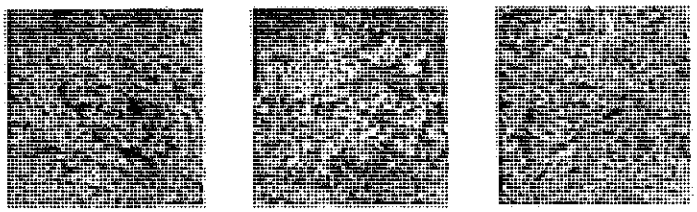
11TH BIENNIAL

noxious weeds CONFERENCE 2001

The Changing Face of Weed Management into the New Millennium

4TH-6TH SEPTEMBER 2001



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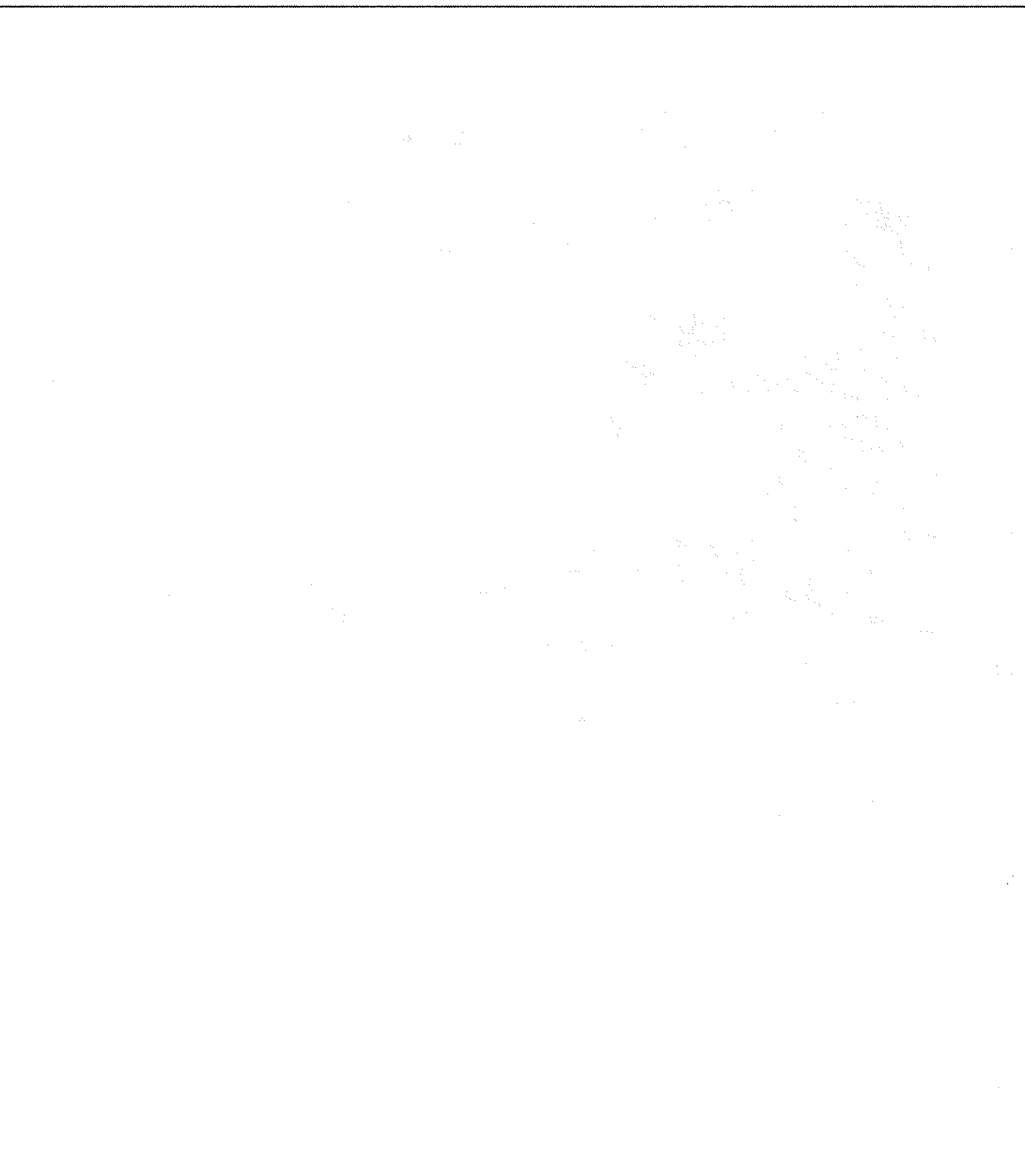

11th Biennial Noxious Weeds Conference
4th - 6th September 2001
Moama NSW

HOW CAN WE MANAGE WEEDS IN THE NEW MILLENNIUM?

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Weeds remain and will continue to be one of the most important land management issues in Australia, a point that remains under-appreciated by the Australian public, who generally seem more concerned with mining and salinity (see Tim Low's book, *Feral Future*!). For example, despite the current interest in salinity, weeds probably cost more and are a greater threat to Australia's agriculture and biodiversity (see "Land degradation" at www.abs.gov.au/).

Invasive species are second only to land clearing as most important cause of biodiversity loss, and given the practically unaffordable costs of removing weeds and revegetating natural ecosystems, these costs mean that the weeds are effectively as permanent as salinity. Further, weed problems are probably on the increase. New potential weeds are probably continuing to arrive in Australia. Existing weeds are expanding their ranges and covering their current ranges more thoroughly.

To raise the importance of weeds in comparison to salinity is not to diminish the importance of salinity or other related land management issues. Rather, it emphasises the need to educate the public and policy makers that weeds are a comparable threat, and also need to be considered in the total land management program. It is therefore a great pleasure to attend the Noxious Weeds Conference because you are on the front line for dealing with the threat of weeds and raising community consciousness about them!

Main problems in managing weeds?

What are our main problems in dealing with weeds? Perhaps you'll agree that the following list covers the major issues.

-Costs of control (generally over large land areas and often greater than the value of the land's productivity)
-Too many weeds to be researched individually (cost-effective weed management tactics are not yet known for all or probably even most weeds, yet some 75 weeds were nominated to be Weeds of National Significance; far more are very important locally)
-Lack of public support/funding
-More weeds appearing all the time
-Fatigue (land managers have suffered so many failures that they are discouraged to try)
-Fragmentation of effort

The National Weed Strategy (NWS) recognised in 1997 at least some of these issues in its four basic principles:

- Weed management is an integral part of the sustainable management of natural resources, and requires an integrated, multidisciplinary approach.
- Prevention and early intervention are the most effective techniques.
- Successful weed management requires a coordinated national approach.
- The primary responsibility for weed management rests with landholders, but collective action is often necessary.

However, our problem is how to address these issues practically on the land

Possible Solutions

The solutions to these problems can be classified into four major categories. First, because government resources for weed management are always going to be inadequate, we must develop

inexpensive strategies. As recognised by the NWS, early intervention is one of the most cost-effective techniques, but many properties continue to ignore infestations until they became serious. Further, despite the general need for an integrated approach, the practical reality is that many of our current weeds have such extensive distributions that classical biological control (the release of natural enemies collected from the home range of the weed) must remain a key tactic.

Second, there are already too many weeds for us to research and tailor cost effective strategies for each one. We have to work with one another to develop "generic" tactics that work for weed problems that are similar to one another.

Third, we need to prevent more weed species from becoming established. The recent development of permitted lists for plant importation, based on weed risk assessment protocols, are a step to slowing the deliberate introduction of new species of plants that might become weeds, but we have many potential weeds already in Australia, and still more that may be illegally or unintentionally introduced. To help more rapidly find new weeds before they become serious, the CRC plans to test whether key "sentinel sites", places where weeds are most likely to first show themselves, can be monitored to efficiently identify future threats. Finally, we need improved approaches to find and eradicate or contain new infestations.

Finally, we all need to network more effectively at all levels and share more ideas and information. Each region has problems that are unique and worse than other regions, but there are more similarities than differences. For example, despite the geographic and ecological spread between boneseed in South Australia and mimosa in the Northern Territory, two weed management tactics are shared by both: fire followed by applications of the herbicide metsulfuron methyl to control seedlings. We all share common problems in research, educational needs, and in raising community support. We all need to build public awareness and support, and publicise success stories to build optimism. We can learn from one another, and avoid duplication.

Returning with that perspective to weed control options, in addition to early intervention and biocontrol, we need also need to help landowners to better understand how to use fire and grazing management. Accidental fires, however tragic, are often an opportunity for weed management if we can be prepared with contingency financing to take advantage of them. We need to identify what are the common questions that people have, and how to answer them. How do we best choose insects as biocontrol agents, and then most efficiently distribute them? In the absence of local experiments, can we give general guidance on fire and grazing? Classical biocontrol can be made more efficient with improved release strategies, and may gain improved funding with wider public support. In general, with all of these tactics, we need to work with land managers to tailor more effective management programs to their own needs on the basis of relevant examples from elsewhere, rather than seek to give local advice for every weed. Along the lines of the old adage, we need to give guidance as to how to fish for long term management of weeds rather than simply give fish for today's weeds! The CRC is looking for patterns and general rules for weed management, and is focusing on weed "syndromes", such as woody and aquatic weeds, weed in riparian zones (which raise similar concerns about herbicide use across Australia), unpalatable grasses (eg., serrated tussock), and bird dispersed weeds (eg., bridal creeper, camphor laurel).

But perhaps most importantly, we all need to network more effectively! Our experience in the CRC is that occasional travel within Australia and bringing in international experts from abroad is a key to rapidly acquiring new information and developing effective collaborations that can be capitalised upon over the phone and internet. It's also important to maintain the links between people working in cropping, grazing and natural ecosystems, all of which have different kinds of information to contribute. We also need to collaborate more effectively in education and raising community

support, including building more about the costs and management of weeds into University, vocational, secondary and primary education. A major step toward this is WeedBuster Week.

The internet is a particularly efficient way to share information. As an example, the Enviroweeds listserver now links more than 400 dedicated weedies across Australia and New Zealand, with considerable exchanges of advice on weed management. If you are not on Enviroweeds, you should be! (send a email message "subscribe enviroweeds" to owner-enviroweeds@majordomo.nre.vic.gov.au)

Weed management in the in this new millennium is at a cross-roads. We have major problems ahead of us, but also major opportunities. To take advantage of the opportunities, we need to communicate, coordinate, and cooperate! All of you have a major role in this, and the Weeds CRC aims to help (www.adelaide.edu.au/CRCWMS).

WEED RISK ASSESSMENT - Its Use For Noxious Weed Management In South Australia

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Summary
Weed risk assessment (WRA) is the use of standard, technical criteria to determine the relative weed threats posed by plant species. Three applications of WRA are the prediction of new weeds, prioritisation of existing weeds, and minimising spread from plantings. In South Australia, a system to rank the importance of noxious weeds has been developed for use in planning weed control programs and in assessing new weeds for proclamation. The system consists of multiple choice questions to derive scores for invasiveness, impacts and potential distribution, which are then combined to give an importance score. In 1998, an Olives Advisory Group was formed in SA to examine the conflicts between economic development of the olive industry and environmental impacts of feral olives. Risk assessment and risk management guidelines were subsequently published, including a simple scoring system for local governments to assess the likelihood and consequence of olive spread from proposed new olive orchards.

THE WEED PROBLEM

Weeds can be defined as plants that have negative economic, environmental and/or social impacts. Examples of economic impacts are reductions in crop and pasture yields from weed competition, illness in livestock, disruption to water flow in irrigation channels and hydroelectric schemes, and physical damage to urban infrastructure. Environmental impacts of weeds include suppression and exclusion of indigenous flora, reduced access to water and food sources for indigenous fauna, and increased fire frequency. Social impacts include human allergies and reduced recreational value of parks and reserves. A consequence of all of these impacts is the need for weed control programs, which in turn represents a major economic cost to land managers, as well as potential environmental costs through off-target damage, and potential social costs through time spent on weed control instead of other activities.

The economic impact of agricultural weeds in Australia has been estimated at several billion dollars per year, in terms of lost productivity and cost of weed control (Combellack 1989). Economic costs of weeds in natural ecosystems are not readily quantifiable, particularly on a national scale, but their biodiversity impacts in Australia are being gradually more recognised by the community, and government funding has increased for research and control programs. Australia has at least 2750 plant species that have been reported as weeds, mostly exotics but also some invasive native species (Lazarides et al. 1997). In the period 1971-1995, nearly 300 new species were found naturalised in Australia, with a trend of increasing naturalisation rate with time (Groves and Hosking 1998). The majority of these species were likely to have been introduced prior to 1970, mostly for intentional use in horticulture and agriculture. Australia is not the only country to be facing significant weed problems. Weeds are a global problem and their numbers will increase as international trade and tourism increases, and as more species presently restricted to cultivation in gardens and farms "jump the back fence".

Given the future threat of new weeds and the magnitude of the current weed problem, there is a need for efficient screening procedures to prevent the entry of new weeds at quarantine barriers and to prioritise control of weeds that have established. Weed risk assessment is a developing science to meet this need.

WHAT IS WEED RISK ASSESSMENT?

Weed risk assessment (WRA) is the use of standard, technical criteria to determine the relative weed threats posed by different plant species. In general terms, risk assessment compares the likelihood and consequences of an event happening, to estimate the degree of threat posed by the event. In the case of WRA, the "event" is the invasion of a new weed. The term "invasiveness" is often used instead of "likelihood". Invasiveness refers to a weed's ability to invade a landuse (or ecosystem). The term "impacts" is often used instead of "consequences", and comprises the types of weed impacts, current and potential distribution of the weed, and the value of threatened landuses.

There are various approaches to WRA, including scoring systems (e.g., Pheloung 1995, Owen et al. 1996, Hiebert and Stubbendieck 1993), decision trees (e.g., Reichard and Hamilton 1997, Tucker and Richardson 1995) and process-based models (e.g., Sutherst et al. 1998). Scoring systems typically consist of a series of technical questions for criteria such as invasiveness or impacts, from which a score is calculated. The questions may be answered as yes/no/don't know, or have multiple-choice answers such as low/medium/high. The choice of questions is based on studies of factors influencing weed invasion, and the effects of weeds on landuses/ecosystems.

WRA came to prominence in Australia with the development of the (aptly named) "Weed Risk Assessment System" by Pheloung (1995). This system (hereafter known as the Pheloung system), consists of 49 yes/no questions covering a plant's domestication, climate preferences, weed history, undesirable traits, growth form, reproduction, dispersal and persistence attributes. It is used by Biosecurity Australia (formerly AQIS Policy) to predict the weed risk of new plant species submitted for import to Australia. Its development and implementation have been described in Pheloung (2001) and Walton (2001) respectively.

In addition to predicting new weeds, WRA has also been applied to the prioritisation of control programs for existing weed species, and to reduce spread of economic species with known weed potential. South Australian developments in these two fields are detailed below.

PRIORITISING WEEDS IN SA

In moving from prediction of new weeds to prioritisation for control, the assessment focus shifts from whether a plant species will become invasive, to what potential impacts a weed will have, and how soon these impacts will be realised. The feasibility of preventing these impacts (ie. controlling the weed) is also an important consideration in prioritising weed control efforts.

The APCC Weed Assessment Scoresheet (Virtue 2000) is based on a draft ranking system developed to determine weeds of national significance in Australia (as described in Virtue et al. 2001). It has three main assessment criteria; invasiveness, impacts and potential distribution.

Invasiveness is used as an indicator of a weed's rate of spread. Faster spreading weeds are considered more urgent for control and thus of higher priority. A score for invasiveness is calculated from five multiple choice questions, relating to a weed's establishment ability, tolerance to routine weed control, reproductive ability and dispersal by natural and human-influenced means.

The impacts criteria relates to the economic, environmental and social effects of weeds. The APCC system has six multiple choice questions for impacts, covering the weed's effects on establishment and growth of desired plants, reductions in product quality, effects on animal and human health, limits on physical movement, and effects on environmental health.

Potential distribution considers the area at risk of invasion by the weed. This is best determined from a GIS analysis of climatic and soil preferences, overlaid with the locations of susceptible landuses/ecosystems.

Scores for invasiveness, impacts and potential distribution (each ranging from 0 to 10) are multiplied to give a weed importance score. Weeds are assessed separately for various landuses (i.e. aquatic, crop/pasture rotation, forestry, irrigated crops and pastures, native vegetation, non-arable grazing, perennial horticulture and urban), so that the most important weeds of different landuses can be identified. Ranking weeds across landuses has not been attempted, avoiding subjective arguments about the relative value of different landuses. The system is designed as a Microsoft Excel spreadsheet (Figure 1) and has an explanatory guide.

The system was developed in consultation with Animal and Plant Control Officers at regional workshops. Consultation was vital in the development of an objective, user-friendly tool to help decide control program priorities at the local, regional and state levels. The system has been used in policy development at the state level, and by several Animal and Plant Control Boards in reviewing and developing strategic and operational plans. The system is being routinely used by the APCC to assess new weeds proposed for proclamation, and has recently been applied to assess the weed risk of various species used in farm forestry and revegetation in SA.

The current APCC system only considers one aspect of weed control prioritisation - the weed's potential importance. Feasibility of control is another major aspect to consider. Can the weed be eradicated or at least contained via government enforcement, or is it so widespread that resources are better directed to developing integrated weed management systems for landholders? A robust scoring system for feasibility of control is still being developed. Key factors would include how widespread a weed is, ease of finding infestations, cost of controlling infestations, difficulty of limiting the weed's dispersal, willingness of landholders and governments to control the weed, and commercial use of the plant. The goal is to follow Hiebert and Stubbendieck's (1993) approach of plotting weed importance versus feasibility of control, to give a simple yet effective visualisation of weed control priorities.

OLIVES RISK ASSESSMENT AND RISK MANAGEMENT

Some commercially important agricultural, horticultural and forestry plants can also become weeds of significant impact in natural vegetation. Examples include the pasture grass *Phlaris aquatica*, the timber tree *Pinus radiata* and the European olive, *Olea europaea*. Olive production is undergoing a significant expansion in SA and other Australian states. SA is well suited to olive production, with a similar climate and soils to the Mediterranean region. However, this suitability has already led to spread of feral olives from historical orchard plantings in many areas of the state (APCC 1999). Feral olives rank highly in the APCC Weed Assessment Scoresheet as an major weed of native vegetation. They form dense, tall thickets, particularly in woodland communities, and are readily dispersed by various bird species and foxes (*Vulpes vulpes*). Crossman (1999) measured reductions of more than 50% in native plant species richness and abundance in *Eucalyptus microcarpa* woodland invaded by olives. In order to promote a more sustainable olive industry, the APCC convened the Olives Advisory Group, with government, industry and community members representing commercial and conservation interests. The APCC also supported university research examining bird dispersal of olives (Mladovan 1998). The outcomes of meetings were (i) a draft discussion paper outlining a code of practice for orchards, (ii) the formation of an olive grove register, (iii) a risk assessment system for local government planners examining new orchard proposals, and (iv) guidelines on how to deal with the levels of risk through planning and noxious weed laws (APCC 1999, Jupp et al. 1999).

The risk assessment system for olives (APCC 1999) was designed as a decision tool for local government planners to rate the risk that a proposed olive orchard poses to native vegetation. The scoring system has two criteria: the likelihood of olive spread from the orchard, and the consequences of this spread. The system is in a Microsoft Excel spreadsheet (Figure 2).

The likelihood criterion is split into two sub-criteria; non-management factors and management factors. Non-management factors rate the possibility of spread based on rainfall, surrounding landuse and incidence of soil waterlogging. Management factors consider steps that the orchardist will take to minimise dispersal of fruit. These relate to bird control, fruit maturity and size at harvest, visibility of fallen fruit, a control zone around the orchard, and fox control. The consequences criterion has factors considering the distance to significant native vegetation, the presence and control of feral olives, and the presence of existing orchards. A risk rating is determined by simply adding the likelihood and consequence scores (each ranging from 0 to 100), with low risk orchards scoring 50 or less, medium risk 51-100, high risk 101-150 and very high risk >150.

Local government planners are recommended to reject planning approval for orchards posing very high risk (APCC 1999). For high risk orchards, compulsory management conditions to limit seed dispersal are recommended as a condition of approval. For medium risk orchards, a voluntary land management agreement or a memorandum of understanding between local government and the orchardist is advised, to encourage compliance with an industry code of practice (APCC 1999) on minimising seed dispersal.

CONCLUSION

WRA provides standard, robust and objective processes for making weed management decisions. The systems are also educational, providing a means to explain and justify these decisions to people with limited weed knowledge (e.g., landholders, politicians). WRA systems are a tool for sharing information on weeds, and provide a means to capture both scientific knowledge and field observations. It is important that systems be kept comparatively simple, with as few questions as possible whilst still retaining accuracy, and with questions that can be answered relatively quickly using existing knowledge or rapid field observations. In order for the general public to have confidence in the use of WRA, it is vital that systems are developed and used with community input, and that the questions, calculations and weed scores are transparent and accessible. Finally, WRA should be seen as evolving and flexible. Scoring systems will change as new knowledge is gained on their accuracy, and as our understanding of weed invasions and weed impacts increases. Similarly, scores for individual weeds will change as we gain a greater understanding of their biology and management, and as ecosystems/landuses change.

ACKNOWLEDGEMENTS

This paper is a revision of a previous paper presented at the 8th Annual North American Weed Management Association Conference and Trade Show, August 8-10, 2000, Nebraska City, Nebraska

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Figure 1. Extract from the APCC Weed Assessment Scoresheet (Virtue 2000) showing scores and calculations for five pasture weeds in southern South Australia. "Don't know" answers get a zero score. Potential distributions were not yet determined and are given a score of 1 to demonstrate calculations only.

REGION: Southern agricultural zone of South Australia.

LANDUSE: Non-arable Grazing

Assumptions/Comments: Perrenial grass pasture with weed control simply being sheep or cattle grazing. Assume that there is no routine herbicide control. Assume there is no hay cut (as non-arable), however hay may be brought to the landuse for supplementary feeding.

WEED:	African boxthorn *Lycium ferocissimum*	African feather grass *Pennisetum macrourum*	African lovegrass *Eragrostis curvula*	African rue *Pegenum harmala*	Bathurst burr *Xanthium spinosum*

A) INVASIVENESS

(Answer all questions with the landuse in mind, except for question 5(a).)

1. **What is the weed's ability to establish amongst existing plants?** (3 = very high, 2 = high, 1 = medium, 0 = low, ? = don't know)	2	0	1	0	1
2. **What is the weed's tolerance to average weed management practices in the landuse?** These practices (or lack thereof) can be listed in the above landuse assumptions (3 = very high, 2 = high, 1 = medium, 0 = low, ? = don't know)	0	2	2	3	2
3. **What is the reproductive ability of the weed:**					
(a) Time to seeding? (2 = 1 year, 1 = 2-5 years, 0 = >5 years / never, ? = don't know)	*1*	*1*	*1*	*1*	*2*
(b) Seed set? (2 = high, 1 = low, 0 = none, ? = don't know)	*2*	*2*	*2*	*2*	*1*
(c) Vegetative spread? (2 = fast, 1 = slow, 0 = none, ? = don't know)	*0*	*2*	*0*	*1*	*0*
TOTAL:	***3***	***5***	***3***	***4***	***3***
SCORE FOR 3: (3 = total of 5 or 6, 2 = total of 3 or 4, 1 = total of 1 or 2, 0 = total of 0)	2	3	2	2	2
4. **How likely is long-distance dispersal by natural means:**					
(a) Flying birds? (2 = common, 1 = occasional, 0 = unlikely, ? = don't know)	*2*	*0*	*0*	*0*	*0*
(b) Other wild animals?	*2*	*0*	*0*	*0*	*1*
(c) Water?	*1*	*2*	*1*	*1*	*1*
(d) Wind?	*0*	*1*	*1*	*0*	*0*
TOTAL:	***5***	***3***	***2***	***1***	***2***
SCORE FOR 4: (3 = total of 6 to 8, 2 = total of 3 to 5, 1 = total of 1 or 2, 0 = total of 0)	2	2	1	1	1
5. **How likely is long-distance dispersal by human means:**					
(a) Deliberate by people? (ignore landuse) (2 = common, 1 = occasional, 0 = unlikely, ? = don't know)	*1*	*1*	*1*	*0*	*0*
(b) Accidently by people?	*1*	*1*	*2*	*1*	*1*
(c) Contaminated produce?	*0*	*1*	*1*	*1*	*0*
(d) Domestic/farm animals?	*0*	*2*	*0*	*0*	*2*
TOTAL:	***2***	***5***	***4***	***2***	***3***
SCORE FOR 5: (3 = total of 5 to 6, 2 = total of 3 to 4, 1 = total of 1 or 2, 0 = total of 0)	1	2	2	1	2
TOTAL INVASIVENESS SCORE:	7	9	8	7	8

B) IMPACTS

Assume the average weed management practices have not changed to specifically target the weed, and it has spread across a whole paddock, orchard, plantation, nature reserve or water body.
If the weed is well-controlled by these average practices then it will occur at a low density and will have minimal impacts.

What density would the weed achieve? (L = LOW, M = MEDIUM, H = HIGH)	L	L	M	L	M
1. Does the weed reduce the establishment of desired plants? (3 = > 50% reduction; 2 = 10-50% reduction; 1 = <10% reduction; 0 = none; ? = don't know)	1	1	2	0	0
2. Does the weed reduce the mature yield or amount of desired vegetation? (4 = > 60% reduction; 3 = 26-60% reduction; 2 = 10-25% reduction; 1 = <10% reduction; 0 = none; ? = don't know)	1	2	2	1	1
3. Does the weed reduce the quality of products or services obtained from the landuse? (3 = high; 2 = medium; 1 = low; 0 = none; ? = don't know)	0	2	0	1	2
4. Does the weed restrict the physical movement of people, animals, vehicles and/or water? (3 = high; 2 = medium; 1 = low; 0 = none; ? = don't know)	3	2	0	0	1
5. Does the weed affect the health of animals and/or people? (3 = high; 2 = medium; 1 = low; 0 = none; ? = don't know)	1	0	0	2	1
6. Does the weed have major, positive or negative effects on environmental health:					
(a) food/shelter?	*0*	*0*	*0*	*0*	*0*
(b) fire regime?	*0*	*1*	*1*	*0*	*0*
(c) increase nutrient levels?	*0*	*0*	*0*	*0*	*0*
(d) soil salinity?	*0*	*0*	*0*	*0*	*0*
(e) soil stability?	*0*	*0*	*0*	*0*	*0*
(f) soil water table?	*?*	*0*	*0*	*0*	*0*
TOTAL:	*0*	*1*	*1*	*0*	*0*
SCORE FOR 6: (3 = total of 4 to 6; 2 = total of 2 or 3; 1 = total of 1; 0 = total of 0 or less)	0	1	1	0	0
TOTAL IMPACTS SCORE:	6	8	5	4	5

C) POTENTIAL DISTRIBUTION

In the Board, what area of the landuse is suitable for the weed? (10 = > 80% of landuse; 8 = 60-80% of landuse; 6 = 40-60% of landuse; 4 = 20-40% of landuse; 2 = 10-20% of landuse; 1 = 5-10% of landuse; 0.5 = <5% of landuse; 0 = unsuited to landuse; ? = don't know)	1	1	1	1	1

WEED IMPORTANCE SCORE

Scores corrected to range between 0 and 10

CORRECTED INVASIVENESS SCORE:	4.7	6.0	5.3	4.7	5.3
CORRECTED IMPACTS SCORE:	3.2	4.2	2.6	2.1	2.6
POTENTIAL DISTRIBUTION SCORE:	1.0	1.0	1.0	1.0	1.0
WEED IMPORTANCE = (Multiplying the scores)	15	25	14	10	14
Number of questions answered as "don't know"	*1*	*0*	*0*	*0*	*0*

Figure 5. Risk assessment scoresheet for new olive orchards (APCC 1999). The total likelihood score is rounded up to zero if a negative score is achieved.

Risk assessment for new olive orchards

Please answer each question by typing a '1' opposite one of the alternative answers

LIKELIHOOD OF OLIVE SPREAD FROM NEW ORCHARD:		SCORE
Non-Management factors:		
1 Is the annual rainfall suitable for olive seedlings to establish (based on Bureau of Meteorology long term records)?		
a Median rainfall greater than 500 mm per year.		50 Go to question 2
b Median rainfall between 350 and 500 mm per year.		35 Go to question 2
c Median rainfall less than 350 mm per year, but annually flowing watercourses within 1km of the proposed orchard.		15 **Go to next section**
d Median rainfall less than 350 mm per year with no annually flowing watercourses within 1km of the proposed orchard.		0 **Go to next section**
2 Are the surrounding landuses within 1 km of the proposed orchard (eg. grazing, cropping, native vegetation, horticulture) suitable for olive seedlings to establish?		
a Less than 50% of the surrounding area has grazing, cropping or perennial horticulture.		25 Go to question 3
b Between 50 and 90% of the surrounding area has grazing, cropping or perennial horticulture.		15 Go to question 3
c More than 90% of the surrounding area has grazing, cropping or perennial horticulture.		5 Go to question 3
3 Are the soils within 1 km of the proposed orchard waterlogged for at least one month per year?		
a Less than 50% of the surrounding soils have waterlogging.		25 **Go to next section**
b Between 50 and 90% of the surrounding soils have waterlogging.		15 **Go to next section**
c More than 90% of the surrounding soils have waterlogging.		5 **Go to next section**
SUB-TOTAL =	0	Max = 100 Min = 0
Orchard management factors:		
1 How is bird predation of olive fruit to be managed in the proposed orchard?		
a No bird control plan described.		0 Go to question 2
b Integrated bird control will be done, following the guidelines provided.		-10 Go to question 2
c Permanent bird-proof netting over entire orchard.		-65 **Go to Question 6**
2 At what stage of maturity will olives be harvested?		
a Ripe only.		0 Go to question 3
b Green and ripe.		-5 Go to question 3
c Green only.		-10 Go to question 3
3 How large will the fruit be when harvested? (Consider variety and use of irrigation)		
a Small fruit (length <15 mm).		0 Go to question 4
b Medium fruit (length 15-25 mm).		-5 Go to question 4
c Large fruit (length >25 mm).		-10 Go to question 4
4 Will fallen fruit be visible on the ground?		
a At fruit fall there will be minimal ground cover, as weeds will be controlled by cultivation and/or herbicides.		0 Go to question 5
b At fruit fall there will be ground cover of at least 10 cm height, as weeds will be controlled by mowing or grazing.		-5 Go to question 5
5 Will a control zone be established around the orchard? Olive seedlings must be controlled in this zone. Perch trees for birds in this zone should be over 7 m high and spaced at 50 m intervals (or less) around the orchard.		
a Buffer around 50 m wide or less, with no perches for birds.		0 Go to question 6
b Buffer around 100 m wide, with no perches for birds.		-5 Go to question 6
c Buffer around 200 m wide, with no perches for birds.		-10 Go to question 6
d Buffer around 20 m wide, with perches for birds.		-5 Go to question 6
e Buffer around 50 m wide, with perches for birds.		-10 Go to question 6
f Buffer around 100 m wide, with perches for birds.		-15 Go to question 6
g Buffer around 200 m wide, with perches for birds.		-20 Go to question 6
6 How is fox predation of olive fruit to be managed in the proposed orchard?		
a No fox control plan or fox baiting is not possible due to legal restrictions.		0 **Go to next section**
b Fox control program by olive grower only.		-10 **Go to next section**
c Coordinated fox control program amongst properties in the local area.		-20 **Go to next section**
d Fox proof netting around orchard, or no foxes present (Kangaroo Island only).		-35 **Go to next section**
SUB-TOTAL =	0	Max = 0 Min = -100 Max without bird control = 75
ADJUSTED SUB-TOTALS =	0	
LIKELIHOOD SCORE =	0	Max = 100 Min = 0

CONSEQUENCE OF OLIVE SPREAD FROM NEW ORCHARD:

1 How close is the proposed orchard to the nearest area of significant native vegetation?

a	Less than 500 m.	50	Go to question 2
b	Between 500 m and 1 km.	40	Go to question 2
c	Between 1 and 2 km.	30	Go to question 2
d	Between 2 and 5 km.	15	Go to question 2
e	Greater than 5 km.	0	Go to question 2

2 Does this area of significant native vegetation already have feral olives (within the reserve or within 1 km of its boundaries)? Is there a formal, ongoing control program (eg. coordinated by the local Animal and Plant Control Board)?

a	No mature trees are present in the reserve, or within 1 km of its boundaries.	25	Go to question 3
b	Fewer than 10 mature trees are present, and there is a control program.	20	Go to question 3
c	Between 10 and 100 mature trees are present, and there is a control program.	15	Go to question 3
d	More than 100 mature trees are present, and there is a control program.	10	Go to question 3
e	Fewer than 10 mature trees are present, and there is no control program.	10	Go to question 3
f	Between 10 and 100 mature trees are present, and there is no control program.	5	Go to question 3
g	More than 100 mature trees are present, and there is no control program.	0	Go to question 3

3 Does this area of significant native vegetation already have legal (council approved) olive orchards within a 5 km radius of its boundaries?

a	There are no existing, legal olive orchards.	25	
b	There are 1 to 3 existing, legal olive orchards.	10	
c	There are more than 3 existing, legal olive orchards.	0	

CONSEQUENCE SCORE = 0 Max = 100 Min = 0

RISK SCORE = 0 Max = 200 Min = 0

OVERALL RISK: LOW

Low risk = 50 or less
Medium risk = 51 to 100
High risk = 101 to 150
Very High risk = over 150

OUTCOMES OF CHANGES TO WEED MANAGEMENT IN NEW SOUTH WALES

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INTRODUCTION

There have been significant changes to noxious weed funding and management since the introduction of the NSW Weeds Strategy in 1997. These changes have largely been brought about by the adoption and implementation of a range of new policies by the Noxious Weeds Advisory Committee (NWAC) on the priorities and processes for making recommendations to the Minister on the allocation of the Noxious Weeds Grant. These policies have resulted in more targeted and strategic weed programs which are benefiting the community of New South Wales. The results of these programs can now also be more clearly demonstrated to stakeholders and the Government.

It is not possible to provide any update on amendments to the Noxious Weeds Act 1993. These are still being considered by the Government.

STRATEGIC PLANNING

There is little doubt that the best way to ensure that our limited collective resources achieve the most effective outcomes, is to focus our activities around well developed plans which are "owned" by the various stakeholders. Such plans should also be inter-connected so that activities undertaken in one area are consistent with desired outcomes in other areas. Consequently, considerable effort has been placed on developing weed management plans at National, State and Regional levels. Links between and within these levels ensure that all planning has a high degree of consistency.

At the national level, we now have a **National Weeds Strategy**, which has identified 20 Weeds of National Significance (WONS). We also have a **NSW Weeds Strategy** which lists the desired outcomes, how these are to be achieved, and the key participants responsible for achieving these outcomes.

NWAC has also encouraged the development of **Regional Plans** through the formation of Regional Noxious Weeds Advisory Committees representing a range of stakeholder groups within the regions e.g. local councils, RLPBs, public authorities, private landholders etc. Although this process has had its difficulties, it now provides a solid basis for the development of funding applications for noxious weeds grants.

This process should also provide tremendous opportunities for local control authorities to maximise the impact they can collectively have on weed control through collaboration. Such plans should also be very useful in convincing decision makers within local councils of the importance of weeds and the need to fully resource this important area of responsibility. Also, the process ensures that activities being implemented in one LCA area are complemented by and not compromised by activities (or non-activities) in adjoining areas.

FUNDING OF NOXIOUS WEED CONTROL

Funding comes from two main sources – the LCA through rates, and the Noxious Weed Grant from the State Government. The Government provides grant funding to encourage the adoption of a strategic approach to weed control, with the following specific objectives:

- To establish a noxious weed control network and infrastructure in NSW.
- To ensure that weeds of national, state and regional significance are controlled.
- To ensure that weed control programs are technically proficient.
- To assist LCAs with their weed control programs and to meet their responsibilities for noxious weed control.
- To benefit the whole community of New South Wales.

Other details on priorities and procedures for allocating the Noxious Weeds Grant are outlined in a brochure and are also available in more detail on NSW Agriculture's website (http:/www.agric.nsw.gov.au/).

We strongly believe that NWAC has taken the most effective path in relation to the need to adopt best practice processes and planning as a basis for allocating funds. There is no option to revert to a system which does not provide a basis for demonstrating accountability or for achieving targeted outcomes.

It is also important to reinforce that LCAs are the responsible agencies for implementing the Act, and that the State Government provides the Noxious Weeds Grants to assist LCAs with their weed control programs. However, the Government also has responsibility at the State level to ensure that wider strategic objectives are achieved to benefit the State as a whole.

As the Noxious Weeds Grant is a finite amount, NWAC has to have guidelines and priorities as a basis for recommending allocation of these funds to the Minister. Also, as requests for funds always exceeds their availability, it is not possible to provide maximum levels of support for all requests.

This is perhaps the most contentious issue related to the funding process. While the need to submit funding applications based on well considered plans is now widely accepted, it is regrettable that not all worthy projects can be funded at the levels requested. Perhaps there is also often an unrealistic expectation that sufficient funding is available to support all proposals.

