Herbicide control of exotic grasses in south-east Australian native grasslands: case study with serrated tussock (*Nassella trichotoma*)

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Summary

Australia's south-eastern native grasslands are one of Australia's most threatened ecosystems. Limited knowledge of grassland dynamics in the land management and scientific fields in the past has contributed to native grasslands being in poor quality today. Native grasslands of poor quality usually exhibit senescing native grass tussocks that are deteriorating in structure. Native forbs are also swamped out by the senescing grass tussocks leading to the forbs struggling to survive and reproduce. Soil nutrient enrichment can also occur due to the native flora not able to assimilate the nutrients to the same extent as they would if they were growing in a healthy state – not senescing. Poor quality grasslands are unable to compete adequately with invasion from exotic weeds. Invasion by exotic grasses into native grasslands in poor condition is a very real problem that is intrinsically connected to the decreasing biodiversity and sustainability of our native grasslands. To adequately control the spread of exotic grasses in native grasslands the authors present a checklist for weed control measures in native grasslands. The checklist incorporates the biology and ecology of both the native flora and the exotic invaders. Also, timing, type and mode of action of weed control are considered. These points can provide a window of control for a particular situation. However, this is not the end to the weed control problem. In most circumstances the same or another exotic will re-establish in the control zone. Allowances need to be made to reintroduce native species back into the control zone to compete with the exotic invaders. A case study is presented using the checklist of control with a prescribed herbicide to control serrated tussock in a native grass and forb matrix.

Introduction

Europeans have documented the past beauty of Australia's Grassland plains since the time of their colonization of occupied Australia. The traditional owners not only felt the beauty of these plains but were able to sustainably manage the plains to provide themselves with a livelihood. The once rich biodiversity of the Australian grasslands adapted over thousands of years to be able to survive under frequent burning, grazing and animal disturbance regimes. European settler invasion into Australia brought with it an invasion of exotic animals, plants and rangeland management principals. A combination that has greatly modified the native grassland plains. Where once native forb and grass species would have invaded soil disturbance areas now exotic flora invades. Further changes in the type of invading plants have been made over the last 200 years of European settlement in Australia. With the introduction of livestock from around the world came exotic plants attached to the hide or found within the intestines of the livestock. Some very common examples such as serrated tussock (*Nassella trichotoma*) and Chilean needle grass (*N. neesiana*) found their way here by such means. These two exotic stipoid grasses are part of a family of aggressive native grassland invaders. The situation native grasslands are in today are highly fragmented, reduced in size, weed invaded, have depleted biodiversity and in some cases senescing their way into oblivion. A large battle to conserve the wealth of untapped knowledge of native grasslands is ahead of us.

Reducing the rate at which native grasslands are destroyed is a major priority for conservation. Followed by the creation of grassland reserves that still have some linkage with other grassland reserves. Improving our knowledge and implementation of stewardship practices for increasing or balancing the health, vigour and therefore the native biodiversity of native grasslands is also a major challenge still facing us. This paper address part of the third point relating to grassland stewardship. In particular, weed control within native grassland reserves.

Exotic weeds in native grasslands

In native grassland situations a weed can be any plant not indigenous to a particular grassland area. However, the time when a plant first establishes itself in a particular area and is able to reproduce is not always clear (when is an indigenous plant indigenous?). To address how to effectively control a weed we first need to know what makes a plant a weed. The authors Hance and Holly (1990) cover some major characteristics of a weed:

- The seed will germinate in most environments*
- Seeds are long lived through dormancy mechanisms*
- There is rapid growth from the vegetative phase to flowering*
- Seeds are produced in a wide range of environmental conditions*
- Seeds are produced for as long as conditions permit*
- Under favourable conditions seed production is very high*
- Self-compatible but not completely self-pollinating or apomictic
- Traits for long and short distance distribution of seed*
- If cross pollinated, unspecialized pollinators or wind pollinated
- If a clonal species, vigorous vegetative growth and regeneration from fragments
- If a clonal species, brittleness of leafy parts ensuring survival of main plant
- Strong inter-species competition by special mechanisms* (e.g. allopathy).

