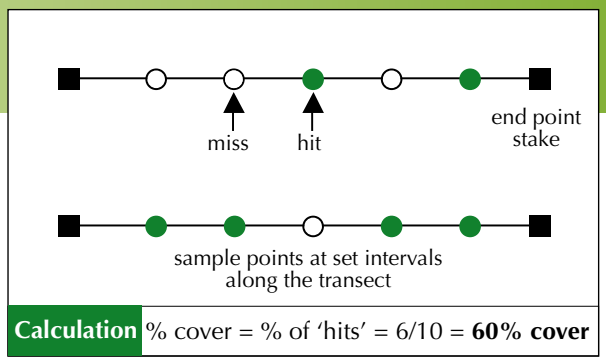
Measuring cover

Sample point method

Counting individual boneseed plants is only possible for scattered or light infestations, as separating individual plants is very difficult in dense infestations. An easier method for measuring dense boneseed populations is to determine percentage cover using the sample point method.

Use a tape-measure and a narrow pole to measure sample points along a transect. Place the pole next to the tape at set distances along each transect, and record a 'hit' if the pole touches a boneseed plant, or a 'miss' if the pole does not touch a boneseed plant. The proportion of sample points with a 'hit' is an estimate of the cover. Using more sampling points gives you more precise results.

Alternatively, walk between two points (e.g. two stakes or other permanent features) and record a 'hit' if a boneseed plant is present within a metre of you at a given step interval. For example, you start at the gate and walk towards the large gum tree for a total of 400 steps, recording 'hit' or 'miss' every 10 steps. You can vary distances and intervals to suit your site.



Calculating percentage cover using the sample point method.

Surveying and recording boneseed distribution

The information you record on the distribution of boneseed at your site may not have been recorded before. If you think you have identified a new or previously unknown boneseed infestation, report it to your local weeds officer (contactable through your local council or shire). The information can then be passed on to state agencies, and be added to maps at state and national levels.

Consider surveying for boneseed beyond the boundaries of your site. This will help you to identify possible threats to your control efforts such as a large boneseed infestation nearby, and will improve knowledge of the distribution of boneseed in the region. Recording the absence of boneseed in an area is also important, so the area is known to be surveyed and free of boneseed. Be sure to pass the results of your survey on to the relevant weed contacts.

A field manual has been developed by the Bureau of Rural Sciences to standardise the mapping of Weeds of National Significance. *A field manual for surveying and mapping nationally significant weeds* (McNaught *et al*. 2006) lists the attributes that should be recorded when surveying for weeds, and describes various methods of determining weed density. Copies of the manual are available from the Weeds Australia website <www.weeds.org.au>.

Section Five

Case studies

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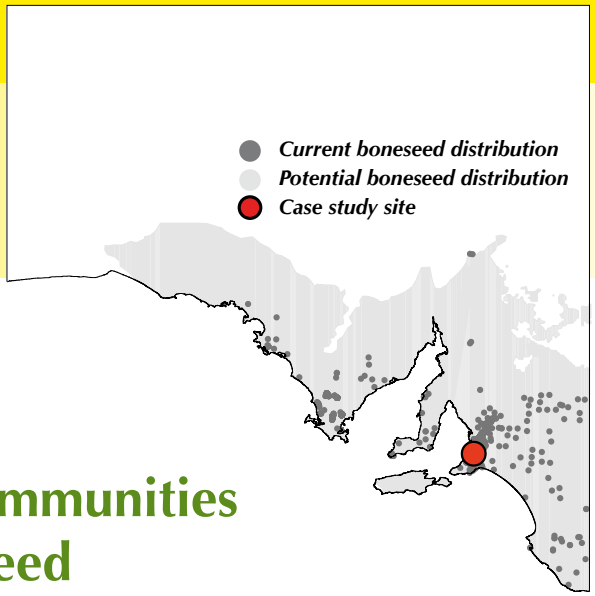


Our Patch helps urban communities take action against boneseed

Kate Hallahan, Our Patch Officer, Adelaide and Mount Lofty Ranges NRM Board

Volunteer groups can find it difficult to access the resources and expertise needed to rehabilitate native bushland. To support the valuable work of volunteers, the Adelaide and Mount Lofty Ranges NRM Board's *Our Patch* program involves the local community in the restoration of bushland. The program operates within the Torrens and Patawalonga catchments in greater Adelaide, South Australia. Groups adopt 'patches' of bushland or degraded sites to rehabilitate and revegetate. Our Patch groups are supported by an Our Patch Officer, who provides regeneration expertise, training opportunities, and practical assistance by managing grants and contractors.

The Rotary Club of Burnside established an Our Patch site at Chambers Gully in the Adelaide Hills in 1997, with the aim of reducing the weed infestation and revegetating the gully with indigenous species. Chambers Gully is owned by the City of Burnside and managed through its Biodiversity Unit. The control of boneseed throughout Chambers Gully is a joint project between Burnside Council, the Rotary Club, Our Patch and the Urban Forest Biodiversity Program (a state and federal government initiative).

The site has some very steep slopes with areas of good-quality native woodland, dominated by drooping sheoak (*Allocasuarina verticillata*), South Australian blue gum (*Eucalyptus leucoxylon*), golden wattle (*Acacia pycnantha*), sticky hopbush (*Dodonaea viscosa*), Mount Lofty grass tree (*Xanthorrhoea quadrangulata*) and kangaroo grass (*Themeda triandra*). The native vegetation in the gully floor and along the creek is an open woodland dominated by South Australian blue gum and river red gum (*Eucalyptus camaldulensis*).

Over the years, the Rotary Club has focused its efforts on the gully floor and the creekline. Control of woody weeds such as boneseed, blackberry, ash, figs, willows and olives has been followed by control of herbaceous weeds such as fennel and millet grass. The limited native regeneration has been supplemented by revegetation with locally indigenous species such as golden wattle, drooping sheoak, river red gum, South Australian blue gum,

Kerry Brougham

Boneseed (foreground) in Chambers Gully 'Our Patch' site, SA.

Kate Hallahan

Hand pulling boneseed on the slopes of Chambers Gully.

sticky hopbush, and sweet bursaria (*Bursaria spinosa*). The Rotary Club propagate these native plants each year using local provenance seed collected and supplied by the Burnside Biodiversity Unit.

The steep north-facing slopes of Chambers Gully contain a combination of scattered boneseed plants within areas of good native vegetation, and patches of dense boneseed interspersed with sticky hopbush. The control of boneseed and other weeds by the volunteers is restricted by the steepness of the slopes and the extent of the infestation.

Engaging contractors for the hard stuff

Our Patch has helped the Rotary Club obtain financial support to engage contractors to tackle the weed infestations on the steep slopes, which will support the valuable work that the volunteers do throughout the gully floor. The Rotary Club received an Urban Forest Biodiversity Grant of $4000 in December 2005, and an Our Patch Grant of $4000 in May 2006. These funds will also be used to spray blackberry and control other woody weeds along the creek, and to assist with the maintenance of the previous years' planting sites.

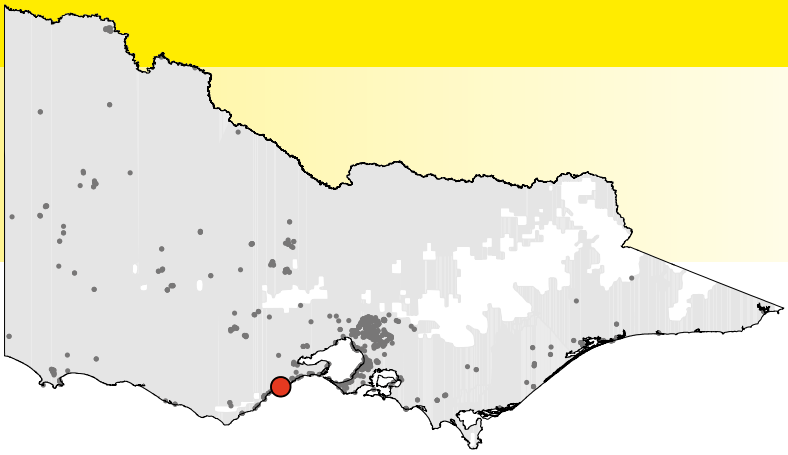
A priority of the project is to prevent the further spread of boneseed and to remove

Kerry Brougham

Boneseed forming a monoculture in the understorey.

it completely from the areas of good native vegetation. Boneseed will be controlled on the slopes using several methods. Where it is sparsely scattered in areas of good native vegetation, large boneseed plants will be cut-and-swabbed with herbicide (glyphosate 360 g/L, mixed 1:1 with water) and small plants hand pulled. In the thick infestations, the boneseed will be selectively brush-cut in winter, and followed-up by foliar spraying in spring through early summer to target regrowth (glyphosate 360 g/L, at a rate of 10 mL/1 L water).

