

best practice management guide

3

BEST PRACTICE MANAGEMENT GUIDE FOR ENVIRONMENTAL WEEDS

ISSN 1442-7192

Bitou bush, *Chrysanthemoides monilifera* subsp. *rotundata*

Taxonomy and status

Botanical name: *Chrysanthemoides monilifera* subspecies *rotundata* (DC.) T.Norl. - Family Asteraceae (daisy family).

Standard common name: bitou bush. Other common names applied in Australia include South African star bush and Mort's curse.

Relationship to other species in Australia:

The introduced weed boneseed, *Chrysanthemoides monilifera* subsp. *monilifera* is the only close relative. There are no closely-related indigenous species.

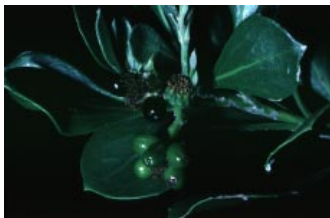
Legislation: Bitou bush is declared noxious in Queensland and a Category 2 or 3 listed plant for Lord Howe Island and certain shires in NSW. It is listed as a *Key Threatening Process to Biodiversity* in NSW and as a *Weed of National Significance* in Australia. Keep up to date with the latest legislation through local and State/Territory government weed agencies or on the web at www.weeds.org.au

Description

Habit/lifeform: spreading woody shrub with succulent stems, often prostrate on the ground.

Description: Shrub dimensions are typically 1-2 m tall and 2-6 m wide. Bitou bush develops a creeping habit under shade and may smother canopies up to 10 m in height. Its leaves are bright green, succulent, oval in shape with a tapering base and irregular teeth along the edge, 3-8 cm long. Young growth is typically covered by a cottony down. Mature plants produce lots of bright yellow daisy-like flowers with 11-13 'petals' (Figure 1). Fruits are green, becoming black when ripe and contain only a single seed. The seeds are egg-shaped, 5-7 mm long, fleshy

externally with an internal hard bone-like shell which is dark brown to black when dry.



Bitou bush fruit.
Photo: K. Blood.



Bitou bush infestation.
Photo: J. Vranjic.



Bitou bush being sprayed.
Photo: J. Vranjic.



Figure 1. Bitou bush flowers and fruit.
Photo: K. Blood.

Bitou bush differs from boneseed by its sprawling growth habit (versus the erect habit of boneseed), rounder and less obviously toothed leaves (Figure 2), flowers with more 'petals' (11-13 for bitou bush versus 5-8 for boneseed) and egg-shaped ribbed seeds (versus round, smooth seeds for boneseed) (Figure 3).



Figure 2. Bitou bush (right) leaves, flower and fruit compared with boneseed (left).
Photo: K. Blood.



Figure 3. Bitou bush leaves and fruits (right) compared with boneseed (left).

Photo: P. Weiss.

Origin and distribution

Origin: Bitou bush is native to coastal regions of South Africa.

Introduction: The exact date and manner of introduction of bitou bush into Australia are unknown. The introduction probably was accidental through dumping of ballast by ships arriving from South Africa. Earliest herbarium records indicate an introduction to the Stockton area near Newcastle, NSW, in about 1908. From 1946-1968 bitou bush was planted deliberately along the NSW coast by the Soil Conservation Service of NSW to aid in erosion control and post-mining rehabilitation.

Distribution: Bitou bush has invaded coastal habitats in south-eastern Queensland, NSW and Lord Howe Island. Bitou bush is particularly prevalent on the central and north coasts of NSW (Figure 4). A population was also planted and has persisted near Menindee in western NSW and a small population is present near Melbourne, Vic. The total area infested is estimated currently to be over 70 000 ha in Australia.



Figure 4. Distribution of bitou bush in Australia.

Map based on Parsons and Cuthbertson, 1992.

Ecosystems invaded: Bitou bush primarily invades disturbed and undisturbed coastal ecosystems (Figure 5). A variety of ecosystem types have been invaded including sand dune heathlands and grasslands, headland heathlands and

grasslands, coastal woodlands, coastal dry sclerophyll forests, and littoral rainforests. Mallee vegetation in western NSW has also been affected by bitou bush.



Figure 5. Bitou bush infestation (paler green vegetation) along coastal dunes.

Photo: K. Blood.