It is unlikely that a particular weed will exhibit all of the above characteristics but may posses many. Chilean needle grass is an example of a weed that possesses many of these attributes (marked by an asterix). The invasiveness of a species is also determined by aspects of the habitat that is being invaded such as: disturbance regimes; water table; climate; topography; rainfall and; other biotic and abiotic factors. Many factors must be considered to increase the likelihood of a successful exotic weed control program. For a land manager, weed control must be strategy led. Managers of remnant grassland areas have recreational, community, cultural, ecological and financial objectives that must be satisfied. Often urban grassland reserves strategic land rehabilitation burns and weed control burns are hampered by external land use considerations i.e air quality standards, surrounding industry, surrounding urban areas and, road safety problems. Dealing with effective integration of land use priorities, ecological management and weed control need further study.

Research based weed control considers the biotic and abiotic variables of the weed and invading area. Our understanding of all of these variables is limited and further research is needed (Prieur-Richard and Lavorel 2000). However, advances in integrated weed management are teaching us that understanding the biology, ecology and growth/invasion habitat of a weed is a good starting point to controlling a weed (Williams and West 2000, Robinson 2002). The practical methods of weed control in a native grassland setting are presented as a checklist. This checklist is not definitive and therefore may not work in all situations but it is a good starting point.

Checklist for grassy weed control in native grasslands

1. Prior land use history: Land use history can help identify what weed seed may be available to germinate from the soil seed bank. Knowing what could potentially germinate will identify what will occupy the site of control once the problem exotic has been killed. Land use history can also help identify if there may be a problem of herbicide tolerance in the exotic to be controlled. The type of native species that may have occupied the site prior to exotic invasion can also be identified. This information can be used in native flora revegetation works. Identifying land management history that has lead to the weed invasion can help with adaptive management planing in the future.

2. Biology and ecology of exotic and native species: Knowing the germination, growing, seeding and possible dormancy cycle of the exotic can identify the best and worst time to apply a control measure. The best time to control exotic grassy weeds is when they are growing and most susceptible to control measures. Generally during the seedling stage a plant will be most vulnerable to herbicide, fire or disturbance. If grazing or slashing is to be used as a temporary control measure, this should be done before seed is ripe. If the exotic is allowed to set ripe seed, problems such as seed dispersal via slashing equipment (Bedggood and Moerkerk 2002) or grazing animals can occur (Bray *et al*. 1998). The authors Popay and Field (1996) offer some further insight into integrated weed management using grazing animals. Some stipoid seeds cause problems to grazing animals via piecing of the animal hide and causing health problems (Bedggood and Moerkerk 2002). This has an adverse effect on the animal and the quality of the product obtained from the animal. Knowing the native species that are present and their biology/ecology can also help identify the optimal time for exotic control. If a non-selective herbicide is to be used, any native species present would be killed if the herbicide is applied in large volumes during the growth period of the natives. Optimal timing of herbicide application is during dormant periods of native plant growth. Kangaroo grass (*Themeda triandra*) being a dominant native grass and having a C_4 photosynthetic pathway (summer growing, winter dormant) allows for exotic control during the winter, dormant period. However, avoidance of directly spraying native plants is recommended as death may occur. Some native forb species have a dormant period in either the late autumn or early winter period (in some cases also over the summer period) e.g. *Stackhousia* sp., *Arthropodium* sp. During a wet summer some forbs will continue to grow and flower through the year. In this case weed control in native grassland areas will be more difficult. A problem can arise if the growth and dormant period of the exotic and favourable species overlap.

3. Timing of control measure: To optimize the efficiency of the control measure with minimal adverse impact of native flora, the above points must be considered. The ideal time to apply a control measure is when native flora are dormant and exotic flora are growing. This will not always be possible. In such a case, a series of control measures may be necessary to optimize the health of native species before exotics are killed. For example fire at the start of the growth period for kangaroo grass and during the growth period of most native forbs (approximately early November for native grasslands around Melbourne, Victoria) can lead to strong competition to weeds from kangaroo grass and native forbs. Competition is for bio-stimulant resources (water, light and nutrients) during plant growth available after the fire (Wijesuriya and Hocking 1999). In this case fire can initially equalize competition between plants. Exotics, if annual species, can be adversely affected if their growing season is interrupted (Robinson 2002) but could possibly germinate from available soil seedbanks. If the exotics are perennial such as serrated tussock, seed set will be aborted in the exotic for that growth period. However, care must be taken as some perennials are able to flower more than once per growth season i.e. Chilean needle grass and Texas needle grass. Fire (unless during drought conditions) can promote growth and seeding in some native forbs (Robinson personal communication) and in kangaroo grass during that growth season if there is sufficient soil water available. This leads to an increase in spatial competition and an increase in soil seedbank addition by native species. However, herbicide use may be needed to control the resprouting perennial and germinating annual exotics. A difficult exotic weed control scenario is removing exotic stipoid species when intermixed with native grasses with the same biology. An example of this would be controlling serrated tussock amongst *Austrostipa* or *Austrodanthonia* species. The window of opportunity for weed control would be very small.