A coordinated approach to weed control is the most effective way to protect native vegetation. When councils, NRM Boards, volunteers and other project partners all work together, weed management can be implemented at all levels, and management can be sustained over the long term. The Our Patch program allows the valuable work of the volunteers to be supported by the use of contractors, which delivers more comprehensive weed control. In addition, the support generated by the Our Patch program is extremely beneficial for maintaining the enthusiasm and commitment of volunteers.



The community protects a beautiful corner of Victoria from boneseed

Margaret MacDonald and Ros Gibson, members of ANGAIR Inc and Friends of Aireys Inlet Wetlands

ANGAIR (Anglesea and Aireys Inlet Society for the Protection of Flora and Fauna) was established in 1969. The members are volunteers who offer their time and skills to help look after the natural assets of this beautiful part of south-west Victoria, which includes a section of the famous Great Ocean Road. ANGAIR plays a major role in environmental weed control and in the education of the local community about weeds.

Community Education

The group works with the Surf Coast Shire on a monthly *War on Weeds* publicity program with a featured Weed of the Month, which is publicised in the local papers, newsletters, and on local noticeboards. The publicity program aims to reach members of the public who would otherwise have no knowledge of or interest in the natural environment.

ANGAIR has also worked with the Surf Coast Shire to produce a booklet called *Environmental Weeds – Invaders of our Surf Coast*, and is developing a weed exchange program to be carried out in autumn where residents bring along environmental weeds and exchange them for up to five indigenous plants.

Weed control activities

During the *Annual Weed Week*, ANGAIR and community members work to remove weeds across the region. ANGAIR also has weekly working bees to remove environmental weeds from the reserves, heathlands and dunes in the area. Once a month members take a break from the weeds, and go on a nature ramble. This allows members to step back from the weeds and get to know and appreciate the various indigenous species and communities they are working so hard to protect. These occasions are also used to maintain indigenous plant lists for the reserves in the district.

Boneseed in the Painkalac Valley

The Painkalac Valley (near Aireys Inlet) was cleared of woody vegetation early in the 1800s and used for stock grazing. ANGAIR has always recognised the conservation value of the Painkalac Estuary and was able to secure a Trust for Nature Covenant for the area in 1995. Ten important Ecological Vegetation Classes have been identified in the valley and on the estuary margins, with five of them classified as endangered, rare or vulnerable.

In 1996, ANGAIR members could no longer bear to see the large masses of yellow boneseed flowers that appeared each spring among the grassy scrubland and along the

Margaret MacDonald

Volunteers cut down large boneseed plants in 1996.

Margaret MacDonald

Kangaroos supervising weed control in the Painkalac Valley.

edges of the creek. Hazard reduction burns had stimulated the germination of boneseed and other weed seeds, and neglect of the area allowed the woody weeds to spread.

In September 1996, the group made its first attack. It was a major operation under the surveillance of a mob of kangaroos that watched from afar. The boneseed plants had been growing undisturbed for many years, and chainsaws were the order of the day. The stumps were sprayed with herbicide to prevent regrowth.

Since that time, with a great deal of support from the community, shire, and state government, ANGAIR members have worked tirelessly in the valley to bring boneseed under control. In 2000, an ANGAIR sub-group, Friends of the Aireys Inlet Wetlands took over the project.

Seedlings and small boneseed plants are pulled up by hand and left with their roots in the air to prevent re-establishment. The stems of the larger plants are cut with long handled loppers or bush saws, and the stumps are treated with herbicide. Glyphosate (360 g/L)

Ros Gibson

ANGAIR members hand pulling small boneseed plants.

is diluted 1:15 with water, and applied using small spray bottles. The cut boneseed plants are left to gradually decompose in the valley.

To help with control, each year during the boneseed flowering season a Community Day is organised with the support of the Surf Coast Shire. ANGAIR also devotes one of its Annual Weed Week days to controlling weeds in the valley.

Access to the boneseed is not easy, and this year members arrived in canoes instead of making the long walk along the margin of the estuary and across the sedge wetland. Over the years the kangaroos have become accustomed to 'intruders' coming into their territory to control the boneseed.

The efforts of the volunteers are supplemented by paid workers. In the last few years two Green Corps crews have concentrated their efforts in the Painkalac Valley for periods of up to three days at a time, achieving great results.

Margaret MacDonald

Volunteers arrive at the site in canoes.

Case studies

Margaret MacDonald

After ten years of hard work, only small boneseed plants can be found in the long grass.

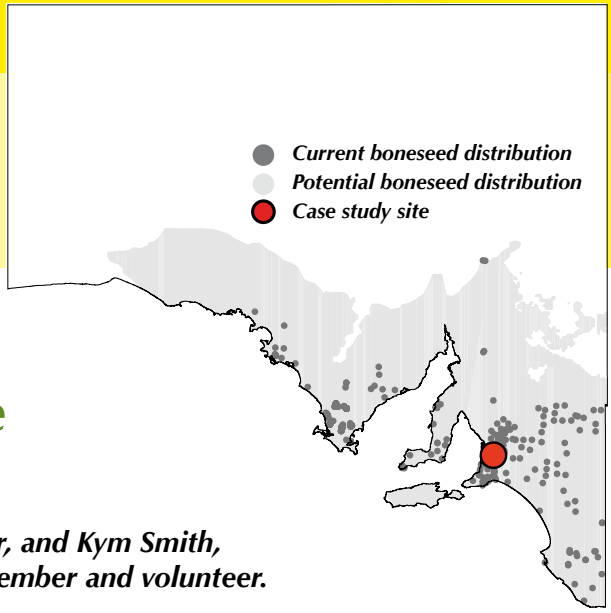
The Surf Coast Shire has employed contractors to work on the larger boneseed plants in more precarious positions, and an environmental officer from the shire has also worked in the area removing boneseed and other species of weeds.

Despite all the hard work, new problems arise. Boneseed grows on adjoining properties, for example, and in particular on a large new residential development adjoining the estuary. The area was cleared some time ago, and no weed control has taken place since. To help manage this issue, the shire has made funds available to inform people about this invasive weed and to assist with boneseed removal from private properties. ANGAIR members are planning a flyer campaign to inform residents about the environmental value of their land, and to alert them to the problems associated with boneseed.

The large boneseed seedbank means that the battle is ongoing, but the group feels it is gradually winning the war. Ten years after the first removal of large plants, we are now tackling smaller and fewer plants than in the past. In fact, this year our volunteers had to search for the seedlings and small plants growing amongst the native grasses.

Because of ANGAIR's efforts, boneseed on public land in the area is generally under control. The main exception is on high, inaccessible steep ridges along the Great Ocean Road which volunteers simply can't access. We are hoping for an effective biological control agent to help control boneseed in those areas.

'We feel that all the efforts we have made over the years have been well worthwhile and we will continue to strive to protect the valley'



Successes in cross-tenure boneseed management

Tansy Boggon, South Para Biodiversity Officer, and Kym Smith, South Para Biodiversity Project Committee member and volunteer.

In the Mount Lofty Ranges south-east of Adelaide, the South Para region is home to a number of endangered plant species and contains large areas of linked remnant native vegetation of high conservation value. The South Para Biodiversity Project (SPBP) works to protect and manage this region, and includes stakeholders such as private landholders, Kersbrook Landcare Group, Department for Environment and Heritage (SA), Friends of Para Wirra, ForestrySA, Adelaide and Mount Lofty Ranges NRM Board, SA Water, and community volunteers.

The SPBP is funded through a variety of federal and state agencies and programs and these funds support a dedicated project officer hosted by the Adelaide Hills Council. The SPBP attributes its funding successes to the high level of project coordination and the ability to involve such a wide range of stakeholders from across the region.

Tackling weeds

Weed strategy

The SPBP has developed a weed strategy to prioritise weeds for control, based on input from all major land managers in the region and Mt Lofty Ranges Animal and Plant Control Board (APCB) officers. This strategy categorises weed species based on their threat to biodiversity and their abundance in the region.