Priorities for allocation of noxious weeds grants

When making recommendations to the Minister, NWAC determines the allocation of funds for the following purposes in priority order:

- To control new W1 weeds.
- To ensure LCAs employ as a minimum, one full time equivalent weeds officer.
- To assist cooperative arrangement between LCAs.
- To fund State plans for weed management, usually W1 weeds.
- To fund approved regional projects.
- To fund weed control on local council land, waterways and roads and RLPBs.

NWAC has placed a high priority on funding weed coordination and inspection activities because the Committee believes that more can be achieved by identifying and controlling noxious weeds on private lands than has been the case in the past, and that this is where real gains can be made. The

policy was developed to encourage authorities to employ specialist, full-time weeds officers as distinct from part-time or positions combined with other duties, e.g spray operators.

The outcome of these changes inevitably means that less funding will be available for the routine control of widespread weeds on roadsides unless other means can be implemented to gain extra funding, either from local councils or local landowners.

More demands are also being placed on the Grant. Each year more councils, who previously did not receive funding, are now requesting funds from the Grant. Also, many councils, for example on the coast, are putting more funding into weeds each year, thereby potentially being able to attract more funds, while other councils are generally putting in static amounts. The pressures of implementing control measures on some W1 weeds such as parthenium and alligator weeds, are also having an impact on the amount of funds available to allocate for activities such as roadside control.

OUTCOMES OF NOXIOUS WEED CONTROL PROGRAMS

The Noxious Weeds Advisory Committee recommended grant funding totalling $6.7 million for 2000-2001.

Some significant outcomes achieved are described below.

1. Establishment of a network of skilled weed control coordinators

Councils employ weeds officers to inspect private lands and implement weed control programs on council lands. These officers ensure private landholders comply with the legislation and survey the land to find new weeds. The Committee identifies these activities as the most effective use of Noxious Weed Grant funds to achieve noxious weed control across the whole State on both public and private lands. Outcomes achieved:

- Most authorities now have committed well-trained, weed inspection and operational staff. Over half the authorities receiving grants now have at least one full-time officer and 80% have at least a half-time weeds officer.
- The number of full-time equivalent weeds officers increased from 87 on 30 June 1998 to 131 on 1 July 2001.
- During 1999-2000, the Clarence Valley Weeds authority was established. This enabled three smaller authorities to combine resources and employ weed control staff.
- The committee also continued support for 12 joint weed control authorities and county councils and 14 regional advisory committees.
- The Committee identified 49 local authorities either with no weeds officer, or insufficient coordination of weed control capability.

2. Improved skills and knowledge of weed control staff

The Committee recognises that an important initiative to improve the strategic management of weeds in NSW is to improve the skills and knowledge of local authority weeds officers. It is also very important that the vast amount of existing skills, knowledge and experience of weeds officers is acknowledged through Recognition of Prior Learning programs which have been facilitated through these training initiatives. The Committee therefore expanded the training program in 2000-01 and achieved the following:

- Over 513 local authority officers participated in the training programs in 2000-01. The training included legal training, conflict resolution, spray-drift management, report writing, environmental weed management and aquatic weed identification. This will ensure officers are equipped to implement the Noxious Weeds Act.
- The Committee also supported projects to assist the Macquarie and Lachlan Valley Regional Advisory Committees to develop training resources and the "Recognition of Prior Learning Kit" for use throughout NSW. These resources are now being used to streamline training of weed officers.
- In 1998-99, the Committee supported projects that led to the development of weed management competencies. It now appears that a National Training Package for Conservation and Land Management (Weeds) will be endorsed by the Australian National Training Authority late in 2001. When endorsed, local authorities will be eligible for Commonwealth Government New Apprenticeship Scheme funding. This will further enhance the skills base of weed management in NSW.
- Local authorities are already applying training given in 1998-99 and 1999-2000. For example some Shires reported that they conducted their first successful prosecution of a non-compliant landholder.

We believe that these training initiatives have been a highlight of the new NWAC policies and congratulations are due to all staff of agencies and local authorities who were involved in developing, delivering and taking part in the program.

3. Prevention of new weed problems in NSW

Inspection and surveys of the land is an important strategy to manage existing weeds as well as to identify new weed problems. The Committee's policy to increase the numbers and competencies of weed officers is reflected in the significant overall increase of 30% in the number of inspections in 2000-01 compared to earlier years. Many new noxious weeds spread through commercial trade. To address this the Committee asked local authorities to specifically target pet shops, aquaria and other businesses. Funds were also retained by the Committee to manage new weed incursions.

Some outcomes include:
- Local authorities inspected 72,326 properties for noxious weeds in 1999-2000, an increase from 55,457 in 1998-99 and 37,187 in 1997-98.
- Local control authorities reported 518 inspections of business premises compared to nil in previous years.
- During 2000-01 local authorities and NSW Agriculture identified 36 new weed incursions. Fortunately only two new weed incursions required assistance from the New Incursions Contingency Fund during 2000-01. The newly identified outbreaks of the weed *Asystasia* at Port Stephens and Hudson pear (*Opuntia tunicata*) near Baradine were both treated.
- Contingency funds were also used to locate and treat alligator weed which spread after November 2000 floods in the Port Stephens and Maitland Shire areas.

4. Minimising the spread of weeds and ensuring best practice is adopted

In 2000-2001, the Committee continued to give high priority to projects addressing parthenium weed, alligator weed and other W1 weeds. The second priority was to fund regional projects to help local authorities implement regional weed management plans.

At this early stage in the implementation of regional projects it is not possible to report on their final achievements.

However, some significant issues and outcomes in relation to operational activities included:

- During 2000-01 only 12 new outbreaks of parthenium weed were recorded. As all of these infestations were detected early they were controlled rapidly. These were discovered due to the vigilance of local control authority officers implementing the NSW Parthenium Weed Strategy. The Strategy includes training of weed officers and council outdoor staff, and an awareness program using television, display-caravans and signage.
- Applications for grants to control alligator weed on the North Coast were substantially reduced, indicating the effectiveness of the NSW Alligator Weed Strategy. The initial infestation found in the Lismore area in 1998 was identified after local authority officers developed an alligator weed strategy. Contingency funds were used to control the outbreak immediately. The alligator weed in the North Coast is not eradicated but is very close to it.
- Most local authorities and regional committees have now embraced regional projects. In 1999-2000 the Committee recommended funding to help implement 23 regional plans, covering all regions of NSW. For 2000-01 this increased to 71, reflecting an increasing importance of strategically allocated funds. These increases also reflect increased awareness of the availability of the grants to other public authorities such as rural land protection boards, and the fact that authorities were prepared to commit funds to programs where they knew neighbouring authorities were also cooperating. Unfortunately, insufficient funding was available to support all projects.
- New technology for weed management was promoted by supporting local and regional extension programs through Regional Weed Action Program projects. The Committee continued to recommend assisting NSW Agriculture to print and distribute extension resources such as posters, Agnotes, Agfacts and brochures to local authorities.

The development of regional plans has greatly improved the focus of noxious weed control programs. It has also contributed to the adoption of best practice weed management by local authorities and rural lands protection boards.

The first year of project funding to help authorities to implement regional plans was difficult for some authorities, especially where the authorities were treating widespread weeds. However, there is a pleasing acceptance of the regional planning principle in local authority reports. Many authorities, councils and county councils referred to their participation in regional weeds committees and the production and adoption of regional plans, as highlights of the year's activities. Some mentioned the need for increased funds to implement these plans, while others were concerned about a reduction in funding for local weeds. A number noted that time spent developing these plans had reduced the time available for their inspection programs.

The Government is responsible for the control of noxious weeds on vacant crown lands and crown reserves. In 1999-2000 the Committee again recommended making a small grant to the Department of Land and Water Conservation (DLWC) which matched these funds with its own recurrent funds. These were provided to local control authorities and trusts to assist in the control of noxious weeds. The program assisted 78 small projects with grants ranging from $500 to $20,000 in 1999-2000. In 2000-01 the program was continued assisting 96 small projects.

5. Other achievements of local control authorities and rural land protection boards

Other outcomes reported by local control authorities and regional committees for activities completed in 1999-2000 included:

- Many authorities have well-developed weed policies and plans which are available to the general public. This obviously heads off criticism and increases accountability.

- Some authorities have excellent relations with Landcare and Bushcare volunteers and many have good integrated programs with other authorities.
- A number of innovative authorities use an environmental levy to expand the funds available for weed control programs.
- Some authorities have modern equipment and a thriving contractual business. This no doubt generates income to supplement expenses and shortfalls in grants. Others hire external contractors for all work. There is a strong case for authorities to earn income by contracting out their services, however, this has great potential to create conflicts of interest.
- There is a real commitment to weeds publicity and promotional activities by many authorities. There is a strong presence at the large rural field days with cooperation amongst surrounding authorities.
- Most authorities reported on Weedbuster Week activities including field days, displays in shopping malls and school competitions.
- Many very professional brochures, calendars and weed identification charts and booklets have been prepared. Many authorities attached extracts of excellent publicity material to their reports, and some reported on successful television campaigns.
- Rural land protection boards are cooperating in regional weed management projects. In 1998-99 only three rural land protection boards received operational assistance. In 2000-01 this increased to fifteen rural land protection boards as partners in regional projects.

BACKGROUND TO CHANGES IN WEED FUNDING POLICIES

In the mid-nineties, a number of events occurred which made it necessary for the Noxious Weeds Advisory Committee to reconsider its policies and processes for advising the Minister on the allocation of the noxious weeds funding to local control authorities. These events included the development and adoption of the National and State Weeds Strategies and the promulgation of guidelines for the allocation of Government grants by the Independent Commission Against Corruption (ICAC).

In order to meet its obligations and to become more strategic, the Committee consequently determined that it would have to align its activities with recognised best practice in the allocation of grants. The Committee also determined that it must base its activities on policies which could deliver high priority and more strategically based outcomes for the community of New South Wales.

Independent Commission Against Corruption

The ICAC document "Taken for Granted – better management of Government funds" lists eight principles for administration of grants. While these principles were developed to ensure accountability as a means of overcoming possible corruption, they also represent best practice principles for efficiency and effectiveness in achieving real outcomes from public funding. The first four principles which apply up to the point of making allocations are:

1. Identification of specific objectives, selection criteria and decision making processes.
2. Standardisation of application formats.
3. Project approvals based on established criteria, consistently applied.
4. Funding recommendations and decisions to be fully documented, and made available for external scrutiny.

The Committee had little option than to apply some objective basis for making grant payments on the basis of submitted plans and applications.

A further ICAC principle is that individual projects should provide verification that project aims and objectives have been achieved and that the conditions of the grant have been met. This is best achieved by organisations providing reports on their achievements. This reporting requirement also allows outcomes to be reported to the Minister, the Government and the community.

Preparing and submitting project reports can also be seen as a burden. However, until now, the Committee has never had comprehensive information on the real extent of the weed problem in NSW, nor the degree to which current resources are achieving the desired outcomes. Without such information, it has not been possible to report on the real costs and benefits of investing in weed control.

FUTURE DIRECTIONS

The Committee intends to recommend to continue providing grants for local control authorities across NSW to assist them to employ skilled weed control staff. To complete the network, the committee intends to continue to provide incentives for local authorities currently not employing skilled weeds officers to form cooperative arrangements.

To develop the skills base of weed control staff employed by local authorities, the Committee will continue to provide grants to employ competent staff and for developing competency based training programs. Training programs will assist authorities to utilise sampling techniques and improve planning of surveys, to develop and manage regional projects and to address other skill gaps identified by local authorities.

There are still 49 authorities without a Weed Control Coordinator or with insufficient staff to enforce the Noxious Weeds Act. The Committee proposes to encourage these authorities to appoint a competent officer or to increase the time for dual duty officers on inspections and coordination of weed control.

The general support for regional planning and targeting of grants to projects addressing higher priority needs is broadly accepted. The Committee believes that the strategic approach they have adopted will make best use of the funds available. The Committee is currently reviewing the policy on how available funds are allocated to regional and local weed control projects.

CONCLUDING REMARKS

We fully appreciate that the new policies imply that less funding will be available to control widespread weeds on roadsides. We also realise that there is a funding squeeze placed on local control authorities to fully implement their responsibilities under the Act to control noxious weeds. In addition, the Government's responsibility is to ensure that the State as a whole is strategically well placed to address weeds.

The Noxious Weeds Advisory Committee's task is to ensure that the outcomes desired at a State level are achieved, while also integrating these activities with local authorities to assist them achieve their regional and local objectives. In the end, it must be a shared responsibility to ensure our limited resources are used to maximum effect.

Our aim is to establish an effective partnership between the State agencies through NWAC, the local control authorities and the community, to collectively address noxious weeds across the State, in an effective, efficient and strategic manner. This can only be achieved if we coordinate our collective resources to achieve shared goals. We believe that we can achieve a collective force to address this

most important problem facing our production systems and environment. We are certainly keen on receiving constructive input to achieve this outcome.

Finally, on behalf of the Noxious Weeds Advisory Committee, it is important that we acknowledge that the outcomes being achieved across New South Wales in noxious weed control are largely due to the vast amount of cooperation and commitment of the weeds staff employed by local control authorities in this State. While there has been frustration in relation to the level of available funding and the need to adopt new processes, we are very impressed with the professionalism and dedication of all staff involved in weed control throughout this State. The capability to demonstrate your achievements is the most effective means of gaining improved public awareness and increased resources to achieve even better results in future.

REFERENCES

1. Taken for granted? Better management of government grants. http://www.icac.nsw.gov.au/

A.C.T. PEST PLANT LEGISLATION

[1]Kerrin Styles, [2]Geoff King, [2]Paul Coleman and [2]Leonie Badham
[1]Technical Adviser - Weeds
[2]Project Officers
Environment ACT

BACKGROUND

Legislation is only an effective tool in weed control if the majority of those most affected understand and agree on the outcomes it is trying to achieve.

The ACT Noxious Weeds Act 1921, which applied in the ACT until 1996, required land managers to destroy declared noxious weeds. The noxious weed list was long and the task of destroying them all was impossible. Therefore, the legislation could not be complied with and was ineffectual.

Increased awareness of weed control in the National Capital has been achieved due principally to three factors.

- The development of the 'ACT Territory Plan' which identified specific land-use categories.
- The development of the ACT Weeds Strategy, aimed at achieving control of priority weed targets more effectively and efficiently than previously.
- The formation of the ACT Weeds Working Group (made up of representatives from the ACT Government, Commonwealth Government and the community) to take a cross agency approach to weed control.

CURRENT LEGISLATION

In 1996 the Noxious Weeds Act was repealed and amendments to the Land (Planning and Environment) Act 1991 empowered the Minister to declare a class of plants as a pest plant, either generally or in a specific area. The Act also provided for the making of orders, in respect of pest plants, against land managers who use or manage land in a way that fails to control the propagation of a pest plant. The legislation does not prevent the sale of pest plants.

The ACT Weeds Working Group recommends plants to be 'Declared' to the Minister. Under current legislation the Minister has the power to declare a pest plant after consultation with an expert statutory advisory group - the ACT Flora and Fauna Committee. Once a plant is declared to be a pest, the Minister must arrange for the preparation of a plan for the control of the pest plant. Unlike other jurisdictions, which may have multiple pest plant categories, there is only one category of pest plants in the ACT. The current list has 34 declared pest plants

In 2000, the National Competition Policy Review of the pest plant provisions of the Land Act recommended further reforms to pest legislation, as a key strategy to strengthen the ability of government to protect the environment in the ACT.

PROPOSED LEGISLATION REFORMS

The ACT Government has released a discussion paper for public consultation on ACT Pest Legislation Reforms. The paper's purpose is to canvas views on proposals aimed at reducing the weed problem through the strengthening of existing legislative powers. These reforms include:

Separate Pest Plant Legislation. The inclusion of pest plant provisions in the Land Act makes the provision difficult to access and understand. Separate legislation would make it easier for the community to know where to look when considering their responsibilities as land managers.

Weed Categories/Control Measures. There are currently two pest plant lists in the ACT, which is confusing. There are 34 pest plants declared under the Land Act and and an informal list of 53 "harmful" pest plants. There is no legal basis to take action in relation to weeds on the harmful list. A review of the ACT declared pest plant list and categories is necessary to ensure the list is meaningful and credible. Consistency with ACT's neighbours is important in managing weeds on a regional basis.

There are three identified options for weed control measures:

1. ACT weed categories modelled on NSW.
2. Simply require that all land holders must undertake control as per the local action plan (prepared by the Weeds Working Group) for each weed. This would require an action plan for each declared pest plant.
3. Tailored control measures. Under this option a set of control measures would be developed for application against each group of weed species identified. This would allow for individually tailoring the actions required to manage a particular weed.

Mechanisms for Enforcing Control. It is important that the ACT be consistent in its weed management with neighbouring Shires and Councils.

It is proposed that provision for orders to be made against land managers (including the Crown) be retained with some changes. It is proposed that an order would be available against a land-manager if they were not fulfilling the requirements set out under a particular weed category, local action plan or control measure.

Where an order is issued, it is proposed to make the land-manager liable to pay a fee that reflects the cost of issuing the order. If the land-manager does not carry out the provisions of the order, the Minister will have the power to have someone carry out the work at the expense of the land-manager.

Pest Plants on Urban Properties. All land holders should have an obligation to keep their land free of declared plants. However, there is little point in imposing obligations on urban residential property owners if it makes no difference to the control of weeds in the ACT.

Currently the Minister can limit the geographic area in which a plant is declared a pest. If it were thought that weeds in the urban area did not contribute significantly to weed problems in other areas, the Minister could exempt urban areas from the operations of the provisions. A second option is to only place obligations on residential areas where the presence of a weed posses a threat to an area of environmental significance (eg. a nature reserve). A third option is to impose the same obligations on urban residents as rural residents. Options two and three will require investment in resources to provide a team of 'Garden Police' to identify weed threats in the urban area.

Sale of Weeds. Although there are no restrictions on the sale of declared pest plants in the ACT, most local nurseries have agreed to discontinue the sale of weedy plants. However, the absence of controls on commerce in pest plants means control objectives are unable to be fully met, particularly in the case of casual market sellers outside of the established retail industry.

All other jurisdictions have legislation preventing the trade in weeds. To create consistency with legislation in other jurisdictions and the National Weeds Strategy, it is important to provide an offence for the sale or display for sale of specified plants.

Sale of Weed Contaminated Material. The ACT Landscape Design and Construction Guidelines specify details for weed seed testing of imported landscape material. It is proposed that provisions be placed in the new legislation to make these specifications enforceable. Also, approaches in other jurisdictions suggest it is wise to make it an offence to sell or distribute material potentially contaminated with viable seed or reproductive parts of a weed in stock fodder (including hay), straw, grain, machinery, soil and landscape products.

Economic Incentives for Controlling Weeds. In some instances where a pest is a particular threat and its removal and disposal is important, it is proposed that the government may remove the weed at its own expense. This would particularly apply to the occurrence of new species identified as being potential weeds.

Where a weed problem is beyond the capacity of a single land manager to bring under control, government has a role in coordinating and providing resources for weed control to the extent that the community as a whole benefits. However, the government does not want to create the expectation that it will always step in where there is a weed problem.

CONCLUSION

The ACT Government is serious about weed control and is actively promoting awareness of weeds and their impact on agriculture, recreation and the environment. The discussion paper will provide the framework for development of policy and legislation to assist in the management of 'Declared Plants' in the ACT. It is expected that in 2001 a proposal will be presented to the ACT Government to amend current legislation to provide a modern legislative framework for the suppression and destruction of weeds in the ACT, and at the same time bring the ACT's legislation in line with other states, particularly NSW.

With new Pest Plant Legislation, established objectives and weed control goals can be realised.

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THE *WEED MANAGEMENT ACT 1999*: Strategic Weed Management Legislation In Tasmania

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ABSTRACT

The *Weed Management Act 1999* is a modern piece of legislation that for the first time directly underpins a strategic approach to integrated and coordinated weed management in Tasmania. The legislative model was first discussed in WeedPlan, Tasmania's Weed Management Strategy, in 1996 following extensive public comment on weed management issues in Tasmania. A core component of WeedPlan is the importance of community weed management in delivering on strategic weed management objectives. This Act requires a plant to have its weed risk objectively assessed prior to a proposed declaration. In addition, to ensure action is taken to control a declared weed, there is a statutory requirement to produce a management plan that details roles and responsibilities and specifies restrictions and measures required in respect of the weed. Both these processes involve a significant consultation phase, which allows the community to participate in their development. The *Weed Management Act 1999* promotes a government/community partnership approach to weed management, which will result in greater support for its implementation and advance weed management in Tasmania.

INTRODUCTION

WeedPlan, developed in 1996, is a strategic plan for the management of weeds in Tasmania; it is an underpinning State strategy for the National Weed Strategy (CoA, 1999). The overall objective of WeedPlan is to coordinate and integrate the available weed management components to better manage weeds and lessen their impact on Tasmania's environment and production sectors (DPIF, 1996). Recommended actions include:

- the need to identify and prioritise existing and potential weed problems
- recognise the roles and responsibilities of all weed management stakeholders
- ensure noxious weed legislation was updated to better facilitate and support a community based strategic approach to weed management in Tasmania.

During the public consultation stages of the development of WeedPlan, no other issue attracted as many comments as the perceived deficiencies of the then-current legislation, the *Noxious Weeds Act 1964* (DPIF, 1996). The comments received indicated that implementation and enforcement of the Act were not meeting community expectations. There was a lack of defined statutory policies for declared weeds and no legislative support for community based weed management programs. It was apparent that the success of WeedPlan would require significant changes to the way in which weed legislation was developed, structured and implemented.

In response to WeedPlan recommendations, the *Weed Management Act 1999* was developed after extensive public consultation and was proclaimed in December 1999. This paper details the reasons new weed legislation was needed and then describes the main components of the Act which underpin a community based strategic approach to weed management in Tasmania.

THE NEED FOR NEW LEGISLATION

An important component in delivering WeedPlan recommendations was the need for appropriate weed legislation, which underpins weed management programs enabling them to achieve their objectives (Bishop and Harradine, 1999). A core component of WeedPlan is the importance of community weed management in delivering on strategic weed management objectives (Welsh *et.al.*, 1999; Bishop, 1998). Modern legislation that directly underpinned this philosophy was essential if WeedPlan was to succeed. The previous *Noxious Weeds Act 1964* did not reflect contemporary thinking with respect to community weed management programs. Although weed management is the responsibility of all land managers, the *Noxious Weeds Act 1964* promoted the perception that Government has the total responsibility for the management of declared weeds in Tasmania because of its legislative responsibilities.

The previous legislation also permitted a weed being declared without having to go through an objective and transparent assessment of whether the plant warranted declaration as a weed. In addition it did not provide for the development of a management plan for a specific weed prior to its proclamation as a declared weed under the Act. This is essential if the proclamation of a weed is to result in its long term management.

Another significant criticism of the *Noxious Weeds Act 1964* was the long, slow process of forcing reluctant landholders to control weeds and that by the time enforcement could be legally implemented, the weed had already spread to new areas. There was no instrument available such as an infringement mechanism that could be used to speed up the process.

MAIN COMPONENTS OF THE WEED MANAGEMENT ACT 1999

Declaration of Weeds

A core component of the legislation is the legal process of declaring a weed species under the Act. Once declared appropriate legal actions can then be taken against the plant species. To be declared, a weed must demonstrate potential adverse impact on Tasmania's productive capacity, natural or physical resources, genetic diversity or maintenance of ecological processes (Bishop, 2000). The process of declaration under the Act is consultative and objective. It is based on the preparation of a Ministerial Statement of Intent (SoI) to declare a species. The SoI is a dossier on the plant species in question including the results of an objective Weed Risk Assessment and information on economic, environmental, and social impacts. The Minister's intent to declare the species is advertised and the SoI made available for public comment. Based on public comment and the results of the assessments that contributed to the SoI, the Minister may then declare the weed under the Act.

The SoI ensures that there are sound reasons for declaring a plant as a weed. Although the Department of Primary Industries, Water and Environment (DPIWE) is responsible for preparing the SoI, any organisation including community groups, can nominate a plant species for declaration and include supporting information with this nomination.

Weed Management Plans

Once declared the legislation requires that a Weed Management Plan (WMP) be prepared for the weed. A declaration cannot persist without a WMP with a period of 12 months available to prepare the plan. A WMP must include the name of the target weed, area of the State covered by the plan, distribution and extent of the weed, the reasons for declaring the weed and include restrictions and measures required to control, eradicate or restrict the spread of a weed. Restrictions on import, distribution and sale are also included. Weed Management Plans are the product of extensive consultation and are initiated by Government or other organisations including community groups.

The public consultation phase attempts to promote community input into the process of legally enforced weed control. This is extremely important if the principles of community ownership of the weed problem, which is the philosophy of community weed management espoused by WeedPlan, are to be underpinned by complementary legislation (Bishop, 1998; Welsh et al, 1999, Bishop, 2000).

Inspectors

Inspectors are appointed by the Secretary, DPIWE and can be employed in State/local government or other relevant organisations such as community weed management groups. Appointments are made based on competency, and powers under the Act can be varied in their delegation by the Secretary eg. geographical restrictions.

Appointed inspectors are required to undertake basic training related to their responsibilities under the Act. Training includes instruction on the powers of an inspector including the procedure to work through to persuade a landowner to control weeds and the enforcement process from offence to prosecution.

Compliance

The Act includes an infringement mechanism enabling inspectors to issue 'on-the-spot' fines for offences. If an offence under the Act is detected, an inspector can issue an infringement notice that describes the offence and its associated penalty. In addition to an infringement notice being issued, a requirement notice can also be issued that details the measures to be undertaken by the offender to appropriately control the declared weed. Failure to comply with a requirement notice can result in prosecution in court with fines up to $10 000. All measures specified by the weed inspector must be consistent with any WMP that has been developed for a declared weed.

The Act also provides for the authorisation by the Secretary for an Inspector to organise control measures to be undertaken should the landowner fail to comply with a requirement notice. The costs for such work are billed to the landowner.

CONCLUSION

The authors conclude that a strategic approach to weed management must include underpinning legislation. In Tasmania, the development and implementation of a State weed management strategy was the driver for legislative reform. The resulting Act by encouraging community participation promotes a government /community partnership approach to weed management which will result in greater support for its implementation and advance weed management in Tasmania now and in the future.

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REGIONAL WEED MANAGEMENT IN VICTORIA

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Background

Pests are a major problem in Australia as they represent one of the most significant threats to economic, environmental and social values. More than a thousand species of weeds in Victoria have been estimated to cause hundreds of millions of dollars worth of damage annually to Victorian agriculture. The amount of environmental and social damage has not been quantified. Pest animals also have a significant impact on the value and quality of the State's resources (VPMF 2001).

Institutional arrangements for pest management in Victoria are robust and relatively straightforward. The Department of Natural Resources and Environment (NRE) has a statewide policy interpretation and legislative responsibility for pest management, as well as its responsibilities as a land manager. The Pest Plant and Animal Program is an extension compliance program responsible for technical advice, enforcement action, financial support, and provides information to all land managers.

Land management in Victoria falls into two main areas;

Private land managers:

Landholders and other agricultural industries eg plantations,

Public land managers:

State Government: Forests division, Parks, Flora and Fauna division, through Parks Victoria and Land Victoria - are the NRE divisions responsible for the management of most public land in Victoria, VicRoads, Vline, Water Authorities

Local Government: Shire Councils, Water Authorities, Committees of Management

Victorias' Catchment Management Authorities provide a regional focus to enable priorities for pest management activities to be developed within a catchment and landscape context. Land owners and public land managers, Landcare groups, industry, local government and the general community all play important roles in delivering pest management outcomes.

This paper will be focussing on the roles and responsibilities of the Pest Plant and Animal program in Victoria with particular reference to the North East Region.

Pest Plant and Animal Program

The NRE Pest Plant and Animal (PPA) program encompasses the delivery of pest plant and animal extension/compliance program across the region predominantly on private land. The program is focussed on the development of private landholders pest management skills and providing technical advice to public land managers.

Whilst staff are involved in some research development, most of the program is extension orientated and is based on the principles of adult education that is delivered in group and individual learning situations. The objective is to speed up the rate of adoption of best practice for pest management control.

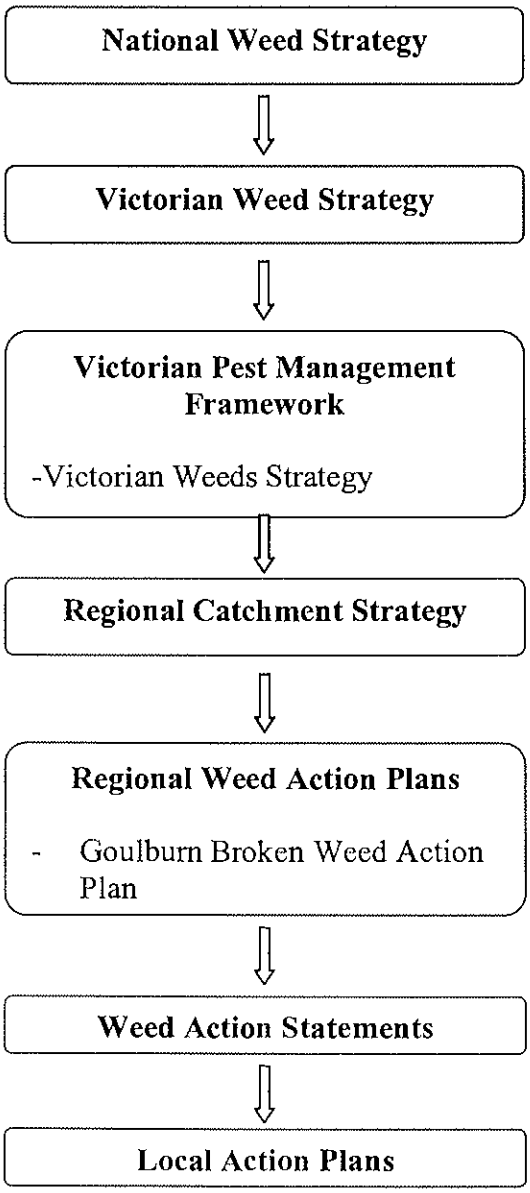
The North East PPA Program has 29 staff working from 15 locations. Some activities are statewide, whilst the majority are regionally based.

The funding of the program comes mainly from the Catchment and Water (CAW) purchasers. The total budget for the 1999/2000 period was just over $2.2 million.

Incentive funding is also available through Good Neighbour Program (GNP) for works on public land, Second Generation Landcare (for works on private land) and Weeds of National Significance (WON's).

Pest Plant Management

The PPA program is guided by state, regional and local policies and strategies for pest management;



The Regional Weed Action Plans provide a regional approach to weed management that complement the directions established by the National Weeds Strategy and Victorian Weeds Strategy. These plans were prepared through a co-operative effort involving the Department of Natural Resources and Environment, the Catchment Management Authorities and in consultation with the community.

The aims of the Goulburn Broken and North East plans are to;

* Identify priority areas for weed control programs to protect threatened assets, such as agricultural industries, biodiversity;
* Establish regional weed priority species;
* Encourage community ownership of weed program priorities;
* Clearly identify roles and responsibilities for land managers; and
* Provide a framework for investment on public and private land

The Pest Plant and Animal Program in line with the Regional Action Plans, has identified priority areas for weed control programs. These areas have been mapped on ArcView and data on the weed infestations placed onto the state recording database Integrated Pest Management System (IPMS). The criteria used to identify the priority areas are based on;

* the status of the weed
* Linkages to other co-ordinated control programs
* Project achievability
* Future threat
* To support Local Area Plans

The Regional Action Plans outline a list of priority weeds. This list encompasses known state prohibited weeds, regionally prohibited weeds and new and emerging weeds.

The Pest Plant and Animal Program for the North East Region is currently in its second year of the Rural Extension Program (REP). This program has been developed by regional staff and through negotiation with the Catchment Management Authority (CMA) and is funded through Second Generation Landcare. Traditionally weed control has been focussed on large infestations, however this program aims to move the focus, to targeting isolated infestations where long term control can be achieved. The program started in 1999/2000 with only 5 REP's and in the financial year of 2000/2001 has increased to 14 casual staff. Each REP is given a project area, priority weed and expected to visit around 100 landholders, deliver an extension package on the targeted weed, map infestations and develop a workplan agreement with each landholder. A follow-up inspection of properties will be carried out, and, if the weed control is unsatisfactory the REP reports to the Catchment Management Officer who then proceeds with compliance action under the *Catchment and Land Protection Act 1994* (CaLP Act).

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WEED MANAGEMENT IN QUEENSLAND

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Abstract:
This paper discusses changes to weed management in Queensland. Recent activities have included: actions under the strategic weed eradication and education program; the ongoing development of local government pest management plans, as well as state and national species plans; specific projects targeting state land management; and weed seed spread and the development of new legislation.
Key words: Queensland, legislation, pest management planning, SWEEP.

INTRODUCTION

Covering an area of over 1.7 million square kilometers, Queensland has 13 terrestrial bioregions which support more than 1000 regional ecosystem types, and habitat for approximately 65% of Australia's known frog, reptile, bird and mammal species and 47% of its vascular plants (Environment Protection Agency 1999). An estimated 1226 introduced plant species have become naturalised in Queensland since European settlement (Specht 1981). A number of Queensland's weeds are nationally important. 15 of the 20 Weeds of National Significance (WONS) occur in this state. Some of these weeds impact on significant areas. Parthenium weed occupies more than 17 million hectares, while rubber vine covers an area of 28 million hectares within the national containment line. The Australian Bureau of Statistics estimates that expenditure on "eradication of plant growth, animals or insects affecting sustainable land use" is a significant greater component of environmental expenditure by Queensland agricultural industry, comprising 60% of expenditure in 1995-6. The average for Australia was 40% in the same period (Environment Protection Agency 1999). The significant financial, approximately $500 million per annum, and environmental impacts have resulted in a number of regulatory and non-regulatory approaches to weeds in Queensland. Rather than focusing solely on widespread weeds, these approaches include a number of actions to prevent weed establishment and spread.

Legislation

The major legislation relating to invasive plants in Queensland is the *Rural Lands Protection Act 1985*. Currently 65 species/genera are declared under this legislation. Although noxious weeds were originally those that caused stock deaths, this term has been expanded to cover plants with significant impacts of all types. This Act seeks to reduce the rate at which major weeds colonize new areas and to prevent the introduction of species that pose a threat to the state. The Act has five categories that define the level of control required by landholders. As well as the above act, legislative measures relating or applicable to weeds are also included in a large number of other pieces of legislation: *Agricultural Standards Act 1994, Land Act 1994, Chemical Usage (Agricultural and Veterinary) Control Act 1988, Nature Conservation Act 1992, Local Government Act 1993* and *Environment Protection Act 1994*.

The Act lists 29 taxa as P1, not present in Queensland. The listing in legislation of these species has two roles: awareness raising (leaflets are developed to help officers identify the species if found) and regulation, which enables/requires rapid on-ground actions by Departmental staff and landholders. Eight species in this group have been found in Queensland in recent years and are now under active control or have been eradicated. Siam weed was one of these species, and more recently, *Limnocharis flava* has been discovered in Cairns. The listing of these species followed assessment of a large number of potential plant introductions with a weed risk assessment system. It paid off by alerting the State to plants that pose a high risk. A more recent study (Csurhes & Edwards 1998) has

shown a number of high-risk weed potential species, found in small numbers in the state. These will be targeted for removal as a prevention measure in the coming years.
After several years of drafting and delays, a revised Act will be proclaimed this year, the *Land Protection Act 2001*. In this Act the declaration categories are reduced to three that represent the groups: *potential weeds, established weeds* and *environmental weeds*. The potential weeds are quarantine pests, those not yet in the state or naturalised but under eradication, while the established weeds are those that are widespread but need state coordinated action. The environmental weed category is new. Species in this category, as in the other two, will be prevented from trade and distribution but actions will specifically be required and enforced on these weeds in environmentally significant areas. Some species will also be removed from the new Act and added to local government legislation (see local government section) as they are not significant pests at a state level and are better managed by affected local governments. Under the revised Act, management will be defined by guidelines for species management, rather than defined by regulations, allowing local management flexibility.

Strategic Weed Eradication and Education Program
One of the activities overseen by Land Protection over the past 5 years was the Strategic Weed Eradication and Education Program (SWEEP). SWEEP was unique as it tackled new weeds while they are still in their vulnerable early stages of invasion, as well as established weeds. SWEEP has, in partnership with local government and landholders, taken action on 15 species resulting in the signficant suppression in Queensland of honey locust, miconia, mikania, Siam weed, alligator weed and bitou bush. An economic analysis (Adamson & Lynch 2000) of the Siam weed control work showed that the investment has provided a positive return on the investment with a benefit: cost ratio of $8.90 for each dollar spent.
As well as controlling new weeds, SWEEP assists some local governments and landholders to initially "clean up" invasion fronts of major weeds in threatened catchments using best practice mechanical and chemical control methods. This has included activity inside and outside the national rubber vine and prickly acacia containment lines. The benefit: cost ratio to agriculture of these programs is positive and they assist the environment and non-costed industries like tourism. The budget for SWEEP has been significant, at over $12 million for 5 years. SWEEP will not be continuing in its current form but a number of key activities will continue with Weeds of National Significance funding.