4. Control measure type and mode of action: Various control measures can be used including fire, grazing, slash and catch of clippings, herbicide and the controversial soil disturbance. General methods of good hygiene to stop weed seed spread are important in suppressing further weed invasion. Keeping the grassland ecosystem in a semi-vigorous state can reduce the availability of space, light water and nutrients necessary for weeds to establish (Mason and Hocking 2001).

Small scale cultivation of isolated patches of exotic weeds can be used but may make the situation worse. Cultivation in grassland remnants has been shown to greatly increase the invasive potential of exotics (Hobbs and Huenneke 1992, Wijesuriya and Hocking 1998 and Prieur-Richard and Lavorel 2000). King and Buckney (2002) also noted that increased weed invasion correlated with increasing soil nutrient availability. If cultivation is used, inoculation of the soil with native plant seed or reintroduction of natives by seedlings or tubestock is a must. The authors McDougall 1989, Phillips and Hocking 1996, Waters, *et al*. 2000 and Mason and Hocking 2002 all provide suggestions for replacing exotic perennial grasses with native grasses.

Fire, grazing and slash and catch of thatch can be used to limit seed set of exotics but are most effective for controlling annual exotics. These three control measures usually need to be used in conjunction with other weed control measures. Fire was used by Henderson (2002) to control the annual grass *Briza maxima*. Over three years of annual burning, density of *B. maxima* was actively reduced (Henderson 2001). Some perennial stipoid exotics such as Chilean needle grass respond favourably to slashing, setting seed in a horizontal culm fashion instead of the normal vertical culm (Mason unpublished data). This can lead to further control problems if using grazing or slash and catch control measures considerations made in point 2 must be considered.

Herbicide control of exotics can be very effective. However care must be taken that the herbicide to be used will not kill wanted species. This can lead to a greater final problem than the initial problem. The herbicides used should also be prescribed for the exotic that is to be controlled. Always adhere to the herbicide label. A problem arises here. Some exotic weeds have no herbicides prescribed for their control. The local Department of Environment should be contacted in these cases. Some Universities are trialling un-prescribed herbicides for exotic control but these cannot be recommended to the public. In some cases selective herbicides can be beneficial for controlling exotics in native grasslands. The selective herbicide Fusalilade (Cropcare®) followed by glyphosate and then the selective bulb targeting herbicide metsulfuron methyl (Brushoff® Du Pont) was used in a trial to control the bulbous exotic yellow soldier (*Lachenalia reflexa*) in a native bushland situation (Brown *et al*. 2002). Over the three years of treatment the cover of yellow soldier decreased whereas the native geophytes species cover remained relatively close to pre-treatment cover. When using a herbicide care must be taken to follow the directions for individual herbicides. Some herbicides are taken up by leaf material and would be suitable for application such as wick wiping. Where as some herbicides are taken up through the soil-water-root interface and therefore need to be applied to soil. Some herbicides are also hydrophobic (water hating) in nature and to be taken up through the soil-water-root interface there must be sufficient soil water to ensure some of the hydrophobic herbicide is dissolved in the soil water (Hance and Holly 1990). Otherwise the hydrophobic herbicide will strongly attach to soil particles in dry conditions making the plant unable to assimilate the herbicide. Examples of hydrophobic herbicides are the triazines.

5. Window of control opportunity: The window of control opportunity arises from considering all of the above points. In general the best window of control opportunity is when wanted species are dormant, exotic species are actively growing and the type of control measure will be effective. This window is partially theoretical and will not always be able to be opened. In such cases a series of control measures may be needed. An instant total eradication of most exotics is not possible. The best window of opportunity is when there is only few plants at the initial stages of invasion.