Priority management zones

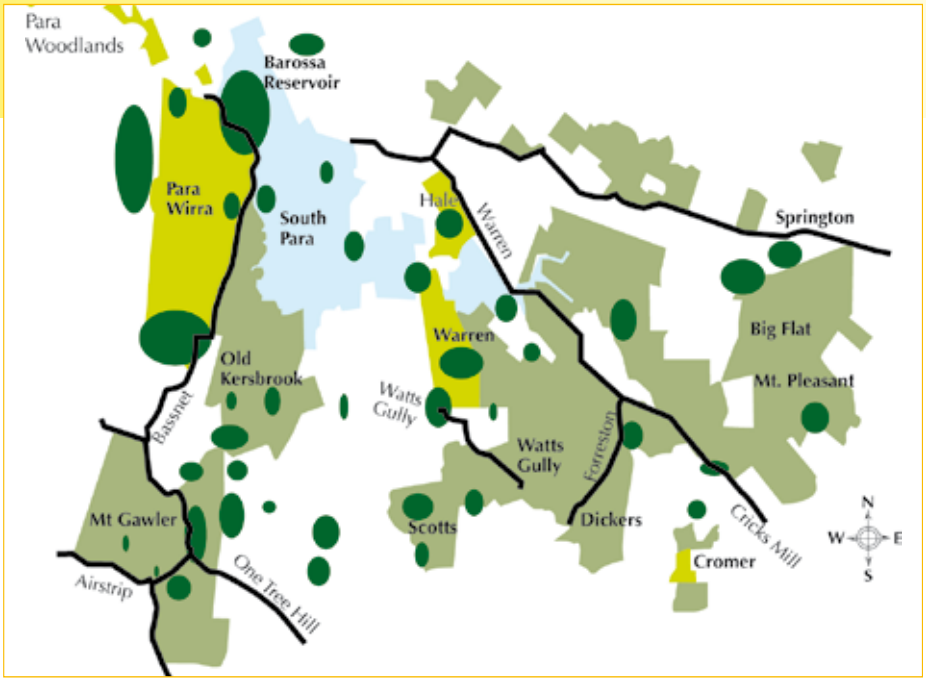
Areas within the region were also prioritised for on-ground works based on the value of biodiversity assets. The locations of threatened plant species, priority vegetation associations and other high quality remnant areas (e.g. significant roadside sites and Bush For Life sites) were mapped. The location and priority of weed species was then overlaid on biodiversity assets to determine priority management zones. These zones are the priority focus areas for weed control.

Managing boneseed

The regional boneseed control program began in 2002 when the Mt Lofty Ranges APCB received $32,000 of Commonwealth funding. The SPBP was deemed the best body to deliver the on-ground works because of its ability to coordinate major land managers, government agencies and private landholders. Boneseed control was planned based on established priority management zones, and contractors carried out work on public land managed by SA Water, ForestrySA and National Parks.

The SPBP complemented these works by funding additional contractors to control boneseed on private land. Control efforts were also assisted by Green Corps teams and volunteer bushcarers. The funding paid for some 1300 hours of work, and 158 hectares of boneseed were treated. All boneseed plants were cut-and-swabbed or hand pulled, as these are more selective control methods than foliar spraying, and thus help to promote the regeneration of native plants.

Monitoring was undertaken at all sites to assess the effectiveness of the control treatments. Prior to treatment, control areas were mapped using GIS software and photopoints were



Key:

- – SA Water
- – National Parks
- – ForestrySA (including both plantation and native vegetation)
- – priority zones

SPBP priority management zones are based on areas of high biodiversity value and the location and priority of weed species.

set up at each site. Contractors reported on control activities, hours worked, and any other issues by filling in detailed site report sheets that were subsequently stored with the SPBP. Good record keeping and detailed management plans were very valuable, as they allowed project managers to direct volunteer groups, such as school groups and Green Corps teams, to the most suitable areas at short notice.

In 2005, surveys were done to re-assess the extent of the boneseed infestations, and determine what follow-up work was required. Photopoints were also taken again at each site. The SPBP committed $10,000 for follow-up work where boneseed regeneration was recorded. The boneseed plants that had emerged from the seedbank had not yet produced seed, which provided suitable time for follow-up control. The surveys also revealed good regeneration of native plants. The project has proved very successful, and today, much of the boneseed control work is carried on by volunteers, especially Friends of Parks, Trees For Life and other community groups.

Our most successful boneseed control methods

The region covered by the SPBP is very large and thus contains grades of boneseed infestation ranging from isolated plants to dense infestations. Where boneseed or other weeds have been established for a long time, the native seedbank may be depleted. Good bushcare techniques that cause minimal soil disturbance can allow natural regeneration of native vegetation from sparse remnant plants. For these reasons, Trees For Life have trained many volunteers in minimum disturbance bushcare techniques, such as hand pulling, cut-and-swab, and drill-and-fill (or stem injection). These techniques are preferred over foliar spraying, which often causes off-target damage resulting in bare ground that is readily invaded by other weeds.

Staged or gradual removal of boneseed (as opposed to clearing large areas at once) is proving successful in the South Para area, with excellent native regeneration occurring at sites where it has been carried out. Gradual thinning of dense boneseed infestations allows native species to regenerate while

being protected from grazing by feral deer and kangaroos. Leaving cut boneseed plants to decay on site can also help to protect the regenerating native plants, and reduces exposure to sunlight which may help to reduce weed growth.

Our work within the region has also highlighted the importance of trialling different control techniques in different areas. A method that works in one location may not work elsewhere. An example of this is the method of cutting boneseed plants without applying herbicide, which has been successfully used on smaller boneseed plants in semi-shaded areas of good-quality native vegetation in the Barossa Reservoir area. However, in the nearby Para Wirra Recreation Park cutting alone has been unsuccessful, with numerous plants resprouting.

Conclusion

The regional coordination of weed control by the SPBP has been successful on many levels. Engaging all stakeholders in the planning process allows comprehensive weed management plans to be prepared and implemented across land tenures. This ensures that all boneseed control in the region is prioritised based on the relative value of the biodiversity assets, with control efforts yielding the best results for biodiversity. The high degree of regional coordination also helps the SPBP attract funding from various sources, ensuring that finances are available for ongoing control work. This is very important in maintaining support for community volunteer groups, who are instrumental in the long-term success of the boneseed management program. Finally, minimum disturbance control techniques and trials of new methods have resulted in effective boneseed control and good native regeneration – the ultimate goal of the boneseed control program.

Kym Smith

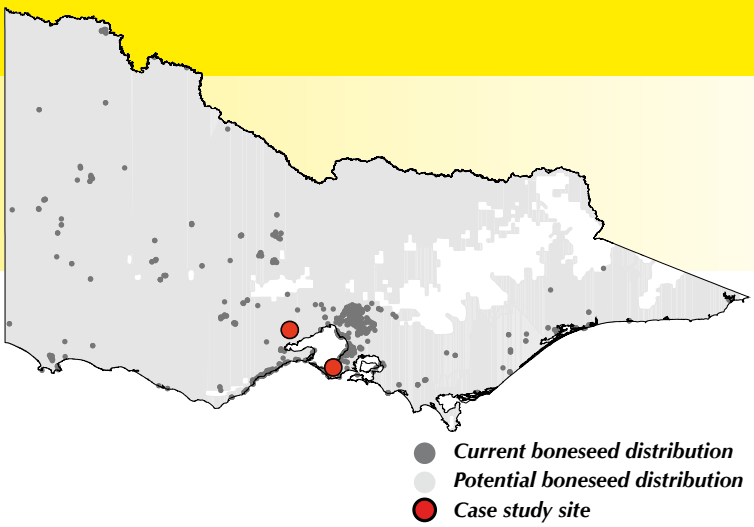
Dense boneseed infestation before control, South Para, SA.

Kym Smith

Native species regenerate well after partial and gradual boneseed removal.

Kym Smith

Gonocarpus elatus*,* Calostemma purpureum *and* Hydrocotyle *sp. regenerating after boneseed control. Ground storey vegetation is better in this partially treated area than in adjacent areas where dense boneseed was removed completely.*



Boneseed control: fire, herbicide, hand pulling and competition

Rachel Melland, University of Adelaide,

Boneseed control experiments were undertaken in the You Yangs Regional Park near Geelong, and in the Arthurs Seat State Park near Dromana in Victoria. In the You Yangs, dense infestations of boneseed had developed over more than 30 years, causing the native open woodland vegetation (dominated by *Acacia mearnsii*) to become highly degraded. At Arthurs Seat, on the other hand, a highly diverse native closed woodland community remained (dominated by *Eucalyptus viminalis*), interspersed with the boneseed infestation.