Strategic planning for weeds
Queensland is currently developing management strategies for weeds at a number of levels (Wilson et al. 1999). Under the National Weed Strategy (Anon 1997) each state was tasked to develop a state weed strategy, which compiled the biological, scientific, social and regulatory factors in addressing the causes for the weed problems in the State. This state strategy has recently been finalised. Queensland has also been responsible for the development of nine Weeds of National Significance (WONS) strategies. Each of these strategies clearly identifies the problem with the plant and outlines the actions which need to be undertaken to manage the species, including managing underlying causes such as overgrazing or changes in fire regimes. It is essential to the success of these strategies that government and the community commit to undertaking the changes identified during the planning process.
A national strategy has been developed for Weedy Sporobolus grasses and this strategy was endorsed by the Australian Weeds Committee. As a non-WONS strategy, it was important that funds be sourced outside the National Weed Strategy. The Weedy Sporobolus Grasses Management Group has been successful in soliciting funds for research and coordination of the group from Meat and Livestock Australia and from the deputy Prime Minister, respectively. This group has also generated signficant media interest in several states within a very tight budget.

Weed management projects

Two projects were undertaken under the SWEEP umbrella to manage State lands and weed spread. State agencies in Queensland collectively manage over 10.8 million hectares of land. This includes national parks and state reserves, unallocated state land, state forests, roads and railway easements. A project undertaken by Jim Willmott in 1999 resulted in a new government poliey for the management of pests on state lands. Under the policy the five government agencies will develop, adopt and implement agency strategies and plans to control pests on land and water bodies for which they have direct management responsibility.

The Department of Natural Resources and Mines recently concluded a 12-month project, managed by Gary Zerner, to develop a comprehensive and strategic approach to weed infestations caused by human vectored seed spread. Major components of the Queensland Weed Seed Spread Project included:

- developing best practice procedures for clean downs, inspections and wash downs;
- introducing a Voluntary Vendor Declaration scheme for weed seed spread;
- coordinating construction of washdown facilities, signage, and location maps;
- protocol development with industry groups, service utilities, government departments and private companies;
- establishing collaborative arrangements with other states; and
- reviewing policies and developing a consistent approach for internal policies.

The outputs of this project are available on the Land Protection web site at: http://www.dnr.gov.au/resourcenet/land/landprotection/weedseed/outline.html.

Local government planning

Local governments act as agents under the *Rural Lands Protection Act 1985,* responsible for implementing pest management on their own lands and for monitoring and enforcing pest management on other lands in their jurisdiction. Therefore, local councils can issue a notice to a landholder requiring that declared plants be controlled on the land they own or managed by a specified date. In this way, the regulatory function has been delegated to the local governments in Queensland. Local governments can also declare weeds in their area but this legislation is subsidiary to state declaration. Local governments are able to impose rates on all landholders and this money can be spent on issues including weed management.

Until recently, to ensure that local government undertook pest management, funds were levied on these authorities on an annual basis and monies reimbursed after works were carried out. Under the new Act the councils will be responsible for financial management of weed control in their area and will carry this out under a pest management plan developed through consultation with landholders, industry and government agencies with land management responsibilities. This system of management has raised the awareness of pest problems in council areas as the council is required to conduct community consultation during its planning. A number of local governments have found that this community consultation has identified pest plants as a higher priority to the community than other issues and therefore budgets for the management of these species have increased accordingly. Local governments have also seen the value in increasing awareness for weeds present in neighboring shires but not yet in their own, considering them quarantine pests for their regions. Other councils have also regulated modes of weed seed spread (including the building of wash down facilities) and some have undertaken eradication programs on new weeds not yet recognized by the State. Some local governments have been elected on weed platforms. Most importantly, weeds have been raised to a higher level of importance.

DISCUSSION

The major challenges for Queensland in the next years are the implementation of the new legislation and the developed strategies to see real on-ground changes in weed management. The new legislation embraces both urban and country pests, which is a change in focus from the previous

legislation that had a strong production focus. This is reflected in the new environment pest class, although it will be applied to all environmentally signficant areas; urban or rural.

At the same time the significant resource and time put into the various levels of planning in recent years now requires that the plans are implemented to achieve the anticipated benefits. These plans must be made consistent at all levels, which will require significantly improved coordination of the plans and at times changes in attitude by some stakeholders or changes to the plans. Dedicated coordinators, similar to Landcare coordinators, are likely to be required to oversee them and ensure this consistency. To date some plans, for example, the state parthenium weed plan, have seen changes to policy and on-ground activities including increased rigor to the assistance scheme for herbicides, signage for wash downs and increased awareness activities but many plans currently exist only on paper. A strong management group that embraces and progresses the strategies is likely to be an important component in effectively operationalising the strategies. The current activity by the Weedy Sporobolus Grasses Management Group provides a good example of this trend.

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COMMUNITY CONSULTATION FOR DEVELOPMENT OF WEED CONTROL POLICY

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INTRODUCTION

Over the past four years we have seen major changes in the approach to the management of weeds in NSW. The arrangements now in place link funding to outcomes. To demonstrate success we have had to increase our strategic approach to noxious weed control. In a competitive environment, programs which use a strategic approach, are well planned and incorporate a balance of methods, are more likely to obtain government funding.

Community involvement is an important principle in plan-making. Engagement of the community to help develop ideas and concepts will make plan-making more collaborative, give the community a greater sense of ownership, and ensure support for a legitimacy of the plan and its corresponding actions.

In this paper I will give an overview of the challenges facing weed managers as they try to integrate public input into the plan making process, and help communities identify with, and participate in, the development of Weed Control Policy.

WORKING WITH THE COMMUNITY

As with any collaborative exercise, community consultation in the development of weed control policy faces a number of obstacles on a range of levels. These include the presence of conflicting values amongst participants, uncertainty about outcomes, the difficulty of defining responsibilities, and basic resource issues such as time, money and personnel.

Combined with these there is often a dissatisfaction with conventional consultation methods such as public meetings and formal submissions. Many of us can easily remember poorly attended meetings, a feeling among participants that they haven't been heard, and rumblings that valuable time and resources have been spent less effectively than they could have otherwise been.

The good news is that many of these doubts and difficulties can be overcome. Differences of opinion are inevitable. However, successful management of these issues is possible by developing a strategic, integrated and 'involving' approach to consultation and participation.

Each of us engages with the community to varying degrees in our current work practices. With the recent changes to the approach in the management of weeds in NSW, the opportunity has arisen to engage the community in all aspects of the (Regional) Weed Planning process. How successful we are in empowering the community to develop a sense of ownership and responsibility for this problem, ultimately relies on a number of key elements.

1. Planning

Developing Weed Control Policy in consultation with the community requires careful planning to ensure it is involving, meaningful, useful and effective.

Figure 1 details a step-by-step guide that addresses a number of key issues that need to be considered when consulting the community in developing Weed Control Plans and Policies.

WEED TRAINING/INDUSTRY SKILLS RECOGNITION

Bryson Rees
Supervising Officer Weeds
Wellington Council

As a Weeds Officer back in 1978 with a 44 gallon drum on its side in the back of a ute, put in whatever chemical you have, no PPE or qualifications now go to work. What a way to start a career.

A Weeds Control Practice course not available in all parts of NSW, Local Government ITC course never reached any heights and while all this was happening your Council provided little or no specific training. What training was provided was not co ordinated or accepted by other Councils.

A brief summary of the past 20 years or so, one must admit a few Councils were well organised in training of their staff, but still not accepted state wide.

With a new direction needed and Weeds Officers continually calling for a co ordinated approach to training, something finally happened.

A national approach to weed competencies, Regional Weed Action Program funding and a concentrated approach by Macquarie Valley Weeds Advisory Committee we had a chance of a co ordinated approach to training.

Then with a Project Officer/Consultant employed, a partnership with Tocal Ag College, developed an audit of Weeds Officer current qualification and their need a very clear picture was appearing. NSW Weeds Officers and Councils needed and supported the Macquarie Valley Education and Training package.

By this time another clear picture was emerging, in that Weeds Officers where not going to support a training package that was going to see them heading back over training already completed. Now we have recognition of prior learning.

With the pieces of the package falling into place the light started to appear at the end of the tunnel. The support was growing, further backing by key stakeholders made sure that end result was going to be achieved.

Unfortunately still we have Councils, Directors/Managers within Council's that believe we do not need to train weeds staff as they only spray weeds. How far behind times these people are.

The new Pesticide Act,1999 and Regulations, plus funding criteria set out by NSW Agriculture for the next few years will change the negative thinking within these organisations. Only then will all Weeds Officers receive the required training and qualifications to carry out their job professionally in the future.

Now to have a full time training co ordinator, an Education and Training Package, National Competencies ready to be signed off the Weeds Officers of NSW and their employers have the opportunity to lift their skills and profiles.

Finally to all involved in developing the Education and Training Package congratulations on a magnificent job. Yes it has taken some time but in the end the Weeds Officers of NSW now have a training package endorsed across NSW.

Many thanks to you all.

A DREAM BECOMES A REALITY FOR WEEDS OFFICERS

George W. Hammond
Chairman
Macquarie Valley Weeds Advisory Committee
Narromine

When the Noxious Weeds Advisory Committee called for applications for funding for innovative projects that would be a benefit to the community I immediately thought of past efforts to establish training and educational programs for Weeds Officers. In the past these programs had failed and that there was a very poor perception within the community of who a Weed Officer was and what his job requirements were.

After reading the request for proposals for funding under the Regional Weed Action Program I decided to suggest that our committee submit an application for funding to create a suitable **EDUCATION AND TRAINING PROGRAM** for Weeds Officers.

THE IDEA

In considering the proposal it was not just for the sake of training but it would also benefit the profile of noxious plants within our community and also lift the image of all people involved with noxious plants eradication.

The idea required that a concerted effort should be made to develop a training course which would be acceptable by all authorities (Councils, County Councils, Rural Lands Protection Boards, National Parks & Wildlife , State Rail, Forestry Commission, etc.) resulting in suitable accreditation for all personnel involved in noxious plant control. The curriculum would be divided into modules covering all essential aspects of a Weeds Officer's activities such as personal hygiene, safety, spray drift (including recommended control measures adjacent to organically grown crops), application weed identification, all the various workplace requirements (RTA, SRA, etc.), safety on roadways & highways, 4 wheel drive courses, legal aspects, integrated noxious plant control (an environmentally acceptable approach and the factors contributing to land degradation),etc. The course would need to be uniform, simple because people do tend to relocate from one area to another. Only the actual weeds would differ from one area to Biennial Weeds Conference held in Dubbo. The executive of the MVWAC another, administration, legal aspects, control techniques, etc. would remain the same. The judiciary system would develop confidence in the presentation of court cases, as all cases would be prepared in a uniform manner. Material which would be included in the course had already been prepared under previous programs eg. Farm Chemical Users Course, legal aspects, etc.

COMMENCEMENT OF THE PROJECT

The proposal was accepted and supported by the Macquarie Weeds Advisory Committee (MVWAC) and a diligent Subcommittee of the MVWAC was comprised with Messrs Roger Smith (Orange City Council), Bryson Rees (Welling Council), Ian Chapman (Mid-Western County Council), Peter Giles (Bogan Shire Council) and George Hammond (Chairman, MVWAC – Narromine).

The committee was assisted by Cr Reg Kidd (Orange City Council) with his wide and varied experience and knowledge, in both, the education and noxious weeds aspects of the field . His input was invaluable with the preparation of our proposal. Cr Kidd was later employed as the programs Project Officer.

WHY IS IT NEEDED

Over many years numerous efforts have been made to develop and conduct training courses for Weeds Officers with extremely disappointing results. This was largely due to a lack of singular direction and positive goals, resulting in frustration. A disjointed approach had been in operation. A number of agencies have been in the process of developing courses and/or modules but with a lack of co-ordination and genuine consultation with Weeds Officers, resulting in duplication, confusion and a waste of scarce resourses and finances.

Both the New South Wales and National Weeds Strategies were launched in mid-year 1997, emphasising a strong need for a uniform approach to training and listed improved management and education as two major objectives in developing a sustainable weed strategy.

Training has been often an agenda item on most weed meetings, including the Weeds Association and MVWAC agenda's. It was also on the agenda of the have on many occassions been asked to circulate member LCA'S alerting them to matters such as that it may be necessary for their officers to attend a 4 wheel Drive Safety course and/or an RSA Track & Awareness course,. LCA's were also advised by the MVWAC to clarify where they stood legally should ramifications arise and to examine operational contracts to ensure officers are legally qualified to carry out the required tasks.

Local Control Authorities that did not have their Weeds Officers properly trained could be faced with controversies involving large amounts of money due to ignorance in relation to officer training.

THE EDUCATION AND TRAINING PROGRAM

- The best part about this course is if a Weeds Officer out at Condobolin wishes to apply for a job on the north coast, he will be properly trained for the position, only the weeds will change.
- Officers will be able to set a career path, strive and achieve that ultimate goal by climbing the module ladder.
- Have confidence in their qualifications and know they are highly efficient, up to-date and competent operators in their choice of employment.

This Noxious Weed Education and Training Program has been prepared by **Weeds Officers** for **Weeds Officers,** which has made their dream become a reality.

It is most important that all personnel involved with protecting our environment and valuable resources for future generations through the control of noxious weeds be fully conversant and up to-date with all techniques available with using chemicals, using competitive pastures, biological controls, integrated pest management systems etc. An investment in their future training and skills development will pay large dividends and be extremely cost effective measure in the long term.

This program is consistent and uniform throughout the State allowing officers to relocate from one position within NSW to another, requiring equivalent qualifications.

The introduction of this training program for Weeds Officers will develop better management programs, environmental protection and reduce liability prospects for LCA'S . Further benefits will include increased communication skills, budgetary knowledge, standardisation of reporting requirements, more efficent project planning in conjunction with landholders, which will result in more successful noxious weeds eradication.

CONCLUSION

- This program will assist Local Government weed control programs
- It has been developed by a Regional Advisory Committee

- This innovative program will reduce the call on State funds over time
- It forms part of the regional plans and addresses declared weed issues
- This program addresses issues raised in the State Weeds Strategy and outcomes will have Regional, State and National benefits

Finally thank you to my fellow sub-committee members for hard work and diligence for a job well done and to the Macquarie Valley Weeds Advisory Committee for their support of the program.

The program will also provide

- Uniformity in the control of noxious weeds
- Increased efficiencies in the control of noxious weeds
- A higher level of competencies for the control of noxious weeds
- Better accountabilities
- Better job adaptability for weed officers
- Better abilities in planning, communications and people planning
- Reduced risk exposures for LCA's with their noxious weeds control activities
- Better public perception of weed control activities
- Acceptability to Local Government bodies in their training programs

MACQUARIE VALLEY WEEDS ADVISORY COMMITTEE: Education and Training Program

Reg Kidd
'Roma"
ORANGE NSW 2800

DEVELOPING THE PACKAGE

Development of the Weeds Officers Training and Education Program (Package) has taken a relatively short period of time in comparison to development time I have experienced in over 20 years involvement in education and training.

In August 1997 – NWAC invited submissions for funding for projects under the Regional Weeds Action Plan.

At a meeting in Orange, the Macquarie Valley Weeds Advisory Committee (MVWAC) decided to put in a submission. A subcommittee was formed and a submission put together in late 1997. The submission was forwarded for signing off in November 1998. There was a delay of some 12 months to allow sufficient time for the completion of the national competency standards and to avoid unnecessary duplication with the two projects. The Committee then advertised for a Project Officer to assist with the development of the Program. I was successful in being appointed and an Agreement was signed in late 1998.

The basis of our submission was to have a quality training management system that would be nationally recognised with clearly defined career pathways.

An important factor in the success for the project was that in addition to grant funds provided through NWAC, participating councils contributed in finance or in kind a matching proportion of funds – this gave ownership of the process.

The Application was granted $120,000 and local control authorities contributed a further $50,000.

The Committee worked closely with the National Competency Project Committee so the two projects were completely compatible. Two project steering committee members were invited to take part on the National Competency Project Committee so that MVWAC had direct input and knowledge of the ultimate goals being achieved by the Competency Committee, thus assuring the MVWAC project was integrated.

The Committee wanted the project to pull together the national competency work that was occurring, and to integrate training proposals.

A training subcommittee was formed consisting of Roger Smith, Bryson Rees, Peter Giles, Ian Chapman, George Hammond and myself. The enthusiasm of this group undoubtedly was a key component of the project's success.

The MVWAC Education Training Committee worked extensively towards meeting the requirements of the national competency standards, and local government training requirements.

An extension of the activities of the Committee was to achieve support and backing from vital components of the overall workplace, those being Local Government & Shire Association (LGSA), NSW Government, NSW Agriculture, State Forests, Road Traffic Authority, Rail Services of Australia, National Parks and Wildlife, Municipal Employees Union (MEU), Department of Land & Water Conservation, Landcare, Rural Land Protection Boards (RLPBs) etc. Also Education providers such as TAFE and NSW Agriculture, Primary Industry Training and Advisory Board (PITAB), Rural Training Council of Australia, and the Cooperative Research Centre for Weed Management Systems were all consulted to ensure relativity and to avoid duplication.

The Project was the first time all relevant stakeholders had been involved and fully committed to achieving a satisfactory result of developing a course acceptable to the industry and one that would be taken up by weeds officers.

Numerous attempts have been made over nearly two decades to develop training programs for the industry. Extensive amounts of state government funds, effort, and time have been expended but there has never been any cohesion and few measurable outcomes.

Rapid progress towards the final development of the project began with the listing of all the minimum requirements weeds officers need to comply with with competency standards within their workplace. A skills analysis was done with officers within the Macquarie Valley.

A review was done of the national competency work in conjunction with a meeting of Macquarie Valley weeds officers, NSW Agriculture, MEU, LGSA, Tocal College, TAFE and Charles Sturt University. This peak meeting of all relevant stakeholders gave endorsement to the direction and establishment of the national competency standards. It must be emphasised that this was the first time that the ultimate stakeholders, ie weeds officers, actually had empowerment of the process.

This peak meeting also gave endorsement to the development of the Weeds Officers Training and Education Program. Weeds officers were always involved following this forum and have been the major players in the development of the project.

A state advisory committee on education and training was established comprising all known stakeholders to supervise the overall development of the Training and Education Program. This committee is chaired by Mr Richard Carter, Program Leader Weeds, NSW Agriculture.

The skills analysis done of weeds officers in the Macquarie and Lachlan regions and a search of all existing training courses and resource materials resulted in an agreement to use, in a modified form, Certificate 2, Weed Control Operations and Certificate 4, Weed Control Practice as core units to benchmark the training program.

In conjunction with skills analysis and Certificates 2 and 4, a Recognition of Prior Learning (RPL) process was developed to be piloted within the Macquarie Valley. Five officers undertook an RPL exercise in conjunction with Tocal Agriculture College (NSW Agriculture) who were contracted to co-develop a manual, a skills book, video and an information package.

In the meantime all officers were benchmarked with their chemical accreditation and various other training modules were undertaken to fulfil agreed upon skills deficiencies ie Technique of Presentation (TOP) at Yanco Agricultural College and weed seedling identification training (a CRC course).

To date 45 weeds officers have completed Certificate 2 in weed control operations and 8 of these have completed Certificate 4 in weed control practice. The first Certificates 2 and 4 were presented in 1999 at the Tocal College Certificate Day by the Director General of NSW Agriculture Dr Kevin Sheridon.

In November 1999, 15 officers successfully completed a Rural Workplace Trainer and Assessor Course in Mudgee. It was the largest group to undertake the Workplace Trainer and Assessor Program for the Primary Industry Training Board. The value of the assistance from the PITAB is conservatively placed at $15,000.

We attended and did a presentation to the 10th Biannual Noxious Weeds Conference held in Ballina in July 99 to make sure everybody in the industry were kept informed. I addressed NWAC, elected members (Councillors) and weeds officers and Mr Richard Carter gave a presentation to the conference on National Competency Standards and the Training Program.

The Project team participated actively in Weeds Buster Week in 1998, 1999, 2000 and will again this year.

MVWAC and the Education and Training Committee have initiated a noxious weed awareness-training program through an extensive TV advertising campaign. This has lifted noxious weeds awareness to a high level.

In an effort to raise the awareness of noxious weeds problems and identification, study tours for weeds officers and elected members were developed and introduced for the Macquarie and Lachlan Valley regions in 1997 and are now held biannually and are available to weeds officers throughout the whole state.

Presentations have been given to several other Advisory Committees and several officers from those regions have now commenced RPL assessment.

Presentations have been given to NSW Weed Society Conference in Orange in 1999 covering the training and education program.

The manual for the RPL has been printed and is in wide circulation. The skills competency log book developed in conjunction with the national competency work and the training video are also in circulation.

The Education Steering Committee was successful in having a second grant for the extension of the training and education program nationally, and for the development of identified modules to address specific training needs (ie Spray Drift Minimisation and Risk Management).

This project addressed one of the key points and prime objects of the national and state weeds strategies training.

MVWAC has worked very hard to achieve common goals required by all weeds officers in NSW and is grateful for the extensive support extended from all the training providers and other key stakeholders.

It is important to realise that this project has been successful because it fulfilled the educational and training needs of weeds officers.

The project has been owned and driven by the intended participants – the weeds officers. This "bottom up" approach has worked and it is without fear of contradiction that I can say that it has been one of the most cost effective and efficient training programs developed for industry.

The outcomes can be measured in the numbers completed or undertaking the program at present.

It involves all aspects of the National Training Agenda and genuinely uses Recognition of Prior Learning.

What is the "Package"

- Skills audit of officers
- Recognition of their skills (or current competencies)
- Mapping of those skills (competencies) against existing (and in the future, training packages)
- A skills record book
- A simple promotional video
- The whole process underneath the National Training Agenda
- A career training pathway

Conclusion

Currently we are piloting a possible Diploma level course, which will extend the package from short courses to management level.

May I take this opportunity of thanking you – the industry and all involved for allowing me to be part of the most innovative and effective education and training programs I have witnessed in over 25 years involvement in education and training.

CERTIFICATE QUALIFICATIONS FOR WEEDS OFFICERS
Recognition of Prior Learning through Tocal College

Joanna Blunden
Education Officer
NSW Agriculture
CB Alexander Agricultural College, TOCAL

Introduction

Certificate qualifications in weed control are available through CB Alexander Agricultural College, Tocal. The Certificate II in Weed Control Operations and Certificate IV in Weed Control Practice are accredited qualifications that are endorsed by industry.

These qualifications are achieved through assessment of existing skills against the Certificate requirements. This process is called recognition of prior learning (RPL).

RPL recognises the skills and knowledge that a person has as a result of formal training, work experience and life experience. This means that existing skills can be acknowledged no matter how they were developed.

RPL gives people experienced in weed control credit for what they have been doing. It provides many benefits for weeds officers including:

- formal skill recognition
- increased career and education options
- reducing the time taken to achieve a qualification
- not having to cover areas where you already have skills
- providing a clear picture of what training you need (if any) to gain a qualification
- reducing the cost of your qualification.

To meet the requirements for these qualifications weeds officers can:

- undertake RPL for all modules
- combine RPL and further industry training.

The framework for delivering the qualifications

In 1999 NSW Agriculture developed an RPL information kit for weeds officers on behalf of the Macquarie Valley Weeds Advisory Committee. This kit provides all weeds officers with access to the qualifications no matter where they are located.

The RPL Kit includes a manual, video and skills record book.

The manual provides information about:
- Certificate qualifications in weed control;
- RPL; and
- preparing an RPL case.

The video introduces the RPL Kit and encourages weeds offieers to get their skills formally reeognised. It features personal descriptions and experiences from weeds officers who have participated in the RPL program to aehieve qualifications.

A skills record book is also ineluded in the kit. This provides another option to get skills development recorded. It is important to weeds officer who require more training and industry experience to meet the requirements for a qualification.

A series of workshops was run throughout NSW to provide further information and assistance to weeds officers when preparing applications for RPL. Importantly, this was an opportunity for Tocal to build relationships and for education staff and industry participants to meet face-to-face.

Steps to formal skill recognition

To get skills formally recognised weeds officers need to make a written application to Tocal College. There are five steps to be followed when preparing a written application for RPL:

1. find out how RPL works;
2. decide in which modules to apply for RPL;
3. prepare a written case;
4. collect evidence to provide; and,
5. submit the application for assessment.

Tocal provides support to applicants throughout all stages of the RPL process.

Experience counts

These certificate qualifications include compulsory and elective modules. Both qualifications require a balance between technical and interpersonal skills. Weeds Officers applications for RPL have varied according to the region they were from and their previous training.

The applications revealed a diverse range of experience. Weeds officers provided evidence of their skills and knowledge including

- certificates or other qualifications
- training courses that had been completed and topics covered
- job descriptions
- workplace competency statements and on-the-job skills evaluations
- reports and written documents such as property inspection reports, chemical record sheets, monthly reports, budgets, reports, weed management plans, diaries, logbooks and photographs of projects
- references and testimonials
- answering questions and discussing achievements on the phone
- descriptions of previous job experience and relevant activities.

Weeds officers get qualified

A total of 83 applications for RPL have been submitted by weeds officers from throughout NSW. These applicants are from the following regions:

- Eastern Riverina
- Hunter and Central Coast
- Lachlan Valley
- Macquarie Valley

- Mid North Coast
- Namoi Gwydir
- Far North Coast
- South Coast and Southern Tablelands
- Western Riverina
- Western Sydney/Blue Mountains.

Weeds officers continue to show a keen interest in getting their skills and knowledge formally recognised. The number of applications received demonstrates the acceptance of the benefits of qualifications for an individual and the weed control industry.

The wealth of skill and knowledge amongst weeds offices is evident in the number qualifications that have been achieved. Since this program began in 1999 Tocal has issued:

- 43 Certificate II in Weed Control Practice qualifications
- 18 Certificate IV in Weed Control Operations qualifications.

The names of these people are recorded as graduates of CB Alexander Agricultural College, Tocal.

Applicants who received RPL for most of the certificate requirements now have a clear training pathway to achieve a qualification.

Conclusion

RPL provides skilled weed control officers with the opportunity to be recognised for what they do in their workplace. It provides a link between previous training and new qualification structures.

The achievement of qualifications is a collaborative process between industry workers, councils, advisory bodies and educational providers.

This is a model that your industry can be very proud of.

ACKNOWLEDGEMENTS

I acknowledge the Macquarie Valley Weeds Advisory Committee (MVWAC) for the commitment it has shown to education and training for weeds officers.
I would like to thank Mr Reg Kidd, Project Officer MVWAC, for the support and assistance he has provided to this program.
Sincere thanks to the weeds officers who formed the original pilot group and tested the program methodology.
I thank Mr Darren Bayley, NSW Agriculture Tocal for reviewing this paper.

TRAINING PROFESSIONAL WEEDS OFFICERS – it's a whole new ball game!

Darren Bayley
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INTRODUCTION

In response to industry demand, a formal training program specifically designed for weed control personnel has been established. The focus of the program is to provide professional accredited training to weed officers that is practical, timely and immediately relevant. This training is delivered through a variety of methods, including workshops, short courses and external study units. All training is aligned to industry standards and counts toward industry qualifications. Each training event is recorded and documented by the Registered Training Organisation (RTO), CB Alexander Agricultural College, Tocal.

The purpose of this industry-led training program is to develop highly skilled and recognised specialist weeds officers, who work to industry standards and have an improved career pathway.

This new training strategy is funded by the NSW Noxious Weeds Advisory Committee (NWAC) with the support of NSW Agriculture. Local control authorities also contribute to the cost of training their weeds officers.

WHY GET INVOLVED IN TRAINING?

The role of weeds officers and the way they go about managing weeds is changing and expanding. There is now a greater emphasis on:

I. planning
II. achieving best practice and meeting industry standards in all control activities
III. communication
IV. measuring performance, outcomes and benefits of weed management programs
V. being accountable for resources
VI. environmental protection.

Getting involved in training and working towards a qualification will help weeds officers meet the challenge of their work environment and deal with an ever-changing industry. Training and achieving an industry qualification will help weeds officers:

I. improve the way they do their job
II. identify their skills and knowledge
III. increase their career opportunities
IV. raise their profile as a weed control professional
V. enhance their self-confidence
VI. gain the skills to take on management roles.

TRAINING FOR ALL LEVELS OF EXPERIENCE

Training is available throughout the state for all weeds officers. Highly experienced instructors deliver all courses through CB Alexander Agricultural College, Tocal.

Training courses include:

I. chemical application and management courses, such as SMARTtrain
II. weed identification, including aquatic plants
III. weed inspection and vegetation surveying
IV. legal training for weeds officers
V. communication training
-report writing
-presentation skills
-conflict resolution
I. integrated weed management training
II. minimising off-target damage from agricultural chemicals
III. leadership and management training.

The NSW Noxious Weeds Advisory Committee supports and promotes training. Most training is available to weeds officers at a heavily reduced rate because it is subsidised. Table I outlines the NWAC supported training courses undertaken in the last financial year and the number of participants. The total number of participants in training events for this period was 525 (see table 1).

Table 1 - Training summary for the financial year 2000-2001

Training Course Title	**Number of Participants**
Legal Training for Weeds Officers Stage 1	86
Legal Training for Weeds Officers Stage 2	175
Aquatic Weed Identification	12
Conflict Resolution for Weeds Officers	61
Report Writing for Weeds Officers	40
Environmental Weed Management	15
Minimisation of off-target damage and spray drift	136
Total participants in training courses	**525**

The range of courses available will expand to meet the needs of weeds officers as they are identified. Weeds Officers are encouraged to suggest new and further training initiatives based on their emerging workplace needs.

Training is delivered through a variety of methods, including workshops, short courses and external study units. All training is accredited and, when completed, counts toward a qualification.

HOW TO TAKE PART

Weeds officers are notified directly by mail of up-coming training events in their region. An overview of the planned course/workshop is provided along with accreditation details so weeds officers can make informed decisions with their managers as to whether they should be involved. Weeds officers are asked to confirm their interest and participation in training workshops by faxing the return confirmation sheet that is provided. The location of training events is flexible and is based on demand.

Getting involved in training and working towards industry qualifications is a simple process:

I. have current industry skills recognised
II. identify training needs
III. take part in accredited short courses and workshops
IV. use training materials and resources to improve skills
V. have all job training count towards industry qualifications.

INVESTING IN THE FUTURE

Our greatest resource in the control of weeds are not modern herbicides, biological agents or specialised equipment, it is weeds officers themselves. The basis of any effective control program is having highly competent, skilled and professional weeds officers that are able to plan, implement and review these programs to industry standards. Training plays a major part in the development of this skill and professionalism. As the old saying goes: *training teaches more in one year than experience in twenty.*

The success of this industry training program will depend on the commitment and involvement of weeds officers and the support of their employers. For those weeds officers who have already achieved industry qualifications the training offered should be viewed as part of a professional development program.

WHAT IS ON THE HORIZON?

New national standards are on their way. These competency standards are statements of the level of skills, knowledge and attitudes expected of weeds officers in various positions and roles in the workplace. These standards will set the benchmarks for performance and will guide the design and development of future training programs.

These national standards will benefit weeds officers by:

- providing an industry foundation of uniform standards for quality assured training
- providing greater education and training options
- making qualifications more portable and transferable
- clearly defining performance measures and benchmarks
- providing greater career options.

WHO TO CONTACT

For further information on weeds training, contact your NSW Agriculture Regional Weeds Coordinator or contact the Training Coordinator at CB Alexander Agricultural College, Tocal.

CONCLUSION

The Noxious Weeds Advisory Committee and NSW Agriculture have responded to industry demand by developing a formal training program for weeds officers. The opportunity now exists for weeds officers to take up practical, low cost training to improve their weed management skills and expand their career options.

This program is about getting involved, getting training and getting qualified.

ACKNOWLEDGMENTS

I would like to thank my colleagues David Brouwer and Joanna Blunden for reviewing this paper. I would also like to thank the Noxious Weeds Advisory Committee and the NSW Agriculture Weeds Program for their investment in industry training and education.

NWAC INITIATIVES FOR WEEDS OFFICER TRAINING

Peter Gray
Noxious Plants advisory Officer
NSW Agriculture, Dubbo

The Noxious Weeds Advisory Committee (NWAC) recognises that weeds officer training is vital for the implementation of effective noxious weed control programs in NSW.

Until recently training for weeds officers has been on a rather ad hoc basis without any formal recognition of training requirements or standard qualifications across the industry.

NWAC has recognised the importance of well trained, and consequently qualified, weeds officers to direct noxious weed control in the state. Therefore it has adopted a pro-active approach and is now implementing active leadership so as to provide the state with well trained weeds officers. NWAC is providing funds to subsidise the cost to councils for selected courses and promote the attendance of weeds officers. In particular it is targeting the managerial competencies of the senior weeds officers as the effects of good management will benefit the whole industry.

NWAC provided funding through an Regional Weed Action Program (RWAP) grant to the Macquarie Valley Weeds Advisory Committee for their "Education and Skills Recognition" package. This project has been the subject of earlier reports in the current session of this conference.

NWAC is supporting a position of "Training Coordinator for Local Government Noxious Weeds Officers" to implement specific training proposals adopted by the Committee and to promote training generally. It recognises that to be effective the training program needs to be pro-active, well planned, well delivered and be subject to on going evaluation, ie it requires professional input.

In broad terms the role of the position is to coordinate and expand training for local government (LCA) weeds officers, addressing the draft national competencies.

In summary the role of the position is to:

Identify;

- Target audience
- Their training needs
- What to deliver
- Training priorities
- Available training
- New training resources

Implement;

- The development of new training units as required
- The delivery of training courses
- The forward planning of course delivery
- Liaison with clients

Maintain register of:

- Training materials
- Training resources available

- Training carried out

Mr Darren Bayley, an Education Officer at C B Alexander Agricultural College at Tocal near Paterson, has been appointed to the position. He has considerable experience in education and training and has already implemented a number of NWAC sponsored courses. The College is at the forefront of agricultural training and consequently an officer based there has access to many facilities and expertise.

Mr Bayley will elaborate on the various training courses being implemented or planned in the following presentation.

Mr Bayley is the author of "Efficient Weed Management" which is an excellent information resource for any one concerned with weed control. A copy of this book has been distributed to all Local Control Authorities in NSW for the benefit of their weeds officers. Further copies may be purchased direct from the College. In addition Mr Bayley has been actively involved in the development of the draft national competencies so he is in an excellent position to ensure training is married to the competencies. This will ensure that weeds officers obtain the maximum recognition for their training efforts.

The continuing funding and public support of noxious weed control programs is dependant on the effectiveness and credibility of all those involved, particularly the weeds officers. All weeds officers are urged to take advantage of training opportunities to improve their skills, enhance their job prospects and contribute to the improvement of noxious weed control in NSW.

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ENVIRONMENT PROTECTION AUTHORITY AND THE NEW PESTICIDES ACT
The Pesticides Act 1999 And Its Implementation

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Environment Protection Authority

BACKGROUND

The *Pesticides Act 1999* (replacing the older Pesticides Act 1978) has been in operation since 1 July 2000 and is administered by the NSW Environment Protection Authority (EPA).

Before pesticides can be made, supplied, sold or used in NSW they must be registered by the Federal body known as the National Registration Authority for Agricultural and Veterinary Chemicals (NRA). Registered pesticides have an NRA label with instructions on how to use that pesticide. Following these instructions is essential to minimise possible harmful impacts on health, the environment and trade.

The EPA enforces the proper use of all pesticides in NSW, after the point of sale. This includes pesticides used in agriculture, on public lands and on domestic and commercial premises.

WHO IS AFFECTED BY THE PESTICIDES ACT 1999?

Everyone who uses pesticides including pesticide users in councils and government agencies, farmers, aerial sprayers, ground rig operators, livestock producers, weed sprayers, pest controllers, market gardeners, flower growers and domestic users.

WHAT SORTS OF PESTICIDES DOES THE PESTICIDES ACT COVER?

The definition of pesticides is broad and includes herbicides, insecticides, fungicides, bactericides, rodenticides, baits, lures, external parasite treatments and repellents.

PROVISION OF SHARED LIABILITY

All people involved in making decisions may share legal responsibility under the Act and can be fined if the pesticide is misused. This includes the owner of the land, the person using the land, consultants and contractors as well as the person applying the pesticide.

It is important that a land occupier tells the person applying the pesticide all the information they need to know, such as whether there are surrounding sensitive areas or crops. This provision also tries to stop people from making someone apply a pesticide when the weather conditions are not right.

Similarly the person applying a pesticide should be satisfied that all relevant information has been obtained before applications begin so that non-target impacts are avoided.

HOW CAN PESTICIDES USERS MAKE SURE THEY ARE DOING THE RIGHT THING?

Pesticides users need to carefully read and follow the instructions on the label. They must also think about each application thoroughly before using the pesticide and do everything they reasonably can to ensure that there are no non-target impacts. For example they must make sure that they:

- use only registered pesticides or those allowed for use under an NRA permit

    - use the pesticide strictly as directed on the label (unless they have a permit from the NRA to allow specific off-label use). Label directions must be followed to help minimise possible harmful impacts on health, the environment and trade.
    - identify nearby houses, crops or livestock to make sure they are not exposed to the pesticide. If a farmer or manager has asked someone else to apply a pesticide, they need to provide that person with the information about nearby houses or items that must not be harmed.
- spray in suitable weather conditions so that spray does not drift outside the target area. Don't spray in high winds or when there is no wind. A light steady wind blowing away from houses and other sensitive areas is best. Don't spray just before rain.
- check for people downwind of the application site and make sure they will not be exposed to the pesticide.
- use the right equipment and make sure it is well maintained, calibrated and operated
    - provide adequate instructions and training to all employees or family members who use pesticides on the farm or property.
    - do not store pesticides in containers that do not bear an approved label.

