Broom management

Proceedings of a workshop held at Ellerston and Moonan on 16–17 November 1998. Organized by Bev Adams and sponsored by the Cooperative Research Centre for Weed Management Systems and the Ellerston Pastoral Company.

Editors: A.W. Sheppard and J.R. Hosking

Broom (*Cytisus scoparius* (L.) Link) population management strategies

Andy W. Sheppard[A], **John R. Hosking**[B] and **Andrew R. Leys**[C]
[A] CRC for Weed Management Systems, CSIRO Entomology, GPO Box 1700, Canberra, Australian Capital Territory 2601, Australia.
[B] CRC for Weed Management Systems, NSW Agriculture, RMB 944, Tamworth, New South Wales 2340, Australia.
[C] NSW National Parks and Wildlife Service, PO Box 1967, Hurstville, New South Wales 2220, Australia.

Summary

In November 1998 a broom management workshop was held with this title. The workshop aimed to review the status of broom as a weed, from biogeographic, ecological and economic perspectives, assess the efficacy of available control options, and to start the development of integrated strategies for broom control under a range of situations. Following formal presentations a workshopping session was conducted aimed at developing best-bet management strategies for broom in a range of typical situations where broom needs to be managed. This was followed by a general discussion. The contexts of this workshop, the developed 'best bet' strategies and outcomes of this workshop session are outlined in this paper (see Table 3).

Introduction

Broom (*Cytisus scoparius* (L.) Link) is an exotic weed in five continents. Even within its native range, temperate Europe and eastern Asia, broom can reach an abundance that requires management, particularly within forestry and grazing systems (Hosking *et al.* 1998). In November 1998, the Cooperative Research Centre for Weed Management Systems and the Ellerston Pastoral Company sponsored a broom management workshop, to discuss and develop integrated management strategies for this weed. Thirty-two delegates attended the workshop, including two from New Zealand and one from the USA. Two of the participants had been responsible for most of the research carried out in the international biological control program on broom in Europe since 1988. Workshop participants had expertise in broom ecology, biological control, and management of broom on farms, in commercial forests and national parks. Also present were extension officers, and local and regional council representatives as well as representatives of community and Landcare groups, and the nursery industry.

The aim of the workshop was to review the status of broom as a weed, from biogeographic, ecological and economic perspectives, assess the efficacy of available control options, and to start the development of integrated strategies for broom control under a range of situations. Expected outcomes from the perspective of the participants at the commencement of the workshop are listed in Table 1.

Previous workshops on broom have been held in 1986 (at Barrington Tops) and in 1997 (at Tumut). The recommendations from the 1986 workshop (Atchison 1986) are outlined in Table 2, and many of them have been implemented. Although no proceedings are available from the 1997 workshop, one of its outcomes was that the Alpine Liaison Committee allocated resources towards Victorian releases of broom biological control agents already released in New South Wales.

On arrival at the workshop, participants were allocated to one of six groups relating to their area of expertise and provided with a realistic broom management problem, a suggested budget and a task list. The aim was to develop a management strategy for the given problem (see below), before the end of the workshop. The first day of the workshop consisted of formal presentations to set the stage under the following session headings:

- Broom problem in Australia and overseas
- Conflicts of interest
- Why is broom a weed?
- Practical management options
- Industries affected and current control strategies
- Evaluation

Table 1. Expected outcomes from this broom workshop as defined by the participants at the start of the workshop.

	Outcome	Number. of respondents for each outcome
1.	To meet and establish links with researchers and others doing broom control	4
2.	To gain a broader perspective of the broom problem in Australia	3
3.	To identify knowledge gaps and prioritize areas for future research	3
4.	Develop integrated strategies to contain and eradicate broom in natural ecosystems	3
5.	Refine control techniques and best practice guidelines	3
6.	Become conversant with current best practice for broom control	1
7.	Obtain information on the best native species to re-vegetate broom infested areas	1
8.	Learn of the impacts of broom on pastures	1
9.	Understand the realistic potential for effective biological control	1
10.	Coordinate biocontrol agent redistribution and monitoring of releases and prioritize where / when further releases are to be made	1
11.	Understand further biological control research needs and to prioritize this research	1
12.	Secure releases of biological control agents in north western Tasmania	1
13.	To identify any scope for the use of native predators for biological control	1
14.	Discuss need for research on genetic variation in broom	1
15.	Develop collaborative research projects	1

Table 2. Outcomes of National Park Advisory Committee Broom workshop held at the Barrington Tops in February 1986 (adapted from Atchison 1986).