6. What will competitively replace the exotics: Whenever an exotic plant is killed, eventually another plant will occupy the same area. Usually if the exotic has been established in the area for a number of growth seasons, the soil seed bank will contain seed from that exotic (Waters *et al*. 2000). So when the growing exotic plant is killed, it is usually replaced with a few seedlings of the same type of plant. In the case of serrated tussock and Chilean needle grass, soil seed banks are enormous (Gardener and Sindel 1998). Ranging from approximately 14 000 seeds m^{-2} for serrated tussock to 7000 seeds m^{-2} for Chilean needle grass Mason unpublished data). To keep spraying year after year may eventually kill most of the mature plants and soil stored seed once it has germinated but it is unlikely (Mason and Hocking 2002). The result is usually a re-emergence of the exotic. Contamination of soil and leaching of herbicide into aquifers can also occur after herbicide application (Adams and Thurman 1991, Star and Glotfelty 1990, Close *et al*. 1998 and Epstein 1994) often leading to adverse effects on humans (Hoar Zahm *et al*. 1997, Dich *et al*. 1997 and Kettles *et al*. 1997). There are three main control measures at this point. The first is to do nothing. In this case there will be a repeat of the same level of weediness and the exotics will have to be removed again. The second involves trying some level of re-establishment of desirable species in the exotic removal zone. Exotics will still establish but will have to compete with desirable species for resources. The third involves using advanced competitive replacement methods (Mason and Hocking 2002). These methods aim to establish desirable species that are competitive with any re-establishing exotic species. In the case of controlling exotics in native grasslands it is good practice to put back native species in the area where the exotic was initially found. This is easier said than put into practice. Various methods of establishment of native grasses can be found in Campbell (1968), Hagon and Groves (1977), McDougall (1989), Jefferson *et al*. (1991), Phillips and Hocking (1996), Cameron and Briggs (2000), Phillips (2000), Waters *et al*. (2000) and Mason and Hocking (2001). Mollisom (2002) offers techniques for re-establishment of native saltbushes, which he describes as a useful starting point to rehabilitate saline land. However, with any native grassland, ongoing management of any re-emerging exotic seedlings needs to be considered. Further work is being carried out by Victoria University in the development of re-establishment methods of kangaroo grass and native forbs in the replacement of exotic stipoid grasses. An understanding of the pre-invasion history of native flora occupying the currently invaded area can provide a starting point as to what native species to re-establish in the once contaminated area.

Case study: serrated tussock control within a kangaroo grass, creamy candles grassland matrix

Introduction

An investigation was undertaken to try and eradicate serrated tussock from a western basalt plains grassland community containing the indigenous tussock grass, kangaroo grass and forb creamy candles (*Stackhousia* sp. 1). The problem to be solved was that serrated tussock was occupying the gaps between kangaroo grass tussocks where native forbs would normally be found. The research site was selected within the Victoria University of Technology (St. Albans campus) native grassland located at St. Albans, in the west of Melbourne, Victoria. The site chosen had the following vegetative cover, approximately 50% kangaroo grass, 50% serrated tussock and creamy candles were present at average densities of 107 m^{-2} (± 22.69, n=8). Creamy candles is a short, erect perennial herb that dies back to rhizomes over the warm, dry months of summer (Lunt, *et al*. 1998 and Walsh and Entwisle 1999). Creamy candles have been observed in large patches existing amongst native grasses (Hocking personal communication). These patches have been noted to be up to 50 m^2 in size (Robinson personal communication).

Checklist of exotic weed control in native grasslands: serrated tussock control in a kangaroo grass, creamy candle matrix

1. Prior land use history: The treatment site was within an disused Australian Defence Industry area in the suburbs of St Albans and Deer Park near the city of Melbourne. The area had been predominantly native grassland grazed by cattle within the last 60 years. The exotic stipoid grass serrated tussock had invaded extensively. Some signs of Chilean needle grass (*N. neesiana*) invasion were occurring on the perimeter of the now reserved grassland.

In the summer of 1997 a control burn was conducted within an area where creamy candles had been recorded. This area had a predominant 50% mixture of both serrated tussock and kangaroo grass. The control burn was used to stimulate vegetative growth of creamy candles and reduce the above ground vegetative cover of serrated tussock and kangaroo grass.

