Pushing 37 weed species towards extinction in Queensland

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Summary After many years of concerted effort by state and local government staff, 21 species of high-risk emerging weeds appear to have been eradicated in Queensland, with another 16 tantalisingly close to eradication – a total of 37. The probability of eradication for an additional 12 species is less certain, while eradication efforts have been abandoned for another nine. High-risk targets include a range of species that are notorious problems overseas or interstate. Data have been collected and analysed to estimate likely duration and cost of eradication. The challenge is to maintain pressure on target populations and to prevent additional incursions.

Keywords Eradication, invasive plant.

INTRODUCTION

Early detection and eradication of potentially high-risk weed species is a worthy goal somewhat analogous to the early detection and removal of skin cancer. Once widely naturalised, pest populations become highly resilient and impossible to eradicate.

In the mid-1990s, a range of high-risk weed species known to have major negative impacts overseas or interstate were pre-emptively targeted for exclusion, prohibition on sale and early detection, while they were still absent from Queensland. Species were selected based on a review of the world's worst weeds by Csurhes (internal report, 1991). A key objective was to prevent entry and minimise propagule pressure, primarily by removing the commercial incentive to sell these species as garden ornamentals (this being the primary invasion pathway for at least 80% of species). High-risk targets include most non-native species of *Acacia/Vachellia/Acaciella*, including *V. karroo* (Hayne) Banfi & Glasso (Figure 1), all species of horsetails (*Equisetum* spp.), bitou bush (*Chrysanthemoides monilifera* subsp. *rotundata* (DC.) Norl.), non-native species of witchweed (*Striga* spp.) and

Figure 1. *Vachellia karroo* (Karroo thorn) detected on the Darling Downs, Queensland.

tropical soda apple (*Solanum viarum* Dunal). Weed risk assessments for these species are available at DAF (2018).

The primary aim of this paper is to outline progress towards early detection and eradication of high-risk weed species in Queensland.

METHODS

Data collection and analysis Since the mid 1990s suspect specimens of high-risk targets have been routinely sent to the Queensland Herbarium for positive identification. Whenever detection of a high-risk target was confirmed, eradication efforts commenced and field-staff began recording the species' location and status. Data on the species' full geographic extent was recorded, a process known as 'delimitation', often in parallel with on-ground eradication works. Over the years, as more species were detected, the list of eradication targets expanded. Data were periodically analysed, in 2009 and 2015, using a model called 'Weed-Search' developed by the University of New England (Cacho and Pheloung 2007), to assess the cost and duration of eradication (Panetta *et al*. 2011, Csurhes, internal report 2016). The model requires 24 input parameters, including the number of infested sites, estimated average plant density, search area, detectability, and a range of biological parameters such as seed longevity. Total search area is the primary factor that determines eradication cost. Modelling provides decision-makers with evidence-based information on likely cost and duration of eradication projects.

RESULTS

Eradication targets While pre-emptive restrictions on entry and sale at a state-level have prevented or delayed naturalisation of many high-risk taxa, 59 such targets have been detected in Queensland since the mid-1990s. Detections include isolated cultivated specimens as well as naturalised populations of varying size (area) and density. These 59 species can be placed into six broad categories: (1) cultivated specimens believed to have been eradicated (15 species); (2) naturalised populations believed to have been eradicated (6 species); (3) naturalised populations that appear to be declining and on-track for eradication (16 species); (4) naturalised populations that are proving resilient with a high level of uncertainty associated with eradication (12 species); (5) naturalised populations that were targeted for eradication for many years but subsequently transitioned to containment and ongoing management (9 species); and (6) unassessed species (1 species) (Table 1). Search areas have been estimated for each species, assuming that a 'search buffer' with a radius of at least 200 m needs to be routinely searched around each detection site.

DISCUSSION

Thirty seven weed species have either been eradicated or are 'on track' for eradication in Queensland. This paper acknowledges that 15 species were still restricted to gardens, at the time of detection, and argues that these are true examples of early detection. Eradication of naturalised populations is much more challenging and claiming success is fraught with uncertainty, due primarily to the difficulty associated with delimitation, ongoing incursions, detectability of the last few individuals in a population and the prolonged time required to exhaust soil-seed-banks. Species believed to have been eradicated are species that have not been seen for many years, despite follow-up surveillance. Species 'on-track' for eradication continue to be detected at low levels but with declining abundance. Eradication appears feasible for these species, particularly for those with small search areas, provided current surveillance and control efforts are maintained and provided additional 'outlier' populations are not detected. An additional 12 species continue to be targets for eradication, but carry a high level of uncertainty regarding feasibility of eradication. These species possess traits that make eradication particularly challenging, such as large search areas and multiple invasion sites, poor detectability, poor kill-rates, or inadequate delimitation following initial detection (and hence a low level of confidence regarding population size and extent). The policy objective for these species will be reviewed periodically.

Analysis of successful eradication programs from around the world provides evidence that, for eradication to be successful, the search area involved needs to be small, almost always less than 1000 ha and often only a few hectares (Waldendorp and Bomford 2004). Cost increases dramatically as search area increases. Based on an analysis of eradication programs undertaken by the California Department of Food and Agriculture, comprising 16 species and 50 infestations, Rejmánek and Pitcairn (2002) concluded that for infestations less than 1 ha in size, eradication was almost always possible; for infestations between 1 and 100 ha, approximately 30% were successfully eradicated; and for infestations between 100 and 1000 ha, only about 25% of eradication attempts were successful. Application of the Weed-Search model for eradication targets listed here produced similar results. For example, it predicted that eradication of *Vachellia robusta* (Burch.) Kyal. & Boatwr. listed as a category 1 species in Table 1, and with a total search area of 12 ha, is likely to cost $79,500 over 21 years. Eradication of *Vachellia karroo* (Karroo thorn), a category

Table 1. List of weed species that have been or are currently being pursued for eradication in Queensland (1 = cultivated specimens believed eradicated, 2 = naturalised population believed eradicated, 3 = naturalised population declining and 'on track' for eradication, 4 = eradication being pursued but success highly uncertain, 5 = species no longer being eradicated and 6 = unassessed species) (*species continues to be regularly detected in cultivation).

