Containment as a strategy for tackling contentious plants

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Summary Contentions arise over plant species that are valued for their productive potential but which are also a threat to other industries or natural environments. 'Containment' is potentially a valid strategic goal for such species but we contend that often it will not be feasible. Feasibility is influenced by the characteristics of the targeted plant species, the landscapes within which they are grown and the management and social systems of which they are a part. Reversing breaches of a containment unit requires local eradication. The scale at which containment is attempted and the location of 'containment lines' are particularly critical in making containment a viable option in the management of weeds in general and contentious plants in particular.

Keywords Containment, contentious plants.

INTRODUCTION

Containment involves actively restricting where a species grows (Standards Australia/Standards New Zealand/CRC for Australian Weed Management 2006) so that it does not occupy all available habitat within its potential range as determined by climatic, edaphic or other environmental factors. It is frequently advocated as a strategic option for pest plants when eradication is deemed impossible, the implicit assumption being that it is more feasible than eradication. Typically, containment targets are species that are recognised in legislation as being weeds. Containment strategies are devised at the scale of the species' distribution, containment lines being drawn to separate the current range from the currently unoccupied potential range (e.g. the national strategy for rubber vine *Cryptostegia grandiflora* (Roxb.) R.Br.; ARMCANZ, ANZECCFM 2001). Containment could also be a strategy appropriate to species that are deemed useful in cultivation but problematic when they naturalise and spread.

In this paper we consider the challenges of containing commercially valued, problematic plant species and how those challenges might be met.

THE CHALLENGE OF CONTAINMENT

Defining containment targets Containment must be targeted at individual species and particular areas. Species will vary greatly in how readily they can be contained due to differences in growth form and phenological patterns, mode of reproduction, reproductive output, dispersal mechanisms and the patterns that arise from them, seed-bank size and longevity, temporal and spatial patterns of recruitment and generation time (Grice 2006). Containment is a difficult prospect for species that have a high reproductive output, a capacity for long distance dispersal and high recruitment probabilities (Table 1).

The pre-eminent feature of containment as a strategy is that it relates to specific areas and scales. 'Containment units' could consist of individual infestations or the entire current range of the species on a continent to which it has been introduced. How a 'containment unit' is delineated will strongly influence containment feasibility and the costs and benefits associated with the actions that are taken.

Landscape and management factors The landscape context of any invasion is critical to its rate and spatial pattern and so to the feasibility of containment (Grice 2006 and Table 1). Containment will be more difficult in landscapes that consist of a large area of highly suitable habitat with a high degree of connectivity between patches. It will also be problematic if suitable habitat is available in areas that are difficult to access. Commercially exploited species may be intensively managed (e.g. 'orchards' and other crops) or extensively managed (e.g. pasture species in large paddocks with little direct management). The more intensive the management regime, the more feasible containment will be. Species for which commercial exploitation requires or cannot practically prevent seed production or vegetative reproduction will also be more difficult to contain. A suite of additional containment measures (e.g. use of sterile varieties) will be available for species for which reproduction is not required. Where effective and efficient control

methods are not available, containment will, of course, be extremely difficult The number of growers of a species, their spatial distribution, whether they are organised into an industry body and any policies relating to their use of the species will also influence the feasibility of containment.

Social factors Perceptions and attitudes of stakeholders will always be critical in determining the feasibility of containment (Table 1). In the absence of consensus, which is probably a common situation, the strength with which different viewpoints are held will be influential. Mutual recognition of the validity of different positions in relation to the costs and benefits of a species will greatly increase the prospects of containing that species.

THE UNIT OF CONTAINMENT

Scale of containment Whereas most references to containment of declared plants are at the scale of the species' distribution, we contend that for commercially valued species, containment at the scale of individual plantings would be the ideal. If successful, an operation at this scale would give maximum opportunity to exploit any benefits that would accrue to those cultivating the species but avoid any negative effects outside the specific locations in which it was cultivated. Alternatively, containment could be attempted at the district scale, in which case production opportunities may still be maximised but negative impacts would be experienced outside planted areas if and when the species spread within the district.

Ecology of containment units A containment unit can be conceptualised as consisting of a zone occupied by established plants of the target species plus a 'buffer zone' that is deemed to not (currently) support established plants but which potentially receives propagules from the occupied zone. Beyond the buffer zone is an 'unoccupied zone' that is deemed to neither (currently) support established plants nor receive viable propagules (Figure 1). The size, shape and relative areas of these three zones would depend on the dispersal characteristics of the plant, the spatial arrangement of suitable habitat and the history of the planting/infestation.

Failure of containment Three types of breaches of a containment unit could be deemed to constitute a failure to contain: (I) plants reproduce within the buffer zone; (II) propagules are dispersed beyond the buffer zone; (III) plants reproduce in what was delineated as the unoccupied zone (Figure 1). A type I breach could result if effort in the buffer zone is inadequate to detect and prevent reproduction of any individuals that establish from the seed-rain or vegetative spread that reaches the buffer zone from the occupied zone. A type II breach could result if there has already been a type I breach or if the dispersal capacity of the species was underestimated when the original containment unit was delineated. A type III breach could result if there had already been a type II breach and plants establishing in the outer zone were not adequately treated before they reproduced – this could involve a failure to

Table 1. Species, landscape, management and social traits that reduce the feasibility of containment.