Impacts

Species and ecosystems at risk: In 1999, bitou bush was listed as a *Key Threatening Process to Biodiversity* in NSW and as a *Weed of National Significance*. No species is known to have become extinct as a result of bitou bush invasion but its distribution does overlap with those of some rare and endangered plant species, notably *Pimelea spicata*, *Zieria prostrata*, *Cynanchum elegans* and *Thesium australe*. Bitou bush displaces the dominant plants in communities it invades, for instance *Acacia sophorae* on coastal dunes (Figure 6), and leads to a decline in floral biodiversity, as well as changes in the diversity of birds, indigenous mammals and ground-dwelling insects. Stands of bitou bush may also foster sites that harbour pest animals, such as foxes and introduced birds, which feed on and disperse the seeds or shelter under bitou bush canopies.



Figure 6. Dense stand of bitou bush showing extent of infestation.

Photo: J. Vranjic.



Economic impact: No figures are available for the total cost of bitou bush to the Australian community. The costs of large-scale management to date are high as they involve considerable amounts of labour from Dunecare and Landcare groups, aerial spraying with herbicides, bulldozing and establishing a biological control program.

Dispersal and establishment

Reproductive techniques: Bitou bush spreads primarily by seed. Germination appears to be promoted by fire, soil disturbance (eg. after bulldozing), and ingestion of seeds by birds and mammals. Seeds also appear to germinate better after a period of weathering and leaching in the soil. Unlike boneseed, mature plants of bitou bush may resprout after fire, slashing and herbicide application. The seeds ripen from June to September and most usually shrivel, dry and fall off or are taken by animals. Some seed can stay on the parent plant for up to a year.

Vectors and dispersal mechanisms: Dispersal occurs primarily by animals such as birds and foxes eating seeds and passing them in faeces. This can spread seed over distances of kilometres. Some seeds may also be dispersed by ocean currents or through coastal creeks and waterways. Localised dispersal can occur through movement of sand blown by wind. Human-assisted dispersal was a factor in the initial spread of bitou bush via deliberate planting for early erosion-control programs. Seeds may be transmitted by tyre treads or soil adhering to vehicles and equipment. Seeds otherwise fall to the ground under the parent plants.

Persistence: Mature plants may produce up to 48 000 seeds per plant per year. The soil seed bank usually consists of 2 000 to 5 000 seeds per square metre. The viability of seeds in the soil is variable but generally low: 2-30%. The maximum longevity of seeds is unknown but viability of most seeds is considerably reduced after 2-4 years. Dormancy mechanisms are not fully understood but it is likely that the fleshy cover surrounding the seed contains chemicals that inhibit germination and must be leached or decomposed away for germination to commence. Fire, exposure and soil disturbance appear to enhance germination.

Tolerances: Bitou bush grows in a range of environments from open exposed dunes to shaded forests. It is tolerant of shade, salinity, strong wind, wind-blown sand, salt and water, drought, low nutrients and, to some extent, of disturbances such as fire. Bitou bush grows poorly in wet or swampy soils and has a low tolerance to frost.

Properties

Health risks and other undesirable traits: Cattle graze bitou bush with no significant toxic effect. Bitou bush affects indigenous plants mainly through competition, its high growth rate and, possibly, by releasing chemical inhibitors. Dense stands of bitou bush exclude other indigenous plants leading to decreasing floral biodiversity and, consequently, changes in faunal diversity. Stands of bitou bush also reduce the aesthetic

appeal of natural environments and reduce recreational access to beaches and along walking trails.

Cultural uses: Bitou bush is not used for ornamental, culinary or medicinal purposes in Australia although it is possible to make jam from the fruits. Although formerly used for revegetation purposes in the 1940s-1960s, this practice was discontinued when its undesirable weedy attributes were recognised.

Biology and ecology

Biology and ecological notes: An Australian native organism known to attack bitou bush is the fungus *Sclerotinia sclerotiorum* that causes shoots to rot. There is a low incidence of fungi beneficial to plant growth forming associations on the roots. The weed appears to be quite vigorous and competitive in its interactions with indigenous flora and tolerant of a range of growing conditions and disturbances. Boneseed will hybridise with bitou bush to produce fertile plants with intermediate characteristics.