2. Biology and ecology of exotic and native species:

- Serrated tussock general biology/ ecology: stipoid grass; C_3 (spring growing) photosynthetic pathway; autumn into early summer growing period; relatively dormant over most of summer; seedling germination occurs in the spring.
- Kangaroo grass general biology/ ecology: stipoid tussock grass, C_4 (summer growing) photosynthetic pathway; late spring to early autumn growing period; winter dormant period; seedling germination in late spring to early summer and, some germination in early autumn.
- Creamy candles general biology/ ecology: Perennial herb; rare in grassland plains; growing period between late winter and late spring; flowers August – November, dies back to rhizomes in summer; germination period in the wild unknown.

3. Timing of control measure: During late autumn and early winter kangaroo grass and creamy candles are both relatively dormant, whereas serrated tussock is actively growing vegetatively. Therefore, the period between late autumn and early winter could be appropriate for serrated tussock control depending upon the control measure.

4. Control measure type and mode of action: Fire was deemed an important starting point to reduce aboveground biomass. This enabled a slight separation of serrated tussock plants from native plants by opening up the inter-tussock gaps in aboveground vegetative matter.

Being able to incorporated a slight buffer in terms of gap spacing around plants results in less favourable plants being sprayed with herbicide during spot spraying. The prescribed herbicide glyphosate was to be used for the control of serrated tussock, as per label advise. Glyphosate is a non-selective herbicide that is taken up via plant leaf material. Labels suggest that glyphosate should not be sprayed close to watercourses or directly before or after a rain event. Always follow directions on the herbicide label.

5. Window of control opportunity: Considering the above points will help identify the time to apply a control measure. First a fire is needed before herbicide application. This will mean that application of herbicide will have to wait until the serrated tussock starts to vegetatively grow after the fire. The appropriate time for applying a direct control measure was then identified as late autumn early winter. Glyphosate is to be used to control the serrated tussock. Application via spot spraying at least six hours after and before a rain event is required for the herbicide to be assimilated by the plant. Leaf material should be present and actively growing on the target plants.

6. What will competitively replace the exotic: Serrated tussock plants have been established in the treatment area for at least 10 years prior to the treatment. This would have resulted in a large number of serrated tussock seeds being incorporated into the soil seedbank. Probability is high that serrated tussock seedlings will re-establish in the area once resources below and above ground were available. The dominant native kangaroo grass occupied approximately 50% cover before treatment. With a reduction in competition from dead serrated tussock plants for above and below ground resources, kangaroo grass tussocks should increase in size below and above ground. It is also hypothesized that the herb creamy candles would increase in number of above ground vegetative growth with the reduction of competition for resources from serrated tussock. If serrated tussock re-establishes on the site, further weed control will be needed.

Materials and methods

A randomized factorial block design was used with eight replicates of glyphosate treatment plots and glyphosate untreated plots. The individual plot dimensions were 1.3 m × 1.5 m, a total of approximately 2 m^2. The assessment plot was a 1 m^2 quadrant in the middle of the 2 m^2 treatment area. This allowed for the incorporation of a buffer zone between each plot.

The area where the assessment plots were set up was burnt in early summer 1997. The fire was to serve two purposes. The first purpose was to reduce the above ground biomass of serrated tussock and kangaroo grass. The second purpose was to stimulate the growth of creamy candles.

Glyphosate at 360 g L^{-1} mixed with water at a dilution of 10 mL in 1 L was used for the spot spraying of serrated tussock. No other plant was directly sprayed. Glyphosate was applied in late autumn of 1999. Assessment of the plots was undertaken in early spring, after creamy candles had started to flower.

Results

The average percentage cover of kangaroo grass in plots without application of glyphosate was 52%. The average percentage cover of serrated tussock in plots without application of glyphosate was 44%. The average number of creamy candles in plots without glyphosate application was 106 m^{-2}.

Serrated tussock reduced in average percentage cover to 21% in plots with glyphosate applied. This is a significant 48% reduction in cover of serrated tussock in treated plots compared with plots with no glyphosate applied ($P = 0.008$, $n=8$) (Figure 1 and Table 1). No significant change was noted in percentage cover of kangaroo grass in plots that had serrated tussock treated with glyphosate compared with no treatment plots ($P = 1$, $n=8$, Table 2). The increase in density of creamy candles m^{-2} in glyphosate treated plots was not statistically significant ($P = 0.387$, $n=8$, Table 3) when compared density of creamy candles in no glyphosate treatment plots.

