

Bitou bush

Chrysanthemoides monilifera
subspecies *rotundata*



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Contents

Summary	4
Introduction	5
Identity and taxonomy	5
Description	5
Reproduction and dispersal	8
Origin and distribution	8
Preferred habitat	8
History as a weed	9
Overseas	9
Australia	9
Current distribution in Australia and Queensland	10
Current impact in Australia and Queensland	14
Uses	15
Pest potential in Queensland	15
Control	16
Feasibility of eradication	16
References	17

Summary

Bitou bush (*Chrysanthemoides monilifera* subspecies *rotundata*) is a perennial shrub native to South Africa. It was accidentally introduced to Australia in the early 1900s, but from 1946 to 1968 was planted quite extensively for coastal dune stabilisation following sand mining.

Today, bitou bush is one of Australia's worst weeds, being included among 20 Weeds of National Significance (WONS). Along the New South Wales coast, bitou bush dominates an estimated 80% of the coastal frontal dunes. In many places it forms pure stands that prevent the regeneration of native plant species. As a result, it is listed as a 'Key Threatening Process' under the New South Wales *Threatened Species Conservation Act 1995*.

A concerted eradication program in Queensland since 1982 (costing in excess of \$500 000) has prevented bitou bush from becoming a major problem in Queensland. Currently, its population in Queensland persists at residual levels, with small numbers of scattered plants found and destroyed each year.

Preventative control has protected at least 6600 ha of coastal dune vegetation, including tourism icons with outstanding conservation value, such as North Stradbroke Island, South Stradbroke Island, Moreton Island, Noosa National Park and the World Heritage listed Great Sandy Region (which includes Fraser Island).

This assessment concludes that bitou bush poses a high weed risk, based on the following evidence:

- It is a major pest in New South Wales (to the extent that it is a WONS and a 'Key Threatening Process').
- It is well adapted to extensive areas of coastal dunes in subtropical Queensland.

Therefore, preventative control in Queensland is readily justified.

Introduction

Identity and taxonomy

Species: *Chrysanthemoides monilifera* subspecies *rotundata* (DC.) T. Norl.

Synonym: *Osteospermum moniliferum* L.

Common name: Bitou bush

Family: Asteraceae. The Asteraceae is the largest family of flowering plants, comprising more than 23 000 species. *Chrysanthemoides* contains only two species, *C. monilifera* and *C. incana*, and is part of the Calenduleae plant tribe, flowering plants found mainly in South Africa (Wikipedia 2008a; 2008b; 2009).

Related species: There are six subspecies of *Chrysanthemoides monilifera* in South Africa (Norlindh 1943). One other subspecies, *monilifera* (boneseed), has been introduced to Australia. The latter is more erect than subspecies *rotundata*.

Description

Bitou bush is a perennial, evergreen, woody shrub. When exposed to harsh conditions on coastal frontal dunes it grows prostrate, sometimes less than 0.5 m tall (see Figure 1). However, when protected from strong winds, it is usually 2–3 m tall. Sometimes it reaches 6–8 m when climbing through other shrubs, such as coastal banksias (see Figure 2).



Figure 1. Bitou bush on frontal dunes—when subject to strong winds, the plant adopts a prostrate habit (Photo: Biosecurity Queensland).



Figure 2. Bitou bush growing among taller dune vegetation (Photo: Biosecurity Queensland).

The leaves are arranged alternately along the stems. They are bright green, 20–50 mm long, semi-succulent, oval to oblong in shape and tapering at the base. They have smooth edges.

Leaves and stems of juvenile plants are typically covered by a cottony down. The flowers are yellow, chrysanthemum-like, up to 20 mm in diameter and clustered at the ends of branches (see Figures 3 and 4). The berries have green, fleshy skin that changes to brown and black when mature (see Figure 5). Each berry contains a single egg-shaped seed, which is 5–7 mm long and dark brown to black when dry (Agriculture and Resource Management Council of Australia and New Zealand 2000; Department of the Environment and Heritage and CRC for Australian Weed Management 2003).



Figure 3. The bitou bush flower (Photo: Biosecurity Queensland).



Figure 4. Clusters of bitou bush flowers (Photo: Biosecurity Queensland).



Figure 5. Ripe fruit on a bitou bush (Photo: Biosecurity Queensland).

Reproduction and dispersal

Bitou bush reproduces from seeds. Each plant produces up to 50 000 seeds per year. In established infestations, soil seed-banks can contain up to 3500 seeds per square metre (Weiss 1984). Seed longevity is believed to be around 3 years (Weiss et al. 1998).