The experiments aimed to:

- determine the effectiveness of fire as an initial control treatment in depleting the boneseed seedbank
- determine the best follow-up treatments for boneseed seedling control.

Fire as the initial treatment

Controlled burns were undertaken in autumn (March 1997) at both sites, with the aim of killing boneseed plants and surface boneseed seeds, and stimulating germination of boneseed seeds buried in the soil.

The effectiveness of a controlled burn as a boneseed management technique depends on the density of boneseed infestation and the quality of the native vegetation. The density of the boneseed infestation influences the fuel load at ground level. This affects soil temperatures during a burn, which in turn influence the degree to which the boneseed seedbank is depleted. Native vegetation burns more readily than boneseed, and provides

Rachel Melland

Boneseed in Arthurs Seat. Note fine fuel (grass, bark and leaves) in foreground.

Rachel Melland

Controlled burn at Arthurs Seat.

more fine fuel in the form of leaf litter and grasses.

In experiments in the high-quality native vegetation at Arthurs Seat, soil *surface* temperature in some patches peaked at 300 °C and overall temperatures remained above 100 °C for just over five minutes. The temperature *2 cm below* the soil surface remained above 50 °C for more than 30 minutes. As a result, the soil seedbank under the scattered boneseed infestation was reduced from an average of 400 boneseed seeds per square metre before the burn to 70 seeds per square metre four months after burning. In the four months following the burn, an average of 30 boneseed seedlings germinated per square metre. No boneseed seeds were found in the seedbank 12 months after burning. Temperatures achieved in this burn therefore eliminated the relatively small boneseed seedbank at this site via seed death and stimulation of germination.

The situation was different in the You Yangs, where the severely degraded vegetation contained large monocultures of boneseed and an extensive boneseed seedbank (1700 to 3600 seeds per square metre in most places, and up to 19,000 seeds per square metre in some areas). This dense type of boneseed infestation did not carry the fire well, and resulted in a patchy burn. Two centimetres below the soil surface the temperature rarely reached 50 °C, which meant the fire did not have an impact on the entire seedbank. Although the seedbank was significantly depleted in some areas, an average of 230 viable seeds per square metre still remained after twelve months.

Rachel Melland

Hand pulled boneseed left to dry prior to burning, Arthurs Seat.

Peak soil surface temperatures of 250 to 300 °C are required to substantially deplete the boneseed seedbank through seed death and germination. To generate these temperatures in degraded vegetation containing dense boneseed infestations, mature boneseed plants must be felled and dried prior to the burn to increase fuel at ground level. Cutting or hand pulling boneseed prior to a fire also improves access for follow-up control. Mature boneseed plants may be killed but not destroyed by a controlled burn, and the dead stems will have to be removed to provide access for seedling control.

Rachel Melland

Seventeen months after a fire through a dense boneseed infestation, boneseed seedlings were spot sprayed with metsulfuron-methyl herbicide. These seedlings had only just begun to flower due to low rainfall. A year later, this area had a thin cover of grass, healthy Acacia mearnsii *seedlings and an average of seven boneseed seedlings per square metre.*

Follow-up treatments

After the controlled burns, boneseed seedlings were controlled using different combinations of:

- **herbicides –** seedlings were sprayed with glyphosate or metsulfuron-methyl at two different times, either during the first or second winter growth season (5 or 17 months after the fire, respectively).
- **sowing of native grass seed to provide competition** – the seed of a potentially competitive native grass (*Poa sieberiana*) was sown onto the ash-bed to investigate whether increasing the density of native grass species could suppress the emergence of boneseed seedlings.
- **hand pulling** – flowering seedlings were pulled out by hand from the plots that had been sprayed in the first winter growth season, as well as from plots that had had no other follow-up treatment.

Herbicide application

Spraying with herbicide is an effective boneseed seedling treatment, and is best done during the second winter after a burn (12 to 17 months after the fire). Applying herbicide to boneseed seedlings during the first winter growth season after burning is inefficient because natural seedling mortality due to summer drought, competition and pathogens were found to kill as many seedlings as did a first season herbicide application.

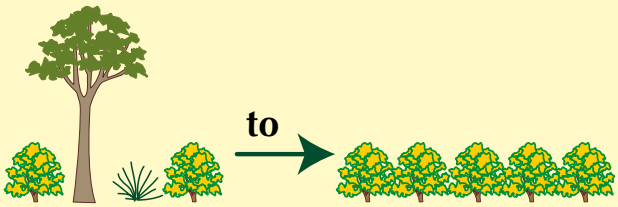
At Arthurs Seat, seedlings that were not sprayed in the first winter growth season commenced flowering as early as 12 months after the fires due to favourable rainfall conditions. It is important that flowering seedlings be controlled before they seed to prevent the boneseed population from re-establishing.

These experiments found glyphosate herbicide and metsulfuron-methyl herbicide equally effective in killing seedlings. However, glyphosate also killed all native species in test plots, resulting in unwanted bare ground, whereas native grasses and some native seedlings survived the application of metsulfuron-methyl.

Boneseed infestation in good quality native vegetation

- Diverse native vegetation
- Abundant fine fuel for fire
- < 500 boneseed seeds per square metre

Dense boneseed infestation in severely degraded native vegetation



- Few native species left or boneseed monoculture
- Little fine fuel to carry a fire (thick layer of boneseed seeds)
- 2000–19,000 boneseed seeds per square metre

Brush-cutting of boneseed in late spring prior to controlled burn in autumn advised but not essential

Brush-cutting of boneseed in late spring prior to controlled burn in autumn required, unless boneseed plants are predominantly dead and canopy is in contact with the ground

- Controlled burn in autumn
- Aim for peak surface temperatures of 250 to 300°C

Boom-spray with low dose of herbicide at end of first winter growth season (5 months) after burn
→ Average 1 boneseed plant per square metre 2 years after burn

OR

Distribute native grass seed onto ash bed two weeks after burn then boom-spray as above
→ Average 0 boneseed plants per square metre 2 years after burn

OR

Spot spray flowering boneseed plants with herbicide at recommended rate 12–17 months after burn
→ Average 0 boneseed plants per square metre 2 years after burn

Average 0 boneseed seeds per square metre 2 years after burn

Spot spray flowering boneseed plants with herbicide at recommended rate at end of second winter growth season (17 months) after burn
→ Average 7 boneseed plants per square metre 2.5 years after burn
→ Only 1–2 flowering boneseed plants per square metre

Average 230 boneseed seeds per square metre 2.5 years after burn

Continued hand pulling of boneseed plants

Summary of results from boneseed control research in southern Victoria.

Sowing of competitive native grass seed

While the addition of native grass seed (*Poa sieberiana*) to post-burn areas suppressed boneseed establishment, it also reduced the diversity of native plant species emerging after the fire. Thus, sowing of native grasses should only be undertaken in checkerboard patches to allow other native species to regenerate.

Hand pulling of flowering boneseed seedlings

This technique is useful for preventing new seed from entering the seedbank when there are too many boneseed seedlings for all to be pulled. When boneseed growth is slow, such as during periods of low rainfall, removing only flowering seedlings can prevent seed fall for up to 6 to 12 months.

Conclusion

These experiments illustrate the need to achieve an even burn, with peak temperatures above 250 to 300 °C, to eliminate as many seeds from the boneseed seedbank as possible. A patchy burn is likely in populations of dense, uncut boneseed. Tall boneseed plants with canopy foliage more than a metre above the ground will not carry a fire. A patchy burn will lead to an increase in post-burn control costs, as seeds in unburnt patches will be unaffected by the fire, and will continue to germinate gradually rather than in a mass germination event.