OTHER KEY POINTS ABOUT THE PESTICIDES ACT 1999

- Maximum penalties for most offences have increased to $60,000 for individuals and $120,000 for corporations. Fines for offences committed wilfully or negligently are $120,000 and $250,000 respectively.
- There are also Penalty Infringement Notices (like on the spot fines) for minor offences.
- Compliance notices may be issued (eg prevention notices and clean up notices) where harm is occurring or has occurred, or where a breach of the Act is likely.
- Lower application rates can be used unless specifically disallowed on the label.

PRIORITY TASKS OF THE PESTICIDES IMPLEMENTATION COMMITTEE

The Act established the Pesticides Implementation Committee (PIC) which provides advice to the Minister for the Environment and the EPA on how to put the new Pesticides Act into practice.

The committee has an independent chair (Dr. Cameron Hazlehurst) and broad community representation. It is addressing as a priority the following key areas:

Proposed record keeping regulation

A draft regulation and Regulatory Impact Statement (an assessment of the costs and benefits of the proposal) detailing proposals for mandatory record keeping for all commercial pesticide users (including farmers, pest controllers, weed sprayers, government agencies and local councils) were released for public comment in early February 2001. The EPA has reviewed the approximately 300 responses to the proposal and the Pesticides Implementation Committee is considering the results of the analysis. When the regulation is finalised, the EPA will prepare and publicise guidance material to assist pesticide users understand what is required for record keeping.

Proposed training regulation

Proposals for mandatory training of commercial pesticides users, including farmers (and others as for the record keeping proposal) are being considered by the PIC.

While the proposals are still being developed, it is intended that the training would be competency based and that people who have already done training under the Chemcert (or former Farmcare) or SMARTtrain programs would be accepted as meeting the training requirements for 5 years after the date of their training. It is also intended that there would be a 2-year phase-in period to allow people to have their experience and skills formally assessed and recognised or to undertake any training they

may need. A draft regulation and associated Regulatory Impact Statement are likely to be released towards the end of 2001 and the EPA will then be seeking comments on the proposal.

Prior notification of neighbours
The Pesticides Implementation Committee (PIC) has been considering the use of notification in minimising the risk associated with pesticides use and in meeting community expectations of "right-to-know". The PIC has recommended a multi-pronged approach that incorporates: the continued role of the National Registration Authority in identifying any product specific notification requirements during registration and assessment processes; the possible use of mandatory notification in certain high risk situations such as near schools, hospitals, in common areas of multiple occupancy premises and in public places; and the development of voluntary notification principles.

A Statement of Principles on notification for pesticide use in agriculture has been developed by the PIC as part of this strategy. The aim of the Statement is to encourage agricultural pesticide users to voluntarily draw up and implement a notification plan in consultation with their neighbours. The Statement outlines how to develop such a plan and what it should contain. The Statement could be used by individual growers but the initial focus is to encourage its incorporation into industry Codes of Practice.

The PIC is also seeking information from all Councils in NSW with respect to their notification practices.

Communication Strategy
The EPA has ensured that information on the pesticides reforms and their implementation is made widely available to pesticides users and the general community. The EPA, with the advice of the Pesticides Implementation Committee, developed a communication strategy that includes publication and distribution of simplified information explaining the reforms and both formal and informal briefings with groups and individuals. The strategy includes media releases in rural and metropolitan areas, advertisements, interviews, presentations at peak and regional gatherings such as seminars, conferences, field days and other meetings, ongoing contact with chemical resellers, news items provided to industry and community groups for their newsletters and bulletins and access to information via the Internet.

A specific strategy was developed for growers of non-English speaking backgrounds (NESB) and has included, the translation of information into Arabic, Chinese, Italian, Khmer, Vietnamese and Maltese, information days at the Flemington Markets in Sydney, press releases to the ethnic media and specific and ongoing briefing sessions for individual key ethnic community organisations. The EPA is also taking part in other government initiatives aimed at assisting the NESB community such as the *Market Gardening in a Culturally Diverse Society Project* and the *Education and Training Plan for Sustainable Agriculture in the Sydney Basin.*

COLLECTION OF UNWANTED FARM CHEMICALS

Storage of chemicals is an important issue for the farming community. While it's not unusual for drums of unwanted chemicals to sit in sheds, there are risks to farming communities, trade and the environment if these chemicals escape.

This problem is being addressed by the ChemCollect program, which is a once-only farm chemical waste collection, jointly funded by the Commonwealth and the NSW Government. The program will assist farmers to get rid of old, deregistered or unwanted chemicals and the environmental and health risks they represent. This is a last opportunity to rid their farms of such chemicals free of charge.

Waste Service NSW is coordinating collections progressively through NSW. The collections will largely take place over 2001 and 2002. For information about collections call 1800 507 654 or visit the website www.chemcollect.nsw.gov.au.

The farm chemical supply industry and the National Farmers' Federation have agreed to fully meet their responsibilities for the future management (including collection and disposal) of farm chemical wastes that are generated after ChemCollect, after the conclusion of Chemcollect. They will do this through the **Chemclear** agreement. Chemclear is due to commence within 2 years of the completion of a specified region by the Chemcollect program.

The **drumMuster scheme** is an industry planned and run scheme, which is funded by an industry levy on crop protection and on-farm animal health products. It provides the opportunity for local government to collect, dispose of or recycle properly rinsed farm chemical containers. The scheme was based on an agreement between the farm chemical industry, the National Farmers' Federation and the Australian Local Government Association.

WANT MORE INFORMATION?

Information sheets about the *Pesticides Act 1999* are available from the EPA's Pollution Line on **131 555**. These information sheets and other information about pesticides are also available on the EPA's website at www.epa.nsw.gov.au.

Pesticide officers can advise you on your legal responsibilities and other pesticide issues and they are located at the following EPA offices.

Sydney	02 9995 5789	Newcastle	02 4926 9971
Parramatta	02 9995 6823	Queanbeyan	02 6122 3100
Dubbo	02 6884 9757	Tamworth	02 6766 7871
Grafton	02 6640 2500	Moree	02 6751 1519
Griffith	02 6964 1880		

Please refer any detailed questions about the proposed regulations and other work of the Pesticides Implementation Committee to the NSW EPA's Pesticides Unit in Sydney on 02 9995 5799.

MID NORTH COAST WEEDS ADVISORY COMMITTEE

Terry Schmitzer
Project Officer
Mid North Coast Weeds
Advisory Committee

BACKGROUND

Following consideration of the issues raised in the NSW Weeds Strategy, local Councils within the Mid North Coast Region decided to form a broad based committee to develop and implement a co-operative and co-ordinated approach to weed control and management issues.

The "Manning Weeds Co-ordinating Committee" was established in July 1997 with the name being changed to the Mid North Coast Weeds Advisory Committee on 4 March 1999 to more accurately reflect the composition of the committee, its geographical boundaries and its adherence to catchment management principles.

MEMBERSHIP

Local Control Authorities -
- Hastings Council
- Greater Taree City Council
- Great Lakes Council
- Gloucester Shire Council

Agencies and Organisations -
- NSW State Forests
- National Parks and Wildlife Service
- NSW Agriculture
- Department of Land and Water Conservation
- Rural Lands Protection Board
- State Rail Authority
- Roads and Traffic Authority
- Catchment Management Board
- Landcare
- Nursery Industry Association of Australia
- Environment protection Authority
- NorthPower
- Aboriginal Land Council
- NSW Farmers
- Dairy Farmers Association
- Local Environment Group
- Community Volunteer representatives (4) - one per local government area

THE MID NORTH COAST REGION

The Mid North Coast Region covers the areas of four (4) Local Government Councils:

Hastings Council
Greater Taree City Council
Gloucester Council
Great Lakes Council

From a weed strategy perspective it is important to note that the four Councils cover basically the catchments of:

The Hastings and Camden Haven river systems for the Hastings Council with the exception of part of the Maria River catchment which falls in the Kempsey Council area.

The Manning River system for the Greater Taree City Council and Gloucester Council with the exception of the upper reaches of the Manning River which falls within Walcha and Scone Council areas.

The Great Lakes/Port Stephens Lakes/river systems for the Great Lakes Council area.

TOPOGRAPHY

The Mid North Coast Region consists of five main physiographic zones -

i) Plateau Areas
ii) Dissected Uplands
iii) Alluvial Valleys
iv) Riverine Plains
v) Coastal Lakes and Dunes

The majority of the region is generally undulating to hilly with a steely dissected upland and plateau area and an extensive coastal plain.

Major rivers generally flow easterly through the alluvial valleys to the coast. Catchments include the Hastings, Camden Haven and Manning in the north and the Wallingat, Coolongolook, Myall, Karuah and Branch which feed Wallis Lake, Smiths Lake, Myall Lakes System and Port Stephens in the south.

REGIONAL WEEDS ACTION PROGRAM

The Mid North Coast Weeds Advisory Committee applied for and was successful in obtaining funding for a Project Officer with the Regional Weed Action Program for the period 1999/2001.

Mr Terry Schmitzer was appointed to the position, commencing duties on 1 November 1999.
Terry was previously the Noxious Weeds Officer with Hastings Council.

Tasks assigned to the Project officer position are:

- Develop a Regional Weeds Strategy
- Develop Regional Weed Management Plans for significant weeds

- Develop Education and Extension material and packages, including practical demonstration sites and field days for the region
- Prepare a standard set of forms and documents for use in weed control/inspections
- Prepare a set of standard operating procedures for all aspects of weed control/inspection activities
- Perform the duties of secretary for the Mid North Coast Weeds Advisory Committee.

ACHIEVEMENTS TO DATE

- The Mid North Coast Weeds Strategy Draft was prepared and placed on public exhibition in December 2000 - February 2001 to seek public comment on the document prior to its completion and adoption by constituent councils in August 2001.
- Nine Regional Weed Control Management Plans have been completed with six of these plans being approved for operational funding for 2001/2002.

Plans completed include:

- Alligator Weed
- Bitou Bush
- Blackberry
- Crofton Weed
- Giant Parramatta Grass/Giant Rats Tail Grass
- Green Cestrum
- Groundsel Bush
- Salvinia
- St John's Wort

A significant component of the Regional Weed Control Management Plans has been the mapping of all known infestations of the weeds within the region. This has allowed for the development of realistic actions in the Management Plans and would not have been possible without the assistance of the Port Macquarie office of the National Parks and Wildlife Service, particularly Mr Mike Dodkin and Mr John Gwalter.

- The committee has also developed a set of four (4) weed posters for use in educational and extension programs. These posters are entitled:

  - Agricultural Weeds
  - Weed Trees
  - Weeds from Gardens
  - Beware of These Weeds

  Copies of the posters will be on display at the conference.

- A CD has been produced for the Mid North Coast Weeds Advisory Committee which contains:
  - Regional Weeds Strategy
  - Regional Weed Control Plans
  - Powerpoint display on the Draft Regional Weeds Strategy
  - Weed Maps
  - Weed Data points

- Weed Posters

Another resource completed as a result of the above activities has been the collection of approximately 300 weed photographs.

Projects currently under development include:

- Standard Forms and Letters
- Standard Operating Procedures
- Weed Control Calendar/Year Planning
- Monthly Regional Weed Control Advertising/Education Segment in Local Newspapers
- Weeds of Regional Significance (W.O.R.S.) List
- Red Alert List of Weeds (New Plants with Weed Potential)

REGIONAL PLANNING AND THE WAR ON WEEDS

Philip Blackmore
Noxious Plants Advisory Officer
NSW Agriculture
Armidale

INTRODUCTION

Comprehensive planning is fundamental to the success of any noxious weeds program. In this paper I will use some military analogies drawn from the First World War to illustrate the consequences of inadequate planning and the triumphs that come from thorough planning. These analogies will demonstrate why we need to plan effectively to have a have any success in the war on weeds. I will also show how new and existing plans can be enhanced to increase their effectiveness.

WHY DO WE NEED TO PLAN ?

In his memoirs, Field Marshall Montgomery (of the British Eighth Army at Alamein) recounted his first experience of military action. It was in the first few weeks of World War One and Montgomery was then a young lieutenant. His battalion has just come into contact with the advancing Germans who were at the top of a hill. His commanding officer ordered that his company attack the Germans at once.

"This was the only order. There was no reconnaissance, **no plan**, no covering fire. We rushed up the hill, came under heavy fire and there were many casualties. Nobody knew what to do, so we returned to the original position from where we had started the attack." (Montgomery, 1958)

How many weed control programs does that analogy remind you of ? Where, through the lack of planning a great deal of public money has been expended for no positive result.

WHAT IS A PLAN ?

A plan is an unambiguous guidance framework that helps to organise people and align their efforts towards the same goals. Without a plan there is risk of divergence or dissent (Smith, 1996).

A weed control plan should consist of the following elements:

1. **Aim** — A statement of what the plan intends to achieve. An overall goal for the plan.
2. **Objectives** — Statements of what the organisation, group or individual has to achieve in the period covered by the plan (Smith,1996).
3. **Background & Justification** — Information about the weed and a discussion as to why official control of the weed is both necessary and important.
4. **Null Hypothethis** — A forecast of the likely outcome if no official control of the weed is undertaken.
5. **Stakeholders** — A list of the people and organisations who need to be involved in the development of the plan and implementation of the project.
6. **Barriers & Contingencies** — Both existing and potential difficulties that may delay or obstruct the operation of the plan.

7.	**Weed Distribution**	A map showing the current occurrence of the weed, including areas where it is already well established (core), areas where it is spreading (margins) and areas where the weed is not common (rare and isolated).
8.	**Actions**	Activities that will be undertaken by the stakeholders in relation to the weed. An essential action must be the review of the plan after it has been in operation for a period of time.
9.	**Who Will Carry out the Actions**	List the stakeholders who will carry out each action.
10.	**Performance Indicators**	Statements of how many of each action that will be carried out and by what date the action will be completed.
11.	**Benefits**	Conjecture as to the benefits to agriculture, the environment and human health versus the costs of implementing the plan, in financial terms.

All these elements must be addressed to ensure that the plan is comprehensive in its approach. Clearly, aspects of these elements will need to be addressed differently depending on many factors including:

i. the growth habit of the weed species;
ii. the life cycle of the weed;
iii. the mode of spread of the weed;
iv. the current distribution and impact of the weed;
v. the potential distribution and impact of the weed;
vi. the anticipated life of an existing seed bank;
vii. the cost of control methods;
viii. the aim of the plan; for example a plan that aims to push back a commonly occurring species must have very different objectives, barriers and actions to a plan that aims to prevent the spread of a new weed.

WHY DO WE NEED TO PLAN FOR CONTINGENCIES ?

Planning for contingencies aims to reduce or eradicate uncertainty from plans. The technique involves anticipating contingencies and to make preparations to prevent these uncertain occurrences from unduly affecting the intended outcomes of the plan.

In the spring of 1917 the British command decided that they must launch an all out attack on the Germans to try to break their line and force an end to the war. Their allies, the French were in a bad way after the battle of Verdun the previous year, German submarines were sinking an increasing amount of allied ships in the Atlantic and the British treasury was becoming very concerned at the cost of the war.

The spot they chose was Flanders in southern Belgium. The country was very flat and so the defending Germans would not have any advantage in height. The British decided to try some new some new weapons such as tanks and some new techniques such as the creeping artillery barrage. They also decided to use an old technique of tunnelling under the enemy strong points and blowing them up. So the plans were drawn up and preparations were made. By this time it was autumn. On the first day of the campaign 19 huge mines were exploded and the attack was launched very successfully. But as had happened in previous battles, German resistance stiffened and as the front line got further away from the starting point, so it became harder to supply the attackers. The

planners, who had anticipated a quick breakthrough, had underestimated the difficulties and had not planned on how to supply their troops over shell torn ground.

And then it started to rain. This is something that should have been planned for as it usually rains in autumn in Belgium. The battlefield turned into a quagmire. The shells would not explode in the mud, the tanks got stuck and about two hundred and fifty thousand British and Commonwealth troops were killed or wounded in the mud of Passchendaele. The whole campaign failed due to the inability by the planners to foresee and prepare for the contingencies.

Weed management plans that do not anticipate barriers and plan for contingencies will not have such dramatic consequences. The harm caused by weeds is far more insidious. At the very least, the implementation of the plan will be delayed and a great deal of public money will be wasted. At worst, a weed may become widely established and cause enormous and perhaps irreparable damage to agricultural productivity, foreign trade, the environment and human health.

Examples of barriers and contingencies that weed plans might need to deal with include:
i. drought;
ii. wet seasons;
iii. wind;
iv. increased costs - chemicals, vehicle costs, labour;
v. decreased funding
vi. re-emergence of seedlings from a seed bank;
vii. new germination from seed spread from core areas by wind, water, wild and feral animals, livestock and vehicles;
viii. absentee landholders;
ix. difficult or disinterested landholders;
x. regulatory restrictions imposed by other agencies.

There may be many more.

WHAT CAN BE ACHIEVED WITH A COMPREHENSIVE PLAN ?

In 1918 the Australian General John Monash gained control of all Australian forces in France. Unlike his British counterparts Monash was not a professional soldier. He was an engineer and a member of what today we would call the Army Reserve. He had a firm belief in the need for thorough planning of all aspects of an operation, including contingencies. Luck played no part in the success of Monash's plans.

In June 1918 Monash was granted approval to run a small battle. It was at a village called Hamel in northern France. Unlike previous battles this one did not aim to win the war. Rather it had the very clear aims of capturing a small section of the German front and to demonstrate the effectiveness of a comprehensive battle plan. Instead of using the weapons and forces available to him in a piecemeal fashion, Monash planned an attack in which all arms and weapons, including infantry, artillery, tanks, aircraft and supply all acted to a co-ordinated plan. In weed control terms we would refer to this concept as Integrated Management. His planning also included vigorous training before the battle, so that every soldier, airman, artilleryman and tank crewman knew what he had to do.

"A perfected battle plan is much like a score for an orchestral composition, where the various arms and units are the instruments and the tasks they perform are the respective musical phrases. Every individual unit must make its entry precisely at the proper moment... otherwise there will be discords which will impair the success of the operation and increase the cost of it (Monash, 1920).

Previous battles of this size run by the British had lasted for days, had been largely unsuccessful and cost many thousands of casualties. Monash planned for Hamel to be concluded in 90 minutes. In fact it was all over in 93. Casualties were very low by First World War standards. Hamel was a complete success and was the model used for the final battles of World War One.

I would like to be able to point to weeds management plans that have been as successful as the Battle of Hamel.

The Leadership Role of Regional Advisory Committees in Relation to Weed Plans
From this analogy we can see that a comprehensive plan which is fully implemented by all participants will deliver successful outcomes. Many examples exist of successful weed management plans. However most have been a success at a local level only. An example of a successful comprehensive plan over a whole region has been the near eradication of Johnson Grass in the Macquarie Valley. Why has this plan been effective ? Our military analogy can only take us so far. A military plan is driven by a rigid top-down hierarchy, with a strong element of compulsion influencing the actions of all participants.

At local government level co-operation across a region to achieve a common goal must be through consensus. Consensus is achieved and maintained through a strong Regional Advisory Committee. In the case of Johnson Grass in the Macquarie Valley, a common view was agreed that it was in the best interest of the whole Macquarie Valley for Johnson Grass to be eradicated to eliminate a poisonous perennial grass with a high propensity to spread. The outcome of a successful control program was to encourage the development of a seed sorghum industry at Narromine. The accord was achieved and maintained by the dynamic leadership of the Macquarie Valley Advisory Committee (Peter Gray , pers. comm.). If there is no genuine agreement and support across a region for a weed management plan, while the plan may have some local successes, it is likely that it will ultimately fail at the regional level.

HOW CAN EXISTING WEED MANAGEMENT PLANS BE IMPROVED ?
Many existing regional weed management plans contain a number of flaws. Most plans lack a strategic approach. That is, they deal with a particular weed as if it has a uniform distribution throughout the whole region. This is rarely the case. Many weeds are well established in some parts of the region and are spreading to new areas. Control of the weed in the areas of spread should take priority over the areas where the weed is already established. An exception is where weeds are spreading along a waterway. In this case, the plan should deal with the weed on a catchment basis. A comprehensive plan will have different Objectives and Actions for the areas of core, marginal and rare and isolated levels of distribution.

The priorities of noxious weed control are:

1. To find and where possible eradicate, new outbreaks of weeds that have not been recorded or are not common in the region and have a high potential impact.

2. To restrict the spread of weeds that are emerging as problems for the region.

3. To reduce the distribution of widespread weeds.

The Aim, Objectives, Justification, Distribution Map, Actions, Performance Indicators and Benefits should reflect these priorities.
Other more technical flaws include:

Aim - The aim should be clearly stated and not ambiguous. It should also be achievable. Do not try to win the war if it cannot be done. But conversely, do not set a goal that is so low that the plan will be of little benefit.

Objectives - These are the most misunderstood components in existing plans. Objectives are more than statements of intent. They are a quantitative measure of intended performance, a measure of outcomes (Smith, 1996). Objectives should not be confused with Actions or Aims or Performance Indicators. An objective that is written so that it starts with the word To, is probably an Aim not an Objective. An objective that describes an activity that people will carry out as part of the plan is an Action, not an Objective. Activity is not the same thing as achievement ! Keeping busy does not necessarily mean that you are getting results !

Background - Too many plans are long on Background and short on Justification. A plan is not an Justification Agfact. Detailed botanical descriptions of a weed should be placed in an appendix at the end of the plan. The Justification **must** make a case as to why official control of this weed is important. Who cares about this weed and if nobody cares, why should they care ? Why is this weed a concern of the whole community ?

Null Hypothesis - Most plans do not include this element.

Distribution - The information on distribution is an essential part of the plan. A map is the best method for displaying this information. The map **does not** need to be an aerial survey supported by ground truthing, whatever that might mean. An A3 map coloured in with felt pens is entirely satisfactory. The map should identify areas of core, marginal and rare and isolated levels of distribution. The areas that contain each level of distribution **must** have legally definable boundaries.

Barriers & Contingencies - All barriers and contingencies **must** be addressed in the action plan.

Actions - The action plans of many plans are far too brief. Each action should be clearly stated with sufficient detail so that all stakeholders understand exactly what the plan requires them to do. Do not presume that stakeholders will understand "shorthand" or jargon terms.

Performance Indicators - These **must** clearly state how many of each action stakeholders will carry out and a Date by which the actions will be completed.

Benefits - These are not a formal cost benefit analysis. However, some estimate must be made of the financial benefit to agriculture and to the community versus the cost of implementing the plan. The section should state the likely beneficiaries of the plan.

TAKE HOME MESSAGES

- Planning is not a hoop jumping exercise to secure grant funding.

- Plans must be strategic in their outlook and comprehensive in their detail.
- Don't bite off more than you can chew. Make sure that the plan is achievable.
- Plan to deal with barriers that can be seen and contingencies that can be foreseen.
- There must be regional consensus and support for a regional weed management plan for the plan to be successful.
- The regional advisory committee must drive the plan to ensure that Objectives and Performance Indicators are achieved.
- If you fail to plan, you plan to fail !

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LIMITATIONS TO NOXIOUS WEED CONTROL

Kerry Pfeiffer
Deputy Chair
South East Catchment Management Board

Introduction

I am sure that you are all aware that we have had noxious weed legislation in NSW since the turn of the century of one type or another, and contained within that legislation there has always been a list of noxious weeds. Plants that have been identified as harmful or unwholesome, either to the industry of agriculture or to human quality of life. Of course in recent times environmental weeds have become an important part of the list.

As I have said, we all know of this legislation and we know of the noxious plant list, many of us also know that since the beginning of regulatory effort to control unwanted and/or damaging plants, there has never been a plant taken off the list. This must mean that we have never eradicated a harmful plant once it has escaped into the countryside. It also must mean that we have never or rarely decided that a plant, once listed, has ceased to be a threat to our community.

My talk today is about the limitations to noxious weed control and many here may think that the greatest limitation to getting the job done is very simple, the lack of money. Money for chemicals and machinery and money for administration, mapping inspections and all those sorts of things. Unfortunately, I do not know of one incidence where pouring money at a problem was a means in itself of solving that problem. However, I do agree that adequate resourcing is important and investment is an indicator of commitment and support.

It is my opinion that the greatest indicator that limitations exist in relation to noxious weed control is the noxious weeds list. The list is an indicator because of its size and the fact that it just grows larger year by year as new harmful plants or recently identified incursions of already listed plants are identified. Unfortunately the recipe for rectification is not just rationalisation of the listed weeds but a paradigm shift in our approach. There are probably 5 issues that we need to prioritise to maximise protection for agricultural industries, the environment and human health.

The 5 Priorities

The first of these priorities must be, **"new incursions."**

It is clear that there are limits to farm enterprise resource allocation that make it obvious that the number of category 2 and category 3 weeds cannot continue to rise. Weed administrators must recognise that there is a limit to the ability of the enterprise to effectively manage an ever-increasing responsibility for weed management especially if there is no economic benefit.

It is quite clear that the introduction of new plants that have the ability to escape onto our lands and cause damage is going to be hard to manage. We now live in a global village and services such as the Internet allow communication and commerce worldwide. It is now a simple matter to place an order for a plant or seed on the other side of the world or even the other side of the country. Quarantine services do not have the capability of filtering all these imports that flow through our delivery services.

The second priority to address is, **"A reluctance to integrate with other land management initiatives that might allow maximisation of investment dollars and utilisation of other needed resources."**

Let me remind you of my opening statements about money. The NSW State Government supports weed control compliance, administration and regional weed management strategies to the tune of about $6.9 million last year. Environment Australia and AFFA Commonwealth Government agencies through the National Weed Strategy, The National Landcare Program and Bushcare will probably invest 4 times that amount this year across Australia. Local Control Authorities, Rural Lands Protection Boards and Weed County Councils may spend as much as 15 to 20 million in NSW this year. The land managers of NSW being farmers, State Forests, NPWS, DLWC, Councils and RLP Boards spend tens of millions a year in weed eradication works. The fact is many good works are done and there are many successes but many of our problems just get worse each year.

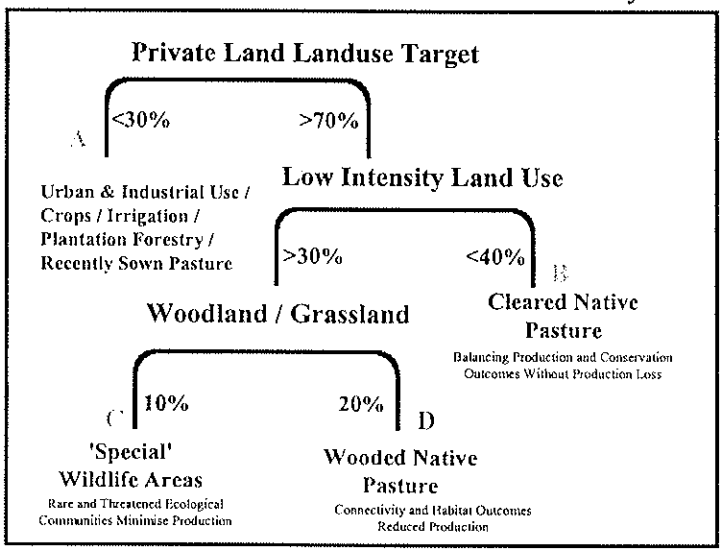
Biological diversity conservation strategies, regional vegetation management plans, local and regional vegetation restoration and river rehabilitation incentive programs and farm forestry are some of the newer land management initiatives introduced to encourage adoption of management systems that attempt to define a balance between conservation and production outcomes.

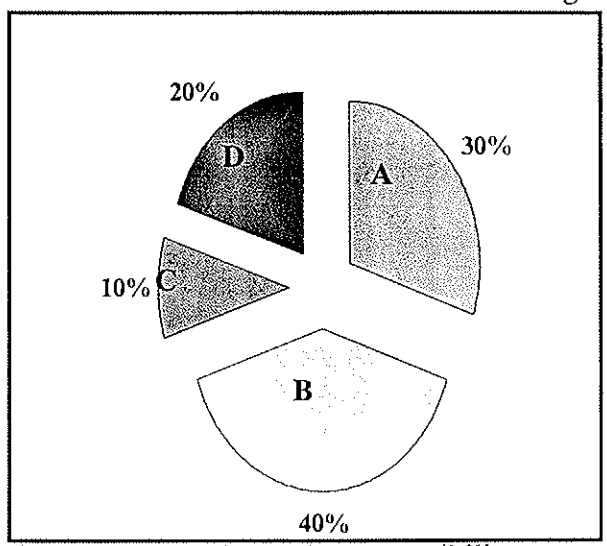
Weed control is an integral part of these new proposed management systems and quality outcomes will not be possible across our grazing lands without containing some of our more aggressive weeds.

Diagram 1. Model Biological Diversity Conservation Catchment Target

The third limitation or priority issue to address is, **"Unrealistic expectations about what can be achieved."**

I am a member of the Noxious Weeds Advisory Committee and the Chair of the Technical Working Group. The TWG has the responsibility to evaluate the regional and local strategic plans that come forward for funding each year. How often do we see proponents make application for funding assistance with a very well thought out submission that includes a map with the weed distribution well marked, even the detail about the intensity of infestation. On many occasions the proponent is seeking assistance to apply similar control actions on all the weed zones of infestation intensity. This approach is unlikely to be SMART (specific, measurable, achievable, realistic and time bound).





especially in degraded grazing pastures where there is low rainfall or low fertility. In these circumstances the issue of medium and long-term outcomes might lead to different perceptions regarding competition and production values.

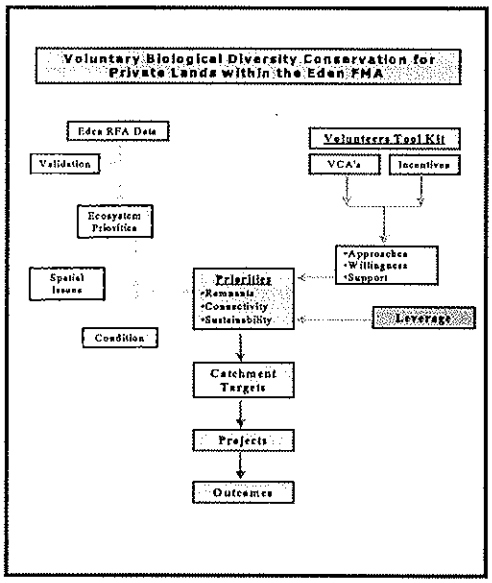


Diagram 3. Model implementation Vehicle for natural resource management

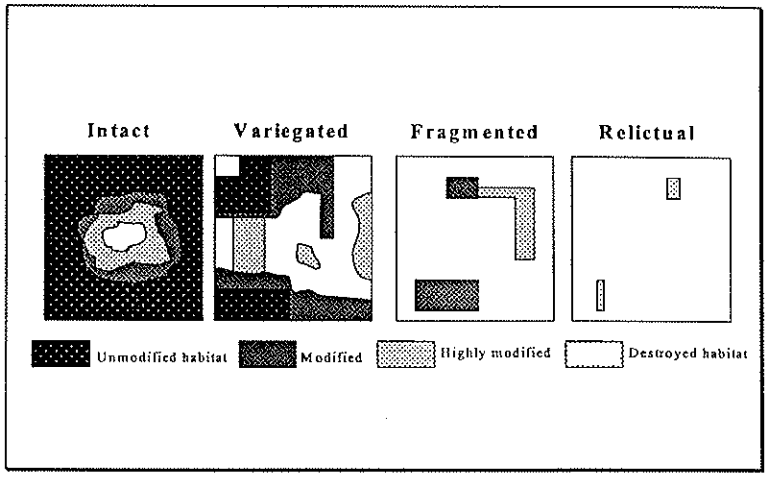


Diagram 2. A model for degradation assessment

The fourth limitation to noxious weed control is, "An inability to realise that to achieve outcomes weed control is a whole of community responsibility."

There are a number of aspects to this statement. During the decision making process for the inclusion of Serrated tussock as a weed of national significance I was responsible for leading a delegation of people to make a presentation to the Agriculture, Fisheries and Forestry Commonwealth Cabinet Committee. Unfortunately I spoke of the support that the National Landcare Program was providing to farmers during a critical time whilst Frenock ® was unavailable as a herbicide. I told the Cabinet Committee that in NSW the State Assessment Panel for NHT had an unofficial policy of allowing up to 20% of NLP projects on grasslands to be applied to weed control. They stated that weed control was a landowner responsibility and stopped the practice of direct weed control support.

I hear farmers complaining to Local Control Authorities about other farmers who have weed infestations on lands that might spread to the complainants land. The problem here is that the complainant takes no other action in most circumstances to prevent the weed spread. This attitude is widespread and not restricted to farmers, many within the community complain but will not become part of the solution.

The fifth priority to address the limitations to effective weed control and the one done after consideration of all of the above is, **"The number of listed weeds."**

Every Local Control Authority should review the list of category 2, 3 and possibly category 4 noxious weeds that apply to their region, as I believe weed issues should be addressed at a regional level as part of wider regional vegetation assessment and management planning process.

The proposed review should develop criteria for review of noxious weeds that includes social, environmental, economic and sometimes cultural considerations. The new list should include only those weeds that have a regional control strategy written with the aim of justifying investment, listing partners and articulating time bound outcomes as targets.

Every region should have a strategy for new incursions (regional) as the State has a strategy for new incursions. This regional new incursion strategy should include measures for swift action to deal with threats and have an active prevention strategy utilising suitable geological land features and other measures including development of new pasture and crop management systems to prevent spread and reduce risk. Likewise landowners should be encouraged to develop new incursion strategies that might include strategic pasture management, wind breaks and vegetation strips, fencing of vehicular access to properties etc.

Conclusion

In closing I would like to say that I do not believe that the current Noxious Weeds Act is offering the leadership and strategic direction that weed control in NSW needs currently, and is not offering us the sort of assistance needed to lead us into a new challenging era of greater threat and market driven need for quality assurance. To protect our communities we are going to have to become SMART.

Acknowledgements
CSIRO Sustainable Ecosystems. The Grazed Landscapes Management Project

WEED MANAGEMENT AND NATIVE VEGETATION: WAGING WAR ON WEEDS GREENING AUSTRALIA'S ROLE

Martin Driver
Regional Representative
Greening Australia-Riverina

Introduction

Weeds, like beauty, are in the eye of the beholder. One persons "weed" is another persons "feed". When it comes to native vegetation management there are many species of plants that ,though not categorised formally as "noxious", are "obnoxious" in the sense of their threat to the integrity and future regeneration of many native vegetation types. In fact it may not be too strong a point to suggest that our understanding and management of such "biological pollution" will hold the key to the future of many of our ecosystems.

Background

Greening Australia, Riverina has over a period of about six years, adopted a strategic approach to helping landholders protect and manage existing native vegetation on their land. This has involved the development of an extension management and financial incentive program in conjunction with the former NSW Murray Catchment Committee and current Catchment Board.
This initially involves responding to landholder enquiry's with a on site inspection by experienced field staff to assess the remnant vegetation and identify management issues, including weed status.