Most plants begin flowering when 2–3 years old. However, flowering has been recorded on plants 12 months old. Flowering can occur year-round, with a peak between April and June. Seeds are produced from June to September.

Seeds are primarily dispersed by birds, especially crows (Anderson and Whyte 2000). In south-eastern Queensland, bitou bush seedlings are often detected around camp sites, where crows tend to congregate. Seeds are reported to be spread by flowing water. Other dispersal vectors include machinery and vehicles.

Germination is stimulated by soil disturbance, fire, and ingestion by birds and other animals. Seeds can still germinate in undisturbed situations, but at a lower rate.

Vegetative reproduction occurs from adventitious buds along prostrate stems. This tends to occur most commonly after fire, slashing or sublethal herbicide application.

Bitou bush can hybridise with boneseed to produce fertile plants with an intermediate morphology (Agriculture and Resource Management Council of Australia and New Zealand 2000; Department of the Environment and Heritage and CRC for Australian Weed Management 2003; Weiss et al. 1998).

Origin and distribution

Bitou bush is native to the Cape Province and Natal in South Africa. It is strictly coastal, being restricted to the predominantly summer-rainfall region of eastern South Africa (except for a few populations inland of Durban). It has not naturalised anywhere other than Australia.

Preferred habitat

Climatically, bitou bush is adapted to humid coastal subtropical areas. These areas typically receive most rainfall during the summer months and can be relatively dry in winter. Annual average rainfall is between 1000 mm and 2000 mm per annum. Seed germination occurs at temperatures between 9.5°C and 27.5°C, with optimum germination between 21°C and 25°C (Weiss et al. 1998).

Bitou bush prefers coastal sand dune habitats, especially open frontal dunes that are subject to episodic disturbance by wind and wave action. However, while bitou bush grows prolifically on disturbed sites, disturbance is not essential; bitou bush will readily invade less-disturbed 'hind dune' habitats including eucalypt forest, banksia shrub-land and closed littoral rainforest. This study suggests that bitou bush tends to grow most prolifically on sand dunes that have formed over the last 4000 years or so, following a point in time when sea level was 1–1.5 m higher than at present (Flood 1984). As sea level fell, relatively 'young' dunes developed close to the sea. In contrast, bitou bush seems to be much less abundant and often absent from 'ancient dunes' (those formed over 100 000 years ago). These dunes

are typified by strongly leached (very infertile), bright white sand and often stunted native vegetation. Bitou bush also tends to be absent or rare in coastal wallum communities. It can grow along the edges of wetlands but does not tolerate prolonged waterlogging.

Bitou bush has a range of features that enable it to survive the harsh conditions experienced on coastal frontal dunes. Its leaves are waxy and almost succulent, an adaptation for sandblasting (in strong winds) and intense summer temperatures on exposed sand. It has extensive lateral roots to anchor itself in strong winds and to find underlying moisture. It has a poor tolerance to frost.

An intense fire can kill most bitou bush plants, whereas a cooler fire can result in resprouting. Intense fire also kills seeds in the litter and topsoil; however, it stimulates germination of much of the remaining deeper soil seed-bank (Thomas et al. 2006). Regular wildfires might be helping to keep large areas of North Stradbroke Island and Moreton Island free from bitou bush.

History as a weed

Overseas

This study was unable to find any record of bitou bush naturalising elsewhere in the world.

Australia

Bitou bush was first discovered in 1908 at Stockton, near Newcastle, New South Wales (Gray 1976). It is thought to have been introduced in ships' ballast carried from South Africa and dumped on the banks of the Hunter River. From 1946 to 1968, bitou bush was planted extensively along the New South Wales coast to stabilise coastal sand dunes following sand mining. By 2001, bitou bush had invaded 80% of the New South Wales coast (some 900 km) and was the dominant species along 400 km (Department of the Environment and Heritage and CRC for Australian Weed Management 2003; CSIRO 2007).

In Queensland, bitou bush was planted for post-mining rehabilitation in the late 1960s and early 1970s at North Stradbroke Island, South Stradbroke Island, Rainbow Beach and parts of the Gold Coast and the Sunshine Coast.