Required further research	Status
1. Develop greater contact and collaboration with the New Zealand broom biological control group and consider taking advantage of CSIRO's infrastructure to commence an Australian biological control program for broom	*Ongoing*
2. Monitor the extent of broom infestations and distribution on the Tops	*Ongoing*
3. Encourage the collection of background information about broom and the interactions with the rest of the landscape (particularly by Jeremy Smith at University of New England, Armidale)	*Ongoing*
4. Support research into the impact of broom on catchment hydrology	*Not done*
5. Support research into broom physiology and the impact of broom on modifying soil nitrogen levels	*Pilot study*
Required control measures	
6. Manage track access to prevent further spread of broom south into the National Park	*Ongoing*
7. Clean National Parks and Wildlife Service vehicles likely to have become contaminated with broom seeds	*Ongoing*
8. Filter infected rivers and streams from the park with mesh that will prevent seed spread	*Impractical*
9. Control feral pigs	*Ongoing*
Required extension	
10. Increase public awareness of the threats of broom to the public good via media and mobile exhibitions	*Ongoing*

The majority of these presentations has been edited (these proceedings). After meeting socially in the evening to discuss the aim, the six workshop groups were allocated a two-hour intensive session in the morning of the second day to hammer out their respective management strategies. A plenary discussion session took place for the last hour of the workshop. This discussion focused on relevant control options for different situations where broom is causing problems. Finally a field trip was organized to allow participants to see first hand the extent and severity of broom infestations in the Barrington Tops area.

A summary of specific weed problems presented to each group is given below, together with the management goal, management strategies and evaluation procedures each group developed. This is followed by the outcomes of the final discussion.

A National Park

A 10 000 ha broom infestation in a forested National Park, with limited vehicle access, is still spreading with small satellite infestations building up from the edges. The infestation supports a large feral pig population. The aim of control includes a focus on broom control along roadsides and in public camping areas to ensure some sensitivity towards how the public perceives the park is managing its broom problem. Control budget $150 000 per annum.

Management goal: (a) Maintain the biodiversity of invaded habitats with high conservation value and (b) contain broom spread and presence in areas used by the public.

Management strategy: (a) Identify and map biodiversity 'hot spots' for local control of broom ($20 000 in the first year). (b) Pull and spray broom at these sites in first year and then monitor and control broom in these sites in subsequent years ($20 000 per annum). Management should include protecting / encouraging the existing native flora. (c) Map extent of broom distribution in the park and monitor spread ($10 000 per annum). (d) Contain spread of broom by strategically spraying (Garlon® at 2 mL L^{-1}) around the perimeter of the infestation and satellite populations, along roads and tracks, and at campsites ($80 000 in the first year then $100 000 per annum). Delimit main infestations and control the main disturbance agent, i.e. by trapping pigs within these areas ($20 000 per annum). This would limit the amount of broom regeneration. Old broom stands contain more native species and are thus less dense and therefore less undesirable than young stands. (e) Support biological control initiatives as the main control option for the main infestations.

Evaluation procedure: (a) determine whether biodiversity at specific sites is maintained, (b) monitor broom spread in the short and long-term through successive mapping and (c) assess success of pig control through trapping frequency and on-ground assessment of disturbance levels.

The group considered that if further funds were available, these should be used to conduct studies within the main infestations on the management value of fire trialing both pre- and post-fire treatments of slashing and herbicide. Funds would need to be ensured, however, for subsequent long-term biennial clean up and monitoring of cleared areas.

Catchment management

Broom is scattered along a 10 km stretch of a watercourse at the head end of a catchment in native bush within c. 20 m of the bank except at the source of the infestation in an old homestead. A key risk is that the broom will spread downstream into the whole river system, which includes a World Heritage Area (WHA). The aim of control includes a focus on protecting as much as possible the native riverine plant community, thereby minimizing risk of spread downstream. Given that broom seed is known to be able to live for several years on the riverbed. Control budget c. $20 000 per annum.