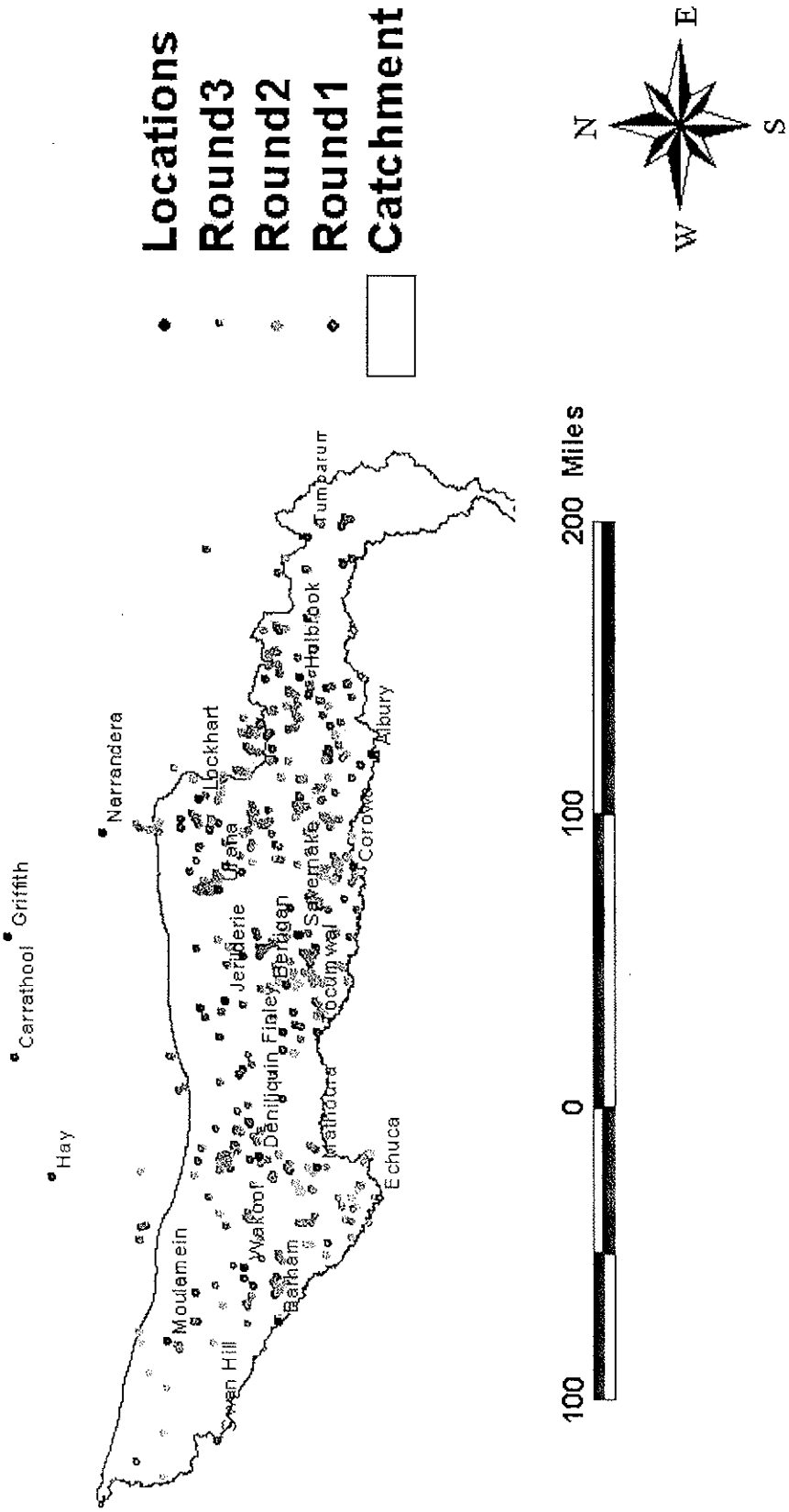
The key priorities in achieving improved management are to -

1. Secure the more intact areas of native vegetation through fencing to achieve grazing management (the primary threat to vegetation quality and extent in most situations).
2. Enhance site quality (through encouraging regeneration and introduction of species diversity) or expand site size and extent (through regeneration, direct seeding, and planting).
3. Create linkages or stepping-stone clumps across the landscape (through regeneration, direct seeding, planting).

The support that GA offers landholders (through Bushcare/ Natural Heritage Trust funded projects) to achieve this are to provide -

1. Technical site management and planning advice
2. Incentives of up to $1200 per kilometre for fencing materials to manage grazing pressure.
3. Incentives of up to $250 per hectare for direct seeding or planting to provide species diversity / enrichment for the site.
4. Incentives for specific site management (weed/feral animal control, scalping, fire, or specialized site treatment -NB These incentives have been dropped due to a reduction in funding grants).

There have been significant numbers of landholders taking up both the advice and incentives. To date over 1100 landholders have been involved in the program. There have been 42,420 hectares fenced in the Murray/ Murrumbidgee catchments to date involving 20 main vegetation communities. The distribution of allocated grants for fencing site locations in the Murray Catchment is shown in Figure 1.

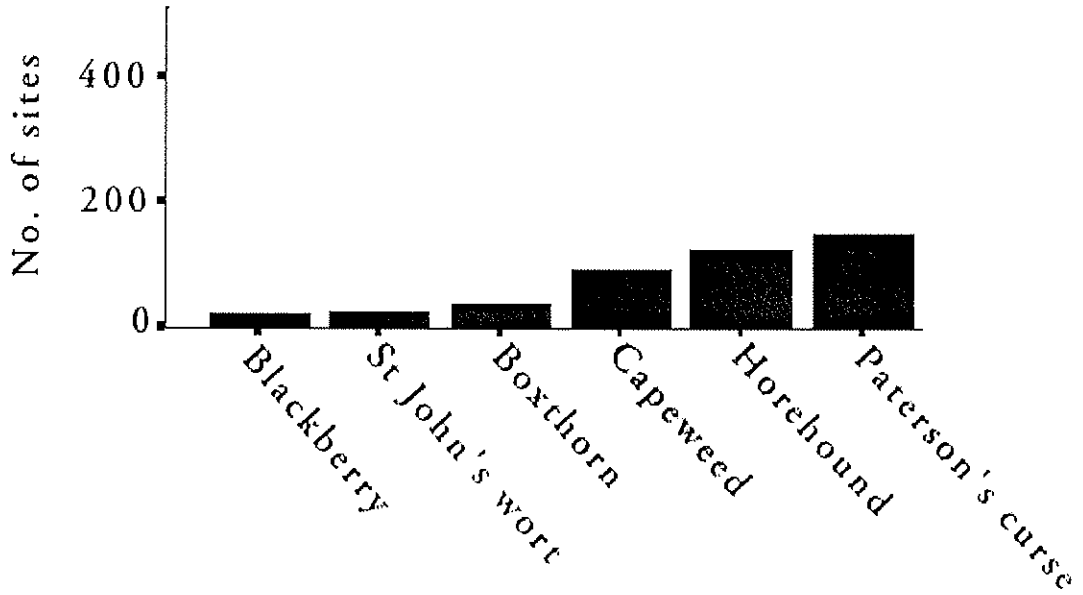


Initial site surveys are carried out with landholders at all sites with the information stored on a database showing site location, quality, habitat value and weed status (among other management information).Weed status is looked at not just in terms of the actual or potential occurrence of noxious weeds but also the status of 'obnoxious' weeds. That is those species which prevent or out

compete regeneration (eg. Phalaris, Barley Grass, Paterson's Curse, Ryegrass, Wild Oats, Silver Grass, Brome), or which directly impact on the existing vegetation (Peppercorns, White Cedar, Ash, Boxthorns).

Weed status is scored by species and as introduced annual or perennial pasture species. The main broad leaved weed species identified in the first three years of the program. (in order of occurrence) were Paterson's Curse, Horehound, Capeweed, Boxthorn, St John's Wort and Blackberry. (Fig 2)

Fig 2



While various broadleaved weeds occurred in different vegetation communities, annual pasture grass 'weeds' were dominant in all vegetation communities except Dry Schlerophyll Forests in the east. Invasive pasture grasses were recorded in 90% of all sites and in 100% of all Yellow Box sites in the past three years of the program. (Table 1)

Table 1 **Major weed type within each vegetation community (where number of sites is greater than 10.**

Veg communities	No. of fenced sites	No. of sites with pasture grasses	Major weed species
Buloke	21	17	Annual- pasture grasses*
Dry Schlerophyll	21	4	St John's wort
White Box	48	45	Annual- pasture grasses
River Red Gum	49	47	Annual- pasture grasses
Black Box	66	54	Annual- pasture grasses
White Cypress	85	73	Annual- pasture grasses

Yellow Box / Blakelys RG	105	105	Annual- pasture grasses
Grey Box	123	114	Annual- pasture grasses

*Pasture grasses are identified as: Barley, Rye and Silver grass and Brome spp.

Follow-up assessments by project staff and monitoring by Charles Sturt University researchers (Spooner, 2000) validate the short- term success of the the project. While there is huge variation in each site, vegetation community and soil type there has generally been an improvement in the trend, status and quality of the sites with increases in perennial native grasses compared with annual grasses of the ground layer, increases in tree regeneration and increases in structural and species diversity.

There is going to be a significant increase in the scale of vegetation management/ revegetation and fencing schemes in the next two to five decades to address salinity and biodiversity decline issues. There has already been announced an extension of the National Heritage Trust Bushcare Program has been announced and there are other State and Federal programs under development to address salinity and biodiversity decline issues which will require significant increases in vegetation management and revegetation. The management of these areas in relation to regeneration and potential weed invasion is going to become an increasingly important issue over time.

The Issue

The one area of some uncertainty requiring on-going and adaptive management and effective extension is with the future management of 'weeds' in these fenced areas.

On the whole, weeds (either noxious or 'obnoxious') are not a major issue in high quality native vegetation sites. An intact and undisturbed ground layer is the strongest indicator of site quality, site regenerative capacity and resistance to weed invasion. Provided disturbance is minimized and some form of monitoring is pursued, the threat from weed invasion is negligible.

However the majority of the remaining native vegetation in the landscape has been disturbed and soils tend to be nutrient enriched through past agricultural use. In future these treed but disturbed areas are likely to offer the greatest potential for the increase in quantity and quality of native vegetation to address biodiversity decline and salinity recharge issues. This will primarily be achieved through managing regeneration and in direct seeding or planting of locally lost species. These sites will need to be monitored and managed for 'weeds' of two forms -

1. Noxious Weeds -some species exist or will volunteer into native vegetation management sites which, if not managed will act as harbour sites and potential seed source for re-invasion and further spread (these are species either declared under the Noxious Weed Act or those that have a detrimental effect or economic loss to agriculture or negative impact on the environment and are listed)
2. 'Obnoxious Weeds'- those species which, if not managed will degrade the integrity of the site, or which may impact on the health, vigour, reproduction or recruitment and essentially dominate or 'lock up' the site and prevent regeneration or an increase in species diversity and reduce site resilience.(These species tend not to be listed and many are introduced pasture grasses).

Weeds of both forms are the enemies for landholders whether trying to manage these vegetation areas or in direct agricultural management. In either case potential 'biological pollution' of native vegetation areas is a major threat and one that needs to be realistically assessed and managed.

The Current Situation

Early awareness of the potential threats and appropriate action to deal with these threats is essential. The form and reproductive characteristics of potential weed species is relatively easy to recognise

and these are best dealt with in the early stages as volunteer plants.

It has been the role of Greening Australia project staff to provide extension advice to landholders to draw attention to noxious weed issues or the potential threat of emergent weed species on site or nearby. It is the responsibility of the landholder to either treat the issue themselves, contract a commercial operator to execute treatment or contact the local weed authority for advice or eradication.

The main methods of weed control open to extension staff advising landholders are-

- Physical- digging, cutting, chopping,(with or without herbicides) pulling, scalping, burning.
- Chemical-spot spraying, boom spraying or stem injection (using only on-label, certified chemicals by properly trained endorsed operators)
- Grazing Manipulation- using appropriate classes of domestic stock, timing, duration and intensity to achieve physical biomass removal, reduce seed production and recruitment and ultimately to positively change floristic composition while minimising negative impacts on native plant species.
- Competition Plantings or Seeding- using over planting or direct seeding to assist in swamping out less desirable species in discrete areas until a more favourable balance is reached.
- Biological- the introduction of biological control agents into fenced regeneration sites.
- Vigilance and Prevention- the encouragement of active monitoring.

The more difficult issue from a native vegetation management perspective is that of the management of the groundlayer composed predominantly (over at least part of many sites) of exotic annual grasses (for at least part of the year). These invasive pasture species are in many cases completely inhibiting regeneration of native species while at the same time creating a potential seasonal fire risk. To break this cycle some management control or disturbance may be required. This may be in the form of initial resting followed by either controlled strategic grazing or patch spraytopping to reduce seed set, soil surface scalping or burning.

Ongoing monitoring and adaptive management is the key to addressing the impacts of this level of weed management within fenced native vegetation sites. For most sites the first step is to get the fence up to delineate the site and to be able to control and manage grazing (either inside or outside the site). The important elements of any grazing management is to identify the most sensitive elements to grazing and then to manage the time (season, growth stage), duration (length of time), and intensity (stock number, type, class) of grazing on these elements. What we can't offer at the moment is any form of direct financial incentives to assist in effecting this level of management or monitoring.

The Future

In any case there is the need for on-going inputs and management and monitoring by the landowner or manager and on-going extension support and monitoring. This involves costs to the landowner and Greening Australia and these costs are not yet covered. This is not just for the site in question but needs to include the potential impacts of surrounding areas.

The primary objectives of these native vegetation management programs are to address nature conservation decline and water management or salinity issues by enhancing the amount of perennial vegetation. The majority benefit of the efforts of effective management accrue to the general public as opposed to individual benefit of effective control of most agricultural weeds (although there is obviously some overlap). Therefore there is a strong case to be put that the majority of costs and inputs be met by the public at large and not just the private landholder trying to achieve better management. This principal is already reflected in the Greening Australia and Murray and Murrumbidgee Catchment Fencing and Vegetation Enhancement programs.

It is for this reason that any future programs for on-going native vegetation management recognise the various noxious and 'obnoxious' weed issues with appropriate incentives for management and control. This would also need to ensure that appropriate resourcing to authorities, extension groups and incentives to individual landowners is forthcoming to maximise the benefits of native vegetation management programs and minimise the risks of further degradation of what native vegetation we have left.

It is important that any incentives that are developed would need to be -

- effective in achieving environmental objectives
- cost-effective in outcomes
- equitable across a range of issues and land management systems
- attractive to landowners and without undue administration

A greater level of awareness, liaison and co-operation between all groups and programs involved in natural resource management is going to be essential to ensure that our combined objectives are met. This will help ensure that –

- Commitment, priorities and approach are standardised
- There is more efficient and effective targeting of resources
- There are more integrated funding opportunities

Without this level of co-operation (and appropriate resourcing to go with it) it is going to be increasingly difficult to improve native vegetation management across our rural landscapes.

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CHANGES IN WEED MANAGEMENT OVER THE LAST THIRTY YEARS

Dick Honeyman
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INTRODUCTION

To contemplate the changes in weed management over the past thirty years one has to look at the priority of the day and the changes in technology in that time.

I started my career with a burr hoe and a horse and cart on a section of a large sheep property and in those days Bathurst burrs were considered the major weed problem in wool production.
My equipment was considered the best on the station because my horse followed me and I did not have to walk back to him.

As well as the jackaroos the station employed three teams each of fifteen men to cut the paddocks. Seeded plants were cut and stacked, to be burnt when they were dry.

As my career continued I saw the control of Zamia palms in New Guinea. The seeds of these were toxic to cattle and were manually collected and removed.

In central Queensland during 19967/68 we had a major problem with Mexican poppy in wheat production. History tells us that Parthenium Weed was beginning to emerge as a major problem in the area although it drew little comment at the time.

In the north west plains of NSW we cut and stacked Bathurst burrs and hand pulled mintweed on the Creek. Crawling around on hands and knees was not something I enjoyed.

I experienced Serrated Tussock in the highlands around Bathurst and Oberon and the historians would tell you that Tussock was initially considered to be a "good plant" because it was green when no other plants were actively growing.

My employer was very conscious of his obligation with Tussock (and he owned 13,500 ha and 7 bulldozers) but was a bit casual about blackberries, rabbits and thistles.

EQUIPMENT

Equipment, over the time I have worked, has developed from horse and carts and Grascos fire pumps with 44-gallon drums as tanks, to fully computerised boom and hand sprays. Technical knowledge has improved from "wet or wetter" to needing knowledge of spray patterns, nozzle size, pump pressure and onsite hand held weather meters to record the conditions.

Modern equipment is a far cry from 3.6 metre booms that were considered only of use in "large areas" of weed infestations. Today spray booms range up to 30 metre or better and spraying speeds have increased from 10 km/h to up, to 30 km/hr.

Application rates of water have also reduced from 112 l/ha down to as low as 50 l/ha with some chemicals.

Wording of chemical rates has changed from such things as ½ a pound of "24-D salt/acre" to "10 grams of product/ha". With the first example it was a mathematical nightmare to calculate the required amount of actual product after discovering the percentage of Active ingredient and then

working out the number of litres required. In actual fact most farmers worked it out "sort of" and then doubled the mixture. When I started it was impossible to stop one farmer from using as a standard mix, 4.5 litres 24-D ester 800 to 200 litres of water to hand spray Bathurst burrs.

TRAINING

In my early career with local government weed officers were drawn from many walks of life and had been grader drivers, RLPB rangers, station managers or workers, taxi drivers, carpenters and many other trades or professions. Most were employed and told to "get rid of the weeds" in the area. Training was very difficult to acquire and many of the Noxious Plants Advisory Officers stationed around the state had a long job bringing the new staff up to scratch. Just ask Hugh Milvain and Peter Gray, to name but two of the NPAO's that reared me.

It is interesting to note that at my first conference (Then known as Training Schools for Council Weed Staff), Cec Webb and Ron Nalder (respectively President and secretary of the NSW Weed Officers Association) announced that a course by correspondence through TAFE was now available. They pleaded with officers to take up the course that had been negotiated to lift the image and knowledge of weed staff.

Now at my last conference it is announced that a new training program and qualification has been launched. But now the grant requisite is for weed staff to acquire this qualification within a time frame over the next two or three years.

LEGISLATION

Legislation has changed dramatically over this time. In my early career the ministers of Agriculture and Local government equally administered the weeds section of the Local government Act. The responsibilities were on Local Government and we, as weeds Officers, walked the land with virtually total authority. I even remember being told by a speaker at a previous conference that we had full authority to cut a locked chain to enter a property if refused access by the owner. (How times change!!)

In those days there were some 20 odd Acts that had to be considered prior to action, and then usually noxious weeds were exempt. Today there are some 43 acts of Parliament to be aware of and some of these restrict the actions available to you as weed controllers/advisers.

The personal jousts between weed inspectors and landholders were something to enjoy. As we parried backwards and forwards with verbal and active cunning to get evidence and statements of guilt it was quite a battle. But in those days it was an honourable and sporting event. I remember being in the pub after one long and successful prosecution and the subject landholder was at the other end of the bar. He approached me and I wondered what he would do. I advised my fellow drinkers that there might be trouble approaching.

He came up and after offering his congratulations on a well-prepared case and admitted to losing the case. He then shook hands and invited me to make up a four to play pool. That was the way it was in the early days and to a greater degree could still remain.

The legal cost to Council of a successful prosecution were often greater than the eventual fine, and at $200 for first offenders was a joke on 30,000 to 80,000 acre properties. (And they were acres at that time). Since then fines have been updated to a realistic figure

Today society says that each must have an equal right, and perhaps this is good. Weed officers now spend much more time issuing letters to notify intent to inspect and stipulating time and date. Then

we have the warning statement regarding evidence and possible prosecution, which must be given at a time to warn the offender of their rights.

In short the preparation for an inspection is now more detailed

HERBICIDES

To consider the changes in herbicides is even more daunting than previous sections. Such things as 245-T, 24-D, Frenock, Velpar and Atrazine products have all come and done their job and then virtually been lost to the industry for a variety of reasons.

Whilst I admit that the very examples I am about to give are examples of the cause of our loss of these products, it is a fact that early in my career in local government we nearly bathed in the products we used. Many examples of farmers using 4.5 litres of 24D ester 800 per 200 litres of water for hand spraying. Drums were recycled in many ways including fruit pickers buckets (rescued from the local tip). Personal protection equipment and safety rules were not even thought of and only sparingly dispersed.

ATTITUDES TO WEED CONTROL

It is noticeable that weed control is becoming more pro-active than in past years. My early memories were of waiting to see if the weeds actually grew prior to planning any control. This was apparently the case for many years. Older weed manuals relate that in 1868 a botanist identified what became known as Bathurst burr and noted that " if not vigorously controlled, this weed has the potential to become a major weed in agriculture".

Similarly Noogoora burr, Serrated tussock, Variegated thistle, Silverleaf Nightshade and Parthenium weed were virtually ignored until it became obvious that they were a major problem and sometimes beyond control.

Today best management practices take into account the likelihood of a weed outbreak and allow ways and means of accessing the weed for control. Farming practices and crops are being adopted more and more to prevent or lessen weed growth.

It is notable that in our noxious weed industry, more importance is placed on new incurring weeds where it is known they are a potential problem. This will allow weeds to be controlled (dare I say eradicated) before they become beyond management.

One major change needs to be introduced. The thinking of some senior management and Councillors needs to be brought into this century and weed staff should not be considered "burr cutters" but weed instructors and management planners and advisers.

We are a trained force and are dedicated to our job. We mostly have one interest in life (beer and sex aside) and that is our weed control. With more support and recognition of the contribution our activities make to environmental and economic well being of our council areas, by senior management and councillors, weed control in the state will improve further.

CONCLUSION

In conclusion I am reminded of a chemistry master at my high school that said "there is nothing new under the sun, man does not invent new substances, but as mankind's knowledge and equipment improves new combinations and uses will be found".

I am also reminded that the basics of weed control are the same as they were 40 years ago when I commenced jackarooing.

The early identification, prevention of spread of seeds and plant parts, the introduction of replacement or competitive species and the control of existing plants are just as applicable today as they were back then.

Land managers today are just the same as they were in 1976, but today they may have a University or College degree in something and try to outsmart you with science rather than good honest cunning.

As you continue through the conference you may see the changes I have mentioned and I hope you gain something from my reminiscences.

At a previous conference Bob Phelps (former weed inspector Gunning shire) once concluded his talk by saying

"To control noxious weeds you need three things they are

1. The method or means
2. The money
3. The intent to do the program.

And if you have the intent, then you don't need as much of the other two".

That has carried me through a number of years and is a fitting way to end my talk.

NATIONAL WEED AWARENESS (NWA) HELPED VIA ELECTRONIC RESOURCES

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Abstract
Advances in technology over the past decade have resulted in organisations involved in information transfer planning ahead to maximise its usefulness. Electronic resources are an important information medium available to assist in information transfer and their potential for further development and use is enormous. As weed workers, we often suggest to our clients the importance of Integrated Pest Management for the management of many weeds. If we apply the same principle to electronic resources, we have the opportunity to maximise the benefits that exist as part of this technology and other information delivery mechanisms. This paper will focus on the existing National Weeds Strategy web site (Weeds Australia), its development, and links to other existing electronic resources, such as electronic mail discussion groups and CD Roms.

Introduction
The Macquarie dictionary defines the word electronic as: *relating to, or concerned with electronics or any devices or systems based on electronics* and the word resources as: *a source of supply, support, or aid.* When the words are added together, electronic resources can be summarised as: *a source of supply, support or aid using electronics or any devices or systems based on electronics.* Electronic resources could include a multitude of devices such as the telephone, computers, radio or television. This paper will focus predominantly on computer driven electronic resources.

Organisations have taken on the challenge to provide material via electronic resources. In 1997 the National Weeds Strategy identified the need for a weeds web site to act as the central link mechanism for all computer based electronic resources from reputable sources across Australia. The challenge is to ensure that the electronic resources we use are in a user-friendly format, easily accessible, and provide the client with enough information to undertake the action or to at least link them to sources that can assist them further.

Literature Search
It is estimated that over 6.4 million Australian adults accessed the Internet between May 1999 and May 2000, an increase of 0.9 million from the previous year (ABS, 2000). Unpublished Australian Bureau of Statistics (Agricultural Commodity Survey, 1999) data shows that in March 1999 close to 48% of farms had a computer and 19% of farms were connected to the Internet. This compared favourably to figures for Australian households with 47% of households having a computer and 22% having Internet access.

Advancements in telecommunications and their increased use has meant that electronic information is available to about 20% of Australians. A survey commissioned in 1995 by the South Australian Farmers Federation found 47% of the population surveyed would be interested in technical and/or production topics through electronic information sources (Da Rin and Groves, 1999). This is supported by Groves and Da Rin (1999) who state the usage of the Internet by Australian farmers is set to grow in areas like electronic commerce, Internet banking, and education and training. Groves (1999) adds the second greatest potential for the Internet is formal education and training, behind electronic commerce uses. The National Farmers Federation also supports the use of information technology. In their 1996 Directions Paper, one strategy expressed the need to focus training and

education systems for industry participants on improving industry competitiveness through adoption of innovative strategies and, more specifically, for educators to develop more 'train the trainer' courses, alternative delivery modes, and increased information technology use.

On the other hand Cutler (1999) states that although much of the east coast of Australia is well advanced with telecommunications networks, there are significant difficulties in regional Australia through reduced bandwidths and line quality. Groves (1999) agrees with Cutler but adds there are other difficulties, such as the non-availability of good two-way audio and video facilities and resistance by many involved in the education community still attached to the traditional teaching methods. To redress the imbalance between the telecommunications riches of urban verses non-urban Australia, the Federal Government has established a $250 million Regional Telecommunications Infrastructure Fund.

Discussion

How many times have you asked yourself one of the following questions:

- How much information is there that I don't know about weeds?
- How much of this information do I want to know?
- How can I get this information when I want?
- Where can I find this information?
- Is the information that I gather from a reputable source?
- I have searched the Internet! Why can't I find what I want?

The answer to this may, in part, lie in the use of electronic resources such as the Internet, electronic mail groups, or CD Roms. Electronic resources are available at any time of the day to assist you with finding information. The information collected can then be incorporated into other learning and information transfer sources. As with any other information delivery method, electronic resources need to be customised to the target audience.

It is believed by many that as electronic technology develops further, the potential use of electronic resources will also continue to evolve. The challenge is to ensure all available electronic weed information is linked together and linked to other programs. Links to other electronic information from agricultural, natural resource and environmental programs will assist the integration of weed information into their programs and can help increase awareness and potentially effective weed management. Links to other education programs including those improving the computer skills or access to the Internet external to agriculture, natural resources, and environment helps promote weed awareness messages to new audiences.

It is important to realise there are limitations to electronic resources, including limited access to computers, information credibility, and, at times, specific material is not available or easily accessible. Added to this is the Internet's inability to currently provide high quality imagery that assists clients with identification. These factors, and many others, reinforce the need to continue with existing information delivery mechanisms in association with electronic resources.

In a 1998 report to the Rural Industries Research and Development Corporation, Groves (1998) provides six recommendations in relation to agricultural information on the Internet, which reinforced the National Weeds Strategy vision for the development of one national weeds web site. The recommendations proposed by Groves were to:

- create a specialised search engine;
- provide training in search techniques;
- encourage information providers to adopt "best practice" in terms of the access, navigation and marketing of their sites;

- create a directory of the search pages on sites with site-specific search engines;
- support regional communication initiatives; and
- create an aus.agriculture newsgroup.

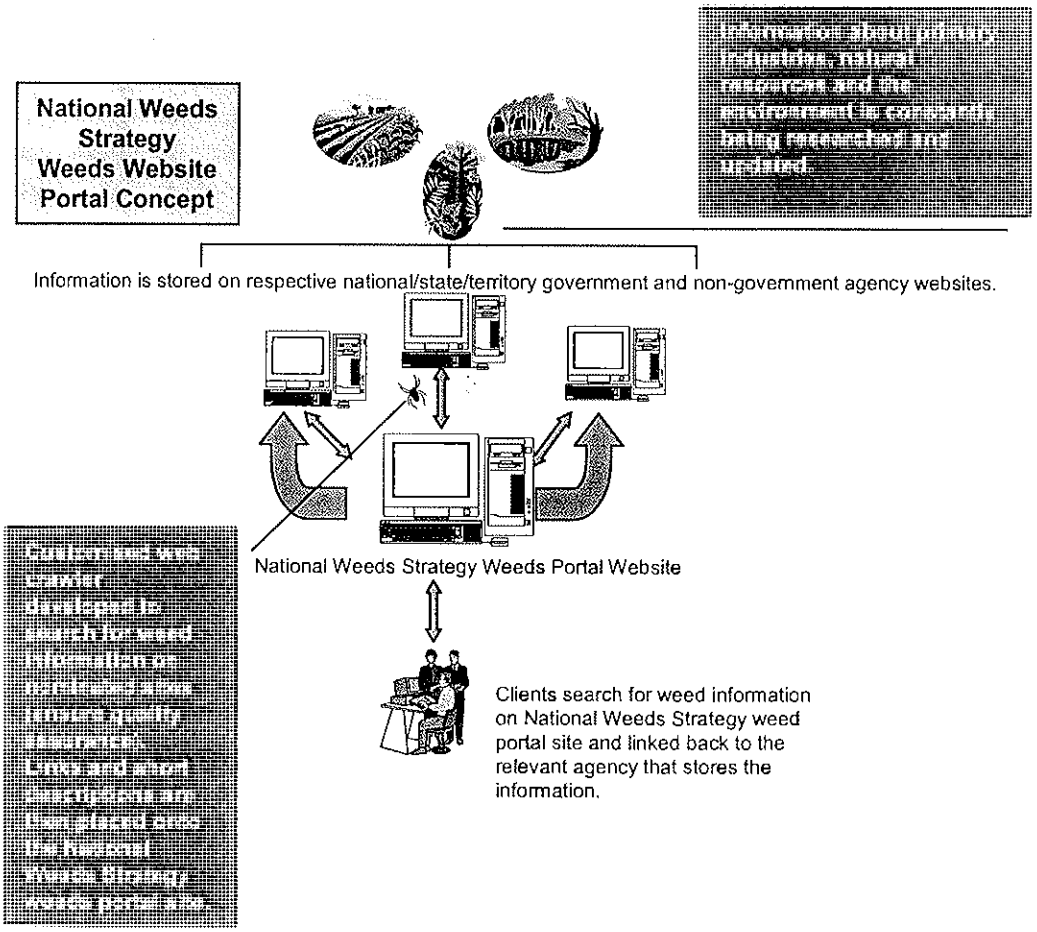

Figure 1: The Weeds Australia Portal Concept

As part of the National Weeds Strategy, the developed Weeds Australia web site is relatively easy to use, offers remote clients good speed access, and minimises ambiguous or duplicated results. The web site is located at www.weeds.org.au and has numerous features, which include:

- a comprehensive database of noxious weeds in Australia and their legislative status;
- an outline of the National Weed Competencies;
- contact details for weed legislation officers;
- a list of useful web sites across Australia; and
- weeds of national significance strategies.

Recently a specialised weed search engine was added to the Weeds Australia web site. This addition has moved the Weeds Australia web site closer to a one-stop shop for electronic weed information (weed portal site) from reputable agencies across Australia. Over 6500 weed related documents are now available to clients, which have been electronically sourced from over 50 agencies across Australia.. The search facility makes it easier for clients to find Australian weed information from one site through a direct link to the information owner thus ensuring they receive the appropriate recognition.

The Weed Navigator lists a number of existing electronic mail discussion groups in Australia and the world (Blood *et al.*, 1998). The Cooperative Research Centre for Weed Management Systems has

established a number of these electronic mail discussion groups that help people access information, opinions, and contacts relevant to weeds in Australia.

The Australian weed discussion groups have been incorporated onto the Weeds Australia web site and are offered as an alternative when clients are unable to find specific information they request. These discussion groups assist the Weeds Australia web site becoming an interactive information source with direct links to relevant weed experts in discussion groups. With time there may be potential for these discussion groups to become sub-grouped relative to the needs and interests of visitors to the site.

The Weeds Australia web site also includes an electronic questionnaire, which is broken into two parts:

- Assessment of the web site in terms of the site principles, such as ease of use and reliability ; and
- Quality of information and future technical information needs to assist those agencies that develop weed information.

Monitoring aspects that collate the type of information being accessed have also been added to the Weeds Australia web site. This information is useful for identifying the types of weed information that site visitors search. The incorporation of electronic monitoring and evaluation on the weeds web site will help ensure the web site is meeting the needs of clients.

In some areas, governments have taken a pro-active role in providing Internet access to schools. If this trend continues across Australia there may be greater opportunities for teachers to use the Internet as a resource for their classroom activities. The National Weed Awareness project, in partnership with many other agencies, is developing a teacher's resource kit aligned to curriculum across Australia. The initial product will be in hard copy, though the intention in the future is to develop an interactive computer-learning package that is available via Internet or CD Rom.

The use of CD Roms has been, and continues to be, another information source for people with computers who are not connected to the Internet. Many private and public agencies have been pro-active in the development of a number of stand alone CD Roms and some are moving towards the incorporation of Internet based information.

The Future

Just as we promote integrated weed management, we must use electronic resources as one tool in our integrated communication approaches. The future for electronic resources is limitless. The development of interactive learning activities that can be delivered through the Internet or via CD Rom may in future become more interactive and include questions and activities for landholders, teachers, and students that need to be undertaken outside of the office or classroom. The Weeds Australia web site also offers our clients a one-stop Australian weed shop with up to date weed information, direct links to local weed officers through the addition of respective contact details (electronic mail, telephone, fax, and addresses), and links to weed experts through relevant discussion groups.

Some organisations have already expressed interest in developing decision support tools that link directly to daily weather reports, predicted weed distribution based on soil types, and other production and natural resource issues. These could replace or compliment existing stand-alone CD Rom computer decision support tools if they are delivered through the Internet. The timeframe for these is not known, but as technology advances so does the probability for their development. The dangers associated with electronic resources include information overload but it is important to

consider that the Internet and other electronic resources allow the client to gather information when they require it, in addition to removing the need for them to store everything. In the same manner, if high quality reference material is required, consideration of user pay systems may also need to be investigated for some information to ensure that the material continues to be of high quality and of use to our clients.

Conclusion

Do not be frightened of electronic resources but be excited that they are available and can help us. If you cannot find the information that you need, ask others for help using the electronic mail discussion groups that are available. If the information that you require is not in the format that you would like to see, tell the respective organisations so that relevant changes can be made. Electronic systems allow for information to be updated relatively quickly.

The challenge is to ensure the technology developed meets the needs of the client, is interactive, informative, and entices users back for more. There is also a need for organisations not to work in isolation. A coordinated approach to the development, distribution and communication of electronic resources will provide increased awareness about the proportions and variety of information that exists for weed management action. To assist and maximise the benefits of electronic resources, details such as web sites can be incorporated into all communication plans and information material.

Finally, be proactive and promote the availability of specific information from electronic resources such as the Weeds Australia Web Site (www.weeds.org.au). The Weeds Australia web site makes it easier for clients to access Australian electronic weed information on request, and the incorporation of weed discussion groups helps improve the two-way flow of information or other contacts for clients. Ultimately the success of electronic resources lies with us. We must promote, use, and have input into their development and refinement. If you know of reputable Australian weed web sites you can make contact with us by visiting www.weeds.org.au and requesting their addition to the Weeds Australia web site.

Acknowledgments

The author wishes to acknowledge funding from the Natural Heritage Trust that assists in the delivery of many of the activities being undertaken in the paper. The author also recognises the valuable assistance and guidance provided by John Thorp, National Weeds Strategy Project Manager and National Weedbuster Week coordinators. Thanks also to the weed researchers that indirectly develop the information that is used in publications and to the extension, Land Protection, communications and weeds officers that promote this information.

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WEED CONTROL ON CROWN LAND IN NSW

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Abstract

This paper will outline the legal and moral responsibilities of public authorities to control weeds on land under their control. Management arrangements for Crown land in NSW administered by the Department of Land and Water Conservation (DLWC) will be outlined, including the processes of reservation, leasing, licensing and appointment of trusts. The status and weed management arrangements for 'vacant' Crown land will be discussed and examples given. Existing Department of Land and Water Conservation programs will be detailed, as well as opportunities for new partnerships with other agencies, local control authorities and the community.

Management of Crown land

Crown land is administered and managed under the Crown Lands Act 1989 and its Regulation 2000. This act defines the principles of Crown land management (Section 11). It covers the procedures for lease or licence of Crown land (41-50), vesting of Crown land in Councils (75-77), reservation of land and formation of reserve trusts (78-128). Procedures are established for assessment of Crown land (30-33) and Plans of Management for Crown land (112-116), while sections 153 to 158 cover protection of public land. There is also a complementary Crown Land (Continued Tenures) Act 1989. Commons are not Crown land, but their management is similar under the Commons Management Act 1989.

Most Crown land is directly leased or licensed from the State, with certain lands being set aside from sale, lease or licence through a reserve system. These reserves are generally managed by council Trusts, corporate Trusts or private Trusts, who have *care, control and management* of the land. This includes responsibility for any assets and improvements as well as the management of weeds, pest animals, bushfire risks and other sundry activities. Such activities include control of access, rubbish dumping, illegal extractions and removal of bushrock and firewood.

About 4 million hectares (or 5% of NSW) remains the direct responsibility of the Department of Land and Water Conservation (DLWC). This land includes Crown reserves (without Trusts), some public roads, marine lands and all vacant Crown land. Although it requires management, much of this land is not of commercial value due to its relative inaccessibility, steepness, fragmentation or poor soil types. It often has important natural values and is suited to passive recreational pursuits such as birdwatching, bushwalking, horseriding and primitive camping.

Legal responsibility to control weeds

(a) Duties of public authorities

Prior to 1993 the Crown was not bound by weeds legislation. The Noxious Weeds Act 1993 binds the Crown (Part 1 Section 5). A public authority that is an occupier of land must control noxious weeds on the land, as required under the control category or categories specified in relation to the weeds concerned, *to the extent necessary to prevent the weeds from spreading to adjoining land* (Part 3 Section 13).

The definition of a public authority includes a government department and the trustees of land reserved or dedicated for any public purpose. The above requirements therefore apply to Crown land which is under the direct control of the Department of Land and Water Conservation or the control of trustees. The act also applies to State-owned land under DLWC control, such as the foreshores of major dams.

(b) Leases and Licenses

If the land is leased or licensed the lessee or licensee is charged with the *care, control and management* of the land, including control of noxious weeds. The Noxious Weeds Act 1993 requires such occupiers to control noxious weeds on the land, as required under the control category or categories specified in relation to the weeds concerned (Part 3 Section 12).

