

Overcoming weed eradication challenges in the Indian Ocean Territories

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Summary Parthenium weed and Siam weed are major tropical weeds targeted for eradication on Christmas Island and the Cocos (Keeling) Islands in the Indian Ocean Territories.

On Christmas Island, parthenium weed is a relatively recent incursion found at 24 mostly small infestations within or close to the settlements in the northeast of the island. Eradication treatments began in April 2008 and appear to be working, with 38% sites free of this weed for >3 years; however, viable seeds are thought to persist at some of those sites.

Siam weed has been present on the Cocos (Keeling) Islands for at least 25 years. Strategically significant infestations have been removed mechanically and by herbicide application from locations on the two inhabited islands to reduce the risk of seed spread to other parts of the island group and to the Australian mainland.

Both programs illustrate the importance of identifying and working with stakeholder groups.

Keywords Eradication, parthenium weed, *Parthenium hysterophorus*, Siam weed, *Chromolaena odorata*, Indian Ocean Territories, Christmas Island, Cocos (Keeling) Islands.

INTRODUCTION

Location The Indian Ocean Territories consist of Christmas Island and the Cocos (Keeling) Islands (abbreviated to Cocos below), which are located in the eastern Indian Ocean, southwest of Java and Sumatra and over 2000 km northwest of Western Australia. Both are located close to the Equator. Christmas Island is a small, rugged island (137 km²) 360 km south of the western tip of Java and 2650 km northwest of Perth. The Cocos group consists of two atolls made up of 27 small low coral islands (total land area approx. 14 km²) located 920 km west of Christmas Island, 900 km south of Sumatra, 2950 km northwest of Perth and 3700 km west of Darwin.

The weeds Parthenium weed (*Parthenium hysterophorus* L.: Asteraceae) is a fast growing annual herb and a Weed of National Significance (WoNS) renowned for its invasiveness, allergenic properties,

rapid seed-mediated spread, and capacity to dominate degraded pastures and disturbed open sites (Navie *et al.* 1996). Siam weed (*Chromolaena odorata* (L.) King & Robinson: Asteraceae) is a vigorous shrub noted for its rapid growth rates, its spread potential, and its ability to invade and transform a wide range of agricultural and natural situations in the tropics and subtropics. It has been the target of a nationally-funded eradication program in Far North Queensland since 1995 (DEEDI 2009). Both are declared plants targeted for eradication under WA's *Agriculture and Related Resources Protection Act 1976*.

Parthenium weed is a relatively recent (10–15 years ago) introduction to Christmas Island. Its arrival was probably associated with sea-freight containers; it does not occur on Cocos. Siam weed has been present on Home and West Islands (the only permanently inhabited islands of the Cocos group) since at least 1985. It was possibly introduced as a cultivated plant on West Island, and it was misidentified as *Eupatorium inulifolium* Kunth (Flora of Australia 1993) until collected during a Northern Australia Quarantine Strategy survey in 2000 (Anon. 2000). It was not known to occur on Christmas Island until found there in July 2010 during roadside surveillance for parthenium weed.

RESULTS

Control programs Eradication programs for parthenium weed and Siam weed are currently being delivered by the Department of Agriculture and Food Western Australia (DAFWA) under a Service Delivery Arrangement (SDA) with the Australian Government's Department of Regional Australia, Local Government, Arts and Sport. The parthenium weed program began in April 2008 and the Siam weed program in April 2010.

Parthenium weed Parthenium weed was listed as a high priority control target in a draft weed management strategy for Christmas Island (Jeffery 2005). In 2007 the national coordinator for the Parthenium Weed WoNS Program was advised of the weed's presence at six sites on the island, which led to DAFWA's

involvement with the control program, funded initially by the Parthenium Weed WoNS Program and later by the Australian Government (AG) via the SDA.

To date (May 2012) DAFWA has conducted 13 weed management visits to Christmas Island (involving one to three officers per visit), with the aims of documenting the location of all parthenium weed infestations, conducting trials to identify effective herbicides for eradication, treating and monitoring the infestations, undertaking surveillance for the weed throughout the island, and increasing awareness about the weed amongst the island's major land managers and within the community.

Delimiting surveys have confirmed that all 24 infestations are in the north-east of the island within 5 km of the settlements. Most infestations are small, covering only a few square metres, or consisting of small numbers of plants. The largest infestation (believed also to be the source of others) covers less than 2 ha. Despite extensive surveillance, no new infestations have been found since April 2009.