Management goal: (a) to map broom presence and monitor spread, (b) to remove from, and control broom in, new and peripheral locations and where overhanging a water course, (c) contain and, where possible, reduce existing established infestations around homestead and along access roads, (d) educate local landholders, local land management staff, machinery workers and the general public and encourage their assistance in the control program.

Management strategy: (a) Survey the distribution and general age-class of broom using both aerial and ground surveying by professionals and volunteers. (b) Identify stakeholders including the overcoming of 'grey' areas of accountability between land management agencies, but also understand the State / Regional / Local planning contexts for weed management. (c) Define various management zones such as the homestead, road corridors, river and WHA downstream. (d) Develop management prescriptions, calculate control costs and prioritize action by zone: (i) WHA – high conservation asset risk – annual surveys at flowering time down the catchment to detect broom spread, removing all broom physically as encountered (opportunistic control) – low cost so highest priority. (ii) River – high conservation asset risk, high potential for 'jump dispersal', some risk of weed recurrence – use 'cut-and-paint' method with a suitable ratio of professionals and volunteers targeting reproductively mature specimens at flowering. Start with overhanging plants working upstream from limit of infestation before treating plants up the bank. Mark significant treated infestations (e.g. >4 m^2) for future monitoring of recruitment – high cost, but high priority. (iii) Homestead – low conservation asset risk, high visibility – high volume spraying, mulching and bulldozing could be employed depending on resources, containing the edge of the

infestation before working inwards. Containment a high priority, complete removal a low priority. (iv) Road corridors – if known flora suggests low conservation asset risk, survey and control broom using high volume spraying, marking significant infestations for future monitoring of recruitment. Containment a high priority, complete removal a low priority. (e) Causal factor remediation – encourage staff to remove broom seeds from machinery and to control feral animals. (f) Education and community awareness: (i) Machinery operators need to understand the threats of broom and the importance of good machinery and excavation spoil hygiene. (ii) Land management agencies – organize pre- and post-program implementation meetings to follow State / Regional / Local plans. (iii) Homestead users and adjacent landowners – provide information leaflets and advertising of program implementation in local print media. (iv) WHA users – provide information leaflets, weed identification guides, and articles in bush walking newsletters. (g) Revegetation may have a role to play in the Homestead area.

Evaluation procedure: (a) use successive mapping to monitor short and long-term spread of broom downstream and along access roads, (b) monitor controlled and marked infestations for broom regeneration and treat as necessary, (c) assess the recovery of native riparian vegetation, (d) quantify the area of broom controlled in relation to area mapped.

Infested township

Broom is infesting 1000 ha within and surrounding a township in a high-rainfall zone. The infestation covers both private and public land including a golf course, but generally occurs over previously managed grassland of introduced species, i.e. the underlying flora is of little conservation interest. Vehicle access is good and the area is not used for grazing. The infested area has large, medium and small patches of broom in a mixture of growth stages (seedlings, immature plants and mature plants). This infestation is integrally associated with village activities with potentially many willing helpers to assist with control. The aim of control includes improving the natural setting of the village and gaining a collective responsibility by the community to remove and control the broom. Control budget c. $50 000 per annum.

Management goal: (a) prevent spread, (b) improve the aesthetic value of the town with respect to the weed, (c) transfer ownership of the management program to the local community and d) reduce the amount of broom in the long-term to maintain local enthusiasm / involvement in the management process.

Management strategy: (a) Map the infested areas. (b) Treat outlier infestations to prevent spread, especially along roads (where visibility will be an issue) either by mulching for medium sized stands ($1000 ha^{-1} for 10 ha) or spot-spraying for isolated plants in patches less than *c.* 25 m^2 ($10 000 per annum). (c) Set up a demonstration site at an aesthetically important point in the town, where several control options are trialed e.g. mulching, slashing, and oversowing with local perennial grasses and / or shrubs native to the region ($10 000 per annum). On private land goats and possibly fire might also be included in a trial. (d) Run a public awareness campaign. Educate the community with regard to the threat posed by broom. Capture community interest to change the way people perceive their town (e.g. contract a landscape architect to plan and show how the town would look with the weed replaced by local native species). Provide incentives to encourage local community / council cooperation, involvement, pride and ownership of the broom control project by targeting local identities and groups (e.g. Rotary, Returned Serviceman's League, etc.) and support other communal activities that make use of the land ($20 000 per annum).