Standard conditions in Crown leases and licences also require the holder *to take steps to eradicate or control all noxious plants, animals and insects on the land which he may by law be required to eradicate or control.*

(c) Vacant Crown land

Weed control on most 'vacant' Crown land is the responsibility of DLWC. At present, public authorities are only bound to prevent weeds from spreading. However more substantial control programs are often the only practical option as many serious weeds are easily spread by a variety of means. There is also a strong expectation among local control authorities and the community that public authorities will control weeds on their land as an example for private landholders.

There is no local government authority in the unincorporated area of the Western Division and the local control authority for weeds in this area is the Western Lands Commissioner (Part 4 Section 35). This position is located within DLWC.

Weed control obligations apply to occupiers adjoining Crown land in irrigation areas (Section 17). These relate to weed control on roads, public reserves, channels watercourses, rivers and waterbodies on or near the land.

Other occupiers who adjoin Crown land may have some responsibilities to control weeds on Crown land (Section 17). Some examples are:

(1) where a landholder occupies either side of a waterway and not the bed of that waterway, that occupant is responsible for weed control in the waterway

(2) where a waterway is the boundary between properties and they do not own the bed and a 'give and take' fence has been erected then the occupier who has the bed enclosed with their land is responsible for weed control

(3) if no fence defines the boundaries in (2) above, then the occupiers are responsible for weed control to the middle thread of the watercourse. Exemptions may be given by the local control authority if the depth or width of the watercourse make this provision unreasonable.

(4) similar provisions to (1) and (2) apply where a landowner occupies both sides of a road which is unfenced or where such road is a boundary between two occupants

(5) where a road is a boundary between two landholders and the road is fenced on one side, the occupant with the road fenced in to their property is responsible for weed control

Cooperative arrangements

DLWC is represented on the Noxious Weeds Advisory Committee (NWAC) which is a statutory body set up to advise the Minister for Agriculture on weeds issues.

- Regional staff participate on Regional Weeds Committees, which are preparing and implementing weeds plans on a regional or catchment basis.
- DLWC is a participant in the NSW and National Weed Strategies, including State Weeds Plans and the federal Weeds of National Significance (WONS) initiative. DLWC is also a partner in the NSW Biodiversity Strategy, which aims to protect native species.
- A representative of DLWC assisted with the formal review of the Noxious Weeds Act 1993.
- Regional staff also assist NSW Agriculture and the local control authorities with joint promotional activities including Weedbuster week and attendance at the major rural field days.
-

Current DLWC programs

DLWC is a significant landholder and natural resources management agency and takes its land management responsibilities very seriously. There are never enough funds to undertake all necessary programs. Nonetheless, DLWC commits substantial amounts to land management programs. These include:

- (a) a joint weed control program on Crown land and DLWC land has been in operation for the past three years. This is funded by DLWC and NSW Agriculture, through NWAC. Three hundred projects have so far been supported.
- A further $375 000 will be spent in 2001/02 ($225 000 from DLWC and $150 000 from NWAC/NSW Agriculture). Trusts, Councils, County Councils, community groups and DLWC Regions are eligible to apply. The closing date for applications is 28 September 2001.
- The following criteria apply to this program:

* confirmation of the status of the land as Crown land or State-owned DLWC land
* severity of the weed and its potential to spread to agricultural land or natural vegetation communities
* program meets the objectives of the NSW and National Weeds Strategies
* program demonstrates "best practice" in weed management as recommended by NSW Agriculture, NWAC and the local control authorities
* program is compatible with State, Regional or catchment plans for targeted weeds
* program leads to long term control of identified weeds
* participation in the program by neighbours, community groups or other land managers
* program attracts contributions from other parties in cash or kind
* the program promotes the effective management of Crown land or State-owned land

(b) DLWC participates with the National Parks and Wildlife Service in programs identified in the NSW Biodiversity Strategy. This includes projects to control weeds which are threatening individual species or communities of native plants or animals.

- (c) Substantial amounts are also spent on weed control under other community- based programs eg Coastcare, Dunecare, Rivercare, Landcare and Salt Action.

(d) DLWC assists Trusts to prepare Plans of Management for Crown reserves, including weed control plans

(e) the statutory Public Reserves Management Fund facilitates development, maintenance and protection works on Crown reserves

- Take home messages:
- * Responsibility for weed management on Crown land can rest with DLWC, Councils, Trusts, lessees or licensees. Hence it is essential that local control authorities check the status of any parcel of Crown land before initiating control action

* As a significant landholder and natural resource management agency, DLWC participates in National, State and Regional weed management forums and strategies

- * DLWC will contribute to targeted weed control programs to the level of its financial capability
- * funds are available for the control of weeds on Crown land and DLWC land in the 2001/02 year subject to proposals meeting the published criteria
-
- References and further reading:
- Crown Lands Act 1989 and its Regulation 2000
- Noxious Weeds Act 1993
- National Weeds Strategy
- NSW Weeds Strategy
- NSW Biodiversity Strategy

WEED MAPPING IN THE BLUE MOUNTAINS – THE BLUESPACE EXPERIENCE

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BACKGROUND

Uniquely, the City of the Blue Mountains is surrounded by a World Heritage listed natural environment (Blue Mountains National Park). The City is also located at the headwaters of 46 peri-urban sub-catchments, all of which flow into the surrounding National Park generally through at least some of the approximately 12,000 hectares of Council and Crown bushland which buffers the National Park (in rare instances private land borders the National Park).

Unlike most of Australia's urbanisation (and indeed the world's) the City of Blue Mountains is located upslope and upstream of both National Park and protected water catchments, significantly impacting the surrounding natural environment.

The NSW National Parks and Wildlife Service (NPWS) drafted a regional Introduced Species Management Plan for the Blue Mountains region in the mid 1990's (NPWS, 1998). This plan identified that the biggest pest management problem facing Parks in the Blue Mountains was weed invasion from urban development.

This plan was tabled at the local Regional Weeds Committee for consideration and action. From this committee a strategy was devised to collect data on the full extent of weed distribution across the Blue Mountains region.

Prior to commencing the project no objective, quantitative data existed on weed distribution and composition. There was however, limited bushland condition mapping which had been undertaken in an ad-hoc, project-based manner.

In order that additional resources could be allocated, that available resources could be used most efficiently, that those resources could be bolstered, and that the greatest impact be made on the most damaging weeds, data was needed to allow these decisions to be made.

Available mapping systems and methods were assessed against the specific needs of the Blue Mountains and found to be inadequate because they did not produce adequately detailed data sets and failed to deal with large areas of natural land.

A new approach was required, one which could deal with 12,000 hectares of native canopy, steep topography, a lack of cadastral navigation points yet still produce an accurate data-set.

That new approach is now known as "BlueSpace" mapping, and it is applicable to a range of natural area management spatial mapping uses. BlueSpace refers to this method of mapping natural areas spatial data developed in the Blue Mountains, the term has led to the recently completed vegetation mapping of the City being referred to as "GreenSpace" mapping.

While the current project has focused on weed mapping data collected through this project can be queried as to degrading impact or human impact creating the weed presence, as well as weed presence or absence and weed species density. Redesigning the data collection process would allow this process to map any range of natural resource management issues.

PROJECT ESTABLISHMENT

The Blue Mountains Regional Weeds Committee saw the need in 1996 to quantify the extent of weed infestation from the City's urbanised ridgeline, through Council and Crown bushland buffers into the surrounding National Park. Funding was jointly provided by the NSW National Parks and Wildlife Service (NPWS) and the Hawkesbury Nepean Catchment Management Trust (HNCMT) to identify or develop the most appropriate mapping system for the Blue Mountains. As the greatest level of known infestation occurred on Blue Mountains City Council (BMCC) land it was seen to be appropriate that Council took the lead in managing this project.

Existing mapping methodologies in Australia and overseas were examined and, while appropriate for their targeted environments, such as remnant bushland in urban environments, broad scale agricultural lands or small patches of bushland, they were found to not adequately meet the needs of the Blue Mountains environment.

As well, systems which could potentially have been applied to the City were found to provide a limited data-set, i.e. overall weed density for a polygon with no species listings, or weed densities per each of three layers within a polygon with no species listings, providing only generic information on weed population densities.

In examining these systems the needs of the Blue Mountains became clearer. What was needed included;

- An ability to map remote, isolated areas of bushland
- Detailed data collection, allowing detailed data querying;
- Weed species location
- Species density
- Species composition
- Degrading impacts
- Accurate data collection to 1m accuracy
- Geographic information system (GIS) compatibility

"BLUESPACE" METHODOLOGY DEVELOPMENT & IMPLEMENTATION

The System developed by the project officers, Wyn Jones and Louise Brodie in conjunction with a community-based steering committee involves the following steps;

1. Base data developed – in the case of broad scale bushland mapping this has been infra-red (IR) aerial photography. In urban environments this can readily be an existing cadastral data set and in broad agricultural areas IR photography may again be appropriate. The area to be mapped must be identified and an appropriate level of base data identified.

   In the Blue Mountains IR photography was required due to the broad scale of areas to be mapped, the uniformity of much of the bushland and a requirement to accurately navigate in areas where GPS is not an available option (due to canopy cover). This photography was funded by the Blue Mountains Urban Runoff Control Program (URCP) ($70,000) and covers the entire City of the Blue Mountains and substantial areas of the surrounding Blue Mountains National Park.

   The raw photography required manipulation (Georectification) in correcting spatial errors at the edges. These errors are present in all aerial photography but were exacerbated in the Blue Mountains with our steep and variable topography. Funding for the Georectification was

provided by BMCC who will inherit the data and who are already using the photoset for other uses.

Georectified IR photography at a small scale (flown at 1:6,000, printed for field use at 1:2,000) has enabled data collectors to identify their location on the ground accurately, individual trees and boulders can be readily identified, allowing easy identification of ground location and therefore accurate data recording. Layers of property boundaries and land ownership were overlaid by the GIS operator prior to printing maps for data collection. This information increased accuracy of location.

An advantage of IR photography over true colour aerial photography is the ability to differentiate canopy plant communities. In a bushland setting this assists with ground location and is a significant improvement in broad scale vegetation mapping over traditional true colour imagery (Douglas, 2001). In a rural or agricultural setting this canopy community may well be at grazing height and therefore assists with rapid identification of species such as Serrated Tussock, Blackberry and St Johns Wort.

2. Data collection forms developed – this involved the identification of required data, the development of a trial form, implementing and refining potential formats, discarding non-essential information from the system and arriving at a final format.

   Initially eight layers of vegetation were reported on:
   - Tree canopy > 5m
   - Tree canopy < 5m
   - Shrub canopy 2-5 m
   - Shrub canopy < 2 m
   - Ground covers
   - Grasses
   - Seedlings
   - Climbers

   Experience with this data collection method revealed that limited additional information was being generated at great cost.

   Subsequent data collection has been at the three-layer level:
   - Tree
   - Shrub
   - Understorey

   In order that previously captured data not be lost the database has been developed to cope with the original eight-layer system. It is recommended that anyone pursuing this mapping methodology adhere to the three-layer data collection protocol.

3. Data base development – large amounts of data are generated using this system which requires management, also a well written data base system the data can be queried very extensively. The system used by "BlueSpace" was commissioned from a local programmer, is written for the Microsoft Access database program and is working well.

4. Preparation of data collection information – this includes the identification of areas of public land within a target catchment and the production of A4 prints of the IR photography data at 1:2,000 scale covering areas of public land in the target catchment.

5. Data collection – with IR photography of the target catchment trained data collectors (local bush regenerators in teams of two) identified areas of weed infestation, identified the weeds present and their density, and defined polygons (discreet areas containing a weed density or species composition differing from neighbouring areas) on the IR photograph locating the boundaries of these discrete infestations.

   With every change in species composition or density a new data form is completed and a new polygon identified.

   For each polygon, the following information is collected:
   The weed species identified at the site, and in which vegetation layer they occur
   - The density of each species (1-5 scale) – this indicates the degree of infestation of weed species
   - The % weed cover in different vegetation layers – this indicates the health of the bushland and its ability to recover
   - The impacts fostering weed growth

6. Data entry into the system involves a transfer of data from the data collection form to the digital data base for each discreet polygon with digitising of polygons into a distinct layer within the GIS managed by BMCC. The database is linked to the GIS, allowing information to be extracted regarding specific weed infestations, or for specific sites within the Blue Mountains.

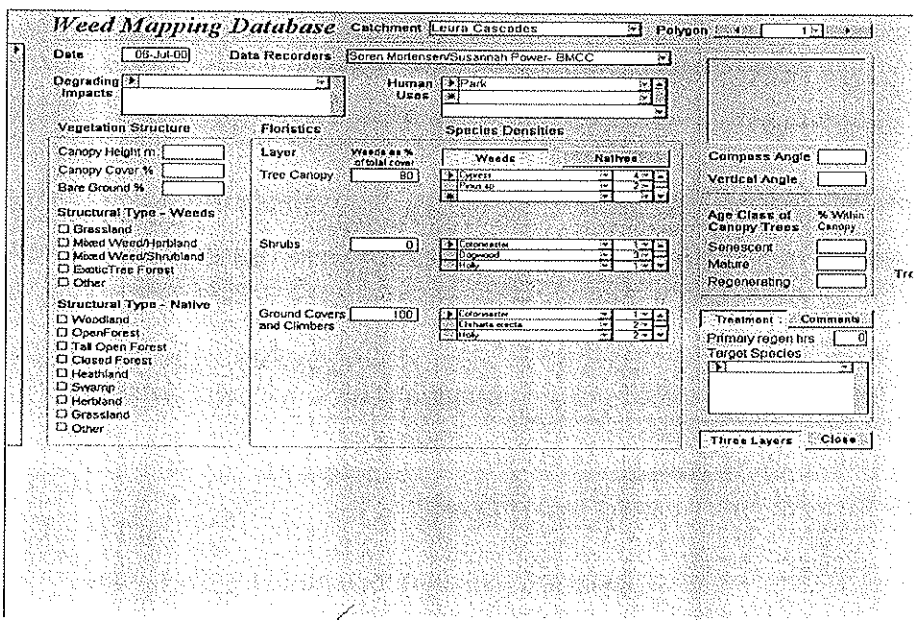


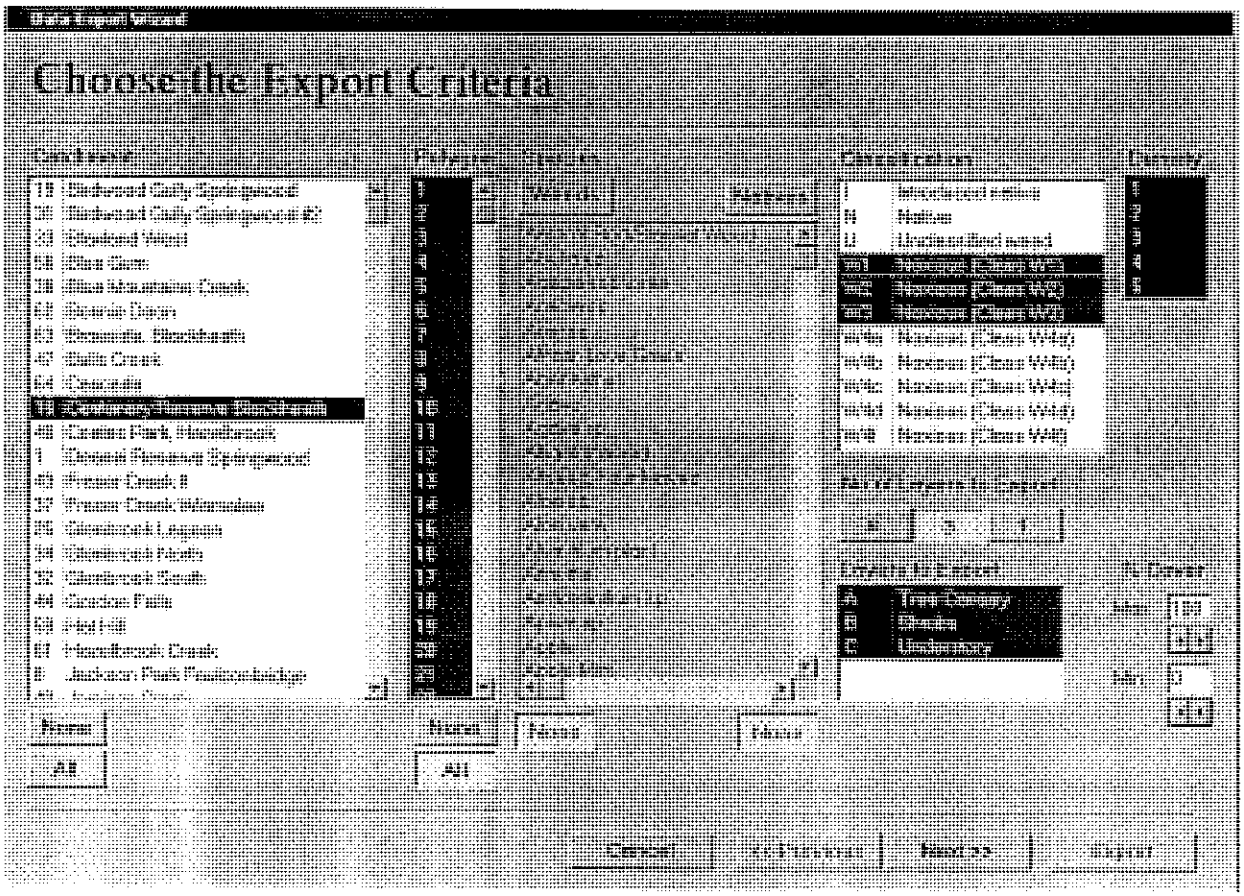
Figure 1: Data Entry page

7. Map production - The information within the database can be queried to produce a report, which can either be linked to the GIS to produce thematic maps illustrating the results of specific queries, or used in the production of reports and funding applications.

Examples of questions that we may wish to answer include:

What weeds are found in Birdwood Gully?
Where does Blackberry occur at high density?
Where in Popes Glen do Noxious Weeds occur?
What is the % weed cover in the ground layer at Centenary Reserve?
How many hectares of Gorse exist in the Blue Mountains, and at what density?

Figure 2: Data Export Wizard, allowing querying by catchment, by specific polygon, for specific classes of Noxious weed or by specific weed.



The weed mapping dataset can also be queried in conjunction with accurate bushland vegetation mapping to answer questions such as:

What weeds are found in hanging swamps?
Which rainforest environments have noxious weeds present?

Overlaying data produced by BlueSpace onto accurate vegetation mapping layers rapidly answers these questions. Both sets of data must be compatible in scale and base data for this to be successful. In the Blue Mountains infra-red photography was the base data-set for both

projects, and their scale is flexible within the GIS ensuring consistent data and accurate outputs.

Figure 3: For each question a table of data is produced by the data base, this in turn can be used to produce a map graphically demonstrating that data.

Species List of Weeds In Redgum Park, Bullaburra

Polygon ID	Layer	Weed Cover	Common Names	Scientific Name	Species Density
7001	Seedlings	0	Pittosporum	Pittosporum undulatum	1
7001	Shrubs 1-2m	0	Blowfly grass	Briza maxima	1
7001	Shrubs 1-2m	0	Catsear/Flatweed	Hypochoeris radicata	1
7001	Shrubs 1-2m	0	Coreopsis	Coreopsis lanceolata	1
7001	Shrubs 1-2m	0	Montbretia	Crocosmia x crocosmiiflora	5
7001	Shrubs 1-2m	0	Plaintain	Plantago lanceolata	1
7001	Shrubs 1-2m	0	Thistle Sow / Milk	Sonchus oleraceus	1
7001	Shrubs 2-5m	30	Lucerne Tree	Chamaecytisus palmensis	1
7001	Shrubs 2-5m	30	Pittosporum	Pittosporum undulatum	2
7002	Climbers	20	Honeysuckle Japanese	Lonerica japonica	1
7002	Grasses	20	Ehrharta erecta	Ehrharta erecta	1
7002	Groundcover	20	Coreopsis	Coreopsis lanceolata	1
7002	Groundcover	20	Montbretia	Crocosmia x crocosmiiflora	2
7002	Seedlings	20	Pittosporum	Pittosporum undulatum	2
7002	Shrubs 2-5m	20	Lucerne Tree	Chamaecytisus palmensis	1
7002	Shrubs 2-5m	20	Pittosporum	Pittosporum undulatum	1
7003	Grasses	60	Couch	Cynodon dactylon	3
7003	Grasses	60	Giant Parramatta Grass	Sporobolus indicus var. major	1
7003	Grasses	60	Paspalum	Paspalum dilatatum	1
7003	Groundcover	40	Agapanthus	Agapanthus orientalis	1
7003	Groundcover	40	Catsear/Flatweed	Hypochoeris radicata	2
7003	Groundcover	40	Clover white	Trifolium repens	1
7003	Groundcover	40	Coreopsis	Coreopsis lanceolata	2
7003	Groundcover	40	Montbretia	Crocosmia x crocosmiiflora	1
7003	Seedlings	0	Blackberry	Rubus fruticosus	1
7003	Shrubs 1-2m	15	Broom scotch	Cytisus scoparius	2

PROJECT IMPLEMENTATION & OUTCOMES

Following the development and trialing of this methodology, funding was obtained from the BMURCP to map the whole of the Blue Mountains City Council area.

$150,000 has been allocated for a Project Officer's position and to employ three teams of contract data collectors. Approximately 90 % of the bushland under Crown and Council control in the Blue Mountains City's urbanized catchments has been mapped.

Data collection has proven to be the bottleneck in the system with data input outpacing data collection by a 4:1 ratio. Querying the data once in the system is rapid and effective.
As at August 1, 11,673 hectares of crown and council public land within the Blue Mountains LGA has been mapped, identifying 1,320 hectares of land infested with weeds at any density. As well, the system has identified 594 weed species in the City, a number of which were previously unknown as bushland invaders.

The data is already being used by Bushcare groups and BMCC environmental staff for planning and prioritising bushland restoration and rehabilitation works.
Three Sydney Catchment Authority (SCA) catchments have been mapped; Medlow Bath/Grieves Creek, Cascade Dam and Woodford Dam and the data is being used by SCA staff in their management decision-making process.

The Blue Mountains Noxious and Environmental Weeds Group, a multi-agency working group comprising various governmental agencies and members of the community, are also using the system to effectively prioritise noxious and environmental weed control. The system will enable sound decision making at all levels of weed control and will allow scarce resources to be applied to the greatest effect.

Sufficient data has now been captured to allow meaningful data querying and map production.

CONCLUSION

This project has developed and tested a new method for quantifying land management issues in a spatial context. Specifically the system has focused on mapping the weeds of the Blue Mountains LGA. The system could equally be applied to the mapping of saline affected pasture lands, acid sulphate affected coastal and flood plain lands, or any other environmental management issue where greater detail is required than is currently being captured.

In the above example saline affected lands would be identified spatially, polygons developed based on the degree of surface crusting and changes in the health and composition of pasture species surrounding the surface crusts. Extrapolations could be made from this ground mapping to predict future saline outbreak sites.

The project has supplied a snapshot of the weed problem on public land in the Blue Mountains during 2000, 2001 (12 months of data collection) allowing accurate decision making to be made by Government agencies and the community as to priority weed management. This baseline also allows successes and failures of weed management activities to be accurately identified and quantified, further enhancing program efficiencies.

Data within the system can be updated at any time and as with any data management system relies on up to date data to ensure its viability and use as a management tool. The Blue Mountains Council has given an in principle commitment to ongoing data collection as it is realized the benefits of such an environmental management system. Options for the continued enhancement of the dataset include;

- Updating data post weed control works in specific sites
- Re-mapping specific sub-catchments on a revolving basis as resources allow
- Re-mapping on a five-year cycle as per BMCC's five local planning areas.
- Re-mapping areas highlighted through this baseline data collection process as weed infested on a regular (2-3 year cycle)

Any of the above processes will produce the desired outcome.

Private lands within BMCC have been monitored by Noxious Weeds officers inspecting properties, this data is now being captured via GPS' linked to laptops, allowing this data to be linked and displayed via BlueSpace.

Early reports from field staff utilizing the system have been glowing, *"It took us three hours to deal with all our target weeds at Medlow bath this year, its always taken us three days in the past, this time we went straight to the sites and the job was so easy."*

Within the Blue Mountains significant weed problems exist with a substantial treatment time frame, specifically Gorse and Broom which both require long term management. In the case of Gorse, 90% of known infestations have been controlled through a concerted inter-agency response to an emerging issue in the 1990's. However, given the 80 year seed viability of this spp. failure to maintain

management of these treated sites into the long term will allow a reinfestation of the Mountains, with BlueSpace we have accurately identified these sites and Gorse control will continue even with the several complete staff turnovers which can be expected.

New weed incursions can be mapped and reacted to quickly using ongoing mapping protocols, and degrading impacts that are influencing the presence/severity of weed infestations can also be prioritized.

Utilising the excellent GIS data set possessed by BMCC allows for comparison of weed infestation against endangered species/communities, allowing a prioritization of works on biodiversity grounds, it allows for comparison against past infrastructure works or against existing sewer or stormwater drains, areas of road work, new subdivisions, etc. Linking the BlueSpace system with an effective existing GIS dataset greatly enhances the power of both systems to enhance management decision-making regarding weed control.

WOODY WEED CONTROL – NEW PRODUCTS

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INTRODUCTION

Dow AgroSciences, a major manufacturer of woody weed herbicides, has expanded its label claims for Grazon* DS Herbicide, Starane* 200 Herbicide and Access* Herbicide for control of St. John's wort, silver-leaf nightshade and peppercorn trees.

The purpose of this paper is to communicate these label changes to the Noxious Weeds Inspectors and other personnel in New South Wales who provide recommendations on woody weed control.

ST. JOHN'S WORT

St. John's wort (*Hypericum perforatum*), a noxious weed on the tablelands and slopes of New South Wales, is a declared noxious plant in 81 shires in NSW (Campbell and Watson 1994). As presented at the last conference by Love (1999), Grazon DS is now registered for the control of St. John's wort by boom application (2 to 4 L/ha) as well as high volume (spot) application (500 mL/100L water) techniques.

Picloram

One of the active ingredients in Grazon DS, picloram, has soil residual properties. If roots from desirable plants (e.g. *Eucalyptus* spp. along roadsides) extend into areas which have been treated with Grazon DS to control St. John's wort, damage may occur to these desirable species from uptake of picloram through the root system.

The length of time necessary for picloram to degrade in soil is based on many factors including the herbicide rate applied, soil moisture, organic matter content, temperature, oxygen status, and soil microbe activity. In general, breakdown is more rapid under warm, moist conditions in high organic matter clay soils. This type of environment promotes microbial activity hastening picloram degradation. In addition, the higher the application rate, the longer it takes for picloram to degrade.

With this information in mind, areas along roadsides where St. John's wort is growing near desirable species, like *Eucalyptus* spp., Grazon DS should not be considered as the first herbicide option in this situation.

Fluroxypyr

Starane 200 (200 g/L fluroxypyr) is now registered for the control of St. John's wort by boom application (3 L/ha). As shown by Campbell and Nicol (2000), split applications of fluroxypyr (0.4 + 0.6, 0.6 + 0.4 and 0.6 + 0.6 kg a.e./ha) at flowering in Novembers 1997 and 1998 gave 100% kill of the weed. Single and split applications of fluroxypyr had no deleterious effects on the regeneration of annual clovers with and without superphosphate and promoted the ground cover and quality of native perennial grasses. Also noted by Campbell and Nicol (2000), triclopyr + picloram (Grazon DS) reduced ground cover of clovers and glyphosate reduced the ground cover of native perennial grasses.

* Registered Trademark of Dow AgroSciences

Fluroxypyr is a systemic herbicide that moves readily throughout the plant via the phloem (nutrient transporting) system. Factors that impact plant growth also impact their translocation and thus performance. Good growing conditions result in better control.

Fluroxypyr may also be taken up from the soil by plant roots. However, since fluroxypyr has little soil activity, with a soil half-life of less than 7 days, it is applied as a post-emergence herbicide. With this attribute, fluroxypyr can be safely used around desirable plants without any harm being caused to these plants, but should not be applied directly to desirable plants.

An off-label permit for the use of Starane 200, as a high volume application technique, has been considered, as it could be used safely to control St. John's wort in heavily timbered areas without harming the desirable species. Kerrin Styles, ACT Parks and Conservation Service, spoke to the National Registration Authority (NRA) on Tuesday 2nd January 2001 regarding the use of Starane 200 for the control of St. John's wort by high volume application. "The NRA are happy for us to continue our current use, without the need for a permit, as our high volume handguns are "accurately calibrated" to actually deliver the boom application label rate of 3 L/ha. The NRA considered that we are using the product at the label rate approved and hand gun equipment for this purpose is acceptable", Kerrin said.

Therefore, at a high volume application rate of 1000 L water/ha, the use rate of Starane 200 would be 300 mL/100L water to be equivalent to the boom application rate of 3 L/ha for control of St. John's wort. Follow-up treatment of regrowth would be required.

Summary

Starane 200 could be used as a replacement for Grazon DS for the control of St. John's wort in areas where desirable species are in close proximity. Overall, Grazon DS gives the best long-term control of St. John's wort, when applied to actively growing plants (growth stage from flowering to early seed set) from late spring to early summer.

SILVER-LEAF NIGHTSHADE

In New South Wales, silver-leaf nightshade (*Solanum elaeagnifolium*) is a declared noxious weed. Starane 200 at 750 mL/ha + Uptake* Spraying Oil was recently registered for the control of silver-leaf nightshade in established grass pastures. Treatment should take place from the onset of flowering to early berry-set. Follow-up treatment of regrowth is critical for optimum control. A recent demonstration trial has shown that higher rates of Starane 200 may be required to give adequate control, as shown in Table 1.

Table 1. Percent control of silver-leaf nightshade following application of Starane 200 and various mixtures, southern New South Wales, 4 months after application.

No.	Treatment	Rate (mL/ha)	Adjuvant	Rate (% v/v)	Percent Control, 4MAA
1	Starane 200	1000	Uptake	1.0	90-95
2	Starane 200	750	Uptake	1.0	70-75
3	Starane 200 + 2,4-D amine	375 + 1500	Uptake	1.0	30-40
4	Starane 200	600	Uptake	1.0	50-60
5	Starane 200 + 2,4-D amine	500 + 2000	-	-	30-40
6	Starane 200 + Roundup CT Xtra	500 + 1000	-	-	20-30

This trial was sprayed on 20th October 2000 by Scott Boothey, Dow AgroSciences, Wagga Wagga. The trial was located between Wagga Wagga and Narrandera. A water rate of 100 L/ha was used on weeds that were at the early flowering growth stage. Dow AgroSciences will continue to monitor this site for regrowth suppression.

PEPPERCORN TREES

In Victoria, the peppercorn (*Schinus molle*) is classified as an environmental weed. It is described as a shrub or small tree to, 10 m tall, with large drooping, divided leaves. Melissa Walsh, Department of Conservation and Natural Resources (DCNRE), Tatura Research Centre, Victoria has been involved with the control of peppercorn trees in that state during 1998/99. At the time this work was being done, there was no product registered to control this weed, although the Government Department had been using Tordon* Timber Control Herbicide, as a stem injection application, and Access Herbicide as a basal bark application. Assessment of 33km of roadside, some 11 months after application, showed 95% control of peppercorn trees using both application techniques (Walsh 1999).

Since this time, Dow AgroSciences supported the request by DCNRE in Victoria to have Access registered, by basal bark application, for the control of peppercorn trees. A label update for Access was registered in October 2000, with a use rate of 1:60 in diesel as a basal bark application only. At this stage, Tordon* Double Strength Herbicide, as a stem injection, has not been registered as a label update has not been pursued for this product.

NEW PRODUCTS

In Australia, there are currently no new herbicides being developed for use in woody weed control. Dow AgroSciences is currently testing a new molecule in this area, but no decisions have been made on commercialization at this stage.

ACKNOWLEDGMENTS

The author would like to thank Scott Boothey, Dow AgroSciences, for supplying the silver-leaf nightshade efficacy data to be included in this paper. Thanks also to Kerrin Styles, ACT Parks and Conservation Service, Canberra for allowing his comments regarding off-label permits to be included in this paper.

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CHANGES IN WEED CONTROL PRODUCTS

Biotech in all its glory

Don Matthews
Heathdon Agricultural Services
WODONGA Victoria

THE PAST

The history of herbicides is one of slow, expensive screening, coming from the minds of experienced organic chemists looking for that elusive compound that would support them in luxury in their retirement. Huge chemical laboratories supported by huge glass house screening operations meant that only the largest, and therefore the richest, international chemical companies could afford the overheads and the time necessary to achieve a "NEW HERBICIDE". It has always been a mystery to me that we have had the diverse range of herbicides that we have had to use. The delicate interplay between the lawyers wanting to patent, and the chemists wanting to prove performance first, was the nerve- racking interplay between failure and success. Many new compounds were snatched from a developer before management approved patenting, which meant that that whole line of development came to nothing.

Our reliance on crude chemistry has given us some very painful experiences. We are all victims of off-target damage from herbicides which also could be volatile. The broad spectrum "hormone weed killers", and in particular their ester formulations still present us with a work environment where we must be constantly vigilant that we maintain the herbicide in the target area. Even some of the so-called new herbicides are esters, as I was shocked to find out when I was getting very excited about the potential of Dow AgroScience's new herbicide STARANE ® 200 as a companion tank mix with DuPont's BRUSH-OFF ® Brush Controller. As most of you are aware, Victoria now has a blanket requirement for any applicator to possess a "CHEMICAL USER PERMIT" if he wants to use the ester formulations of MCPA, 2,4-D, or Dow AgroScience's GRAZON ® DS and GARLON ®, along with some other pesticides. I wonder how long it will take before other bureaucrats decide that this is a good idea and will extend these requirements into other States.

N.S.W.'s E.P.A. are currently contemplating the introduction of a requirement for all commercial applicators to be trained to a national competency which will result in the effective licencing of all those who wish to apply pesticides. I understand that the plan will have six levels of licence, with the highest two being for contractors, which I'm assuming will include all of you. If this comes about, then it will give the legislative background for the introduction of restricted pesticides to various levels of competency. The current ChemCert Certificate is at Certificate IV level, which is assumed to be sufficient for farm applicators, but would not satisfy the competency requirements of a contractor, and therefore of a Shire Weed Officer.

Broad spectrum, crude chemistry herbicides will be a target for selective restrictions and so we may see very shortly that only those holding a licence that requires intensive and technical training, being able to use products like MCPA, 2,4-D, Dicamba, Bromoxynil, GRAMOXONE ®, REGLONE ®, Atrazine, and all of the long-lasting soil residuals such as VELPAR ® and ARSENAL ®.

THE FUTURE

Thanks to some excellent work by N.R.A. we are at last starting to see some consistency coming into the layout and content of our labels. We will hopefully see the end soon of the very confusing situation where a State will require a different label rate from others. It has never ceased to amaze me how States have justified that a weed growing in their State requires a different rate of application

of a herbicide than the same weed growing in another State. The 2,4-D label for instance has one weed which requires more than double the rate in New South Wales than in Victoria.

The constant changing in labels has meant that the only place where up to date labels can be sourced is the internet, along with MSDS's. The old days of every reseller having a label book and an MSDS book with current information, seem to be long-gone. You should be very wary of old books in resellers, as I have found some very significant changes have not made it through to the resellers.

The introduction of the new Pesticide Act from July 1, 2000 and the new Occupational Health & Safety Act 2000, are an indication that State Governments are more likely than not to become very involved in the application of pesticides. As a ChemCert Trainer, I am finding it very stressful to detail to farmers their legal obligations under these two Acts. Most farmers' response is that it is all now too hard to operate within the law, particularly as they have no experience of any enforcement action. The attitude tends to be one of "I'll worry about that if it happens". Unfortunately we cannot ignore these laws. As professional Weed Officers, we must show the way and help our customers understand their duty of care to all other stake holders in their catchment. To comply totally is going to demand discipline and some assistance from knowledgeable trainers on how to conform. We as a group need to identify those amongst us who understand the new requirements, and how to implement them, and then use these skills to ensure we comply.

A major irritant to me has been the development of so-called "information hotlines" that are promoted by chemical companies where the person who answers the phone is either a call centre or a junior member of staff. There are some notable exceptions and I here acknowledge that Dow AgroSciences and DuPont at least have a field trained person on the other end. Of course, depending on where you live, the person's experience may be irrelevant to you and your location. I strongly advise you to not expect an instant answer from these information lines, but rather to present a query and be prepared to wait for the relevant person to get back to you, who is the company's most qualified person to answer your question.

The other major concern of course is that of the changing names of our chemical suppliers. The consolidation of the agricultural chemical industry in the last 10 years has accelerated lately to the stage where I can't pronounce the new names, let alone remember them. The emergence of the huge conglomerates AVENTIS and SYNGENTA has certainly stirred up the industry, as has the emergence of the small player in the past – B.A.S.F., into a major player today. Now it appears that Aventis will be sold to BAYER, who will then pass some segments across to B.A.S.F. Some old names have disappeared, HOECHST, MAY & BAKER, I.C.I., CIBA –GEIGY, SHELL, and now ROHM & HAAS have been swallowed up into DOW. I personally miss the old friendships that we had with their field staff and am at a loss to know how to deal with the new corporate identities who all seem to be run by people I've never heard of. Oh, the problems of retirement!

