

## Boneseed in Australia: research, management and coordinated action

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**Summary** Boneseed, *Chrysanthemoides monilifera* subsp. *monilifera* (L.) T.Norl., is an aggressive South African shrub that has invaded large areas of south-eastern Australia, where it has spread rapidly and caused serious impacts on natural ecosystems. In 2000, boneseed was listed as a Weed of National Significance (WoNS) in Australia and a nationally coordinated program began in 2005. Over the last 5 years, coordinated actions have led to increased awareness and spread prevention aimed at reducing the impact of this widespread weed in Australia. Westward spread is being prevented by eradication and containment programs, while outlier populations in the eastern states and Tasmania are prioritised for control to prevent spread and contain core infestations. Seed persistence studies and research to determine the impacts of boneseed invasions on biodiversity are underway to inform management. Education resources developed by the program are being used to increase weed awareness among young people. These activities lead to more informed, targeted management and support thousands of volunteers and land managers striving to control boneseed across Australia. This paper examines how these and other strategic actions are contributing to the success of the Australian WoNS boneseed program.

**Keywords** *Chrysanthemoides monilifera*, boneseed, Weeds of National Significance, weed management, eradication, containment.

### INTRODUCTION

The Australian Weeds of National Significance (WoNS) program began in 2000 (Thorp and Lynch 2000). This joint program, between the Australian Government and seven State and Territory Governments, facilitates cooperative weed management action to reduce the spread and impact of 20 of Australia's worst widespread weeds.

Boneseed (*Chrysanthemoides monilifera* subsp. *monilifera* (L.) T.Norl.) and bitou bush (*C.m.* subsp. *rotundata* (DC.) T.Norl.) are highly invasive South African plants that pose a major threat to natural ecosystems in Australia. Due to their capacity for rapid spread and intense impacts on natural areas, these two weeds were jointly listed as a WoNS. Bitou bush infests over 80% of the New South Wales (NSW) coastline, where

it threatens over 150 native plant species and multiple ecological communities (DEC 2006). Boneseed has a much wider distribution across large areas of Victoria, Tasmania, South Australia, and to a lesser extent NSW and Western Australia.

The WoNS program for bitou bush and boneseed began providing coordinated national action in 2005. Program direction is set by the National Bitou Bush and Boneseed Strategy (ARMCANZ 2000) and strategy implementation is overseen by the National Bitou Bush and Boneseed Management Group and a National Coordinator. This arrangement allows two-way interaction between community, local, regional, state and national partners from all affected jurisdictions and has led to cooperative ownership of long-term projects that are preventing impact and reducing spread of these weeds. The national focus and partnerships developed through the WoNS program are critical to managing widespread weeds because management must occur consistently across all boundaries and encompass all aspects, including prevention, eradication, containment, asset protection, research and education. Several key cooperative actions facilitated by the national bitou bush and boneseed program are highlighted below.

### NATIONAL BONESEED INITIATIVES

**Boneseed eradication in WA** Boneseed has the potential to invade millions of hectares in southwest Western Australia (WA) (Figure 1), a global biodiversity hotspot (Myers *et al.* 2000). Currently, boneseed is limited to 37 small (i.e. majority <1 ha) infestations. A WA boneseed eradication program began in 2007, fostered by the WoNS program. All boneseed infestations were delimited and a WA eradication strategy was written with input from all stakeholders (Cherry 2006). The strategy is being implemented and, as of January 2010, all known mature boneseed plants were extirpated. Critical to the eradication strategy is an on-going awareness program, as boneseed is largely unknown in WA and public participation is essential to uncover any remaining infestations. A 'Boneseed Blitz' awareness campaign is organised each year during flowering season, and this has led to the discovery of six new infestations. The eradication program was also an impetus for seed dynamics research (see

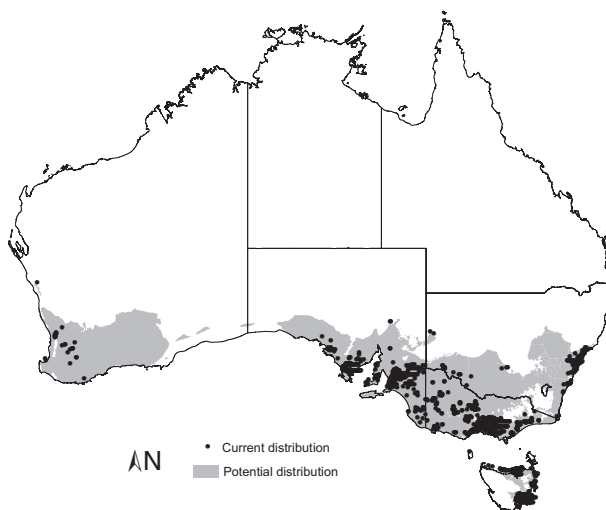
below), as information on seed persistence is needed to determine eradication program duration.