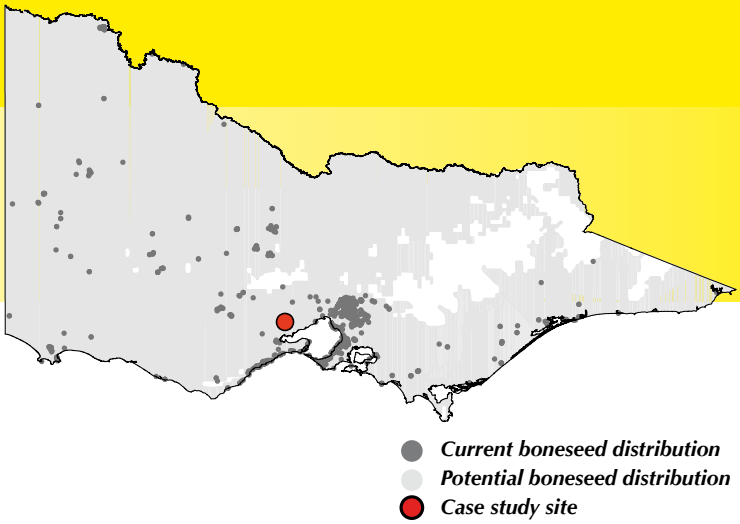
In dense infestations, brush-cutting boneseed and leaving it to dry on the ground prior to burning effectively increases the fuel load and enables the fire to be carried throughout the boneseed infestation. This higher fuel load promotes even burning and increases soil temperatures, thus killing or stimulating germination of more boneseed seeds. Allow several months for cut boneseed plants to dry (depending on weather conditions and assessment of bushfire risk), because recently cut boneseed plant material will not be dry enough to help carry the fire through the infestation.

Rachel Melland

Dense boneseed infestation with few native species, You Yangs.

After any burn, boneseed will continue to re-invade from seeds that survived the fire, or seeds from nearby plants that escaped the fire. Yearly surveying and hand pulling of seedlings is essential to prevent the boneseed seedbank and population from re-establishing.

The chart on page 63 summarises the research findings and outlines the most successful boneseed control methods for degraded or species-rich native vegetation based on experiments in southern Victoria.



Fire leads to extreme boneseed invasion

Craig Bray, Ranger-in-Charge, You Yangs Regional Park

The You Yangs Regional Park is home to one of the densest boneseed infestations in the country. The story of boneseed in the You Yangs is a prime example of how fire can cause the weed to spread if follow-up work cannot be maintained.

Boneseed was planted in the You Yangs, a small region of steep hills south-west of Melbourne, to control erosion in the late 1950s and early 1960s. This led to scattered boneseed infestations throughout the park. In 1985, a large bushfire destroyed most of the groundcover and shrub species in the park.

CSIRO

Boneseed dominating the understorey of an open woodland, You Yangs.

The fire also triggered a mass germination of boneseed seedlings, which quickly out-competed the regenerating native species. Substantial boneseed seedling control was done the year following the fire, but little or no work took place after the first year due to a lack of resources. Within three years of the fire, the boneseed infestation had become dense and widespread in the You Yangs. Boneseed now covers 1300 hectares of the 2000 hectare park, and threatens the rare brittle greenhood orchid (*Pterostylis truncata,* syn. *Diplodium truncatum*).

The park is now missing many native middle-storey species, as they were out-competed by fast growing boneseed seedlings after the fire. The loss of native plants has had a very detrimental impact on the numbers of native birds and animals that rely upon them for food and shelter. Now, 20 years after the fire, the mature wattles (*Acacia* sp.) are starting to disappear, as new wattles are unable to regenerate through the barrier of boneseed. The loss of the wattle canopy is now affecting the animals, such as sugar gliders, that rely on these trees for food.

Priority control areas

Today, management and control of boneseed at the You Yangs is strategically targeted to areas where boneseed threatens high conservation values. Thus, the 40 hectares where the brittle greenhood orchid occurs are priority zones for boneseed management in the park, and the aim is to eradicate boneseed in these areas.

Nick Pitsas

When boneseed is in flower the You Yangs turn bright yellow.

From November to February when the orchids are underground, park staff and volunteers hand pull boneseed plants, and staff spray larger plants with herbicide (glyphosate). Soil compaction could damage the orchids, so the use of heavy machinery is not allowed around the orchid colonies.

Large-scale control

These methods are labour intensive, and there are not enough resources to control boneseed over the entire park in this manner. While park rangers could foliar spray boneseed as an initial treatment over large areas, we do not have the labour available for follow-up control on a large scale.

We are currently trialling a number of methods for large-scale boneseed control in other areas of the park. In early 2004, five hectares of dense, mature (more than five years old) boneseed was 'groomed'. A 'groomer' attached to the front of a rubber-tyred tractor was used to simultaneously knock down and shred the boneseed plants. The aim was to follow-up with a prescribed burn to kill the mature boneseed and stimulate germination of seedlings that could then be hand pulled by the park's regular volunteers. However, the groomer shredded the plants to such a fine mulch that it did not leave enough fuel to carry a fire. The area was direct seeded with native grasses to provide groundcover, as well as fuel for a prescribed burn in autumn 2006.

Over the last two years, park staff have sprayed the groomed area every 12 months to prevent boneseed re-establishing. One area was not sprayed or direct seeded with grasses, but was left as a 'control' block, to monitor the effect of grooming alone. Although few boneseed stumps resprouted in the control area, the resulting seedling germination has meant that, two years later, the boneseed is as dense as it was before grooming.

The use of heavy machinery to control boneseed is cost-effective over large areas. Hiring the groomer cost $820 per day, and the five hectares were cleared in two days. When combined with a prescribed burn and follow-up seedling control by volunteers, mechanical control is a cost-effective and efficient way to control boneseed over large areas of the You Yangs. Even when the regrowth is foliar sprayed, rather than burned, the initial grooming reduces the bulk of the infestation

CSIRO

Steep, rocky and inaccessible: this boneseed infestation in the You Yangs is very difficult to control.

and hence reduces the amount of herbicide required. The integrated mechanical control and herbicide spraying becomes cheaper (over the large area) than spraying alone. The reduction in the amount of herbicide used also has environmental benefits.

From these trials, we believe that grooming is not an appropriate pre-burn treatment. In future, a slashing attachment will be used on the front of the tractor, which cuts the boneseed into larger pieces suitable for use as fuel for a burn.

Biological control in inaccessible areas

Many areas of the park are inaccessible, being steep and rocky, and the only hope of slowing the spread of boneseed in these areas is with biological control agents. Many agents have been released in the park, but all have failed to establish. In an effort to establish the boneseed leaf-rolling moth (*Tortrix* sp.), park rangers run their own biological control program with local schools, breeding the moth in specially constructed greenhouses. The students then release the moths at the You Yangs.

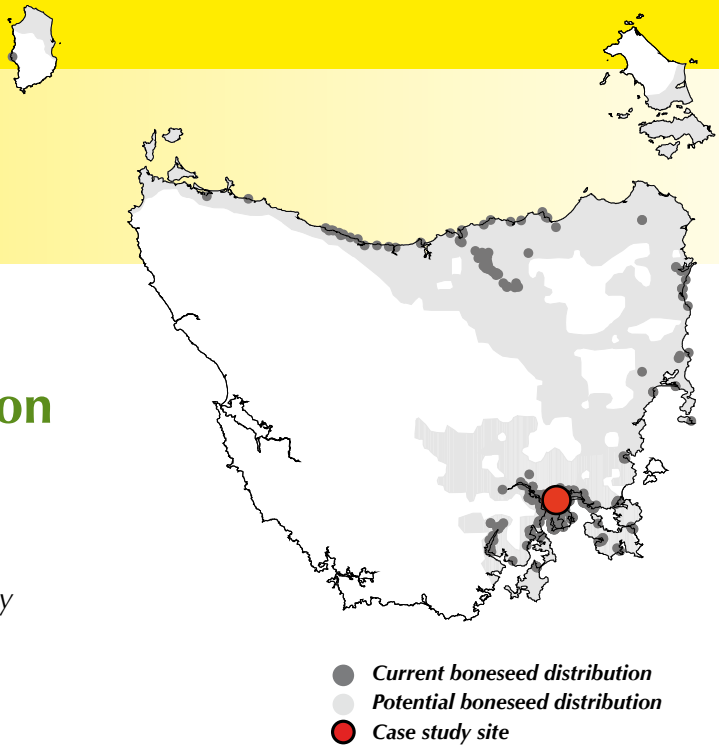
Conclusion

The spread of boneseed after bushfires in the You Yangs highlights how important contingency planning is when managing boneseed infestations. Having a follow-up control plan and the resources to implement it will ensure the boneseed population does not expand. Due to the immense size of the 1985 bushfire in the You Yangs Regional Park, there were not enough resources available to continue with post-fire boneseed control.

Today, as there are not enough resources to control all the boneseed in the park, management is strategically targeted to some 40 hectares where boneseed threatens high conservation values, such as around the rare brittle greenhood orchid. The vast size of the boneseed population has necessitated the use of what some would call 'extreme' control measures, such as mechanical and fire control. These large-scale control methods complement the more sensitive methods (hand pulling and foliar spraying) used around orchid colonies.