These new companies are developing new pesticides in a whole new way. They are also establishing themselves in the new science of biotechnology. We are only just at the beginning of a new age, where the ability of plants to defend themselves against chemical attack will be enhanced. The introduction of TRIAZINE-resistant Canola and ROUND-UP READY crops is only the first step on a long road to discovering those proteins in plants' DNA which can be manipulated to increase either the tolerance or the resistance of both existing and newly introduced herbicides. As more and more plants genomes are published we will increasingly enhance the plant's defences against attack from insects, diseases, and of course our herbicides. These new crop introductions will hopefully significantly minimise off-target damage, as we will be able to spray the resistant herbicide right alongside what were once susceptible crops. I can see the day when farmers will post signs on their external fences indicating which trans-genic crop they have growing in the paddock behind the sign.

We constantly hear today from those who are against the introduction of trans-genic crops, that we will produce "SUPER WEEDS". The suggestion is that as herbicide resistant crops are grown, that there is a potential for the resistant gene to transfer to members of the same family of plants that are weeds. There is no doubt that this pollen transfer can and does occur, and therefore the possibility of gene transfer to weeds is possible. What I don't understand is how we are going to stop farmers from thinking. This situation assumes that the farmers and of course, we as Weed Officers, do not know that there are other herbicides that we can use, or that somehow the herbicide manufacturer has brain-washed us into only using their product. Maybe there is going to be a whole new industry of chemical company people trained in mind manipulation who will succeed in destroying all of our past knowledge and manipulating us into the use of only using patented products.

I think that they will be busy doing other things, and I'd like to briefly discuss some of them.

There is no doubt that we have failed to convince the general public that there is any benefit in the use of agricultural chemicals, and so it is going to be even more difficult to convince them of any benefits of biotechnology. Richard Beckhard's work on the definition of successful change suggests that it is a function of

- dissatisfaction with the present situation
- a vision of the desirability of the future end-state
- a plan indicating the first practical steps to be taken

We certainly have the first prerequisite and probably in the minds of the chemical companies, the last, it is the middle point that eludes us.

There is no alternative on the horizon for herbicides. We will be able to modify plants to resist attack from insects and diseases. The development of resistance to our current herbicides will ensure that companies maintain an active lookout for any new compounds, and if found, they will be very highly prized and probably priced as well.

The old chemical company laboratories are gone and there is a whole new method of identifying biological targets which has resulted in just about automatic, robotically-operated, screening systems that can handle several hundred thousand screening units at a time. We now have indicators, artificially produced, which are in practice a DNA chip, that can determine potential activity right up to an assessment of effect. These screens are ready to accept a diverse range of chemical candidates. All the companies require is to source them from somewhere and these sources are now being developed by specialty companies who are establishing compound libraries.

The old LD-50 test is gone. We now have an inexpensive battery of cell cultures which is more accurate in measuring and understanding toxicity than the animal tests ever were. It was estimated that the accuracy of the old LD-50 tests on rats and mice, was only 60/65% predictable for human toxic effect. These new culture tests using human cell line cultures are 75% accurate in predicting human lethal toxicity.

We now have a non-animal test to determine whether a chemical is likely to burn or corrode human skin. The candidate is placed on a collagen matrix barrier and after penetration the chemical causes a colour change in a liquid detection system composed of pH indicator dyes. The time taken and the colour produced, determine the candidate's corrosion ability.
Blood tests were the old way that we determined if applicators were storing artificial chemicals in their bodies. A new test is being developed where simply by blowing on a specially impregnated card, a Doctor will be able to confirm the presence of any and all chemicals that you may be storing.

These remarkable sensors are based on the sex life of yeasts. The developers are creating a library of millions of different genetically engineered yeast cells capable of responding to virtually any chemical you can think of. This is based on the fact that yeasts use receptors to detect chemicals, "pheromones", which are given off by other yeast cells to attract a mate in the same way that insects do. At this stage of the development it appears that these tests will detect any chemicals present at a level of one part per million.

Application technology is changing to the point where differences in a paddock, eg organic matter, nutrients, or pH can be accurately mapped to within a few metres. By measuring and recording this information using global positioning systems and geographic information systems, we will be able to identify areas to be treated and feed this information into boom sprayers, which will be engineered with adjustable output to deliver the optimal, but varied dose, of either one or more herbicides across the paddock. Research is currently being undertaken into methods of detecting signatures for various plants so that they can be selectively removed from both crop and non-crop situations.

Your future will be one of high tech. equipment applying exact doses of the correct herbicide, only to the invasive plants that may be scattered anywhere in your target area. All this from the comfort of your air-conditioned cab, assuming you can find a space to sit amongst all of the high tech. gear, and copies of the relevant legislation that you will need to achieve this magic new world of weed control!

WHAT'S NEW FROM MACSPRED? - *"An Update for Weed Managers"*

Geoff Keech
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Marayong NSW

INTRODUCTION

There is nothing as constant as change, and change in the world of herbicides is moving at a rapid pace. For many years, when calling on customers, the first question asked has been "What's new?" well now we have something to talk about. Macspred is currently involved in several herbicide trials throughout Australia and has registered four new products in the last few years, with more in the pipeline.

In Northern NSW we are currently participating in several forestry trials, which contain up to 15 different products, some including new chemistry. We also have trials down on a new industrial total weed control herbicide, which has reasonable safety to established eucalypts.

Some of our recent developments include improved packaging systems and product formulations, which minimise the risk of operator exposure to undiluted herbicide. In past years, formulations consisted of wettable powders, which were difficult to mix, blew all over the operator in the wind, blocked nozzles, and abraded pumps. They progressed to liquids, water dispersible granules and now dry flowable formulations such as Brush-off®. Previously with wettable or dispersible powders, the application rate was as high as 40 to 50 kg per hectare. Some current products are as low as 5 grams per hectare. Other innovations include the removal of highly flammable solvents or liquid carriers from formulations, making storage and transport safer and cheaper. Examples here are Velpar® DF™ and Roundup® Dry.

NEW CHEMISTRY

Evolus® (from McQuinn, 2000).
Evolus® is a broad-spectrum herbicide containing Azafenidin as the active ingredient and is a discovery of DuPont DeNemours Agricultural Products. It will provide extended residual weed control in tree crops and plantations, vines and sugar cane. It also has potential in the industrial vegetation control market for use in sensitive areas. This product should eventually fill the gap left by the withdrawal of Visor®.

Mode of Action

Evolus® is absorbed through the roots and shoots of susceptible plants and acts by inhibiting the porphyrin biosynthesis (PB) pathway. Weeds, which have evolved resistance to this mode of action, are extremely rare, making this compound an excellent tool for resistance management in specialty crops. Evolus® belongs to the triazolone sub class of herbicides and is a group "G" herbicide.

Evolus® is weakly mobile in xylem and phloem; therefore, it has limited post emergence activity. Although significant knockdown has been observed on some species, if weeds are present at the time of application, Evolus® should be tank mixed with an appropriate knockdown herbicide such as glyphosate. A significant improvement of the speed of action and efficacy of glyphosate has been observed when mixed with Evolus®.

Formulation

Evolus® is formulated as a water dispersible paste granule (WG), containing 800 g/kg of the active ingredient.

Weed Spectrum
Applied as a pre emergent herbicide at 500-800 gai/ha, Evolus® will control most annual broadleaf and grassy weeds. Activity appears greatest on shallow germinating species, eg Annual Ryegrass. Several important problem species such as *Solanum nigrum* (Blackberry nightshade), *Epilobium* spp. (Willow herb), *Chenopodium album* (Fat hen), *Echium plantagineum (Paterson's Curse)* and *Malva parviflora* (Small-flowered mallow) are sensitive to Evolus®.

Residual Weed Control
The length of residual control is very dependent on application rate. At 500-800 gai/ha, up to 8 months control can be achieved. Lower rates give a shorter period of control. The performance of Evolus® is independent of soil texture, organic matter content or temperature. Incorporation by rainfall or overhead irrigation is essential for optimum performance. Evolus® should be applied to bare soil to provide maximum residual weed control. Where weeds are present, tank mix with an appropriate contact herbicide such as glyphosate, glufosinate or paraquat, to ensure complete knockdown is achieved.

Toxicology
The toxicological and ecotoxicological studies completed to date indicate that Evolus® does not bioaccumulate and presents a very low risk to humans, animals and the environment.
Oral LD50 (rat) > 5000 mg/kg. Dermal LD50 > 2000 mg/kg.

Fate in the Environment
Evolus® degrades in the soil by microbial degradation and photolisis. Microbial degradation is very important. Hydrolysis is not important as a degradation mechanism. Evolus® is not expected to move and accumulate in soil as it binds well to soil. There was minimal movement in soil column leaching studies using a very sandy soil, similar results were found in the four field studies. There is very low risk of Evolus® or its soil degradation products leaching to ground water. It is hydrolytically stable but photolyzes very rapidly in aquatic systems. It is classed as non-volatile.

NEW PRODUCTS
Trimac® is a soil residual herbicide designed for use in industrial weed control situations. Trimac® contains 40 g/kg Sulfometuron Methyl and 880 g/kg Terbacil. The product is for grass and broadleaf weed control, giving bare earth for 6 to 9 months. The active ingredients of Trimac® are derived from the B and C groups of herbicides, giving dual activity on susceptible plants. Trimac ® moves into the soil with rainfall or soil moisture, where it is taken up by the roots of plants and germinating seedlings. The first mode of action inhibits the biosynthesis of the essential amino acids valine and isoleucine by inhibiting the enzyme acetolactate synthase. This causes plant cell division to stop. The second action inhibits photosynthesis at photosystem II, stopping the manufacture of food.

Trimac® has some knockdown capability on seedling plants, however if green plants are present at the time of application, the addition of a suitable knockdown herbicide, such as glyphosate, will greatly enhance the result. In all cases, where perennial species are present, use a knockdown herbicide at label rates prior to application of, or as a tank mix with Trimac®.

How safe is Trimac® to the user?
Trimac® is packed in pre-measured water-soluble bags; so that measuring of concentrated product is unnecessary, thus minimising the risk of exposure to the operator. Extensive testing of both

ingredients, rivalling that of medication for human consumption has, demonstrated no toxicity to humans when used in accordance with label directions. In fact the LD_{50} for both is >5000 mg/kg. However any herbicide should be respected and the correct personal protection and handling procedures, contained on the label, adopted.

What happens to Trimac® in the environment?
The half-life of Trimac® in soil will vary according to several factors. Primarily all compounds are broken down by microbial activity; there is also some photo degradation and chemical hydrolysis of individual components. The rate of degradation is governed by temperature, pH and the amount organic matter and moisture present. The half-life of the most residual component is between 204 and 252 days in soil and 29 and 54 days in water.

Will Trimac® cause harm to wildlife?
Trimac® does not bioaccumulate and because the ingredients act only on enzymes occurring in plants, or in the photosynthesis process, there is little likelihood of any adverse effects on wildlife from normal use. Trimac® is considered non-toxic to birds, honey bees, mammals, and only slightly toxic to some species of fish. The concentration rate of active for the fish studies was extremely high and any harm is unlikely to occur when the product is used according to label directions.

How safe is Trimac® to non-target trees and shrubs?
Because Trimac® is designed to control plants, application adjacent to desirable annual species or to areas of land prior to cropping should be avoided. Green plant material sprayed with Trimac will be damaged.

NEW PACKAGING

Forest Mix® WDH, Trimac® and Eucmix® PrePlant are all recent additions to our product range and are water dispersible herbicides, pre packed in water soluble packaging. This packaging system utilises a water-soluble bag containing a pre-measured amount of product. Water soluble bag technology today is a vast improvement on previous introductions into the market place. The soluble bags and water dispersible formulations have been developed by Macspred to fulfil a need in the forestry and industrial market.

The bag is added to the spray tank under agitation and takes away the need to measure concentrated product when preparing spray mixtures. This system not only increases safety; it also ensures dose rate accuracy, eliminating the risk of mistakes during measuring. The outer packaging is returnable or recyclable and the product is a dry herbicide, which eliminates drum rinsing and container disposal problems. Formulations such as Trimac® also reduce transport and storage costs along with the associated risks.

CONTROLLED RELEASE GRANULES

A new development in granular herbicide technology has been the production of a controlled release granule. When applied to the soil, the granule releases a portion of its active ingredient with follow-up rain fall or adequate soil moisture. The remaining active ingredient is released after a pre-determined amount of follow-up rainfall.

In forestry situations, this means that there is greater tree safety combined with an extended period of weed control. The flow on benefits for industrial herbicides could include a reduction in application costs and better environmental stewardship.

The reason for this is that, as soon as a herbicide is released into the environment, it begins to break down. To achieve a reasonable length of control with a residual herbicide, a higher rate of active is required than is necessary for a shorter-term control. This is best explained by a half-life graph (see fig 1).

Figure 1.

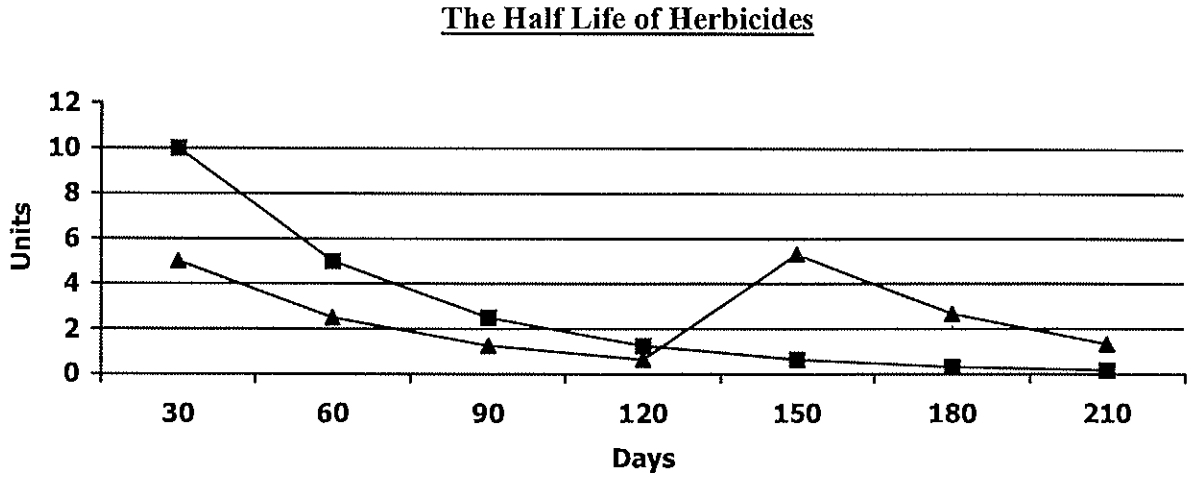

Figure 1 shows that by applying 2 lots of 5 units of active ingredient, the activity lasts longer than a single application of 10 units. By utilising controlled release granules, the second application cost is avoided.

If the half-life of a herbicide were 30 days, then half of the active applied would be degraded in 30 days. In another 30 days, half of what remained would be degraded and so on. With controlled release granules we can make the same amount of active last longer, in providing effective and more extended weed control, ultimately reducing the amount of herbicide released into the environment.

RESEARCH AND DEVELOPMENT

The major trend within the herbicide industry is the emergence of more and more generic branded products. This drives the price and therefore the profitability down, causing the major research and development companies to cut back on their input towards new label claims for those products effected. The drop in profitability in the herbicide area has also caused many companies to divert their funds from herbicide development to R&D in biotechnology.

In the past, herbicide companies came to the end user of the product and said, "This is what you need". Today the committed research based company is coming to the end user and asking "What do you want, how can we help?" This is how today's new designer products are born and the reason why Macspred supports the major Research and Development based companies.

Recently Visor® was withdrawn from the market because it was not profitable. Many people were disappointed because the product performed well and was environmentally acceptable. It is only through research that we may now have a replacement product in the pipeline. So what type of product do you need? Will it have widespread applications? Is there a need to extend the label claims for existing products? Let us know and we will try to find an answer.

For Further Information on Any Products

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Information included in the Trimac section of this paper has been taken from the following sources:
US EPA, Monsanto Australia Limited, DuPont Agricultural Products.

Forestry & Industrial Herbicides

41-A & 38-F SPRAY DRIFT RETARDANTS

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Griffith NSW

Over 20 years ago, Sanag, a Californian chemical company, developed a product that would help allow more even spray droplet size control. As a result of their product, Drifgon, aerial application of Glyphosate was allowed on label. Since then Drifgon has been improved into a granular formulation called 41-A and the liquid formulation 38-F.

Exposure to Australian Market
Soon after it was developed, Drifgon was released on the Australian market. An abundance of "snake oil" products emerged at the same time, all claiming to control drift. They were all tarred with the same brush, regardless of whether they worked or not.

The poor quality of products over the past 20 years has been the major problem confronting the re-introduction the 41-A and 38-F Drift Retardant to the Australian market. The Australian market is very sceptical of any product claiming to help reduce spray drift.

Research carried out in the United States on 41-A and 38-F has been confirmed in Australian with the recent competition of Australian field trials.

41-A and 38-F was reintroduced to Australia in 1996, when Rhett Heffernan, an Agricultural Pilot working on the Rice in the Murrumbidgee Irrigation Area of southern New South Wales, was experiencing difficulty applying MCPA to rice as the soya bean crops where emerging in the area. At that time, the company he was working for, was employing a Californian Agricultural Pilot, Bob Caldwell. Through Mr Paul R. Dale of Sanag, Bob arranged the importing of 41-A and 38-F.

Widespread interest
Through extensive trial work conducted since 1996, the advantages of 41-A and 38-F have been revealed. The primary advantage is the reduced risk of litigation due to off target drift. Operating in an area such as the MIA, with intensive farming in confined areas, it is very rare to have an absolutely perfect wind at the optimum time. 41-A and 38-F has proved effective in ensuring timeliness of application.

Widespread interest in 41-A and 38-F has developed amongst cotton growers, viticulturists, broadacre farmers, community health, environmental groups and government bodies. This includes the application of chemicals for weed control along railway lines, roadside weed control by local councils and residential area fruit fly baiting.

Research Results

To date, Australian research has mainly been conducted on aerial application. From all indications, the ground trials are as good if not better than the aerial trials.

This research was of aerial application from a Piper Brave, with a boom set up that was very poorly configured and conducive to producing spray drift. Despite this poor set up, 41-A was able to provide a significant reduction in spray drift.

41-A and 38-F are constituted of long chain polymers that impart elastic properties onto a spray mixture. This aids in the reduction of driftable fines by allowing the individual spray droplets to be

formed further past the point of release from a spray nozzle, which is where the majority of driftable fines are produced.

Further trials of 41-Aand 38-F, investigating the effectiveness of new nozzle configurations for rice chemical application have been conducted. This research looking at application technology for rice is proving to be exciting and concluded at the end of the 2000-2001 rice season.

Application
41-A and 38-F drift retardants can be used with any pesticide except Roundup Max. The scope for utilisation throughout agricultural and industrial chemical application is extensive, and the benefits incalculable. What price can you put on potentially safer application of pesticides?

For all enquiries on 41-A and 38-F, please call Rhett Heffernan on 02 6964 6000, or 0429 019936, or email: 41a@webfront.net.au.

WHAT WEED MANAGERS CAN LEARN FROM WEED ECOLOGY STUDIES

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INTRODUCTION

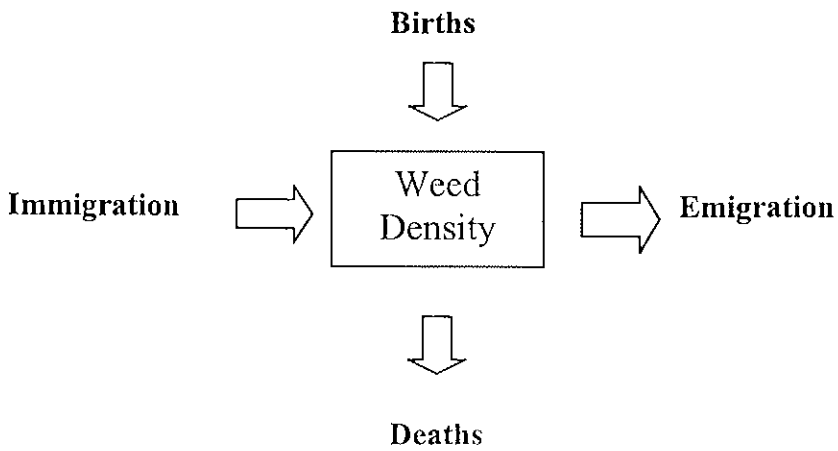
It is often claimed that ecological research will lead to more effective weed management. "Know your enemy" is the catchphrase in many weed research grant applications! By understanding fully the ecology of a species, it is argued that we will be able to identify weaknesses in its lifecycle that we can exploit. Mathematical techniques such as "elasticity analysis" have been promoted as a way to identify critical parts of a species lifecycle. But can this belief in the beneficial outcomes from ecology be justified? There are few clear instances of where ecological knowledge has led directly to better weed control (Cousens & Mortimer, 1955). Rather than providing weed management innovation, the tangible benefits from ecology are:

- Generic strategic advice for policy makers and weed management practitioners
- Understanding of the consequences of given actions
- Confirmation (or refutation) of the likely success of particular weed control innovations proposed by non-ecologists
- Fine-tuning and integration of those innovations into weed management systems.

The aim of weed management is to reduce the sizes (density and extent) of weed populations. The extreme form of this is eradication, often the objective for declared Noxious Weed management. Ecological information can thus best be viewed in relation to population dynamics. We can then use the tools of population dynamics to make predictions.

BASICS OF POPULATION DYNAMICS

The number (or density) of organisms at a particular time and place is the net outcome of reproduction, mortality and dispersal:



If we want to manage weed invasions, then we must manage these factors. Examples of the actions that we can take include:

- Birth control (decrease birth rates): seed-eating biological control agents; spray-topping.
- Death control (increase plant mortality): herbicides; hand-weeding.
- Emigration control (decrease dispersal outwards): quarantine of infected farms.

- Immigration control (decrease dispersal inwards): quarantine of new stock; selective buying of hay from clean farms.

Control of weed seed production is entrenched in folklore – "one year's seeding, seven years weeding" – and is now one of the main tools in the management of population density of herbicide resistant weeds. Increased mortality has, in recent decades, relied on herbicides, although hand-weeding of isolated invaders is critical for preventing new infestations from forming. Quarantine measures, either through legislation or voluntarily as part of good hygiene, can be effective for reducing the number of new outbreaks, but are perhaps the least used control measures.

Although research may be expensive, all of these factors can be identified and measured. Ecological data can be taken from the literature or from new research. Germination, plant mortality, seed production, seed predation, seed bank decline and other relevant variables can be measured under suitable field conditions.

PREDICTIONS OF POPULATION DYNAMICS

Having collected the data, we need to try to use it to assess management options. Although some attempt may be made to do this subjectively, a more formal approach is to build computer simulation models. Different management scenarios can then be tried out and their likely effects predicted. There is, of course, always the danger that the input data will be year- and site-specific and therefore average parameter values may give unreliable predictions. Few plant population models have ever been validated against real data. It has been argued (Cousens, 1995) that quantitative validation is not possible, since there are too many environmental parameters and uncertainties not built into the models. However, if the main values of models are in relation to the relative magnitude of impact and of strategic issues, accurate quantitative forecasting may be unnecessary.

Some examples of information to come from such models are:

- Assessment of the level of control required for a specific biological control agent to be able to reduce weed density
- Prediction that rotation of ploughing and reduced tillage may control weeds that have increased as a result of reduced tillage.
- Demonstration that the sequence of crops in a rotation can have a large impact on weed density
- Conclusion that control of satellite infestations is critical to the success of measures to reduce the rate of spread of an invading weed (also supported by field experience)
- Prediction that it is easier and quicker to reduce the population density of species with short-lived seeds and hence to achieve eradication (as was the case for Kochia in Western Australia).

Some of these results are specific to the particular weed under study, and therefore require complete data sets for that species. However, most of the published models have similar structures, with similar (and very predictable) generic behaviours. Even many years of data collection may then give uninformative results that could have been arrived at with very much less data. It may be that for most purposes we only need to classify weeds in "functional groups", such as those with short- and long-lived seed banks, summer vs. winter germinators, pre- and post-harvest dispersers, and those dispersed by different mechanisms.

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THE CHANGING FACE OF WEED MANAGEMENT IN AUSTRALIA

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Introduction

Weeds are not a recent phenomena or focus of attention within Australia. There are over 2700 plant species that have been reported in Australian literature as weeds (Lazarides *et al.* 1997) with approximately ten per cent of naturalised plant species becoming weeds that cause significant economic and environmental impacts (Williamson and Fitter 1996).

Varying estimates of their impacts have been made, which range across economic and environmental issues that vastly overshadow all other forms of natural resource degradation, other than that caused by land clearing.

Weeds have been an issue since early European settlement and have evolved into a national problem of immense proportions, which requires a concerted and ongoing effort to limit their spread in primary industry and natural ecosystems. The advent of the agricultural chemical revolution and the development of an arsenal of selective herbicides has not solved the problem, but provides a range of useful tools which can be used in the fight against weeds.

Today we recognise that in order to contain the weed menace it must be attacked on multiple fronts, which includes prevention of spread, early detection, eradication and when necessary ongoing management to minimise the impacts.

This paper describes some of the changes taking place across the nation in order to make the fight against weeds more effective. Examples of programs are given to stimulate thought and encouragement, but in quoting them as examples it is not intended to imply that there are not other equally innovative or effective programs in operation that are working well.

Land managers accepting responsibility

Wherever we look today examples can be found of land managers accepting their responsibility for natural resource management and weeds in particular. This is partly driven by the increased awareness that weeds, once introduced become an ongoing cost to primary production and the environment.

Utilities and mining companies are developing protocols for managing their corridors, which can extend for thousands of kilometers. A gas pipeline is being laid in Tasmania and the machinery will be thoroughly cleaned at each property boundary it crosses to minimise the spread of pests, diseases and weeds. A similar line in WA is regularly patrolled and a weed spread protocol observed on an ongoing basis.

The Northern Land Council and indigenous communities are at the forefront of battle against mimosa on their lands in the NT. Indigenous people who have received training in plant identification find new outbreaks in inaccessible parts of the Territory.

Graziers on the Barkly Tablelands are banding together to identify weed occurrences and prevent their spread.

State government departments are starting to take responsibility for their lands and manage them in the same manner that they expect of other landholders.

Lease agreements for rural land in the ACT are being re-negotiated to include pest management plans, which are to be implemented by the landholder.

Community accepting the challenge
Ongoing weed publicity and events are resulting in increased public awareness, which translates into a demand for increased resources and support from all levels of government. This also encourages the formation of community groups for many purposes, which either tackle weeds directly or indirectly in the course of achieving community goals.

Community Action
Seventy percent of Landcare groups in 1997 had some form of weed management as a component of their project.

The WA Herbarium has in excess of 60 volunteer Regional Herbaria scattered across the State, which collect and monitor indigenous and introduced plants.

WA has one of the most innovative and energetic State weeds networks, the Environmental Weeds Action Network which is made up of representatives from over 70 community groups. The network operates at all levels from on-the-ground activities through to effective political lobbying.

Community weed management in Tasmania has evolved from "Weedplan", the State weeds strategy to a network of energetic community groups that target weed problems in a coordinated manner. Group membership varies depending on the nature of the problem under attack and usually they have strong local government support.

Regulators accepting responsibility
State and Territory Agencies
The community has traditionally viewed weed problems as being the domain of governments, which is illustrated by the unrealistic expectation of what can be achieved by declaring a plant and listing it on a noxious weeds list. Adding a weed to one of these lists does not guarantee improved management and control. This requires widespread commitment from all interested parties to effectively manage the problem. The role of legislation is to enforce compliance where individuals in the community are not prepared to accept the roles and responsibilities associated with being landholders and managers.

The community is gradually coming to understand the place of regulatory controls, which must be applied when the situation demands action. This must now be seen as backup support to community action, where a few recalcitrant landholders jeopardise their work.

Most States and Territories use a different system for classifying and listing noxious weeds. The differing legislative mechanisms are more the result of institutional arrangements and culture than the need for differing specialised regulatory controls. The current national list and the rules governing that list are so complex and inconsistent between States and Territories that it is virtually impossible for potential sellers of nursery stock or seed to comply with legislation, particularly when shipping to interstate customers.

However, given the common goals of the legislation, it should be possible to draft an agreed set of noxious weed classifications for the nation. This must be done as a first step to encouraging

compliance. There is also a need to broaden the legislation to encompass agricultural and environmental weeds equally.

In this regard, strategic and effective management of weeds nationally will be assisted by the recently approved Environment Protection and Biodiversity Conservation Act 1999 (301A Regulations for control of non-native species). This Act allows the Commonwealth to develop regulations to provide for the establishment of a list of species, other than native species, that threaten or may threaten biodiversity within Australia.

Local Government

Some jurisdictions use local government to implement regulatory activities, however, they can have a more far reaching influence on the weed problem by taking responsibility for policies which minimise bush dumping of garden waste, control weeds on land under their control, provide support for community action, and plan subdivisions and road corridors to minimise weed impacts on remnant vegetation. A few local government areas have addressed these issues, but they are in the minority.

National cooperation and focus

National Weeds Strategy

The NWS is a strategic approach to weed problems of national significance. The purpose is to reduce the detrimental impact of weeds on the sustainability of Australia's productive capacity and natural ecosystems.

The Strategy is based on the recognition and acceptance of four principles:

> Weed management is an essential and integral part of the sustainable management of natural resources and the environment, and requires an integrated, multidisciplinary approach.
>
> Prevention and early intervention are the most cost-effective techniques that can be deployed against weeds.
>
> Successful weed management requires a coordinated national approach that involves all levels of government in establishing appropriate legislation, educational and coordination frameworks in partnership with industry, landholders and the community.
>
> The primary responsibility for weed management rests with landholders/land managers but collective action is necessary where the problem transcends the capacity of the individual landholder/land manager to address it adequately

The Strategy is the first step towards improving the management of weeds at a national level. It fosters cooperation within and between States and Territories, recognising that weeds do not stop at fence lines or borders. In doing so, it is identifying the barriers between primary production and the wider environmental goals, helping to remove impediments to cooperative action.

The strategy will soon be five years old and up for review in order to determine the future of the National Weeds Strategy and all stakeholders have a responsibility to input into its development.

Weeds of National Significance

The announcement of the Weeds of National Significance (WONS) (Thorp & Lynch 2000) signals the start of national programs that will improve the management of the twenty listed species. The first stage has been the development of national strategies for each of the WONS following

widespread consultation. Future action against each of the WONS is dependent on achieving consensus amongst a diverse group of interested parties. It will also require an increased acceptance of the management responsibility for weeds by landholders, land managers, industry and the wider community as well as local and State governments.

Success of the WONS process and outcomes should be the blueprint for further prioritising of weed issues through a strategic management approach at the State, regional and local level.

National Weed Awareness and Weedbuster Activities
Improved public awareness of weed issues and coordination of activities is being achieved through a National Weeds Awareness Program funded through the National Weeds Program. The aim of the Program is to coordinate national promotional activities such as WEEDBUSTER week, internet information, media promotion, poster displays, species information and educational awareness programs. Products from this Program will focus on information that is common to Australia and where cooperative action reduces the overall cost of production for all States and Territories. This also encourages a nationally consistent message being promoted across the country.

There is an ongoing need for national coordination in order to gain efficiencies of scale and coordination of media publicity.

Natural Heritage Trust / National Weeds Program
The Commonwealth government, (whilst it has no jurisdiction over State and Territory lands) has set aside seed money for implementing the WONS strategies, which has been a powerful catalyst in stimulating national action. But it must be recognised that although the weed problem has at least twelve times the economic impact of salinity, current policies encourage jurisdictions to fund salinity activities at the expense of weed management.

Cooperative Research Centre for Australian Weed Management
The recent expansion of the CRC for Weed Management Systems to cover the whole of Australia is an initiative which will enhance Australia's research and development potential in weed management, avoiding duplication of research. This initiative will place Australia at the forefront of weed management in the world and has the potential to substantially enhance the effectiveness of our programs.

Murray Darling Association and Murray Darling Basin Commission
These bodies are not national, but they do represent a catchment approach to solving common problems. Recent initiatives indicate a growing awareness and commitment to tackling weed issues, particularly as invasive plants could add significantly to water loss and biodiversity, at the same time dramatically increasing the cost of reticulating irrigation water. It is to be hoped that a system of early detection and monitoring for weeds can be implemented in the near future.

National trends
Incursion Reporting and Rapid Response
The formation of the Office of the Chief Plant Protection Officer (OCPPO) within AFFA has resulted in an increased awareness of the importance of weed incursion management. In an attempt to overcome the lack of communication in some areas the membership of Consultative Committees has been broadened to widen the representation of States and Territories. This increases the likelihood of effective on-ground monitoring and action, increasing the possibility of eradicating weed incursions.

The Office is keen to work with all interested parties to improve Australia's capability to detect and respond to exotic pests, including weeds. Notification of suspect weeds has significantly increased

and recent national weed initiatives are seen as a positive step to increase weed awareness, the detection of suspect plants that may be weeds and response measures.

The newly formed Plant Health Australia works closely with the OCPPO, being predominantly comprised of industry members and covers pests, diseases and weeds.

Increased Monitoring and Early Intervention

Stories abound of weeds that have now reached widespread problem status due to no immediate action being taken when the weed was restricted to a much smaller area. We must encourage the identification of weed problems at an early stage, assess the situation using weed risk assessment tools and determine the most appropriate action that should be taken.

Controlling a weed in the early establishment stage is far more cost effective than managing a widespread problem. There is a collective responsibility for landholders and managers through to local, State and Territory Governments to actively manage weeds by early identification and risk analysis and then implementing appropriate action.

There are many cases around Australia where weeds are present with the potential to become major problems for the nation. These weeds are commonly termed "sleeper weeds". They are usually only present in localised areas within a State or Territory. One area that requires further development is an accepted framework for determining the priority of sleeper weeds for further action.

Four States have developed contingency plans that specifically deal with weed incursions and outline the generic steps to be taken to manage the problem. The remaining States and Territories are being encouraged to follow suit. The development of appropriate plans that define roles and responsibilities is a key step in responding to weed incursions and widespread development will improve the effectiveness of response mechanisms.

Emphasis on Biosecurity and Vendor Declarations

The recent outbreak of foot and mouth disease in the UK has stimulated renewed interest in Australia's disease free status and quarantine barrier. Agriculture WA has recently announced a farm biosecurity program (Delane et al 2001) aimed at maintaining the advantage of that State's agricultural production over that of other countries, because its farms are free of many pests, diseases and weeds that cause major production and market losses among its trade competitors. This program links with industry protection plans, such as GrainGuard, StockGuard, HortGuard and BeeGuard. The program focuses on limiting the spread of harmful organisms and provides producers with a list of simple steps which may be followed to achieve this objective. Tasmania operates a similar program under the name of Farm Hygiene and it can be expected that other States and Territories will follow suit. These initiatives should have a marked reduction on the spread of agricultural weeds.

The Department of Natural Resources and Mines, Queensland has developed a Voluntary Vendor Declaration (VVD) form (Department of Natural Resources and Mines 2000) to stop the spread of weeds. VVD's are part of a scheme for buyers and sellers of goods and services, including utility and government service providers. They allow sellers to gain recognition for the measures they have taken to limit the risk of passing on weed seeds or weed contaminated products.

Providers of rural products and services declare on a form what they have done to avoid spreading weeds, while customers are encouraged to ask for the declaration.

It helps land holders prevent weed seed movement to and from their properties and demonstrate measures they have taken to limit weed seed contamination of livestock and other commodities.

It would be expected that these programs will become national or that States and Territories will adopt similar variants of them.

Trained and Committed Professionals
Competencies for weed management open up the possibility of learning and skills training via distance education for weed practitioners that will be nationally recognised. This should result in professional recognition and rewards with increased career opportunities.

When training becomes available, weed personnel are encouraged to enroll and gain accreditation as rapidly as possible. The competencies could also be used to demonstrate to supervisors, managers and others in authority, the range of skills required to undertake weed-related tasks, encouraging a greater understanding of roles and responsibilities.

Weed management training competencies are now being incorporated into the Land Management Training Package, along with vertebrate pests, bush regeneration and soil conservation. It is the intention of the Rural Training Council of Australia to have these endorsed for use by training providers commencing in 2002.

NSW Agriculture has pioneered the development of training modules and the recognition of prior learning for accreditation of staff.

Widespread development and use of management strategies
Well developed management strategies are a vital component of any successful weed program. They combine biological, scientific, social and regulatory factors in addressing the causes of the problem. These factors need to be taken into account if a weed is to be prevented from spreading, eradicated or contained. Management strategies should also gain full commitment and encourage communication between the parties involved.

Management strategies do not need to be complex, long and full of technical jargon. What they do need is a clear statement of the problem, causes underlying the problem, actions that must be undertaken to manage the problem through addressing the causes followed by an action plan with appropriate time frames and method for evaluating programs. The widespread adoption of weed management strategies will ensure that the nation gets best value from the limited funds available for weed management across Australia.

Integrated Management Approaches
The widespread use of strategies which have been based on current research findings and recognise stakeholder responsibilities results in the development of programs that encompass all aspects of the weed invasion. This results in management approaches which identify key mechanisms which must be interrupted in order to prevent the spread of the weed in question. The consequence of this is that management is more integrated and moves far beyond the older concepts of spray, slash and burn.