The Queensland National Parks and Wildlife Service first raised concerns about the negative environmental impact of bitou bush in the Cooloola area (Rainbow Beach) in 1979. On 7 May 1981, bitou bush was gazetted as a noxious weed under the Queensland *Stock Routes and Rural Lands Protection Act 1944*, making it illegal to sell or plant bitou bush. An eradication campaign was started in 1982. It initially focused on the Rainbow Beach area, but subsequently expanded to other locations, as additional infestations were detected (Anderson and Whyte 2000).

Current distribution in Australia and Queensland

Currently, bitou bush exists along the east coast of Australia from Tathra on the south coast of New South Wales north to the Fraser coast in south-eastern Queensland (see Figure 6). It is found along virtually the entire coast of New South Wales, with an estimated 36 000 ha infested. Small infestations occur on Lord Howe Island and near Melbourne (Department of the Environment and Heritage and CRC for Australian Weed Management 2003; Weiss et al. 1998). Populations of mixed subspecies *monilifera* and subspecies *rotundata* exist around Sydney.

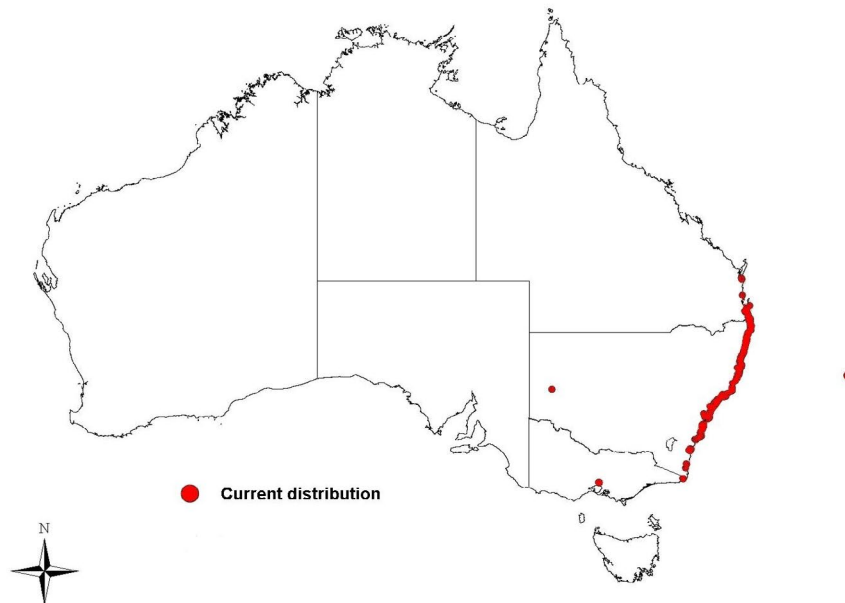


Figure 6. Current distribution of bitou bush in Australia (Source: adapted from WONS 2006).

Bitou bush has been detected at various locations in south-eastern Queensland, including the Wide Bay area (mainly Inskip Point, Rainbow Beach and the southern tip of Fraser Island), parts of the Sunshine Coast, Moreton Island, North Stradbroke Island, South Stradbroke Island, some southern Moreton Bay islands and parts of the Gold Coast (e.g. The Spit, Burleigh Head National Park and around Currumbin).

At all Queensland sites, bitou bush is the target of an ongoing eradication campaign involving methodical searches of sites at least twice each year and destruction of any plants (including seedlings). When the eradication program started (in the early 1980s), bitou bush was a dominant plant over about 53 ha on South Stradbroke Island, and about 500 ha was infested to varying degrees, as shown in Figure 7 (Anderson 1989; Anderson and Whyte 2000). This area had been mined in the 1960s and bitou bush was planted to stabilise the bare sand. Very little native vegetation had managed to colonise the site, due to the dominating effects of bitou bush. This population was initially treated with herbicide applied from a helicopter (see Figure 8) and this was followed by biannual search-and-destroy campaigns, which continue to this day. The site is currently occupied by a range of early succession native plant species (mainly coastal banksia and coastal wattle) as well as abundant ground fauna and birdlife.



Figure 7. Extensive bitou bush (the bright green plants) on South Stradbroke Island in May 1986 (Photo: Tom Anderson, Biosecurity Queensland).



Figure 8. The same area as shown in Figure 7, but with all bitou bush plants (the brown plants) destroyed by herbicide (Photo: Tom Anderson, Biosecurity Queensland).



Figure 9 A pure understorey of bitou bush (beneath rows of coastal casuarina) at Rainbow Beach in 1982 (Photo: Tom Anderson, Biosecurity Queensland).



Figure 10. The same area as shown in Figure 9 soon after the start of an eradication campaign (Photo: Tom Anderson, Biosecurity Queensland).