Grazing and the restriction of boneseed distribution in Tasmania

Grant Scurr, BSc (Honours) student, University of Tasmania



The current distribution of boneseed in Tasmania is concentrated around urban and suburban fringes, and limited to areas close to the coast and the Tamar and Derwent River estuaries. The distribution may be limited by the combined impacts of stock and native vertebrate grazers, particularly wallabies, keeping boneseed in check beyond urban fringes. Alternatively, it may be the result of insufficient time for further dispersal of boneseed from its initial planting in gardens.

To determine the impacts of stock grazing on boneseed populations, a sheep grazing trial was undertaken from December 2004 to June 2005, and a cattle grazing trial from June to August 2005. These both took place at Penna in the south-east of the state. To examine the effects of grazing by native animals, trials were also run at Rosny Hill and Flagstaff Gully, again in the south-east, from October 2004 to December 2005. Enclosure trials were undertaken over a period of two weeks to determine the palatability of boneseed to native vertebrate grazers.

Stock grazing on boneseed

While cattle appear to strongly prefer native grasses over boneseed, they can damage boneseed plants up to about 2 m tall by defoliation and trampling of the branches. Sheep appear to have a stronger preference for boneseed than cattle, and they rapidly defoliated boneseed plants. Over two months of sheep grazing, plants with stem diameters up to 4.5 cm, and around 1 m in height were completely defoliated, and some were killed. Smaller plants were killed more rapidly. Winter grazing in a paddock effectively stopped boneseed flowering. Sheep grazing in semi-natural or natural vegetation completely defoliated boneseed in less than two months, with fairly high boneseed mortality rates.

Boneseed appears to be particularly susceptible to grazing pressure in late winter and late summer. High boneseed mortality in late summer coincided with a relatively low intensity of foliage damage. Drought stress in conjunction with grazing pressure may make boneseed particularly sensitive to late summer grazing.

Implications for property management

Stock can be used to control boneseed in both pastures and grassy natural areas. If the desired outcome of management is boneseed mortality, short periods of grazing in late summer may have the greatest effect. The suitability of late summer grazing for management of boneseed also coincides with suitable times for minimum impact grazing of grasslands and grassy woodlands (Lunt 1991). If the desired outcome is to eliminate flowering, late winter grazing immediately before the spring flowering period should have the greatest impact, and may also cause some mortality.

Grant Scurr

Boneseed seeds in wallaby scats.

The apparent palatability of boneseed to sheep suggests that it is desirable to allow stock to graze selectively in native vegetation. This may effectively maintain the integrity of native vegetation, while still causing high boneseed mortality. Two sheep per hectare would be an appropriate stocking rate for controlling boneseed, and shouldn't have a large impact on native vegetation in south-east Tasmania.

Sheep are being used successfully to control boneseed in Penna. Don and Irene Briant have kept their Penna property free of boneseed through sheep grazing and hand pulling, but the steep hill country and their age (late 70s) has made hand pulling increasingly difficult. In one 12 hectare area sheep were excluded to encourage the regeneration of native species, but this also allowed boneseed to re-establish. After five years of exclusion, light sheep grazing (about one sheep per hectare) has been re-introduced to the regeneration area for a couple of months a year. This is controlling the boneseed, and is not significantly damaging the regenerating native species.

Penna is pretty dry and the country is hilly, so long periods of grazing are not feasible on the steeper areas. Rob Morey of Penna has kept his property clear of boneseed via short spells of sheep and cattle grazing. This is in spite of a 40-hectare forest of boneseed on adjacent ungrazed properties, including thousands of mature plants more than 2 m high, which have been there for over 30 years.

Richard Holloway

Boneseed in ungrazed pasture, Droughty Point, Tas.

Native animals and boneseed

Brush tail possums and Bennett's wallabies showed little interest in eating boneseed seedlings in the enclosure trials, whereas after two weeks, Tasmanian pademelons (*Thylogale billardierii*) had eaten the boneseed seedlings to the ground.

Bennett's wallabies and brushtail possums will eat boneseed fruit, however, as evidenced by small numbers of boneseed seeds in their scats. Quoll scats on Bruny Island (south of Hobart) contained many boneseed seeds indicating that they, along with possums and wallabies, are acting as dispersal agents for boneseed.

It is likely that Tasmanian pademelons are having a significant impact on the distribution of boneseed in Tasmania. In the current study, a boneseed population grazed by pademelons decreased in number of plants by almost half. The number of flowers per plant and plants flowering also decreased over a year, and negative growth was recorded at every two-monthly census, except November to December 2004 and November to December 2005. The heaviest plant damage occurred from late summer through to late winter, and boneseed mortality peaked in late summer and late winter. Plants recovered somewhat in late spring and early summer. Over the same one year period, the number of plants in a boneseed population ungrazed by pademelons increased, with positive growth recorded at every census.

Pademelons regularly graze boneseed plants up to a height of 65–70 cm, and occasionally cause defoliation up to heights of around 120 cm. This implies that pademelons are

Chad Staples

*Tasmanian pademelons (*Thylogale billardierii*).*

most effective at limiting boneseed growth on colonisation fronts (where there are many new plants, and fewer mature plants). Thus, in environments where pademelons are present, human efforts should be concentrated on removing large mature plants, as the pademelons will graze upon the juvenile plants.

Implications for management of boneseed in natural areas

Pademelon grazing appears to have a negative impact on boneseed populations. This suggests that in Tasmania, good-quality native bushland that supports native vertebrate fauna populations may be more resistant to boneseed invasion, due to predation of boneseed seedlings by pademelons (and possibly other native fauna). This is in addition to the resistance to invasion provided by competition from a strong native plant community.

Providing suitable habitat and shelter for pademelons will encourage them to forage in an area. Pademelons use large boneseed plants as shelter, and only come out into the open at night. To provide shelter for pademelons (and other small animals), control techniques that leave large boneseed plants standing, such as stem injection, should be used.

Grant Scurr

Boneseed seeds in possum scats.

An interesting proposition for the management of boneseed in Victoria is the re-introduction of pademelons to the state. Pademelons became extinct in Victoria around 1920, about 10 years before boneseed became a serious problem in the state. In 1979, an attempt was made to reintroduce Tasmanian pademelons to Tower Hill in western Victoria from zoo stock. However, the animals were taken by foxes (Mansergh & Seebeck 2006). If fox numbers were reduced and re-introduction became viable, a source of wild pademelons may be readily at hand, as thousands of pademelons are culled every year in Tasmania.

Section Six

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Declaration details of boneseed in Australia

The importation of boneseed (and all subspecies of *Chrysanthemoides monilifera*) into Australia is illegal, as determined by the Australian Quarantine Inspection Service (AQIS). See the import conditions database (ICON) on the AQIS website for details <www.aqis.gov.au>.

State/territory and lead agency	Relevant legislation	Declaration details for *Chrysanthemoides monilifera*	Area to which the declaration applies
Australian Capital Territory Territory and Municipal Services	*Pest Plants and Animals Act 2005*	**Prohibited pest plant** Boneseed is a pest plant whose propagation and supply is prohibited.	Whole of territory
New South Wales Department of Primary Industries	*Noxious Weeds Act 1993*	**Declared noxious weed** Boneseed (or material containing boneseed) may not be imported into New South Wales, sold, bought or otherwise distributed.	Whole of state
		Class 2 Regionally prohibited weed The plant must be eradicated from the land and the land must be kept free of the plant.	**1 LCA**: Lord Howe Island
		Class 3 Regionally controlled weed The plant must be fully and continuously suppressed and destroyed.	**15 LCAs**: Bankstown, Bega Valley, Burwood, Canterbury, Fairfield, Holroyd, Hornsby, Hurstville, Kogarah, Ku-ring-gai, Liverpool, Marrickville, Parramatta, Rockdale, Strathfield
		Class 4 Locally controlled weed The growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority.	**46 LCAs**: Ashfield, Auburn, Ballina, Bellingen, Blue Mountains, Botany, Byron, Canada Bay, Clarence Valley, Coffs Harbour, Eurobodalla, Far North Coast County Council, Gosford, Great Lakes, Greater Taree, Hunters Hill, Illawarra District Weeds Authority, Kempsey, Kiama, Kyogle, Lake Macquarie, Lane Cove, Leichhardt, Lismore, Manly, Mosman, Nambucca, Newcastle, North Sydney, Pittwater, Port Macquarie-Hastings, Port Stephens, Randwick, Richmond Valley, Ryde, Shellharbour, Shoalhaven, Sutherland, Sydney, Tweed, Warringah, Waverley, Willoughby, Wollongong, Woollahra, Wyong
Northern Territory Department of Natural Resources, Environment and the Arts	*Weeds Management Act 2001*	**Declared weed** **Class A** To be eradicated. **Class C** Not to be introduced to the Territory. Boneseed may not be bought, sold or moved within the Territory. Owners and occupiers of land are required to control boneseed, comply with weed management plans, and notify authorities of new occurrences of boneseed.	Whole of territory
Queensland Department of Natural Resources, Mines and Water	*Land Protection (Pest and Stock Route Management) Act 2002*	Boneseed (ssp. *monilifera*) - not declared. Bitou bush (ssp. *rotundata*) - declared as a Class 1 pest. It may not be introduced or supplied, and is subject to eradication from the state. Landowners must take reasonable steps to keep land free of bitou bush.	Boneseed not declared. Bitou bush declared in whole of state.