Evaluation procedure: (a) determine the amounts of broom controlled by each method and carefully map and record control efforts, particularly along roads and access tracks, also monitor any further weed spread and (b) assess achievements against milestones set for gaining community involvement (e.g. attendance at display days, number of local people signing up and showing up, level of voluntary participation), and for passing on the management of the project to a locally run committee based on the outcomes of the demonstration trial.

A significant budget would need to be maintained for at least five to ten years to ensure that public involvement becomes self-perpetuating.

Forestry

Broom infests several multiple hectare blocks of plantation trees. The plantations have a felling/replanting cycle of about 20 years at the end of which the whole block is disturbed. During this process windrows of tree stumps are formed at seven row intervals in the plantation where broom may persist through most of the cycle. Broom is a problem in the replanting phase, growing up quickly from seed and smothering planted saplings or reducing productivity by slowing growth of the young plantation. In the last few years before plantation harvesting, the broom itself is shaded out within the stand, but it has laid down a large seedbank. Vehicle access is good and aerial treatment is economic. The infested areas are of similar size, but forestry blocks in between them are susceptible to invasion. The aim of control includes limiting economic losses to the forestry industry, by limiting risk of spread of existing infestations into adjacent blocks and a public responsibility of keeping the noxious weed under control. Control budget limited only by need to minimize control costs.

Management goal: (a) containment of broom within existing infested areas, (b) elimination of broom from access roads and fire tracks, and (c) reduction in broom impact on plantation production.

Management strategy: straightforward with regards to (a) and (b) using mapping, chemical control and long-term monitoring to prevent broom spread and to eliminate it along access roads and fire tracks. To achieve (c), however, an adaptive management strategy should be adopted (Shea *et al*. 1998), i.e. using the management process to improve the strategy itself by actively trying a range of management techniques and control levels to provide internal checks on the process.

A research project to demonstrate the impact of broom on forestry production would be required before any further action is taken (e.g. Barnes and Holz 2000). Following this, novel control options to be tried following harvest could be (a) woodchop and roll timber waste and redistribute rather than using windrows, (b) prepare ground for replanting soon after harvest to allow broom to start to regenerate prior to planting, (c) regenerating broom is then sprayed with the highest recommended rates of glyphosate (e.g. 1350 g a.i. ha^{-1}) and the penetrant Pulse® immediately prior to planting (e.g. Hore 2000). For existing broom infestations in young plantings control options include: (a) slashing broom between rows, (b) cleaning up inter-row areas with shielded (to protect trees) applications of glyphosate, and (c) applying urea-based fertilizer (e.g. 200 kg nitrogen ha^{-1}) to the young trees. (d) biological control, particularly using shoot feeders, may also help depress the growth rate and height of competing broom within the plantation, thereby reducing its impact.

Evaluation procedure: (a) monitoring the success of the containment campaign outside plantations and (b) conduct an economic analysis for each of the combinations of management options trialed.

The group suggested that one way to reduce the pressure of broom on future operations might be to set up a long rotation forestry trial (e.g. 40 years) aimed at sawlog (i.e. plank) production rather than woodchips. Thinning the trees as part of the management program may provide temporary openings in the canopy that would force broom to germinate, before the trees shade it out as they continue to mature. A long-term economic analysis in relation to current practice must also be an important component of such a trial.

Cattle farm

Broom infests a property of several hundred hectares, only 20% of the land has no history

of broom. Some areas have had to be abandoned to broom due to poor access and low productivity of the pasture or along water courses, most of the infested productive areas have a broom seedbank that keeps sending up young broom plants every year following attempts to control them. Broom is all down the valley so broom seeds from the property are not likely to infest previously uninfested areas. Only cattle are run on the property, but there are also rabbits, kangaroos and wombats. The local council is threatening to impose a fine if broom is not controlled on the property. Vehicle access is good to most of the property. The aim of control includes limiting loss of pasture to broom, pacifying neighbouring landholders, and convincing the council that you are conducting control as efficiently as your budget allows. A typical annual budget for broom control would be c. $20 000, and would be very variable between years.