A large infestation detected on North Stradbroke Island around 1992 was initially targeted by a ‘SWEEP’ campaign (a short-term statewide weed-control initiative), followed by biannual search-and-destroy efforts. When the eradication program started on the island in 1992, bitou bush was well established at several locations on the island (see Figure 11). The population has since been dramatically reduced (see Figure 12).



Figure 11. Dense bitou bush on open frontal dunes at North Stradbroke Island in 1992 (Photo: Tom Anderson, Biosecurity Queensland).



Figure 12. The same site as Figure 11 after initial control of bitou bush—all brown material is dead bitou bush (Photo: Tom Anderson, Biosecurity Queensland).

Current impact in Australia and Queensland

When growing in suitable habitat, especially coastal frontal dunes, bitou bush can form extensive, pure stands. At many locations in northern New South Wales, bitou bush forms a pure understorey beneath rows of coastal she-oaks that were planted by sand miners. In conservation areas (such as national parks) that were not mined, bitou bush tends to be less extensive, often restricted to open frontal dunes and adjacent areas of coastal plant communities, and often associated with coastal banksia. However, in some places (e.g. Broken Head National Park), it invades the margins of eucalypt forest and littoral rainforest. Where it forms almost pure stands, it prevents regeneration of a suite of native plant species. It is quick to colonise any gaps created in coastal vegetation communities and probably blocks natural succession. Areas dominated by bitou bush support far fewer native animal species (vertebrates and invertebrates) than areas with native vegetation support.

Bitou bush has faster root growth and a greater total leaf area than many native species, giving it a competitive advantage. It usually becomes the dominant member of a plant community, both in Australia and within its native range in South Africa (Weiss et al. 1998).

The plant's leaves decompose faster than native vegetation, and heavy infestations modify the leaf-litter layer and microclimate, making the ground cooler, moister and darker. A study on invertebrate assemblages in areas infested by bitou bush found decreased abundance of certain orders of insects (mites, thrips, spiders, ants and centipedes) and an increase in other orders (isopods, amphipods, earthworms, millipedes and pseudoscorpions) (Lindsay and French 2006). Other ecosystem elements such as soil microflora are also affected. Nutrient cycling rates may in time be altered to favour bitou bush over native vegetation (Lindsay and French 2004).

Bitou bush may create a favourable environment for other highly invasive weeds, such as asparagus fern (*Asparagus* subspecies), lantana (*Lantana camara*) and glory lily (*Gloriosa superba*) (Department of the Environment and Heritage and CRC for Australian Weed Management 2003). Foxes and certain species of introduced birds may also benefit from shelter and food provided by bitou bush (Groves 2008).

The variety of coastal vegetation communities affected by bitou bush include sand-dune heathlands and grasslands, headland heathlands and grasslands, various coastal woodlands, dry sclerophyll forests, wet sclerophyll forests and littoral rainforests. In New South Wales, at least 158 plant species are considered at risk from bitou bush, including 68 species listed under the New South Wales *Threatened Species Conservation Act 1995*.

Three plant species populations and 26 ecological communities are also considered at risk due to bitou bush invasion (Department of Environment and Conservation 2006). In 2000, bitou bush was listed among 20 WONS, in recognition of its status as one of Australia's worst weeds (Thorp and Lynch 2000).

In the Bundjalung National Park (New South Wales), coastal banksia (*Banksia integrifolia*) and coastal wattle (*Acacia sophorae*) are dominant native shrub species in many areas of frontal dune vegetation, providing an important food source for a wide range of fauna. These species are often severely impacted by the smothering effects of bitou bush, which is almost completely replacing these and other species (Thomas et al. 2006). Such loss of native vegetation poses a threat to fauna through the loss of shelter, nesting sites and food.

Invasion by bitou bush has diminished the populations of some native birds (such as little terns, *Sterna albifrons*) and some native mammals (such as bats). Reptiles also may be affected by this invasion, due to loss of habitat (Groves 2008).

Aesthetic impacts can be significant when bitou bush forms a dense shrub layer; it can obscure entire sand dunes and convert picturesque coastal landscapes into weed infestations (Department of Environment and Conservation 2006). Such infestations have been blamed for altering dune morphology (by modifying the way strong onshore winds move and deposit sand grains). Prolific growth of bitou bush can block walking tracks and cover picnic tables.