State/territory and lead agency	Relevant legislation	Declaration details for *Chrysanthemoides monilifera*	Area to which the declaration applies
South Australia Department of Water, Land and Biodiversity Conservation	*Natural Resources Management Act 2004*	**Proclaimed plant** Boneseed may not be imported into South Australia. The following sections of the Act relate to boneseed: • 175(2) The plant (or any matter containing the plant) cannot be moved. • 177(1)(2) The plant (or any matter containing the plant) cannot be sold. • 182(2)(3) Land owners must control the plant on their properties. • 185(1) Land owners may be required to pay an NRM authority for control of the plant on road reserves adjoining their properties.	Whole of state
Tasmania Department of Primary Industries and Water	*Weed Management Act 1999*	**Declared weed** Boneseed may not be imported into Tasmania, and must not be sold or otherwise distributed. Landholders may be required to control boneseed on their property.	Whole of state
		Zone A Eradication of boneseed is the principal management objective.	**16 of 29 municipalities:** Break O'Day, Brighton, Central Highlands, Circular Head, Devonport, Dorset, Flinders, Kentish, King Island, Latrobe, Meander Valley, Northern Midlands, Southern Midlands, Tasman, Waratah/Wynyard, West Coast
		Zone B Containment of boneseed is the principal management objective.	**13 of 29 municipalities:** Burnie, Central Coast, Clarence, Derwent Valley, George Town, Glamorgan /Spring Bay, Glenorchy, Hobart, Huon Valley, Kingborough, Launceston, Sorell, West Tamar
Victoria Department of Primary Industries The declaration status of boneseed is currently under review in Victoria, and the details may change.	*Catchment and Land Protection Act 1994*	**Declared noxious weed** Boneseed (or material containing boneseed propagules) may not be imported into Victoria, and must not be sold, bought or otherwise distributed or moved.	Whole of state
		Regionally prohibited weed Landholders and public authorities must eradicate or control these weeds on their lands. **Regionally controlled weed** Landholders are responsible for controlling the growth and spread of these weeds on their land and adjoining roadsides (except where VicRoads has responsibility for Declared Roads under the Transport Act 1983).	**4 of 10 CMAs:** East Gippsland, West Gippsland, North Central, Mallee **5 of 10 CMAs:** Corangamite, Glenelg Hopkins, Goulburn Broken, Port Philip and Westernport, Wimmera
Western Australia Department of Agriculture and Food	*Agriculture and Related Resources Protection Act 1976*	**Declared plant** **P1** The movement of plants or their seeds is prohibited within Western Australia. **P2** Boneseed should be eradicated. Treat all plants to destroy and prevent propagation each year until no plants remain. The infested area must be managed in such a way that prevents the spread of seed.	Whole of state

	Native vegetation contacts	*Threatened species contacts*
Australia	**Department of the Environment and Heritage** 02 6274 1111 *Environment Protection and Biodiversity Conservation Act 1999*	**Department of the Environment and Heritage** 02 6274 1111 *Environment Protection and Biodiversity Conservation Act 1999*
New South Wales	**Department of Natural Resources** 1800 237 012 www.nativevegetation.nsw.gov.au *Native Vegetation Act 2003*	**Department of Environment and Conservation** 131 555 www.threatenedspecies.environment.nsw.gov.au *Threatened Species Conservation Act 1995*
South Australia	**Department of Water, Land and Biodiversity Conservation** 08 8124 4700 www.dwlbc.sa.gov.au/native/ *Native Vegetation Act 1991*	**Department for Environment and Heritage** 08 8222 9311 www.deh.sa.gov.au/biodiversity/threatened.html *National Parks and Wildlife Act 1972*
Tasmania	**Department of Primary Industries and Water** 03 6233 3295 or 1300 368 550 www.dpiw.tas.gov.au *Forest Practices Act 1985* *Land Use Planning and Approvals Act 1993*	**Department of Primary Industries and Water** 03 6233 8759 or 1300 368 550 www.dpiw.tas.gov.au *Threatened Species Protection Act 1995*
Victoria	**Department of Sustainability and Environment** 136 186 www.dse.vic.gov.au *Catchment and Land Protection Act 1994*	**Department of Sustainability and Environment** 136 186 www.dse.vic.gov.au *Flora and Fauna Guarantee Act 1988*
Western Australia	**Department of Environment and Conservation** 1800 061 025 www.dec.wa.gov.au *Environmental Protection Act 1986*	**Department of Environment and Conservation** 08 9334 0333 www.dec.wa.gov.au *Wildlife Conservation Act 1950*

Safety and other legal requirements

Safety

All weed control activities involve some form of risk, so personal safety must be the top priority. Regulations regarding the safe use of herbicides and machinery must be followed, and personal protective equipment such as gloves, respiratory equipment, and eye and ear protection must be worn when required. Training is necessary in certain situations when using herbicides and machinery.

Legislation regarding Occupational Health and Safety (OH&S) is available from the Australian Safety and Compensation Council <www.nohsc.gov.au>. Volunteering Australia has a good risk management tool for organisations involving volunteers called *Running the Risk?* which can be downloaded free of charge from <www.volunteeringaustralia.org>.

Protection of native vegetation and threatened species

Weed control can impact upon native vegetation (this includes herbs and grasses as well as trees and shrubs) and threatened animals and plants. You need to be familiar with the relevant legislation governing weed control activities in your state. You may need permits if you work near or propagate threatened species, or your activities are likely to damage or kill native vegetation. The presence of rare or threatened species, or vegetation of conservation significance should be identified in your boneseed management plan (see Section 2).

Contact your local government authority for advice before commencing any weed control activities. They will be able to advise you on state and federal legislation, as well as any local laws governing weed control activities in natural areas or near waterways. The table above outlines the main federal and state agency contacts, and the relevant pieces of legislation in each state where boneseed is present.

Cultural heritage

Commonwealth legislation governing Indigenous and historic heritage sites includes the *Aboriginal and Torres Strait Islander Heritage Protection Act 1984* and the *Environment Protection and Biodiversity Conservation Act 1999*. State and local government legislation may also apply. Initially, contact your local government or NRM authority; they will be able to inform you of any issues and advise you on how to proceed.

The Australian Heritage Database contains information about more than 20,000 natural, historic and Indigenous places, and searching by local government area will provide a list of heritage places in a locality. The database can be found on the website of the Department of the Environment and Heritage <www.deh.gov.au/heritage>. A list of Indigenous Land Management Facilitator contacts can be found on the Australian Government Natural Resource Management website <www.nrm.gov.au/contacts>.

Information for community volunteers

Incorporation, insurance and liability

It is recommended that all volunteer groups be incorporated. In most cases, the liability of any legal actions brought against an incorporated group are limited to only the group's assets. Without incorporation, individuals and their assets are liable. Groups may also need to be incorporated to receive any government grants or funding.

All volunteer groups should have insurance that covers them for public liability and personal accidents. Groups should also consider associations liability insurance (provides protection for officers of the group from legal actions). Insurance policies for landcare, bushcare and coastcare groups can be obtained for around $300. Good general information on incorporation and insurance is available from the Tasmanian Landcare Association <www.taslandcare.org.au>.

An alternative to obtaining incorporation and insurance is for your group to join a large organisation that acts as an 'umbrella body'. Organisations such as Trees For Life < www.treesforlife.org.au> and Our Patch <www.ourpatch.on.net> in South Australia, and the Victorian Farmer's Federation Farm Trees and Landcare Association (VFF FTLA) encompass member groups within their incorporation and insurance. The VFF FTLA can be accessed via the 'Organisations' page on Landcare Victoria's website <www.landcarevic.net.au>, and the insurance policy is also available to incorporated groups outside of Victoria.