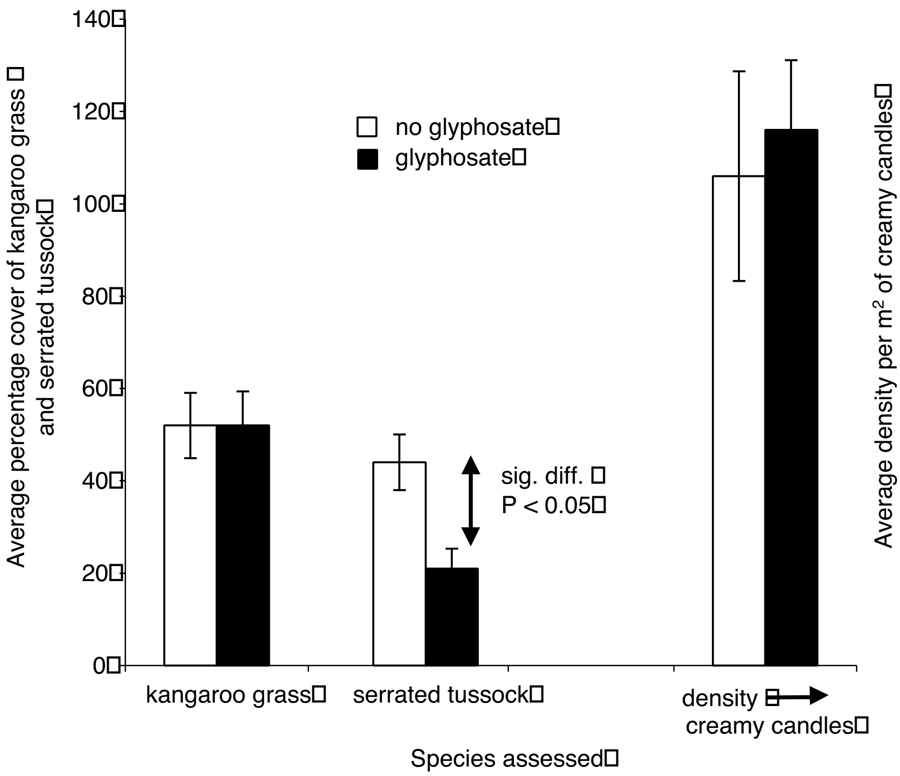

Figure 1. Average percentage cover of kangaroo grass and serrated tussock shown with average density of creamy candles per m^2 in no glyphosate treatment and glyphosate treatment field trials. Trials based at Victoria University St. Albans Campus 1997–1999, standard error is represented (n=8).

Table 1. One-way ANOVA of serrated tussock percentage cover in glyphosate treated plots compared with serrated tussock percentage cover in no glyphosate treatment plots. Data was only slightly skewed. No transformation of data was performed.

ANOVA

ALIVEST	Sum of squares	df	Mean squares	F	Sig
Between groups	2093.063	1	2093.063	9.513	0.008
Within groups	3080.375	14	220.027		
Total	5173.438	15			

Table 2. One-way ANOVA of kangaroo grass percentage cover in glyphosate treated plots compared with kangaroo grass percentage cover in no glyphosate treatment plots. Data was only slightly skewed. No transformation of data was performed.

ANOVA

THEMEDA	Sum of squares	df	Mean squares	F	Sig
Between groups	0.00	1	0.000	0.000	1.000
Within groups	5843.750	14	417.411		
Total	5843.750	15			

Table 3. One-way ANOVA of creamy candle density per m^2 in glyphosate treated plots compared with creamy candle density per m^2 in no glyphosate treatment plots. Data was skewed. A natural log transformation was used prior to performing the ANOVA.

ANOVA

TRNSTACK	Sum of squares	df	Mean squares	F	Sig
Between groups	0.134	1	0.134	0.796	0.387
Within groups	2.0356	14	0.168		
Total	2.490	15			

Discussion

The spot spraying application of glyphosate onto serrated tussock within a matrix of kangaroo grass and creamy candles significantly reduced the cover of serrated tussock by a relative 44%. Neither kangaroo grass nor creamy candles in treatment plots, significantly reduced in percentage cover and density per m^2 respectively when compared with untreated plots. It was also noted that a general increase in the density per m^2 of above ground vegetative growth of creamy candles occurred in all plots after the fuel reduction burn. This point needs further research.