**National boneseed containment** Further boneseed invasion is being prevented in four states through strategic containment efforts initiated by the WONS program (Cherry *et al.* 2008). A national western containment line for boneseed was established in South Australia (SA) in 2006 (Figure 2) and is being implemented by two Natural Resource Management (NRM) regions. The Ten Year Boneseed Management Plan (NYNRM and EPNRM Boards 2008) outlines the containment strategy and ensures control of all boneseed west of core infestations around Adelaide, preventing further spread to SA and WA and supporting the WA eradication effort.

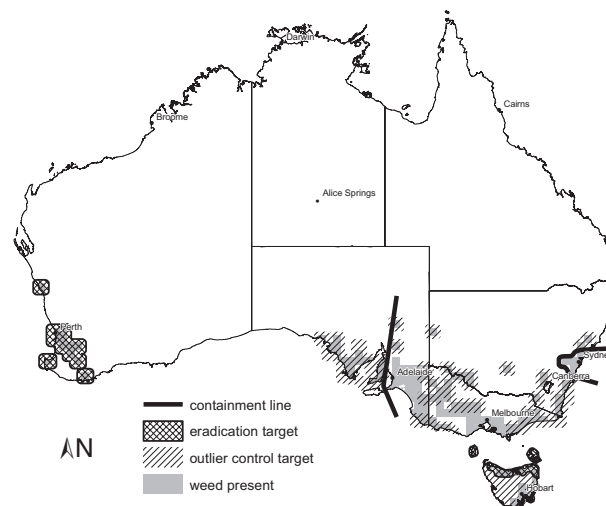
Spread is also being halted in the island state of Tasmania, where containment lines and eradication zones (Figure 3) are established and maintained by regional and local efforts and supported by the national program. Eradication is the aim in the northwest, where all boneseed has been controlled and local land managers are engaged in 3-year follow-up control contracts. In the south and northeast, all outlier populations are prioritised for control and containment lines are maintained around core infestations to prevent further spread.

In NSW, where boneseed is predicted to spread to a much greater extent (Figure 1), regional and state groups are advocating stringent legislation for boneseed that would require total suppression and eradication statewide. In addition, regional and local management plans now include boneseed as a priority target for eradication. Prior to the WoNS program, the threat of boneseed was largely underestimated in NSW. However, more efficient mapping and increased awareness has led land managers to realise the value of eradication to prevent invasions like those in neighbouring states.

**Seed research** Although boneseed and bitou bush are widespread weeds, little is known about their seed dynamics, a critical subject for informing management. In 2008, WoNS program partners initiated an 11 year seed burial study that will provide definitive information about *in-situ* seed persistence. In

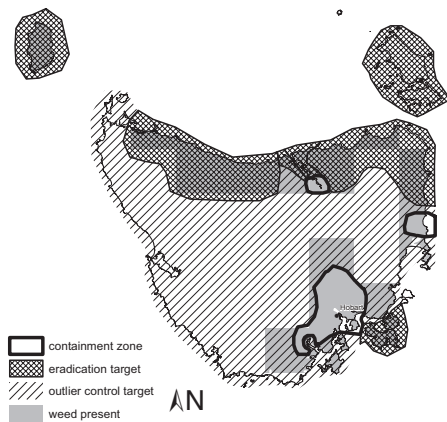


**Figure 1.** Current and potential boneseed distribution in Australia (compiled by the National Boneseed Program 2006).



**Figure 2.** Australian boneseed management actions 2009.

addition, the program sponsored a lab study to determine relative persistence of boneseed and bitou bush seeds. This study, a controlled aging test (CAT), applies moisture and temperature stress to speed up seed ageing (Long *et al.* 2008). The test, which takes only 3 months, can provide predictions of seed persistence in field conditions. The study concluded that boneseed may have a long-lived (>3 years) seed bank and bitou bush may have a transient (<1 year) seed bank, which highlights the need for subspecies-specific control



**Figure 3.** Tasmanian boneseed management actions 2009.

recommendations (Schoeman *et al.* 2010), and suggests that bitou bush seed longevity may be less than previously thought. Seed burial study results will validate the CAT study and provide further detail on seed dynamics. Results will also be used to refine eradication and monitoring programs.