Management goal: (a) to contain the existing infestations within the first five years, and (b) start reducing the size of the infested area between year five and ten.

Management strategy: To satisfy neighbours and local council in year one (a) spray fence lines and tracks using Grazon 1.7 L per 100 L ($4000), and (b) set up a small fenced demonstration area involving a herd of 50–60 dairy goats ($3000 goats, $6000 electric fencing), then (c) carry out wombat and rabbit control ($800). In years two to five: (d) continue to spray fence lines and spot-spray flowering broom every two years ($4000), (e) fence to restrict cattle movement and prevent seed distribution as budget allows, dividing the property progressively into 20 ha paddocks (*c.* $10 000 in a good year), (f) over-sow low to medium infestations with appropriate perennial grasses for the region and add organic fertilizer e.g. processed sewage or ash ($200), (g) build windbreaks of trees (e.g. pine) on windward fence-line of each goat paddock between goat fence on inside and cattle fence on outside ($1500 per annum over four years), (h) mulch around previously sprayed fence lines ($1500), (i) invite Landcare and other interested community groups in years 4 or 5 to learn about goat use.

Evaluation procedure: Estimate the area of broom infestation that has been returned to production each year in relation to the total area infested each year. This should directly involve local council representatives to obtain an independent assessment of success of the management strategy and alleviate their concerns.

Other control strategies could include flaming large broom plants to improve accessibility to goats. Stocking rates should be carefully monitored to prevent overgrazing as this will allow broom to regenerate in cleared paddocks. The estimated required budget in the first year was *c.* $20 000 for a 200 ha property. While start-up costs such as for the goat demonstration paddock and initial fence-line and track spraying would decline with time, continued expenditure would be required for spot-spraying, setting up wind breaks, mulching, vertebrate pest control, and the cattle fencing to divide the property into 20 ha paddocks. This last item might be optional depending on variation in funds between years.

Threat to rare plant

At present, a rare orchid is only known to grow in a broom-infested area of a National Park. The above ground parts of the plant are annual and leaves and flowers are present in January and February. Almost nothing else is known about the biology of the plant. Part of the known orchid population is now under the edge of the broom infestation. The location of the plant is not to be made public because of the risk of orchid enthusiasts collecting known plants. Control budget up to $15 000 per annum.

Management goal: (a) protect the existing threatened plant population by immediately controlling the invading broom infestation in a manner posing minimal risk to the threatened plant and (b) survey for other populations of the threatened plant in similar habitats while starting ecological studies to better understand the plant.

Management strategy: (a) immediate broom control to 10 m beyond the edge of the threatened plant population irrespective of broom stand age, this control would consist of cutting broom and treating stumps with glyphosate to prevent resprouting (*c.* $1000 per annum) and (b) $9000 would be allocated to surveys of the threatened plant and studies on its ecology, using contracted researchers, students or local enthusiasts.

Evaluation procedure: Annual monitoring of the size of the threatened plant population.

Additional actions included: (a) contribute to feral pig control within the threatened habitat, (b) study the role of fire on the ecology of the threatened plant (if possible without further threatening remaining populations), and (c) consider the likely horticultural value of the threatened plant as a way of sponsoring management efforts. Control budget required was considered to be *c.* $10 000 in the first year, with reduced amounts in subsequent years when the nearby broom infestation has been removed and the surveys completed.

General discussion

Biological control was the first focus of extensive discussion. It is still the only option for the bulk of large infestations in Australia – any other method was prohibitively expensive – despite a risk that biological control will not work and a long time frame for implementation.

To date, the biological control program in Australia has resulted in the release and establishment of three biological control agents. Two further agents are in quarantine and two more are still under investigation in the native range. The first agent to be released in Australia, the twig mining moth, was released in 1993 (Syrett *et al.* 1999). None of the agents are yet in large enough numbers to be causing much damage in Australia. While this is disappointing, as each insect species has only one generation a year, it is not unexpected. The likely long-term damage caused by three of these potential agents in New Zealand and Oregon is high (S. Fowler and D. Isaacson personal communication), although for some species it may take anything from 5 to 30 years to have a significant impact. Nonetheless, the evidence to date does not support any idea that an effective suite of agents has already been introduced anywhere in the world to combat broom. For this reason the collaboration between Australia, New Zealand and the Oregon Department of Agriculture continues to support screening and evaluation of new agents. The most promising of these are currently a gall mite (*Aceria genistae* Nalepa), which can kill plants and greatly reduces the growth rate of the weed, and the gall fly (*Hexomyza sarothamni* (Hendel)), which is known to be extremely specific and, without a large complement of parasites, may restrict broom growth.