Growth calendar: Seed germination can occur throughout the year though most seed germinates after autumn rains. On the south coast of NSW, seedlings usually reach flowering age after three years, or earlier if germinated in burnt or favourable exposed sites. On the north coast of NSW, seedling growth is much more rapid and flowering within one year is more usual. Peak flowering occurs from April to June. Peak fruiting occurs from June to September.

Management

Prevention: It is important to keep uninfested areas clear of bitou bush. Once an infestation is established, preventing its spread into surrounding areas should be a priority. This requires integrated management to reduce seed production and the control of undesirable dispersal vectors, notably foxes. The control of indigenous or introduced birds or other pest animals as dispersal vectors is usually not practicable. A gradual replacement of bitou bush by indigenous plants that produce the "normal" food supply of indigenous seed-feeding birds could help to reduce dispersal of weed seeds.

The quarantining of an area to stop movement of seeds in sand on vehicles and equipment may be necessary. Raising awareness amongst recreational vehicle users particularly in coastal areas is advisable where this form of dispersal is a problem.

Integrated management: When treating bitou bush in a natural ecosystem, it is essential to consider its management in light of other management issues so that they can be integrated to get the best results. When using these guidelines, it is essential to realise their limitations and modify them in light of experience and local knowledge. Each situation should be considered individually. Weeds need to be treated as part of larger land and water management issues.

If the weed occurs in small isolated infestations, removal to prevent expansion is advisable. Larger infestations require planning to efficiently reduce the population to an acceptable



level. That level will be determined by the management objectives of the area and the resources available to tackle the problem.

Treatment techniques: There are a number of different treatment techniques that can be used but it is often better to combine a number of techniques for the best results:

Mechanical treatment: Mature plants can be slashed, whilst seedlings can be hand-pulled to remove the entire root system. Plants are liable to resprout after slashing alone, but applying herbicide to stems immediately after cutting should prevent regrowth. Mechanical techniques are laborious and impractical for infestations that are extensive or in areas that are difficult to access and may also cause soil disturbance and erosion problems, particularly when large roots are removed.

Herbicide information: When using chemicals always read the label and follow all instructions carefully. Consult a specialist for advice on registered chemicals in your particular State or Territory. Herbicide information is available at the National Registration Authority web site at www.affa.gov.au/nra/pubcris.html

Herbicides registered for bitou bush can be applied in winter at low rates that effectively kill the weed, yet have minimal impacts on coastal vegetation (Figure 7). Herbicides can be applied from the air, from the ground or by a cut-and-paste method. Plants which are coated with dust or seaspray (eg. those close to tracks or the beach) could be less affected by herbicides. Glyphosate and metsulfuron methyl have been the herbicides most widely and successfully used against bitou bush.

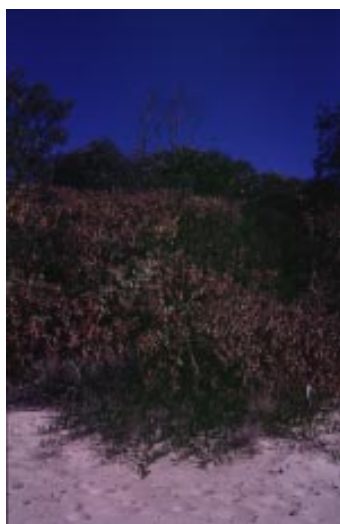


Figure 7. Impacts of herbicides on bitou bush and indigenous species.
Photo: J. Vranjic.

Biological control: Two insects that attack bitou bush in South Africa have been released and established very well in Australia. These are the bitou tip moth (*Comostolopsis germana*) which destroys the growing tips, and the bitou seed fly (*Mesoclanis polana*) that destroys developing seeds. Both agents are now distributed along most of the range of bitou bush and, together, are reducing seed production of bitou bush. Leaf-feeding beetles (*Chrysolina* and *Cassida* spp.) also were released but have either not established or are colonising only slowly. Research is continuing into other South African insects and fungi that attack bitou bush.

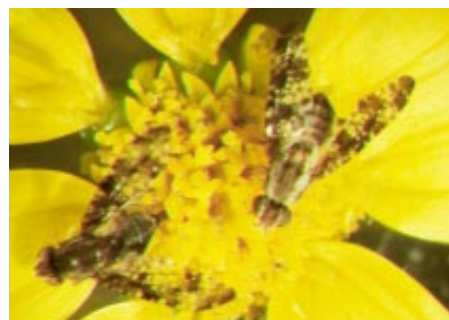


Figure 8. The bitou seed fly (*Mesoclanis polana*) (top) and the Bitou tip moth (*Comostolopsis germana*) (bottom), effective biological control agents for bitou bush.
Photos: P. Edwards.

