Chasing the lion's tail. The value of program review: a case study from the management of *Leonotis nepetifolia* (L.) R.Br. in Rinyirru (Lakefield) National Park

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Summary The annual herb *Leonotis nepetifolia* (lion's tail) has been present in Rinyirru (Lakefield) National Park on Cape York Peninsula since at least the early- to mid-1980s and has been the target of control action for at least 17 years. A review of the program was conducted in 2010. The program is notable for the sustained effort that has been made but the review concluded that eradication was unlikely without some modification of the approach. There was a need for improved delimitation and a shift in where efforts were concentrated. A five-year plan was devised with the aim of eliminating three small outlying infestations whilst containing two larger infestations in the short term. Subsequently, capacity and approach to eliminate the main infestations could be determined.

Keywords Containment, eradication, review, lion's tail, *Leonotis nepetifolia.*

INTRODUCTION

Monitoring and review of progress towards predefined objectives are vital, yet often neglected, parts of weed management programs. The national cost-shared eradication program targeting Siam weed (*Chromolaena odorata* (L.) R.M.King & H.Rob.) is a notable exception. This program has been subject to several reviews by experienced weed scientists external to the control program. The program, which began in 1994, was reviewed in 2003, 2008 and 2011 (M. Jeffrey, pers. comm.). Whilst not suggesting this intensity of review and the associated costs can be justified for all weed control programs, we show, by reference to a recent review of a long running control program targeting lion's tail (*Leonotis nepetifolia* (L.) R.Br.) in Rinyirru (Lakefield) National Park (RLNP), how any program, particularly one extending over many years, can benefit greatly from periodic review.

Lion's tail is native to Africa but now has a pan-tropical distribution. It was probably introduced to Australia as an ornamental. Naturalised plants are known from a number of widely scattered localities across Queensland and the Northern Territory. Formal weed risk assessments indicate that it poses a serious risk (PIER 2001, Gordon *et al*. 2008). It is commonly included in Australian weed handbooks (Parsons and Cuthbertson 2001, Smith 2011) and was included by Csurhes and Edwards (1998) as a candidate species for preventative control in their list of potential environmental weeds in Australia. Although declared a Class B weed under Northern Territory legislation (NRETAS 2012), lion's tail is not declared in Queensland, nor is it currently being considered for declaration there (Steve Csurhes pers. comm.). It is however, listed as a high priority pest in the Cape York Peninsula Pest Management Plan 2006–2011 (Cape York Weeds and Feral Animals Program 2007). The plan advocates its eradication from Cape York Peninsula. This is consistent with the approach initially adopted by Queensland Parks and Wildlife Service (QPWS).

MATERIALS AND METHODS

History of introduction The earliest Queensland Herbarium record of lion's tail in RLNP dates from 1998. However, the plant is known to have been present for several years before this specimen was collected. (QPWS File Reference 213235).

History of control action Control of the species on RLNP began about 1996 and some work has been undertaken each year since then. Initial control efforts were herbicide-based and used glyphosate applied with a hand gun at a rate of 1:100. Some time before or about the 2001/02 wet season, fire was deliberately introduced into the program. Once the minor use permit (PER 3601) for the use of Grazon DS™ (picloram (100 g L^{-1}) + triclopyr (330 g L^{-1})) for the control of lion's tail on Cape York Peninsula was obtained in 2000, this replaced glyphosate as the herbicide of choice. Brushoff™ or Associate™ (metsulfuron-methyl (600 g kg^{-1})) has been used at times, sometimes mixed with formulations of Grazon™. Though the reasons for using this mixture were not recorded, operational staff relate it to a perceived need for a residual effect

of the treatment. The general impression of staff is that Grazon™ alone is an adequate and effective herbicide treatment.

The annual control effort begins in early December, before the onset of the monsoon rains. Each year, a team of up to 20 or more staff is drawn from other parks in the Cape York/Savanna region and/or local indigenous groups. Participants bring with them equipment to augment that available on RLNP and undertake intensive herbicide spraying for a week, or more recently, two weeks. Total areas in excess of 200 ha have been covered by these 'task forces'. Rangers based at RLNP are then expected to carry out necessary follow up work throughout the wet season when road closures, due to flooding, prevent access to the park.

There were attempts in 2008–09 and 2009–10 to focus control operations to ensure seeding was prevented in defined areas but this does not appear to have been adopted as the routine approach in subsequent years.