New funding sources are required, however, as the core sponsors over the last nine years (NSW National Parks and Wildlife Service, Ellerston Pastoral Company and State Forests of NSW) will not be able to maintain the same level of support for the program. A number of other organizations represented at the workshop expressed interest in contributing to the biological control program. A key outcome of the workshop was the recommendation that the future management of the broom biological control program moves from being NSW-based to a National program managed by the CRC for Weed Management Systems.

For national park and state forest areas on the Barrington Tops plateau, funds are still needed for chemical control of broom in priority areas: roads and access tracks, high visitation areas, and threatened species habitats. Such a management approach is expensive and is not sustainable in the long-term, but essential to contain broom infestations while biological control is given a chance to work.

There are more options for broom control on-farm. Discussion revisited information presented in the talks pointing towards the benefit of fencing broom areas into small paddocks and grazing these areas with Boer and milking goats. These goats have been domesticated for many

years and have shorter legs than feral or Angora goats. As such, they are more easily contained and they browse broom and shrubs in preference to grasses and legumes. Similarly the benefits of mulching broom and using the mulch to delay regeneration were also discussed (Talbot 2000), especially if combined with oversowing of perennial grasses, although the cost of mulching at *c.* $1000 ha^{-1} was too high for most agricultural situations.

Use of fire to control broom was also discussed. It appeared that more research was needed before this became a recommended management tool. A concern with the use of fire was the observation that rate of linear spread from an existing infestation can double following fire (P. Downey personal communication). In farming situations it has a use to remove the bulk of the broom and encourage germination of broom seed prior to use of chemicals or goats. Discussions on chemical control supported information from the presentations that this is effective in the short term, but remains expensive and needs to be followed up for many years until the seedbank has been depleted. Nobody treating areas where plants had seeded for a number of years had managed to reach the stage where seed no longer germinated. This was despite control being carried out continuously for over 20 years or more (Smith 2000). There are also significant risks of herbicide damage to non-target species growing amongst broom. Such species need to be encouraged as replacement vegetation.

A major concern with landholders was that broom control on private properties was required by law and imposed by local councils. The councils, however, still expect control measures applied by landholders to be immediate, thus favouring short-term effective, but long-term ineffective control options such as greater use of herbicides. The risk of prosecution is driving this. There was a perceived need by many present to educate local authorities in the need for long-term management practices. Assistance from these authorities and an understanding of what can be achieved on individual properties would also aid long-term control. Arranging field days to demonstrate the effectiveness of long-term integrated strategies over short term, quick-fix strategies is a perceived need in the farming community and is outlined as a recommendation of this workshop.

The workshop provided participants with information about methods that others had used to manage broom. The workshop also provided contacts for future exchange of information on control techniques. The outcomes of this workshop are summarized in Table 3. The proceedings provides a permanent record of most of these discussions.

Table 3. Outcomes and recommendations from the workshop.

Outcomes and recommendations
1. A series of 'best bet' management strategies were developed to manage broom infestations in 6 realistic situations where it causes problems in Australia: (a) a National Park, (b) in a catchment, (c) an infested township, (d) in commercial forestry, (e) on a cattle farm, (f) as a threat to rare plants (see text for details).
2. It was recommended that efforts to complete a biological control program be continued with a shift in funding and priorities from a state-based to a National program under the auspices of a national body e.g. the CRC for Weed Management Systems, which includes all the state and federal research organizations involved in broom biological control research and extension work.
3. Further research was required for the development of situation-focused broom management strategies involving existing knowledge on the effectiveness of herbicides, mechanical removal, fire, goats and revegetation.
4. Arranging field days to demonstrate the effectiveness of long-term integrated strategies over short term, quick-fix strategies to educate local authorities in the need for long-term management practices. Assistance from these authorities and an understanding of what can be achieved on individual properties would also aid long-term control.

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