Fire: An intense fire kills most mature plants although a small proportion of plants resprout. Fire also kills bitou bush seeds in the litter and topsoil and stimulates germination of seeds from lower in the soil profile. Fire, therefore, can be useful in reducing the large numbers of bitou bush seeds present in the soil but much depends on the intensity of the fire which is determined in part by fuel load, season and fire history. Fire can cause additional problems such as increased erosion potential, increased traffic and access by humans and pest animals, and further invasion by weeds. Note that permission of the land owners and a permit from the relevant State fire authority is generally required to authorise the use of fire and that the fire should be undertaken by properly trained and equipped personnel.

Grazing: Cattle eat bitou bush. This limits the spread of bitou bush onto grazed properties adjacent to heavily infested areas. Management of bitou bush through grazing, however, usually is not practised on public lands because of problems associated with stock such as browsing of desirable indigenous species, erosion from stock movement, fouling of areas by dung and the spread of other undesirable weed species.

Management guidelines: The major objectives for integrated management schemes are to: remove existing weeds, run down the amount of weed seeds in the soil, reduce the opportunities for reinvasion by the same or other weeds, and rehabilitate and revegetate with desirable indigenous species. The nature of invasion by bitou bush means that these objectives must be long-term, as considerable time is required to properly apply some of the management techniques. A lack of appropriate follow-up will quickly lead to reinfestation of bitou bush. The following guidelines are some general strategies to manage bitou bush in particular ecosystems.



Isolated plants or small infestations: Ensure that you have correctly identified the plant before removal. Isolated plants can be physically removed, preferably before they have seeded, or treated with herbicide such as glyphosate applied by spot-spraying. As infestations become larger, a strategically staged approach for removal is advisable to ensure that treated areas are not reinfested.

Large and extensive infestations in coastal heath, woodlands and grasslands on hind dunes: A multi-stage spray-burn-spray strategy incorporating biocontrol agents is recommended as a general strategy. Most sites or all now harbour at least one biocontrol agent. Spray large patches of bitou bush in winter with herbicide. This can be applied aerially (Figure 9) or from the ground. Leave some areas unsprayed to allow biocontrol agents to persist and subsequently disperse from.

Next, burn portions of sprayed patches. This should remove unsightly patches of dead bitou bush and stimulate the germination of both weed and certain indigenous species which are present in the soil. On the south coast of NSW, an autumn fire is best but on the north coast, a spring fire may be more appropriate.

Monitor sites for bitou bush, biocontrol agents and indigenous plants. In particular, determine the extent of re-emergence of bitou bush, impact of biocontrol agents on bitou bush seedlings and any regeneration of desirable indigenous plants.

Respray as necessary to control regrowth and bitou bush seedlings which have escaped damage by biocontrol agents. Again, leave some patches unsprayed to harbour biocontrol agents. The timing of the respray depends on the region but in general it is best to spray before seedlings start producing seeds but after they have grown sufficiently tall and self-thinned. The time for bitou seedlings to reach maturity is at least a year on the south coast but as short as six months on the north coast of NSW.



Figure 9. Large area of coastal bush aerially sprayed. Note only dead bitou bush plants.

Photo: K. Blood.

Note that the full implications of a biocontrol-spray-burn-spray strategy to coastal grasslands have not yet been determined but many such ecosystems are known to be fire-adapted. In areas where a large proportion of the remnant vegetation is known to be fire-sensitive, fire should not be adopted.

Large and extensive infestations on coastal foredunes: Fire is not recommended because of the sensitive nature of this ecosystem to erosion. Instead, a combination of biocontrol-

spraying-mechanical removal may be most appropriate. Follow-up spraying may need to be undertaken regularly, as noted above for the hind dunes.

Rainforests: Fire is not recommended because of the sensitive nature of rainforest plants to burning. A combination of biocontrol, spot-spraying and mechanical removal may be most appropriate for infestations within the forest. The numbers of new weed seedlings in rainforests may be low, due mainly to poor flowering of bitou bush under heavy shade. Most seedlings probably will originate from external infestations. It is important, therefore, to give priority to managing healthy infestations of bitou bush in areas surrounding rainforests.