While bitou bush is most abundant along the coastal dunes, it can persist at lower levels within the understoreys of forests and woodlands adjacent to the coastal strip. Infestations have been recorded up to 10 km inland (Department of the Environment and Heritage and CRC for Australian Weed Management 2003).

Uses

Bitou bush was originally planted for use in dune stabilisation (Department of Primary Industries and Fisheries 2007).

Pest potential in Queensland

Bitou bush has the potential to become a dominant plant of coastal sand dunes along most of southern Queensland's coastline, with much the same impact as in northern New South Wales. The computer software Climatch (Bureau of Rural Sciences 2009) was used to predict the area of Queensland where the climate is similar to the climate experienced within the species' native range (see Figure 13). This model suggests that coastal southern Queensland is most suitable and that the species is unlikely to survive in tropical areas.

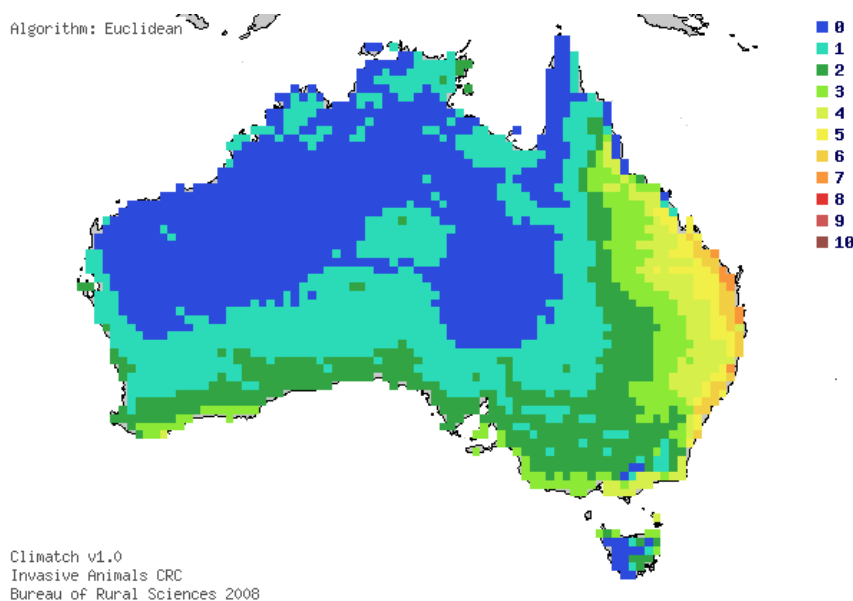


Figure 13. Areas of Australia where the climate appears suitable for survival of bitou bush: orange indicates areas where the climate is highly suitable; yellow indicates areas where the climate is marginally suitable; green and blue indicate areas where the climate is considered unsuitable.

Habitats most at risk are naturally open frontal dune systems and rocky headlands currently supporting coastal banksia, coastal wattle, coastal casuarina, coastal spinifex grass and a range of other species. Hind-dune habitats (including eucalypt forest, littoral rainforest and the margins of wetlands) are also at risk, especially those areas that are not exposed to regular wildfires. In the latter habitats, bitou bush has the potential to persist as a component of the understorey, perhaps forming localised pure stands in highly suitable habitat. If bitou bush is allowed to fill its entire eco-climatic range in Queensland, it is likely to rank as one of our worst weeds of coastal ecosystems.

Control

This study does not attempt to deal with control of bitou bush. Winkler et al. (2008) provide comprehensive information on the management of bitou bush.

Feasibility of eradication

As mentioned previously, bitou bush has been the target of an eradication campaign in Queensland since the early 1980s. Over this time, more than \$500 000 has been spent reducing the population to the point where isolated plants are currently difficult to find. At the start of the campaign, the program relied on application of herbicide, as there were substantial areas of dense bitou bush. Currently, herbicide is used much more sparingly, and many plants are removed by hand.

Eradication of bitou bush is considered to be feasible, provided all known sites of infestation are methodically searched twice per year. Using WeedSearch, a predictive model developed by Cacho and Pheloung (2007), Panetta et al. (in press) predicted that eradication of bitou bush will cost \$221 100 over 5 years (\$44 220 per year). This prediction assumes that a defined search area known to contain bitou bush is effectively searched and that the searched area is not reinvaded from surrounding areas. While theoretically feasible, eradication is generally elusive. This is due to various factors, including the difficulty of finding the last few plants and the reinvansion from plants that exist outside the area of delimitation (i.e. the search area). These factors are mentioned by Panetta et al. (in press).

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