(i) Species
Annual life cycle
Frequent reproduction
High reproductive output
Dispersal mechanisms cannot be managed
Long-dispersal distance
Dispersal non-directional
Large seed banks
Long-lived seed
Frequent recruitment
Short generation time
Broad habitat range
(ii) Landscape
Highly suitable habitat
Large area of suitable habitat
High degree of connectivity
High difficulty of access
(iii) Management
Extensive production system (e.g. pastures)
Production requires reproduction
Difficult to detect
Control methods not available
Widely cultivated
No industry body exists
Lack of legislation or government policy
(iv) Social
Highly valued for production
Perception of low impact on other industries
Perception of low environmental impact
Little acceptance of costs and benefits
Poor compliance with legislation

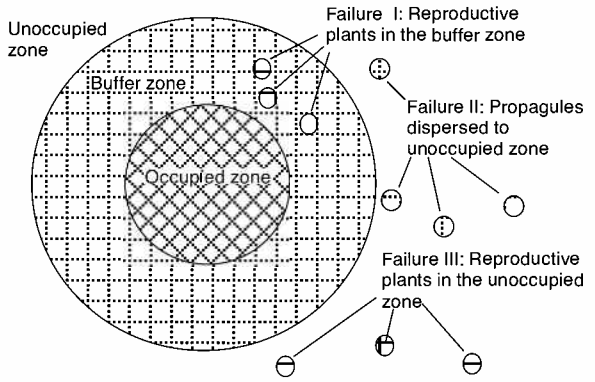

Figure 1. Hypothetical containment unit and three types of breach that would constitute a failure to contain.

detect or use of inappropriate control methods. Type I and type II breaches would result in a 'seed shadow' that was greater than that implied by the initial delineation of the containment unit. This conceptual analysis indicates that successful containment requires: (a) quantitative knowledge of a species' ecology, most importantly its dispersal capacity and time to earliest reproduction; (b) reliable delimitation of a species' current distribution at a scale and with a resolution relevant to the containment unit; and (c) a capacity to detect and prevent reproduction of individual plants that emerge outside the occupied zone.

Long distance dispersal is a major threat to successful containment even if most propagules are dispersed only a short distance. A containment unit delineated on the basis of numerically dominant short distance dispersal mechanisms will be breached by any long distance dispersal events no matter how infrequent they are. Plants that grow to reproduce following these long distance events will give rise to new infestations and engender establishment of additional poorly delineated containment units. An accelerating collapse of the containment strategy is likely to result.

Hypothetically at least, any breach of a containment unit can be reversed by conducting what would amount to an eradication program in what was originally designated as the unoccupied zone and preventing further reproduction in the buffer zone. Such an exercise would present all the challenges of weed eradication programs (Groves and Panetta 2002).

CONTAINMENT IN PRACTICE

Responsibilities It is necessary to decide who should take responsibility for containment of a contentious plant species. Responsibilities could be allocated to (i) those who cultivate the target species; (ii) those on whose land the species is growing (regardless of whether they cultivated the population) and (iii) state or local government agencies. These allocations are not mutually exclusive, as there is scope for shared responsibilities, and they should reflect the containment units that have been delineated. In order for allocations of responsibility to be effective there must be a capacity to detect breaches, identify their source and allocate responsibility for dealing with them. This indicates a need for overall co-ordination of a containment program, analogous to that necessary for eradication campaigns. It would involve 'policing' those held responsible for different elements of a containment program. This may include defining containment units (generally and specifically), establishing containment protocols and monitoring their application, detecting and monitoring breaches associated with individual containment units, determining the sources of breaches and monitoring progress in dealing with them.

The allocation of responsibilities must address situations in which individual containment units extend across multiple jurisdictions. Ideally, containment units are delineated on the basis of the plant's ecology. Management units are generally based on non-ecological factors. Therefore, the two often do not align, especially when containment strategies are devised after problems have developed.

Costs and benefits Plant species are labelled contentious because one or more stakeholders perceive that there are benefits to be derived from cultivating them whilst others perceive that their interests are deleteriously affected by that cultivation. Thus there are real and/or perceived costs and benefits associated with the species and those costs and benefits are not equitably distributed. The application of regulated containment protocols for which cultivators are held responsible is a means whereby some of the benefits derived from cultivation may be, in effect, transferred to those who otherwise would bear the costs of negative impacts.

Containment tools Achieving containment in practice requires a capacity to detect and kill target plants that establish outside the 'occupied zone' of a containment unit or to prevent propagules from escaping that zone in the first place. These 'search and destroy' tools must be backed by appropriate voluntary or legislative arrangements. It seems unlikely that voluntary arrangements alone would be sufficient to

ensure containment. This is because failure to contain in any one location risks making actions associated with other containment units ineffectual. Legislation that requires application of well designed protocols in conjunction with mechanisms to maximise compliance is probably necessary. Potential tools include cultivation under licences to which are attached conditions related to containment; requirements that producers take out insurance against spread or negative impact; and payment of levies or bonds (Clarkson *et al.* 2010). Licensing systems are already employed to help regulate contentious plant species in Australia, for example for Indian hemp in NSW (Zurbo 2008) and poppies in Tasmania (Department of Justice 2010), which are regulated in order to gain the benefits of cultivation whilst minimising risks of illicit drugs that can be derived from these species.

Which species are containable? Grice (2006) has previously published a list of plant species that are contentious because they are both problematic and valued. The criteria identified in Table 1 were designed to help assess the feasibility of containing these or similar individual species. Industries/enterprises will vary greatly in their capacities to bear the costs of containment of plant species on which they depend. This capacity may be best expressed in terms of gross margins per unit area, in line with the fact that the costs of containment will be strongly dependent on the area occupied by the plant. Industries and enterprises based on species that are of high commercial value would be able to bear substantial containment costs. In contrast, where containment is only moderately feasible and the plant is of only low to moderate commercial value, it is less likely that the industry or enterprise based on that species would be able to bear the substantial costs of containment. Legislation requiring containment of contentious species could preclude the use of some species under a free-market approach to these situations. The alternative would be one in which containment measures were subsidised. Containment is not necessarily an easy or inexpensive alternative to eradication.

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