Given the likelihood of scarce resources and the complexity of management issues, the following considerations should also be taken into account when adopting a strategy. Attention must focus on all weeds at a site as bitou bush is unlikely to be the only weed present. The possibility of new and more vigorous weeds filling the gaps left after removing bitou bush must be minimised. Many bush regenerators first manage the smallest weed infestations and gradually work towards larger infestations. Smaller infestations in which much of the indigenous vegetation is intact have a greater potential for natural restoration. Strategies will need to be modified to accommodate special requirements such as the management of endangered plant and animal species. For example, it is possible that bitou bush could provide shelter for certain indigenous fauna. In other cases, endangered indigenous plants may be particularly sensitive to management techniques (eg. *Pimelea spicata* is very sensitive to herbicides). Exercise judgement to address the specific management objectives additional to the control of bitou bush. It is impractical to aim for complete eradication of the weed. Instead, aim at minimising weed infestations to a level where it is easier and cheaper to manage. For instance, target specific sections of the weed population such as seedlings that have not yet reached flowering age in heavily disturbed sites, or only heavily flowering plants.

Disposal: The unsightly stands of dead bitou bush that occur after spraying can be eliminated by compacting, trampling or fire, in appropriate ecosystems. If allowed to stand, the dead canes help to deter undesirable traffic and afford some physical protection to dune environments until they eventually decompose. Small amounts of bitou bush removed by clearing or hand-pulling also can be left in place to decompose naturally but, if practical, seeds should be removed and incinerated.

Community awareness: Being a prolific coastal weed, bitou bush has a relatively high profile, especially among members of the public involved with Dunecare, Landcare and Coastcare groups. These volunteer groups are very effective in assisting with follow-up work, systematic searches for new infestations and preventing weeds from spreading. Erecting simple signs at beach entrances that provide information on what bitou bush plants and seedlings look like and how to help control it are a good way of informing the general public. The bitou bush problem also has received occasional media attention.

Consider running activities as part of national Weedbuster Week in October each year to increase local community awareness of the problem. See the web site at www.weedbusterweek.info.au for more information.



Follow-up: Monitoring should concentrate on the number of regenerating bitou bush seedlings, any impacts of biocontrol agents on those seedlings, and the numbers of regenerating indigenous plant seedlings. The most appropriate time to monitor is in late winter to early spring after the autumn-winter rains have stimulated germination. As some seeds of bitou bush may persist for years in the soil because of dormancy mechanisms, monitoring and follow-up should also be implemented over the long-term. The use of community groups to assist with simple follow-up and monitoring procedures should be encouraged.

Management calendar: The recommended integrated management strategy essentially incorporates biocontrol, winter herbicide sprays, a possible fire in autumn or spring for appropriate ecosystems, monitoring in winter-spring and follow-up winter sprays. The spray-burn-spray strategy should be applied within three successive years to account for the fact that stimulation of massive weed germination by fire will lead to a natural reduction in the numbers of emergent seedlings and allow time for biocontrol agents and indigenous plants to establish or have an impact. In all cases, it is important to remove immature plants of bitou bush before they reach flowering age, which is a minimum of six months to one year on burnt areas and 1-3 years on unburnt sites. If seedlings are to be hand-pulled this is best achieved when they have grown sufficiently tall, say to 1 m in height, as by that stage they have self-thinned and can be pulled out more effectively.

Replacement plants: The indigenous plant species used to revegetate sites invaded by bitou bush depends on the composition of local flora present at each site or habitat. The existing indigenous vegetation at a site should be conserved as far as is practicable as these plants provide a natural seed-source. If active revegetation is to be implemented, seeds or plants from species and populations endemic to a region ideally should be used. Do not introduce native species that were never present at a locality as some native plants can become weeds in the wrong circumstances. Widespread coastal species that could be useful for revegetation include *Acacia sophorae*, *Banksia integrifolia*, *B. serrata*, *Lomandra longifolia*, *Spinifex sericeus* and *Themeda australis*. It is best to seek the advice of local flora and revegetation experts for suitable indigenous plants of local provenance for revegetation. Revegetation by sowing indigenous seed is best implemented in winter after applying the spray or burn so that emerging seedlings are not destroyed by the techniques used to manage weeds.