Herbicide trials conducted in April and July 2008 indicated that the residual herbicide sulfometuron methyl (Oust® or Mako®) diluted to 40 g per 100 litres and applied by boom spray or back-pack sprayer provided a rapid knock-down combined with 6–8 weeks soil residual activity that inhibited germination. By May 2012 live parthenium weed plants were found at only three of the 24 known sites, and nine of the 24 sites had remained free of live plants for >3 years. The persistence of parthenium weed seeds under the prevailing environmental conditions (high soil temperatures, seasonally high moisture content, highly calcareous free-draining soils and heavy monsoonal rainfall) is unknown.

Siam weed The AG approached DAFWA to undertake the Siam weed program on Cocos following the progress made with parthenium weed control on Christmas Island.

Extensive infestations of Siam weed occurred on both Home Island (total area 0.95 km²) and West Island (area 6.23 km²), due largely to the islands' high level of disturbance associated with the replacement of the original plant cover with coconut plantations, and the construction and maintenance of buildings, roads, runways, ports and other infrastructure.

A total of six visits have been made to Cocos to date, involving one to three DAFWA officers each time. The initial visit in April 2010 documented the extent of the infestations and allowed a strategic eradication program to be devised. The aim of the eradication program was to prevent further spread of Siam weed seeds to other parts of the island group,

and to the Australian mainland. This involved the removal of all mature, seeding Siam weed plants from the Home Island settlement, and from high-risk sites on West Island, including the airport, the settlement and the port facilities.

By April 2012, the amount of Siam weed on Home Island had been reduced significantly, with over 90% of plants removed, including all adult plants; the only plants remaining were seedlings and juveniles and these had not begun seeding. In June 2011 a Siam weed seed monitoring site was established to determine the persistence of Siam weed seed after the removal of all adult plants. The trial continues to be monitored and the trend shows a rapid decrease in Siam weed germination after removal of all adult plants. On West Island, the number of mature plants at high risk sites including the port facilities, settlement and the area adjacent to the airstrip has been reduced.

The actual control work was undertaken by DAFWA officers who were assisted by a team of up to 12 Cocos islanders who received training in weed control techniques, safe handling of herbicides and related skills as part of the Siam weed control program. In April 2011 DAFWA appointed a member of the local community as a leading hand, who received additional training and skills development in leading the team and monitoring and evaluating the control work conducted. Control measures on Home and West islands were influenced by the presence of lenses of fresh groundwater that are the islands' main sources of drinking water; consequently, it was decided not to use any herbicides over these water lenses. Instead, mechanical control measures (grubbing, slashing and scraping) were used. Elsewhere on Cocos, glyphosate was used after being found to be remarkably effective against Siam weed.

Surveillance The delimitation survey for parthenium weed on Christmas Island involved inspection of high-risk sites, trace-forward to sites associated with known sites, and systematic searching of the island's road system. Roadside surveillance involved stopping the vehicle every 500 m or 1000 m then searching both sides of the road for 60–80 m in front of and behind the parked vehicle. Despite searching some 100 roadside and high-risk sites over most of the island, no further parthenium infestations were found, indicating that this weed has not spread beyond the settlements.

During roadside surveillance for parthenium weed on Christmas Island in mid-2010 a single well-established infestation of Siam weed was found. This was a significant find because this weed had not been recorded previously on the island. The nearest infestations of Siam weed are in Java (about 360 km

north of Christmas Island) and on Cocos (900 km west).

Most of the islands of the Cocos group have been inspected for Siam weed without any being detected, indicating that the weed has not spread beyond Home and West islands.

Land-use and stakeholders: Christmas Island

The dominant types of land use are National Park (63% of land area), Vacant Crown Land (19%) and phosphate mine leases (12%) (Jeffery 2005). Over 105 km² of the island (77%) is relatively undisturbed native vegetation dominated by rain forest. The rest of the area comprises residential, industrial, transport and other uses. Apart from one small market garden, no land is used for agricultural production. The island's main land managers are Parks Australia, Christmas Island Phosphates and the Shire of Christmas Island. Permanent residents total 1400.

Land-use and stakeholders: Cocos North Keeling Island (8% of land area) is a National Park that retains much of its original forest cover. The remaining islands have been cleared and their vegetation now consists of coconut plantations with some shrubby regrowth (Flora of Australia 1993). Port, airport and communications infrastructure, roads, residential development, and a disused chicken farm and quarantine station are on the southern atoll. Major land managers are the Shire of Cocos (Keeling) Islands, Parks Australia, and the 600 local residents. There is no agricultural activity apart from small food gardens.