Since 2000, planned burns have been conducted after the first storms of the wet season as part of the control operations. The actual time of planned burning thus varied from year to year. Lion's tail infested areas have been burnt for two reasons: (i) to kill lion's tail plants that had germinated after the rains, and (ii) to reduce the cover of ground vegetation and so make lion's tail plants that germinate after the fire more visible.

Aerial culling of pigs has been incorporated into the control program since 2004 because it was thought that they may promote the spread and establishment of lion's tail.

THE REVIEW

Review panel On the recommendation of one of us (JC), a review of the lion's tail control program was conducted in 2010. The review team comprised weed ecologists selected for their interest and expertise in key areas related to the program. Three of the four reviewers were employed by agencies other than QPWS. Tony Grice (CSIRO, Townsville) was invited to participate because of his interest in developing containment strategies for a range of plant types, Dane Panetta (Biosecurity Queensland, Brisbane) for his experience in eradication programs and Wayne Vogler (Biosecurity Queensland, Charters Towers) for his expertise in weeds in tropical savannas. The review was facilitated by John Clarkson from QPWS. The panel visited RLNP from the 7–11 June 2010.

Major findings The program against lion's tail in RLNP is notable for the sustained effort and the dedication and hard work of staff who work in what can be difficult and trying conditions. Funding for the program has also been maintained in the face of many competing demands. However, the review highlighted a number of areas where improvements were possible.

The review could find no single documented control plan with clearly articulated objectives and methods. The objective of the control action was initially eradication from the RLNP but around 2007 the purpose appears to have shifted to containment to the then known distribution. The frequent changes of personnel at RLNP have made it difficult to maintain a coherent and consistent program and the objectives and methodologies of the program have not always been communicated effectively to incoming staff.

Each year, plants missed by the initial spray treatments are often fruiting before follow up treatment or are not followed up at all. These plants are contributing to the perpetuation of the soil seed bank. The 'task force' approach has probably contributed to this because the staff permanently based on RLNP is not large enough to revisit the area covered by the bigger teams brought in for the first big effort of the year. Flooding and boggy conditions which can prevent access to some areas at this time of the year further compound this problem.

Fires for the management of lion's tail have been conducted at any time between October and January. However, other than for small areas where annual fires are used to protect infrastructure, it would be unlikely for a planned burning strategy for any tropical savanna area to call for annual burning such as that being used in the lion's tail control program on RLNP. The core area has been burnt every year for at least 10 years. The general weediness and poor condition observed in this area could be partly attributed to frequent burning. Although small plants are obviously affected by fire, there is no evidence to suggest that all plants subsequently die— nor could evidence be found of an attempt to determine if they do. Some plants could conceivably survive to flower and fruit. Given that this is one of the primary reasons for burning in the first place, field observations to confirm the responses of plants of different ages to fire is warranted.

When the control program began there was a lack of basic information on the biology of lion's tail. This includes such factors as seed dormancy, longevity, germination and dispersal. While several staff members have attempted to gather this information over the years, the review failed to locate the raw data, or any indication that the findings had been used to inform the control program. Such data are critical to any successful control operation.

Although lion's tail is listed as a priority pest in the Cape York Peninsula Pest Management Plan and this plan advocates eradication from Cape York

Peninsula as the goal for this species, no sustained control work is being carried out anywhere other than RLNP. Populations in the northern peninsula area occur at sites which are often visited by tourists who commonly include RLNP in their travels. The risk of reinfestation from this source by persons intentionally carrying plant material is ever present.

Major recommendations The review concluded that eradication was unlikely without some modification of the approach. A number of modifications were suggested and outlined in a report to QPWS (Clarkson *et al*. 2010).

The report recommended that a five-year weed management plan be prepared with clearly defined objectives for the overall population and for individual infestations. The plan should cover areas of responsibility, time-lines, reporting, communication and resources required. It was suggested that a single individual should be given prime responsibility for driving the plan and that the plan should be reviewed annually, with a comprehensive review at the end of the five-year period. Monitoring data collected as part of the implementation of the plan should be considered during the review process. This will allow progress against objectives and targets to be judged. There should also be scope within the plan to modify what is done in response to the annual reviews. Such an approach should insure against problems associated with frequent staff turnover.