**Impacts on biodiversity** Boneseed poses a threat to biodiversity by forming monocultures and replacing native vegetation (Thomas *et al.* 2005). Currently, we have little understanding of which native species are most at risk from invasion and how these vary across Australia. Scientists are working with the WoNS program to identify the suite of species most impacted by boneseed and investigate if there is an invasion threshold that results in rapid losses of biodiversity. They are sampling invaded and native reference sites in SA, Victoria and Tasmania across a range of invasion levels and assessing the capacity of seed banks to contribute to restoration after boneseed control (E. Kroggel and K. French pers. comm.). This work will provide a clear understanding of boneseed impacts on native biodiversity and identify the species most at risk from invasion. This will allow prioritisation of management efforts and ensure control and restoration activities achieve optimum biodiversity protection.

**Weeds Attack! educational resource** Raising weed awareness among young people is a key goal of the WoNS program. *Weeds Attack!* is a high-tech, interactive school education resource that uses the internet and multimedia to engage students in weed issues. *Weeds Attack!* was initiated by the bitou bush and boneseed WoNS program and was developed

in partnership with education experts to address the national science and technology curriculum. Through the use of exciting computer ‘games’, students learn about weed science principles and weed impacts to the environment and primary production. Students also investigate biological control, using bitou bush as an example, and are empowered to take action by rearing, releasing and monitoring agents in local infestations. The resource is being widely used in schools, many of which are now involved in redistributing bitou bush biocontrol agents. *Weeds Attack!* can be freely downloaded from [www.dpi.nsw.gov.au/agriculture/pests-weeds/weeds/schools](http://www.dpi.nsw.gov.au/agriculture/pests-weeds/weeds/schools)

## DISCUSSION

Widespread weed management is often costly and non-strategic as it may be undertaken piecemeal across large areas with no common goal or coordinated effort. By providing national coordination, the WoNS program ensures that local, regional, state and community efforts benefit the national good and vice-versa. Eradication and containment efforts for boneseed are providing cost-effective weed management by preventing spread and reducing boneseed distribution. These programs are often undertaken at a local or regional scale, although benefits are usually cross-regional and, sometimes, as for WA boneseed eradication, state-wide and/or national. The WA eradication program also exemplifies the value of eradication efforts for discrete, outlier populations of widespread weeds and may provide impetus for other land managers to attempt regional-scale eradication (Cherry 2009).

Containment efforts, initiated by the WoNS program following national mapping, have also led to multiple benefits. Control is targeted where spread is most likely, from nascent foci or outliers and invasion fronts. This allows limited resources to have a greater impact and, because the benefits are across jurisdictions, local and regional groups can take advantage of state and national funding. Legislative changes initiated as a result of WoNS coordination, such as efforts in NSW, and inclusion of WoNS in local, regional and state weed strategies will ensure that control and/or eradication continues to prevent boneseed from spreading from core infestations, protecting large regions of Australia from boneseed impacts.

Effective weed management recommendations rely on robust physiology and ecology data. In many cases, no such data exist even for widespread weeds like boneseed. Research enabled by the WoNS program, such as the seed studies, will inform future management. For example, the WA eradication program has a broad end-target of 10–15 years

following removal of the last reproductive individual. This target will be refined once research reveals more about seed longevity for boneseed. A more specific end-target improves understanding of the level and duration of investment needed for complete eradication and allows more efficient allocation of resources by land managers. In addition, research identifying biodiversity at risk from boneseed will allow limited funds to be directed to species or communities most at risk within core infestations.

Education initiatives such as *Weeds Attack!* are teaching the 'land managers of the future' about weed impacts and how to take action on the weed problem. Integrating weed education into school curricula provides a legacy by raising the profile of weeds and inspiring children to take future action.

A recent review of the boneseed WoNS program found that 70% of national strategy goals were achieved over the last 5 years. The review recommended continued coordination to sustain support for volunteers, foster adoption of best practice, continue the biological control program, develop biodiversity protection priorities and maintain national momentum.

The achievements outlined here would not be possible without holistic, nationally coordinated effort. Coordination prevents duplication and encourages investment by providing clear and agreed priorities for each WoNS, which are outlined in the national strategy and continually refined by national management groups. This approach ensures that investment is directed where it is most needed. The WoNS program provides a strong model for widespread weed management that encourages joint effort and information sharing to reduce weed impacts and provide long term commitment to weed management across the national landscape.

#### ACKNOWLEDGMENTS

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