DISCUSSION

The difficulties presented by the islands' geographical isolation were largely overcome by building partnerships at both locations; for example, Parks Australia willingly lent a spray vehicle and other equipment for use on Christmas Island. On Cocos, the relationship with the Indian Ocean Group Training Association (a training provider that also assists with employment opportunities for local residents) enabled a team of Cocos residents to be trained in weed control, which benefited the program, as well as providing paid employment.

Environmental conditions at both locations are markedly different from those on mainland Australia where the target weeds occur. Parthenium weed on Christmas Island grows under a tropical monsoonal climate in free draining, highly alkaline, phosphate rich soils that are quite different from the conditions in the rangeland and cropping areas of southern Queensland where this weed is prevalent. It was necessary to identify herbicides to use on parthenium weed that were appropriate for Christmas Island conditions.

Siam weed on Cocos appears to be less vigorous and of lower seed persistence than on mainland Australia and elsewhere (including Christmas Island). This is probably due to the extremely poor soils on Cocos, which are infertile coral sands. The ease of mechanical removal of Siam weed plants and the lack of seedling recruitment on Cocos have also contributed to the program's progress.

At both locations there is limited recognition by residents of the potential impacts of parthenium weed and Siam weed, despite the weeds' high profiles (on mainland Australia) as a Weed of National Significance and a nationally-funded eradication target, respectively.

For parthenium weed, the weed's inability to invade closed forests and the absence of agricultural activity on Christmas Island means that this weed is not a threat to the National Park or to agriculture; its main impact is on human health, through allergies and dermatitis. It was hard to raise interest in eradicating parthenium weed when the two main land managers were not impacted by it. Moreover, several other major biosecurity and conservation matters are currently affecting the island, especially managing the ecosystem-altering impact of Yellow crazy ants (*Anoplolepis gracilipes*) and conserving the remarkably large number of endemic plant and animal species and other rare or endangered species (Christmas Island National Park 2002).

On Cocos, Siam weed is not viewed as causing economic or environmental impacts, since the coconut plantations are not being managed for economic production. Roadsides, and areas around the airstrip, are slashed and mowed to control general vegetation regrowth, rather than for Siam weed control alone. The immediate benefit of eliminating Siam weed was to prevent its spread to the National Park on North Keeling Island, to other parts of the Cocos island group and to the Australian mainland.

Two other factors might contribute to Siam weed lacking a weed profile amongst Cocos residents. It is suggested that it was introduced for cultivation on West Island (Flora of Australia 1996) in which case it might be considered locally as an ornamental, rather than as a weed. In addition, a closely related and morphologically very similar native plant (*Melanthera biflora* (L.) Wild: Asteraceae, the sea daisy) is found on Cocos. Siam weed could easily have been mistaken for *M. biflora* (except when flowering) masking the weed's spread on Home and West Islands.

On Christmas Island the recent discovery of one population of Siam weed is of direct concern to Parks Australia because of this weed's potential to invade open forests and plantations (Navie *et al.* 1996).

Open forests are found on certain parts of the island (Christmas Island National Park 2002), while the plantation-like character of mine rehabilitation sites, where native tree seedlings are planted at wide spacing, present an ideal habitat for Siam weed invasion. Parks Australia officers are now actively involved with eradicating this infestation, monitoring the site and searching for infestations as part of their island-wide surveillance activities.

Extension activities at both locations included talks to community groups and schools, articles in local community newsletters, and the distribution of multilingual posters and pamphlets. As a result of this there is an increased awareness about these weeds. On Christmas Island this is evidenced by the reporting of parthenium weed infestations in the school grounds following a talk at the school, while on Cocos the eradication activities carried out by DAFWA staff and the local Weed Control Team and the associated publicity have encouraged other residents to start hand pulling Siam weed seedlings voluntarily.

The islands' local governments are also important stakeholders, especially as they are involved with vegetation management activities such as roadside mowing and slashing that have the potential to spread seeds of these weeds. On Christmas Island the Shire is cooperating by using herbicides rather than slashing to control roadside plant growth along parthenium-infested sections of certain roads, to prevent seed spread.

The future for both eradication programs looks positive. Effective eradication measures have been developed that are relevant to each location, and which can be used with confidence. There is also increasing involvement by local land managers, even though these weeds do not directly affect most of their particular interests. A measure of success for the program will be if the eradication programs can be delivered by locally based stakeholders, without the frequent in-person involvement of DAFWA officers as at present.

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