Species	Search area (ha)	Category
Austrocylindropuntia subulata (Eve's pin cactus)	12*	1
Cecropia pachystachya	12	1
Equisetum hyemale (horsetail)	12	1
Nassella tenuissima (Mexican feather grass)	46	1
Opuntia microdasys (bunny ears cactus)	n/a*	1
Opuntia robusta (wheel cactus)	12	1
Opuntia rufida (blind cactus)	24*	1
Opuntia santarita (Santa Rita prickly pear)	12	1
Prosopis laevigata (smooth mesquite)	12	1
Salix alba var. *alba* (white willow)	12	1
Senegalia nigrescens (knob thorn)	12	1
Senegalia chundra (syn. *Acacia catechu* var. *chundra*)	12	1
Vachellia gerrardii (grey-haired acacia)	12	1
Vachellia robusta (syn. *Acacia robusta* subsp. *clavigera*)	12	1
Vachellia xanthophloea (syn. *Acacia xanthophloea*) (yellow fever tree)	24	1
Chromolaena squalida	12	2
Miconia cionotricha	12	2
Opuntia elatior (red-flowered prickly pear)	12	2
Salix cinerea (grey willow)	12	2
Salix nigra (black willow)	38	2
Ulex europaeus (gorse)	25	2
Chrysanthemoides monilifera (bitou bush)	460	3
Cylindropuntia prolifera (jumping cholla)	>250	3
Helenium amarum (bitterweed)	150	3
Heterotheca grandiflora (telegraph weed)	>250	3
Limnocharis flava (limnocharis)	48	3
Miconia calvescens (miconia)	6,224	3
Miconia nervosa	190	3
Miconia racemosa	236	3
Mikania micrantha (mikania)	427	3
Mimosa pigra (giant sensitive tree)	1,000	3
Opuntia leucotricha (Aaron's beard cactus)	62	3
Opuntia puberula (puberula cactus)	25	3
Pithecellobium dulce (Madras thorn)	425	3
Solanum viarum (tropical soda apple)	867	3
Striga asiatica (red witchweed)	439	3
Vachellia karroo (syn. *Acacia karroo*) (Karroo thorn)	25	3
Acaciella angustissima (white-ball acacia)	375	4
Acaciella glauca (red wood)	192	4
Cecropia peltata complex (Mexican bean tree)	800	4
Cylindropuntia pallida (Hudson pear)	842	4
Cylindropuntia tunicata	>500	4
Gleditsia triacanthos (honey locust tree)	62,600	4
Gmelina elliptica (badhara bush)	871	4
Neptunia plena and *N. oleracea* (water mimosa)	>250*	4
Opuntia elata (Riverina pear)	600	4
Opuntia sulphurea (sulphur cactus)	2012	4
Senegalia insuavis (syn. *Acacia pennata* (cha-om)	125*	4
Senegalia rugata (syn. *Acacia concinna*) (soap pod)	138	4
Alternanthera philoxeroides (alligator weed)	>1,000	5
Asparagus asparagoides (bridal creeper)	>1,512*	5
Chromolaena odorata (Siam weed)	>1,000	5
Clidemia hirta (Koster's curse)	>1,000	5
Gymnocoronis spilanthoides (Senegal tea plant)	>1,000	5
Hedychium flavescens (white/yellow ginger)	>549*	5
Hygrophila costata (hygrophila)	>1,000	5
Nassella neesiana (Chilean needle grass)	>14,000	5
Thunbergia fragrans	>500*	5
Striga angustifolia (white witchweed)	not assessed	6

3 species with a search area of 25 ha, is estimated to cost $178,600 over 27 years. However, eradication of *Acaciella angustissima* (Mill.) Brit. & Rose (white-ball acacia), a category 4 species with a total search area of 338 ha (involving 27 separate locations) is estimated to cost $2,632,500 over 34 years. Hence, early detection while populations are very small is highly desirable.

Long timeframes are a common feature of eradication programs, primarily due to long-lived seed banks. This demands years of dedication and perseverance by field staff and partner agencies.

Surveillance for all targets will be on-going, as the risk of re-introduction and undetected incursions remains. A range of traditional and novel surveillance techniques are being applied, including the use of strategically positioned sentinel sites, the volunteer-based 'Weed Spotter Network Queensland' (coordinated by Melinda Laidlaw from the Queensland Herbarium), drones and, potentially, use of eDNA. By using novel techniques, the goal is to achieve detection much earlier than has tended to occur in the past, thereby improving the probability of eradication and reducing cost.

CONCLUSION

Eradication of high-risk invasive plant species from the state is a realistic objective, provided targets can be detected very early in the invasion process. Even so-called 'failed' eradication efforts have achieved significant reductions in population sizes and spread rates and it seems reasonable to assume that such reductions are likely to have generated benefits that exceed costs. Despite this, eradication targets need to be carefully selected to maximise the chances of a lasting outcome and to generate strong returns on investment.

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