Groups working on council or state land (e.g. national parks and reserves or land managed by CMAs, or NRM boards) may also be covered by the agency's insurance policy – contact the relevant authority for details.

Funding for weed management

There are many funding opportunities for weed management, which are often part of a broader natural resource management program, such as the restoration of native vegetation. Grants are available from federal and state governments, CMAs and NRM boards, councils, and private corporations. The Weeds Australia website contains a summary of funding opportunities <www.weeds.org.au/weedfunding>.

When applying for funding, involve the land manager of your site, and seek help from your council and CMA or NRM board in the early stages of planning. For state-wide or national projects you can enlist the help and support of the relevant WONS coordinator – see <www.weeds.org.au/natsig> for contact details.

Useful weed contacts and resources

Organisation	Web address	Information available
National		
Weeds Australia – boneseed and bitou bush	www.weeds.org.au – www.weeds.org.au/WoNS/bitoubush	- legislation - weed ID - contacts and web links
CRC for Australian Weed Management	www.weeds.crc.org.au	- weed management guides - research information
Department of the Environment and Heritage – weeds	www.deh.gov.au – www.deh.gov.au/biodiversity/invasive	- legislation - funding opportunities
Department of Agriculture, Fisheries and Forestry – NRM funding	www.daff.gov.au – www.daff.gov.au/nrm	- Defeating the Weed Menace Programme
Australian Government Natural Resource Management	www.nrm.gov.au	- funding opportunities - contacts and web links
Australian Quarantine and Inspection Service	www.aqis.gov.au	- import conditions database (ICON)
Australian Pesticides and Veterinary Medicines Authority – search for herbicides – search for permits	www.apvma.gov.au – services.apvma.gov.au/PubcrisWebClient – www.apvma.gov.au/permits/permits.shtml	- current herbicide registrations and permits - safe herbicide use
Australian Safety and Compensation Council	www.nohsc.gov.au	- OH&S legislation
ChemCert Australia	www.chemcert.org.au	- chemical use training
Volunteering Australia	www.volunteeringaustralia.org	- risk management tool
Landcare Australia	www.landcareonline.com	- national landcare site - web links
Weedbusters Australia	www.weedbusterweek.info.au	- community weed awareness
Weed Warriors	www.weedwarriors.net.au	- community biological control
Australian Association of Bush Regenerators	www.aabr.org.au	- bush regeneration
New South Wales		
Department of Primary Industries – weed management – noxious weed declarations	www.dpi.nsw.gov.au – www.agric.nsw.gov.au/reader/weeds – www.agric.nsw.gov.au/noxweed	- legislation - noxious weeds list - funding opportunities
National Parks and Wildlife Service	www.nationalparks.nsw.gov.au Click on > Weeds and pest animals > Weeds	- legislation - weed management - web links
Environment Protection Authority	www.environment.nsw.gov.au/pesticides	- pesticide legislation - pesticide use
SMARTtrain	www.smarttrain.com.au	- chemical use training
Catchment Management Authorities	www.cma.nsw.gov.au	- NSW catchment management authorities

Organisation	Web address	Information available
Landcare NSW	www.landcarensw.org	- landcare group resources - CMA contacts
Weeds of Blue Mountains Bushland	www.weedsbluemountains.org.au	- weed ID - bushcare group contacts
Victoria		
Department of Primary Industries – weeds – agricultural chemical use	www.dpi.vic.gov.au – Click on > Agriculture and Food > Crops, pastures and weeds > Weeds – Click on > Agriculture and Food > General farming > Chemical use	- legislation - noxious weeds list - chemical use
Department of Sustainability and Environment	www.dse.vic.gov.au Click on > Land management > Catchments	- Victorian catchment management authorities
AgTrain	www.dpi.vic.gov.au/agtrain	- chemical use training
Landcare Victoria	www.landcarevic.net.au	- landcare group resources - contacts - insurance
South Australia		
Department of Water, Land and Biodiversity Conservation	www.dwlbc.sa.gov.au Click on > Biodiversity > Pests (Animals and Weeds)	- proclaimed plants list - legislation
Primary Industries and Resources SA	www.pir.sa.gov.au/ruralchemicals	- chemical use legislation
Natural Resources Management Boards	www.nrm.sa.gov.au	- natural resource management boards
Landcare SA	www.landcaresa.org.au	- regional NRM contacts - landcare group contats
Trees For Life	www.treesforlife.org.au	- weed ID - bushcare group contacts
Our Patch	www.ourpatch.on.net	- weed ID - bushcare group contacts - photopoints
Tasmania		
Department of Primary Industries and Water – weeds – agricultural chemicals	www.dpiw.tas.gov.au – Click on > Weeds, Pests and Diseases > Weeds – Click on > Food & Agriculture > Agricultural and Veterinary Chemicals	- legislation - declared weeds list - weed management - guidelines for interpreting labels
Natural Resource Management Tasmania	www.nrmtas.org	- NRM region links - funding opportunities
Tasmanian Landcare Association	www.taslandcare.org.au Click on > Latest News > Publications	- landcare group resources - contacts - incorporation and insurance
Western Australia		
Department of Agriculture	www.agric.wa.gov.au Click on > Pests, Weeds + Diseases	- legislation - declared plants list - weed management
Natural Resource Management Council	www.nrm.org.au	- NRM region links - funding opportunities
Australian Association of Bush Regenerators (WA)	www.aabr.com.au	- bush regeneration

Education and awareness materials

Education and awareness materials for boneseed and bitou bush are available free from the National Bitou Bush and Boneseed Coordinator. Available for distribution are: state specific boneseed flyers for New South Wales, South Australia, Tasmania and Victoria; national boneseed posters; and national bitou bush flyers. Available for loan for field days and educational displays are: state specific boneseed banners (around two metres tall) for New South Wales, South Australia, Tasmania and Victoria; a national boneseed banner; and a national bitou bush banner.

For contact details for the national coordinator, and to download this manual, flyers, posters and weed management guides, see the Weeds Australia Website <www.weeds.org.au/WoNS/bitoubush>.

National boneseed poster

(Front)

(Back)

National bitou bush flyer

(Front)

(Back)

State specific boneseed flyer (NSW, SA, Tas., Vic.)

State specific boneseed banner (NSW, SA, Tas., Vic.)

National bitou bush banner

National boneseed banner

Weeds CRC boneseed management guide

Weeds CRC bitou bush management guide

Glossary

achene	a dry one-seeded fruit that does not open at maturity to release the seed.
core infestation	a situation where a weed has a well-established self-regenerating population, the risk of further establishment is high, and wide-scale eradication is neither practical nor possible.
disc floret	a small flower formed in the centre of an inflorescence, with small equal sized lobes.
floret	a small flower, one of a dense cluster that makes up an inflorescence.
inflorescence	the flower-bearing structure of a plant – the boneseed 'flower' is actually an inflorescence made up of multiple flowers (disc and ray florets).
propagule	a structure with the capacity to give rise to a new plant (e.g. a seed).
ray floret	a small flower formed at the outer edge of an Asteraceae inflorescence, with one large strap-shaped lobe (which forms the 'petal' structure).
riparian	located on or near the banks of a river or stream (i.e. near water).
outlier infestation	an isolated infestation or clump of a weed, separate from the core infestation.
seedbank	dormant, viable seeds of a species (refers specifically to seeds in the soil, or 'soil seedbank' in this manual, as opposed to a 'standing seedbank' which refers to seeds remaining on the plant).

Acronyms

APBC	Animal and Plant Control Board (SA)
APVMA	Australian Pesticides and Veterinary Medicine Authority
CMA	Catchment Management Authority
CRC	Cooperative Research Centre
DAFF	Department of Agriculture, Fisheries and Forestry (Commonwealth)
DEC	Department of Environment and Conservation (NSW)
DEH	Department of the Environment and Heritage (Commonwealth)
GIS	Geographical information system
LCA	Local control area or local control authority
NBBBMG	National Bitou Bush and Boneseed Management Group
NPWS	NSW National Parks and Wildlife Service (part of DEC)
NRM	Natural resource management
sp.	species
SPBP	South Para Biodiversity Project
ssp.	subspecies
syn.	synonym
TAFE	Technical And Further Education
WONS	Weed(s) of National Significance

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