A number of discrete infestations have been broadly defined using currently available data. The review recommended that each of these infestations be mapped as reliably as possible to enable the areas to be targeted for control actions to be clearly defined. Each known infestation should again be delimited at the end of this five-year plan.

The current method of treating lion's tail with herbicide kills a very high proportion of treated plants. Alternative herbicide treatments should be explored either to find a method that has a higher kill-rate, to lower off-target damage or to reduce the costs of herbicide treatment. This would also provide some insurance against the possibility of developing herbicide resistance from prolonged use of a single class of herbicide.

The report recommended that efforts aimed at eradication should focus on outlying infestations. These are the smallest populations in RLNP and are clearly separated from the main infestations. It may be unreasonable to expect to achieve eradication of these populations within the five years of the plan but the information collected during the program should help determine the likelihood of success of a diligent eradication attempt against this species. Eradication of an annual plant like lion's tail will be achieved if seed production is prevented within the area targeted for eradication and there is no seed input from outside the target area. The time taken to eradicate an infestation will depend on the longevity of the seed bank and the effectiveness of the program in preventing seed production and immigration.

The review recommended targeting the two largest infestations of lion's tail on RLNP for containment during this five-year plan. Containment is defined as a deliberate action taken to prevent establishment and reproduction of a species beyond a predefined area (Grice *et al*. 2012). The approach recommended was based on the concept of a carefully defined containment unit that consists of an 'occupied zone', a 'buffer zone' and an 'unoccupied zone' (Grice *et al*. 2010). It would be necessary to first define the two containment units. Given that the species' dispersal distances have not been rigorously quantified, it was necessary to make some assumptions about that aspect of the plant's ecology. It was assumed that seeds disperse a maximum of 100 m from the parent plant. This value is precautionary, though it does not address long distance dispersal. The value can be adjusted as knowledge of the species' dispersal capacity improves. The buffer zone around each major infestation would consist of a 100 m wide strip. To contain each of these infestations it will be necessary to prevent seed production within their respective buffer zones. It should be noted that the area treated in this way will be substantially less than the total area which has been treated annually in control operations to date.

As the control techniques that have been developed and applied at RLNP seem effective and appropriate for this situation, the review recommended that they be used until demonstrably better techniques are identified with priority given to eradication targets and the buffer zones of containment targets. Only when these have been effectively treated should effort be directed at the 'occupied zones' of containment targets and that effort should be concentrated on outermost parts of these zones working inwards. It is better to treat the outer parts of this zone comprehensively than a larger area less effectively.

The review highlighted the importance of monitoring the progress made and the need for an annual review of the plan involving those staff who are practically involved, those who are managing the program and appropriate experts. These annual reviews should identify any problems involved and use information collected to assess progress. Toward the end of the five-year program all infestations should again be delimited. The five-year review should take these

data and assess the overall impact of the program and determine the most appropriate objectives for a second five-year plan, should further work be deemed appropriate. Some suggested elements of a monitoring program were provided in the report. This stressed the importance of someone keeping a detailed diary of lion's tail control activities in RLNP

The recommendations made in the report were based on imperfect knowledge of the biology and ecology of lion's tail and of its distribution and abundance in RLNP. A better knowledge of lion's tail would allow a refinement of the weed management plan. The critical knowledge gaps were identified as longevity of the seed bank, dispersal methods, frequency and mechanisms of long distance dispersal, determinants of distribution and abundance, the plant's response to fire, and herbicide efficacy in particular the effect of herbicide application on immature seed.

CONCLUSIONS

The review of the lion's tail program at RLNP clearly demonstrates the value of subjecting control programs to periodic review. This is particularly important for long-running programs where the primary objective may become lost in the routine of day to day control operations. It becomes even more important when staff turnover is high. When resources are limited and many projects are competing for funds, it can provide the rationale for sustaining funding for a project. Since the completion of this review there have been several requests from staff of other national parks in far north Queensland for assistance in reviewing their weed and feral animal programs.

ACKNOWLEDGMENTS

The authors acknowledge the valuable contribution of the following staff or former staff of Queensland Parks and Wildlife Service to the review: Marty McLaughlin, Chris Kinnaird, Carly Greig, Andrew Francis and Andrew Colvill. Sarah Jess, Ranger-in-Charge of RLNP, and her staff Barry Liddie, Carly Smith and Joe Jess are particularly thanked for their patience, cooperation and support. It is not easy having one of your control programs subject to such intense scrutiny.

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