WeedWatch: There are several simple things that can be done if bitou bush plants are found at new sites in the field. Make sure they are identified correctly as bitou bush. If uncertain about identification, send a specimen to the State or Territory Herbarium with details on where and when it was found and the contact details of the person who sent the specimen (see the *White Pages* or the *Weed Navigator* for address details of herbaria).

Isolated smaller plants can be pulled out and left in the field to die. Mature plants and large patches of bitou bush are more difficult to completely remove. It is best to notify the person responsible for weed management on that land,

usually a National Parks or district weeds officer or local community Coastcare representative. These can be contacted at the nearest National Parks or shire offices.

Further reading

Holtkamp, R. (ed.) (1993) *Proceedings of a national workshop on *Chrysanthemoides monilifera**. Port Macquarie, NSW, 28-30 April 1993. NSW National Parks and Wildlife Service, NSW Department of Agriculture, and NSW Department of Conservation and Land Management, Port Macquarie.

Holtkamp, R., Groves, R.H. and Corey, S. (eds.) (1997) *Bitou bush workshop*. Sydney, NSW, 3-4 Sept. 1997. NSW NPWS and CRC for Weed Management Systems, Canberra.

Love, A. and Dyason, R. (eds.) (1984) *Bitou bush and boneseed. Proceedings of a conference on *Chrysanthemoides monilifera**. Port Macquarie, NSW, 8-9 August 1984. NSW NPWS, and NSW Department of Agriculture, Port Macquarie.

Parsons, W.T. and Cuthbertson, E.G. (1992) *Noxious weeds of Australia*. Inkata Press, Melbourne.

Weiss, P.W., Adair, R.J. and Edwards, P.B. (1998) *Chrysanthemoides monilifera* (L.) T.Norl., in Panetta, F.D., Groves, R.H. and Shepherd, R.C.H. (eds.) *The biology of Australian weeds*. Volume 2. R.G. and F.J Richardson, Melbourne, pp. 49-61.

There are a number of management guides on different weeds being published by the Weeds CRC (see contact details below). Other CRC publications include the *Weed Navigator* (lists many weed publications, information resources and contacts in Australia and New Zealand), workshop proceedings, field and management guides, brochures and posters.

Further contacts: Contact your local National Parks and Wildlife Service office or the district weeds officers for your local shire. Many people interested in environmental weeds communicate regularly through the *Enviroweeds* email discussion group established in Australia. If you would like to join this group free of charge, send this message <subscribe> to the following email address: enviroweeds@majorodomo.nre.vic.gov.au

Acknowledgments: I thank Royce Holtkamp, Paul Weiss, Jennifer Carter, Andrew Leys, Samantha Olsen, Brett Pengilly, Craig Shephard, Jeff Thomas, Neale Watson, Lisa Wellman and Graham Harding for useful comments on an earlier draft of this guide. Some information also provided by Robin Adair. Editing by Richard Groves and Kate Blood. Design and layout by Kirsty Villis.

Author: J. Vranjic, CRC Weed Management Systems and CSIRO Plant Industry, GPO Box 1600, Canberra, ACT, Australia 2601.

Publication date: February 2000. Printed on recycled paper.

© Cooperative Research Centre for Weed Management Systems, Australia. This guide can be copied in its entirety including its acknowledgments and publisher and used by those managing or raising awareness about weeds. It may not be reproduced in other work without the permission of the Weeds CRC.

More copies available from the Cooperative Research Centre for Weed Management Systems (Weeds CRC) at University of Adelaide, PMB1 Glen Osmond, South Australia, Australia 5064, ph 08/8303 6590, fx 08/8303 7125, email: croweeds@waite.adelaide.edu.au, web: www.waite.adelaide.edu.au/CRCWMS

The information contained in this publication is offered by the CRC for Weed Management Systems (Weeds CRC) and its partners solely to provide information. While all due care has been taken in compiling the information, it is applied on the basis and subject to the qualification that the Weeds CRC and its partners, their officers and employees take no responsibility for its contents nor for any loss, damage or consequence whatsoever for any person or body relying on the information, or any error or omission, contained in this publication. Any recommendations contained herein do not necessarily represent Weeds CRC policy.