This investigation has shown that it is possible to control serrated tussock in native grasslands with a minimum of 50% cover of kangaroo grass and creamy candles present. The checklist for weed control in native grasslands was shown to aid in controlling serrated tussock in this example. The main benefits the checklist provided in this example were the appropriate initial site treatment and timing of weed control application. This method may help managers of small-scale grassland remnants to control weeds such as serrated tussock within their remnants. However, this trial was conducted on a small scale even when compared to the area of fragmented southeastern Australian grassland that still remains. The authors realize that on a large scale, spot spraying of weeds may not be practicable and suggest that with appropriate site pre-treatment, wick wiping may be a useful alternative to spot spraying.

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The implementation of weed control on Phillip Island

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Summary

Crown land managers, environmental facilitators and educators regard the combination of multiple components to be most effective in combating Phillip Island's environmental and agricultural weeds. Working together to plan integrated control programs that often rely on more than one method of control. Also equally important has been monitoring control programs, establishing a comprehensive system of mapping weeds across public and private remnants and keeping up to date with new and emerging species.

Reaching the permanent and part-time population through a range of education and incentive programs, and supporting an enthusiastic group of environmental volunteers has ensured that more and more people are joining the war against weeds. Future efforts have been boosted by a recently secured Island-wide Envirofund grant. A cultural shift in the way we view and manage the land is taking place. The momentum is building, and although we have a long way to go, we believe we are on the way towards making a real impact.

Introduction

Phillip Island is a place of diverse natural features. This is exemplified in its unique coast line, with exposed sandy beaches, sheer cliff lines in the south coast to lower energy beaches and muddy bays backed by mangrove and salt marsh communities to the north. The island is also renowned for its wildlife, with species such as little penguins, Australian fur seals and koalas responsible for drawing tourists to the area.

Despite its natural treasures, Phillip Island has been highly modified due mainly to its agricultural history, ever increasing tourism and a high proportion of non-resident landholders places increasing pressure on the remaining remnants.

Therefore, those involved in weed control, facilitation and environmental education on Phillip Island are faced with on going challenges. This paper provides a snap shot of some of the strategies in place across the island.

There are two main public land management agencies on Phillip Island. Phillip Island Nature Park manages approximately 80 kilometres of foreshore reserve and a few larger reserves, including the Penguin Parade, Oswin Roberts Reserve, Cape Woolamai and Churchill Island. The Bass Coast Shire Council manage the remainder of the foreshore reserve (approximately 20 km) and some small inland bushland reserves. The other major stakeholder involved in land management is Phillip Island Landcare, who represents over 200 families on the island.

Over the past five years, the Phillip Island Landcare Group, Phillip Island Nature Park and Bass Coast Shire Council's have worked together on a multi-pronged approach to weed management. This involves a wide range of activities such as integrated field management, coordination across land management boundaries, mapping/monitoring, education, incentives, and community involvement.

As we look around Phillip Island it is easy to notice that many of our reserves are suffering from weed invasion. Exotic and non-indigenous native plants, such as blackberry, mirror bush, gorse, bridal creeper, asparagus fern, watsonia and cape ivy to name a few, have the ability to out-compete indigenous plants, resulting in a reduction of biodiversity, thereby impacting the natural characteristics for which the Phillip Island is famous. It has only been in the last ten years that some crown land managers have prioritized weed control. As a result we have inherited some highly degraded weedy native remnants. However a number of enthusiastic people are now working together in the battle to control weeds.

Weed management issues

A number of physical, demographic and legislative factors limit environmental weed control on Phillip Island and place extra challenges to those involved in community education and crown land weed control. These limitations include:

Vegetation loss/fragmentation Phillip Island has less than 7% remnant vegetation remaining; much of it was removed during the early part of the century for agriculture and to provide fuel for chicory kilns. As a result, indigenous remnants are confined to the narrow reserved coastal strip, inland reserves, roadsides and small patches scattered across farm land. The resultant fragmented landscape with predominant edges, makes many reserves susceptible to weed invasion.

Catchment demography Phillip Island is characterized by a high proportion of non-permanent landholders and holiday-makers. Many of these have a limited