Increasing Action on Environmental Weeds
The community is becoming aware that environmental weeds are a major threat to biodiversity and that garden escapes or garden thugs represent an extensive source of introduced invasive species. The work that has been undertaken by the CRC for Weed Management Systems in promoting and cataloguing these problems and raising them with the nursery industry is a precursor to more stringent management of garden plants. A number of the WONS have originated as a result of horticultural and/or production introductions where the ramifications of their escape were not

formerly understood. All new plant incursions are assessed for their environmental and production impacts in order to assess the degree of incursion management that would be applied.

Conservation agencies are generally under-resourced in managing environmental weed problems, but senior manager recognise the threat and the need for action if protected ecosystems are to remain in pristine condition. This sector is hampered by a lack of funding and quantifiable economic losses with which to convince funders of the importance of the issue. It could be expected that the management of environmental weeds will dramatically increase over coming years.

Innovative Research and Development Solutions

New research and development activities underpinned by genetic manipulation and other techniques have tremendous potential to assist with the weed management task. This may result from DNA testing to identify the origin of a species in order to find the most suitable biocontrol agents, such as is being undertaken by the CRC for Australian Weed Management with regard to blackberry. Genetic engineering has the potential to introduce plant characteristics which could well reduce its invasiveness or impacts or possibly modify its herbicide selectivity. Whilst it is not the purpose of this paper to predict the outcomes of future research and development, one can be sure that solutions will be found to our weed problems which we struggle to imagine today. This demands that we remain open and sensitive to the opportunities presented by new technology so that we may adopt the benefits as rapidly as possible.

Program Evaluation

Large sums of money are being spent on weed management programs across Australia, yet there appear to be very few examples where programs are subjected to sound ongoing evaluation and cost/benefit analysis. It seems much easier to pursue control techniques without including the rigors of performance monitoring and accountability in the program. This has been a major failure of current weed management efforts.

With competing priorities for limited resources the emphasis for managers is to use project management as a tool for keeping their programs within budget and on time, and the need to incorporate program evaluation. Evaluation should form an integral part of every weed management program, from the landholder through to the national level, irrespective of the scale of the program.

Open and Effective Communication

Communication by weed personnel across all levels is the key critical success factor behind achieving the ideals described in this paper. Vested interests and the failure to communicate within and across disciplines will relegate weed management to a position where it is today; disjointed and lacking a cohesive, clear focus and increasingly subject to funding cuts.

Conclusion

Over the past five years weed management has made a dramatic shift from the older approach of spray, slash and burn to strategic management and planning which recognises the whole system and a wider group of stakeholders than has previously been the case. Whilst the rate of change varies across Australia, we can be sure that this approach is here to stay and will ultimately result in superior weed management for the nation. The benefit of professionally trained and recognised staff with national employment mobility will be the single most important factor in maintaining Australia's security against the weed invasion.

It is to be expected that weed management will change dramatically over the coming years, but the ideas reflected throughout this paper will be the corner stone of that development. Participants in this

Conference are encouraged to seize the new techniques and principles and translate them into effective on-the-ground action in the war against weeds.

Acknowledgments

The author acknowledges the help and constructive advice given by Rod Lynch in identifying the contents of this paper.

This paper could not have been written without the contributions of many 'Weedos' who have shared their work and described their programs throughout Australia over the past four years.

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WHICH WEEDS THREATEN NATURAL ECOSYSTEMS WEST OF THE DIVIDE?

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INTRODUCTION

Weeds threaten all natural ecosystems in Australia to some extent. The percentage of naturalised plants in regional floras varies from as low as about 5% for Kosciuszko NP in southern NSW to as high as 60% for Norfolk Island, with Western NSW being about 20% (Cunningham *et al.* 1981). Not all these naturalised plants are, or will become, environmental weeds, however, and some, e.g. *Medicago* species, may have positive as well as negative impacts on ecosystems west of the Divide. In 1981, Cunningham *et al.* listed 407 naturalised species for western NSW — a smaller region than the total region to be covered in this paper. Furthermore, the number of such species will have increased over the last 20 years, although to an unknown extent.

Use of the term 'environmental weed' in Australia is confined usually to those plants that have some negative impact on the functioning of natural ecosystems or to people's enjoyment of those systems and the 'services' they provide. It is a term that has been in use only for the last 20 years or so. Environmental weeds may affect the diversity of native plant and animal species or some functional measure of the services they enhance, such as water yield. Only a small proportion (10%?) of the total number of naturalised plants may be regarded as problematic pest plants - whether in the context of agricultural or natural ecosystems. Environmental weeds thus comprise a subset of all invasive plants. Most environmental weeds have been introduced from somewhere else, but some plant species native to Australia are becoming invasive when planted outside their indigenous range and a few species native to Australia are now recognised as environmental weeds, e.g. Cootamundra wattle (*Acacia baileyana*) and Sweet Pittosporum (*Pittosporum undulatum*).

This paper investigates the incidence of environmental weeds in western NSW, discusses the biology and impacts of some of the major ones and points to some other plant species that may have the potential to become invasive in natural ecosystems of the region. Control methods for environmental weeds are sometimes more complex than those for agricultural weeds and we shall point to a few examples where integration of several different methods of control into a management system may be effective. Increased planting of either introduced or native plants in town parks and gardens or as woodlots on farms may exacerbate future environmental weed problems in the region unless such plants are screened for invasiveness before use.

SOME ENVIRONMENTAL WEEDS IN WESTERN NSW

Major weeds of agricultural ecosystems, such as Wild oats (*Avena* spp.), Paterson's curse (*Echium plantagineum*) and some of the thistles, especially Saffron thistle (*Carthamus lanatus*), also invade natural ecosystems and vegetation remnants in western NSW. The same applies to the introduced grasses such as African lovegrass (*Eragrostis curvula*) and some of the *Nassella* species in the higher rainfall western slopes and tableland regions. Some of these species are Weeds Of National Significance because of their effects on agricultural productivity. Their impacts on native species diversity in natural ecosystems are unknown, though probably substantial.

In terms of negative impacts on the biodiversity of natural ecosystems, and hence in terms of environmental impacts, we have good data for only a few major weeds, such as Mimosa (*Mimosa pigra*) and Athel Pine (*Tamarix aphylla*) in northern and central Australia respectively. Furthermore, for these few cases there are some positive and some neutral impacts as well as the negative impacts (i.e. weediness), depending on which taxonomic grouping within the total biotic community is considered. For instance, in the case of Mimosa, its invasion of Northern Territory wetlands has been

accompanied by drastic reduction in habitat for the endangered Magpie Goose (*Anseranas semipalmata*) because of the displacement of the native sedgeland species on which Magpie geese depend for food and nesting. Mimosa thickets also had lower bird and lizard abundance, less herbaceous vegetation and fewer native tree seedlings than uninvaded vegetation (Braithwaite *et al.* 1989). These are all negative impacts on that ecosystem. There seemed to be no effect, however, of Mimosa presence on frog numbers - a neutral impact. And, positively, Mimosa presence led to increased numbers of the rare marsupial mouse *Sminthopsis virginiae*, which probably gains in the short term, at least, from the provision of extra shelter from predators provided by the dense Mimosa thickets.

The effects of even the major weeds on biodiversity of the natural ecosystems of western NSW remain conjectural. From the Mimosa example discussed above, it is probable that whilst there will be some negative impacts of environmental weeds on these ecosystems, there may also be some positive ones, such as enhanced soil stability. Some other measures of biodiversity seemingly may not be affected.

We now wish to consider a few examples drawn from different groups of environmental weeds and discuss their biology and aspects of their negative impacts on western NSW ecosystems.

An aquatic plant

Our first example is the aquatic plant Water hyacinth (*Eichhornia crassipes*). This plant, of South American origin, threatens all still or slowly moving fresh water bodies in Australia, including those in much of western NSW. The outbreak of about 10 000ha in the Gingham Watercourse near Moree in the 1970s shows the potential of the plant to invade fresh water in western NSW. If not controlled at the time, it could have drastically altered habitat for water birds and their breeding in wetlands such as the Macquarie Marshes near Warren. Water hyacinth could have had major effects on the Murray Darling system downstream and thereby have affected human activities over a large part of southeastern Australia. Water hyacinth can outcompete native aquatic species because of its high growth rate under favourable temperatures and the absence of native herbivores (Wright and Purcell 1995). Mats of water hyacinth change the micro-environment below the water surface with concomitant negative impacts on native plants, aquatic vertebrates and invertebrates. A major control program was launched against water hyacinth in the Moree region that was successful and has reduced the weed's impacts considerably in southeastern Australia. The program involved both chemical and biological control as well as water management that was co-ordinated by and funding shared between the four States in which the Murray-Darling river system occurs. At least one previous major occurrence of Water hyacinth in Queensland has also been brought under control (Parsons and Cuthbertson 1992), but continued vigilance aimed at early detection of small occurrences is essential to prevent further major outbreaks, especially in the Murray-Darling system.

A herb

An introduced herb that is becoming more common in western NSW is Lippia (*Phyla nodiflora*). Lippia, in the same family as Lantana, is one of those many environmental weeds that has "jumped the garden fence". A cosmopolitan plant, and probably native to tropical America, this small mat-forming perennial herb has been widely used as a lawn plant and ground cover, especially on road verges, in many country towns of western NSW. Lippia can take over riverbanks and has spread over thousands of hectares of prime grazing land in riverine areas of western NSW (P. Milthorpe, pers. comm.). Whilst its effects on native plants in such habitats is unknown, they are probably considerable.

A woody shrub

African Boxthorn (*Lycium ferocissimum*) is already widespread throughout semi-arid Australia and is a major weed wherever it occurs. It is declared noxious for all of NSW. It was used first as a hedge plant, from where it has spread extensively, partly because its fruits are bird- and fox-dispersed. African Boxthorn was recorded in a nursery catalogue at Camden Park, NSW, in 1850 (Parsons and Cuthbertson 1992) and is certainly a major weed of Cumberland Plain remnants in that region 150 years later. Currently, in western NSW, it occurs as a major weed along most dry stream beds. In an agricultural sense, it blocks access of grazing animals to watering points. Its known negative impacts on natural ecosystems of western NSW are that its dense and spiny bushes provide shelter for rabbits and its fruit may serve as breeding sites for pest insects. Fruits of African Boxthorn are dispersed widely by a variety of introduced and native birds. In places such as the Recherche Archipelago in Western Australia, however, it can seriously interfere with seal breeding (Hussey *et al.* 1997), as it is commonly found at this and other coastal sites around Australia as well as in inland regions of all States. On the positive side, African Boxthorn is claimed to provide habitat for some small native animals (Muyt 2001).

A tree

One of the current Weeds of National Significance is Athel Pine or Tamarisk (*Tamarix aphylla*). In the Finke River system in central Australia this tree species is a major environmental weed; it has been shown to reduce regeneration of the dominant native tree River Red Gum (*Eucalyptus camaldulensis*), change the ground flora and to reduce the numbers of species of reptile and of many birds (Griffin *et al.* 1989). Invasion by Athel Pine does not seem to affect the numbers of seed-eating birds, however, whilst it promotes the numbers of aerial insectivorous birds. As well there are changes in ecosystem attributes induced by tamarisk invasion, of which increased salinity is the major one. All these changes in different components of the natural ecosystem arose within 15 years following major floods in central Australia in 1974. Athel Pine seeds were carried downstream by floodwaters from the large trees planted many years previously for shade and shelter around inland homesteads. A similar scenario appears to be currently being followed in the lower Gascoyne River catchment, near Carnarvon, WA (Anon. 2001).

Western NSW has many amenity plantings of Athel Pine, both around homesteads and in towns, from which similar invasions potentially could arise. Whilst Athel Pine is not known to be an environmental weed in western NSW at the moment it may become so after a future major flood. Already it is known to be weedy along some of the ephemeral watercourses of NSW, to the west of the Barrier range (P. Milthorpe, pers. comm.). Whilst the current distribution of Athel Pine may be limited (Fig. 1a), the area where climatic modelling predicts it could become a serious weed is extensive over most of mainland Australia (Fig. 1b). This potential problem may be compounded by the recent discovery of plants of the related *T. ramosissima* in the Riverina (H. Milvain, pers. comm.). It is this latter species, after all, that has caused so much of an environmental weed problem in southwest United States (Loope *et al.* 1988) and in northern Mexico (Groves, pers. observ.). Athel Pine provides an example of a potential problem for western NSW arising from its widespread use in semi-arid and arid landscapes as amenity plantings.

(See Figs. 1a & b)

In this review we have chosen only one example of each of an aquatic plant, a herb, a tall shrub and a tree - all of which are either already major environmental weeds in western NSW or have the potential to become so. There are many other examples with potential to become more serious weeds in western NSW. For instance, Alligator weed (*Alternanthera pungens*) is known only from Barrenbox Swamp near Griffith, from which it is currently being eradicated, but new outbreaks from eastern NSW sources are likely with devastating implications for irrigated agriculture in the region. Why is the herbaceous plant known as Ward's weed (*Carrichtera annua*) known more as an

environmental weed of the Flinders Ranges when in NSW it "appears to be spreading rapidly throughout the western part of the region, particularly along roads and railway tracks" (Cunningham *et al.* 1981)?

To what extent will commercially planted Olive trees (*Olea europaea* subsp. *europaea*) impact on the diversity of adjacent native woodlands in western NSW, given their ready dispersal by birds (Spennemann and Allen 2000), their existing impacts in parts of South Australia (Crossman 1999) and the severity of infestation of many areas in the Camden region of NSW by the closely related subspecies, African Olive (*Olea europaea* subsp. *africana*; Spennemann and Allen 2000)? The environmental impacts of commercial olives, as yet poorly investigated in NSW, are likely to increase rapidly, as 'propagule pressure' increases, associated with the development of commercial olive plantations and the associated olive industry.

In the moister areas of western NSW the environmental analogue of Athel Pine is Willow (*Salix* spp.). At least some species of Willow are having major impacts on river systems and the biota that inhabits them, albeit to a largely unknown extent. The potential of some willow genotypes to invade and affect riparian ecosystems in NSW west of the Divide is considerable.

MANAGEMENT OF ENVIRONMENTAL WEEDS

Growth and reproduction of any weed, whether agricultural or environmental, can be controlled and its population managed by a variety of different methods. The successful control of Water hyacinth in the Gingham watercourse since the late 1970s resulted from a combination of different methods involving water engineering (physical), the strategic use of herbicides (chemical), the release of an insect to maintain the population at a low level (biological) and continual vigilance to discover any new or isolated infestations (surveillance). For weeds in terrestrial natural ecosystems, some combination of these different control methods is also highly desirable and probably will be more effective in the longer term than any one method alone. For environmental weed management, usually some active practice of revegetation is also required. Strategic use of fire may also be needed to stimulate soil-stored seed of native species to germinate and establish. If such additional methods of control are not used, usually either the particular weed re-invades the site or else another weed comes in to occupy its former place.

A management program for an environmental weed can be complex. For example, aerial applications of herbicides from helicopters to control the environmental weed Bitou Bush may affect the survival of rare and endangered plant species such as *Pimelea spicata* and *Zieria prostrata,* that are associated with the weed in coastal NSW. Further, the management strategy suggested for Athel Pine consists of four main aspects (Anon. 2001). The first relates to the prevention of new infestations of Athel Pine or of closely related species, such as *T. ramosissima* (see earlier). The sale and trade of these invasive species has to be curtailed to prevent further incursions. If new incursions do occur, they have to be detected quickly and action taken, supported by an increasingly aware public. By quantifying the impacts of Athel Pine in the Finke River system, Griffin *et al.* (1989) have increased public awareness of the problems for biodiversity conservation in western NSW. Rarely has such quantification been done for any environmental weed, let alone for one of such potential importance to western NSW.

The second aspect to a management strategy for Athel Pine involves eradicating all occurrences of Athel Pine in riparian zones. At present an effective insect or pathogen has not been found or tested for use in a biological control program, though USDA are investigating this aspect currently for *T. ramosissima*. With such a complex pattern of watercourses and ephemeral streams and former streambeds as exists in western NSW, this aspect is a large undertaking. The third aspect relates to the management of Athel Pine individuals or populations at sites away from the riparian zones so that

propagules are not available to be moved in an infrequent major flood, as happened in central Australia in 1974. And the fourth aspect relates to the national co-ordination of such control and eradication programs because the potential of Athel Pine is so considerable across most of inland Australia, as Figure 1b shows. After all, one reason for the success of the control program for Water hyacinth in western NSW was the very effective co-ordination between the four States at risk.

There are many levels for tackling weed control, ranging from the individual property level, through local, catchment and regional levels to the State and National levels. Whilst it may be the task of the research scientist to quantify the impacts in terms of changes in biodiversity, it is everyone's task to become aware of those changes and to try to avert them using different control methods and working at different levels. The role of local and regional weeds officers continues to be a vital part of the overall task. Some major weeds threaten the natural ecosystems west of the Divide in NSW. Some others are potential weeds that require immediate attention. One of the few certainties is that, with time, more weeds will threaten natural ecosystems as more and more areas of western NSW are reserved. The first suite of environmental weeds will probably be those associated with former grazing regimes, but irregular floods, bushfires or droughts will continue to affect the region. The plants that can take advantage of such infrequent disturbances will become the environmental weeds of the future, as the example of Athel Pine almost certainly demonstrates.

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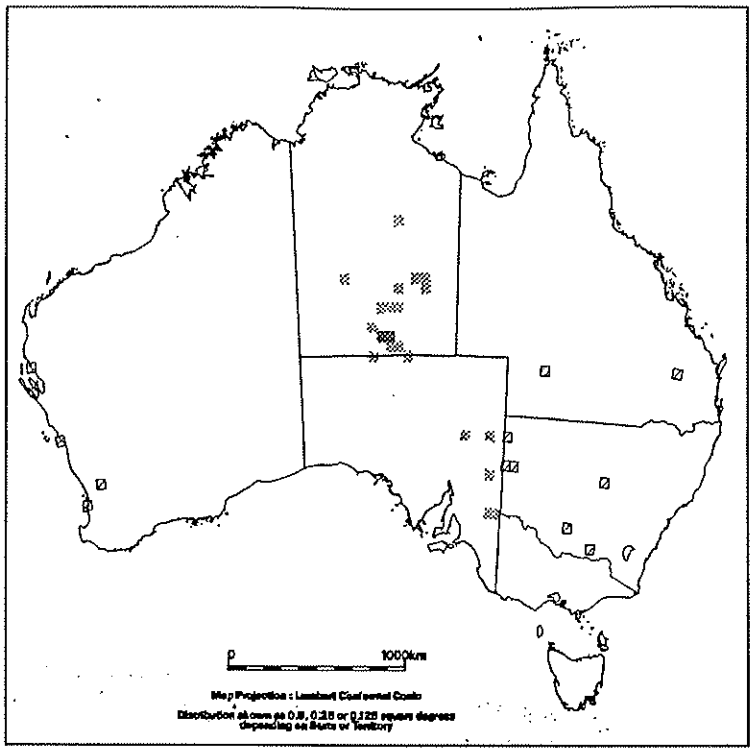

Fig. 1a. Current distribution of Athel Pine (*Tamarix aphylla*) in Australia (reproduced from Anon. 2001, with the distribution data for western NSW coming from Parsons and Cuthbertson (1992).

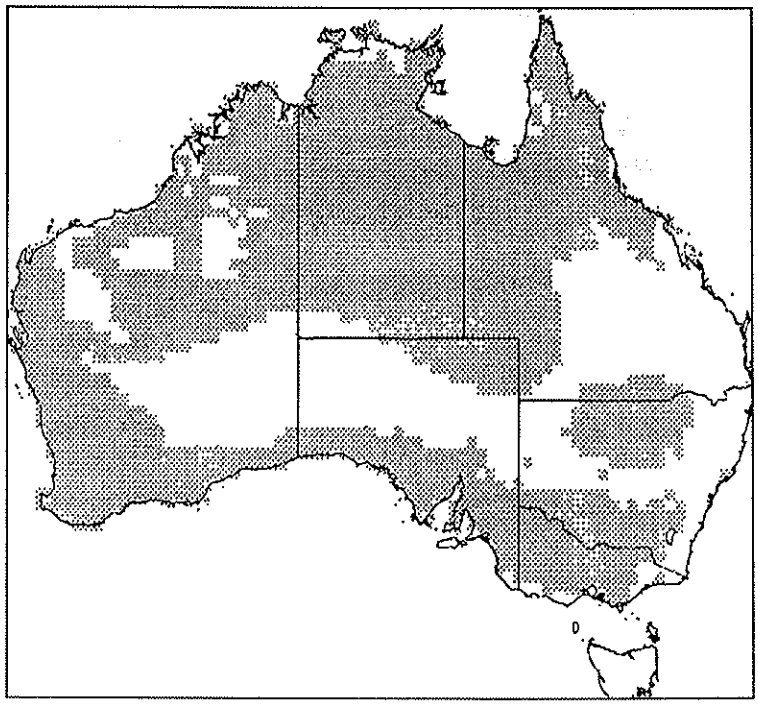

Fig. 1b The area of Australia where Athel Pine (*Tamarix aphylla*) has potential to become a serious environmental weed. The areas under greatest threat are watercourses within the shaded areas (reproduced from Anon. 2001).

DETECTION OF RECENT PLANT NATURALISATIONS IN NEW SOUTH WALES

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Introduction

Early detection of recently established plants is required so that control of potential weed species can be carried out before they become a major problem. Control at this time is more likely to be cost effective than controlling a widespread established species.

Until recently there had been little effort to detect and follow up new plant naturalisations in New South Wales. In June 1998 NSW Agriculture introduced a new weed incursions strategy which was reported in Carter *et al.* (1999). The Royal Botanic Gardens Sydney have developed the "WeedAlert" module of their PlantNET internet site to monitor new plant records for New South Wales. These records are based on authenticated collections held at the National Herbarium of New South Wales (Royal Botanic Gardens, 25 July 2001).

Location of new plant naturalisations

There are many ways of detecting new plant naturalisations. Recent records of plant naturalisations in New South Wales have been from:

1. Targeted surveys by those with a good knowledge of Australian and non-Australian native plants. These surveys often result in many new records of species that have become naturalised. In recent years this has been done using skills of experts who have a good knowledge of local floras. These experts have included local control authority weeds officers, environmental consultants, bush regenerators, professional botanists and staff from Landcare and Greening Australia. Targeted surveys involving a number of these groups working together are usually very productive.

2. Herbaria who deal with identification of plants brought in by the public, government agencies and other professionals.

Confirmation of identification of the naturalised plant

There is also a need to confirm the identification of newly recorded plant species. If the species is non-Australian and has not previously been recorded from New South Wales, then several specimens may be required so that material can be sent to experts in other herbaria for identification or confirmation.

How local control authority weeds officers and others may assist with detection of recent plant naturalisations

One of the major problems with the detection of plant naturalisations in New South Wales is that few people bother to collect herbarium specimens of these plants. Local control authority weeds officers and others can assist with early detection of plants that have recently become naturalised by collecting plants that they are unfamiliar with, particularly if they appear to be weedy. Information on how to collect plant specimens follows:

1. Collect at least three specimens of the plant when it is flowering and/or fruiting. One specimen should be retained by the collector and the others sent to the National Herbarium of NSW (Identification Officer, National Herbarium of NSW, Mrs Macquaries Road, Sydney, NSW 2000) for identification. The Herbarium will distribute surplus replicate material to other relevant herbaria. This additional material is usually sent to experts within Australia or overseas.

2. The collections should be pressed between sheets of newspaper or paper towelling and should be dried rapidly. Electric fan-heaters or air conditioners can, or should, be used. Check that the paper remains relatively dry so that the specimens do not become mouldy. Papers around specimens may need to be replaced with new paper to avoid fungal growth. Make sure that the drying process does not end up burning the specimens (and/or the place where you are drying them!).

3. Make sure that notes are adequate and include accurate location data, date of collection, collector's name and collector's number (if used), plant habit (tree, shrub, herb etc.), plant height, approximate number of plants present in the population from which the specimen was collected, plant part colour (particularly flower colour - these colours often change on drying), soil type (e.g. sand, clay loam), substrate (if known - e.g. granite, basalt), landform (e.g. riverbank, road verge, cliff) and anything else that you think may aid identification. For small plants (e.g. herbs) be sure to include the basal portions (for example bulbs, rhizomes or stolons). An example of a label with useful information is provided in Appendix 1.

Sites where new plant naturalisations are likely to be detected

Recently naturalised plants are often found in certain localities. Such locations include disturbed but undeveloped areas in and around major population centres. Most recently naturalised plants in these areas will have resulted from plants grown in nearby gardens. Areas downstream of rubbish tips or in areas where garden refuse is dumped are also a source of recently naturalised plants. In a number of cases weeds have been introduced with crop seed and machinery, especially if the seed or machinery has come from interstate.

Examples of recent naturalisations of plants in New South Wales

There have been many recent naturalisations recorded for New South Wales where action has been considered necessary. In some cases, further survey resulted in attempts to eradicate a newly established weed and in other cases no control was carried out because the species was established over too wide an area. Examples of a few recent incursions listed below.

(a) *Hygrophila costata* (Acanthaceae) - Glush weed. First detected in NSW by Bruce Scott and a specimen sent to the National Herbarium of NSW on 1997. The species was first recorded in Queensland in 1993. This species was probably introduced for the aquarium trade. Glush weed is an aggressive plant that occurs in shallow water in north-eastern NSW. It is unfortunately well-established in this area and attempts to eradicate the species would be expensive and unlikely to be successful.

(b) *Asystasia gangetica* subsp. *micrantha* (Acanthaceae) - a form of Chinese violet. First detected in NSW by John Hosking on 13 July 1999 at Boat Harbour. This species is a major weed in Malaysia. Some control work has been undertaken in the Port Stephens area. See Appendix 1 for a recent label with information on this species.

(c) *Cyperus teneristolon* (Cyperaceae) - First detected by Van Klaphake early in 2000 with the first herbarium specimen collected by Karen Wilson on 10 March 2000. This sedge is a weed in its native range in Africa. The species is known to be present over a couple of kilometres along a stream below the Blue Mountains Refuse Tip at Katoomba.

(d) *Triadica sebifera* (previously *Sapium sebiferum*) (Euphorbiaceae) - Chinese tallow tree. First detected by Bruce Scott at Casino. First herbarium specimen collected by Bruce Scott and John Hosking on 3 May 2000. This tree is recognised as an environmental weed of wetlands in the USA. To date it is only known to be a problem in New South Wales around a wetland at Casino.

(e) *Myagrum perfoliatum* (Brassicaceae) - Muskweed. First specimen collected by Andrew Storrie and John Hosking on 1 August 2000 from 'Windy Station' south west of Quirindi. This species is a significant weed on clay soils in other states. Muskweed was reportedly identified by private consultants in 1999 but they did not lodge specimens at the herbarium. Once again this species was present over a large area when detected and attempts at eradication would have been costly and likely to fail.

(f) *Hieracium murorum* species group (Asteraceae) - a hawkweed. First specimen collected by John Hosking on 5 March 2001 at Katoomba. This species with early flower buds was pointed out to John by Mark Williams on 6 October 2000. This *Hieracium* does not appear to be very weedy at this location and it is only reported to be a minor weed overseas. A more accurate name for this *Hieracium* is being sought at present.

Conclusion

Additional collections of recently established plants will increase the likelihood of control of plants before they become a major problem. This paper is a plea for increased collection of non-Australian native plants, particularly species that are not recognised by those with a reasonable knowledge of plants.

Acknowledgments

We would like to acknowledge all those who collect non-Australian native plants. We would particularly like to thank Bruce Scott (General Manager, Far North Coast Weeds) and Mark Williams (previously Weed Management Coordinator, Blue Mountains City Council) for providing locality information and assistance with collections of recent plant naturalisations. Alan Maguire, Andrew Storrie and Royce Holtkamp are to be thanked for providing comments on drafts of this paper.

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Appendix 1. Example of a label for a recently recognised weed in New South Wales.

TAMWORTH AGRICULTURAL RESEARCH CENTRE
HERBARIUM (TARCH)

Family: Acanthaceae

Asystasia gangetica (L.) T. Anders. complex

Det.: JRH

Loc. 'Minmara', property of Jack Robinson, alongside Gan Gan Road, Anna Bay

NSW Subdivision: NC

Lat. 32^0 46' 30"S **Long.** 152^0 04' 46"E, **Alt.** 10 m
(Lat. & Long. based on WGS-84)

Coll. J. R. Hosking 2040, A. J. Maguire, P. T. Gorham & D. R. Moore **Date** 31 May 2001

Notes Locally abundant (many 10s of 1000s in collection area - now known from a number of locations in and around Anna Bay and Boat Harbour) herb to 2 m high up a fence, generally to c. 50 cm high when not supported by other vegetation or objects. Roots at nodes along stems. Leaves 5–16.6 cm long, 2–5.5 cm wide on a petiole to 5.6 cm long including the winged section extending from the lamina down the petiole. Flowers 2–2.5 cm long, corolla white with pale purple cross bars on inside of lower lip. Pods guitar-shaped, 2.8–3.6 cm long. Seeds flattened, 5 mm x 4 mm with rounded edges (including one prominent and one less prominent rounded points) and to 1 mm thick.
Landform: flat to 5^0 slopes
Soil: grey sand
Vegetation: growing in native pasture, in nearby native bush and amongst young planted pines

Dupl. to: CANB MEL NSW NE

TARCH N° 6282

REPORTING W1 WEED INCURSIONS

Alan Maguire
Noxious Weeds Liaison Officer
NSW Agriculture, Tamworth NSW

Who should report W1 weeds?
The Noxious Weeds Act 1993 (section 15) has provision for the reporting of any notifiable (W1) noxious weed by occupiers of land to the Local Control Authority (LCA). The reason for this is to reduce the risk of W1 weeds becoming established and creating an environmental and economic burden to the local community, region or state.

The Noxious Weeds Advisory Committee, in March 2001, altered its policy on reporting and control of outbreaks of notifiable noxious weeds. This was in response to increased reporting requirements placed on NSW Agriculture by Government. The new policy requires local control authorities to report all outbreaks of W1 weeds to NSW Agriculture.

Policy 3 item 3.2 reads: When the LCA finds or is notified of any outbreak, including single plants, of notifiable noxious weeds they must notify NSW Agriculture, via the **W1 Weed Reporting Form**, of the location and nature of the outbreak.

A full version of the policy is available from NSW Agricultures web site www.agric.nsw.gov.au/weeds

Why report W1 weed incursions?
Reporting outbreaks of notifiable (W1) weeds, on the W1 weed reporting form, gives government uniform and reliable information on W1 weed threats to the state. This information can be used to develop control strategies and assist in gaining funding for those strategies.

Local control authorities that apply for funding for control of W1 weeds must submit a report (on the W1 weed reporting form) to NSW Agriculture before any consideration for funding is given.

What information should be reported?
The W1 weed reporting form (appendix 1) available from NSW Agricultures web site www.agric.nsw.gov.au/weeds has all the information on recording outbreaks in a standard format.

W1 weeds must be reported each time they are discovered. This includes reinfestation from original outbreaks. Reporting on reinfestation will assist in developing future control plans for that species.

When a new W1 weed (or any new weed or plant) to a region is detected, it is strongly recommended that a specimen be sent to the National Herbarium of NSW for identification whether you know the weed or not. Sending a specimen to the herbarium allows the herbarium to record the weed as a new incursion to the area as well as giving a positive identification. The address to submit plant specimens to the herbarium is Botanical Identification Service, Royal Botanic Gardens, Mrs Macquarie's Road, Sydney NSW 2000.
When sending plant specimens to the herbarium it is recommended local control authorities use the local NSW Agriculture office to submit the specimen as the service will be free of charge. Any specimens sent to the herbarium should have as much information as possible about the location, habitat, abundance etc. NSW Agriculture has a form for submitting plant specimens to the herbarium. This form lists all the information required. The form is also available from the departments web site

www.agric.nsw.gov.au/weeds and must be used when submitting plant specimens to the herbarium through NSW Agriculture.

When reporting W1 weed outbreaks an accurate location is essential. This will assist in reinspecting infestations in future years. A Geographical Positioning System device (GPS) is recommended for this. Local control authorities can purchase a GPS using funds from the Coordination and Extension grant if the GPS is solely for the use of the noxious weeds program. Local control authorities using maps to report the geographical location must give the name and number of the map as well as the coordinates. In addition, a descriptive location should be recorded in the comments section of the W1 weed reporting form, e.g. 6.7 km south of Tamworth on the western side of the Werris Creek road.

Conclusion

W1 weeds are a major threat to New South Wales. Without a comprehensive monitoring, recording and control program, the agricultural viability and environmental diversity of New South Wales could be jeopardised.

Local control authorities are the front line defence in detecting, controlling and eradicating W1 weeds within New South Wales. Information gathered by local control authorities and reported to NSW Agriculture on W1 weed outbreaks will result in better monitoring, recording and control programs.

Therefore, when a LCA finds or is notified of any outbreak, including single plants, of notifiable (W1) noxious weeds they must notify NSW Agriculture, via the W1 Weed Reporting Form, of the location and nature of the outbreak.

LOCATIONS of W1 WEEDS

Name of LCA .....

W1 Weed Species	Geographic Indicator used	Geographical Location		Date	Weed Status		Source	Land		Number of Plants	Area	Verification		Comments
		Latitude	Longitude		Stage	History		Use	Tenure			Person or Herbarium	Voucher No.	Eg. Location, site description etc.

Geographical Indicator used: 1 = Decimal Degrees; 2 = Degrees, decimal minutes; 3 = Degrees, minutes, decimal seconds; 4 = Degrees, minutes, seconds 5 = Australian Map grid (AMG)

Weed Status: Stage: A = Seedling; B = Rosette; C= Juvenile; D = Non-flowering, E = Fruiting; G= Flowering; H = Seeded (combinations can be used, eg stages from seedlings to flowering = A-G or Non-flowering and flowering = D & G)

History: N = New Infestation; R(#) = Repeat infestation (#) = Number of times area has reinfested

Source: H = Header, G = Grain, S = Stock, U = Unknown, Other (please list)

Land: Use: 1 = Pasture, 2 = Cultivation, 3 = Watercourse, 4 = Roadside, 5 = Woodland, 6 = Other (building blocks, quarry sites and wasteland)

Tenure: FG = Federal government; SG = State government; LG = Local government; NP = National Park; SF = State Forest; PR = Private; DL = Land & Water; RL = Rural Lands Protection Board Land; OT = Other (please list)

Number of plants: Count if 100 or less; A = 101-500; B = 501-1000; C = >1000 (Count all plants if possible)

Area: 1 ha = 10,000 m^2 (10 m^2 = 0.001 ha 100 m^2 = 0.01 ha)

Verification: **Person or Herbarium:** The name of the person or herbarium who has identified the weed. Eg National Herbarium of New South Wales

Voucher No.: The voucher number of the specimen lodged with a herbarium. Eg A. Maguire 253

Please return form soon after a WI weed is discovered to:

Noxious Weeds Liaison Officer
NSW Agriculture
RMB 944, Calala Lane
Tamworth 2340
or
Fax 02 67631120

PREVENTING NEW WEEDS – working with the nursery industry

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Frankston, Vic

INTRODUCTION

Many of Australia's established environmental and agricultural weeds have escaped from gardens. These 'garden thugs' have jumped the back fence and invaded native bushland, grasslands and farming areas. They have been carried from gardens by the wind, water, by birds and other animals including foxes, fruit bats, pets and people. People dump garden waste, move soil and swap cuttings and seeds with other gardeners. 50% of Australia's 1900 environmental weeds are garden thugs (R Randall pers com).

Many nurseries and garden centres sell and trade in invasive garden plants often without any knowledge of the plants weedy potential. Gardening magazines, radio and television programs often promote them. The garden and nursery industry and horticultural media are becoming more aware of the issue and becoming part of the solution.

Below are some of the things happening around Australia and overseas to tackle the problem of invasive garden plants.

NATIONAL APPROACH

The Nursery Industry Association of Australia (NIAA, now the Nursery & Garden Industry, Australia (NGIA)) and various government agencies, including the Weeds Cooperative Research Centre (Weeds CRC) contributed to a draft national strategy on invasive garden plants called "Garden plants under the spotlight" (GPUTS) published in February 1999. Numerous agencies and community members submitted comments to the Weeds CRC and two to NIAA. The Weeds CRC worked with the Department of Agriculture, WA (DOA) and national weed experts to compile a list of over 700 garden thugs in Australia (main author Rod Randall, DOA) a subset of which was used in the GPUTS strategy. The draft strategy has not been finalised, however, some of its recommendations have or are being carried out by industry and agencies as described below.

INDUSTRY NATIONALLY

- NGIA have come up with a short list of 52 plants they would consider doing more weed awareness about, and replace in-store. This was published as a 'The Nursery Paper' titled "Invasive plants not wanted in public or private gardens identified" which is available on the web at http://www.ngia.org.au/np/index.html It was printed inside the October 2000 'Australian Nursery Manager' magazine inside 'Australian Horticulture'.
- NGIA contributed to a successful National Heritage Trust (NHT) funding bid for a community awareness program in the Hawkesbury-Nepean Catchment of NSW. The project is called "Discovering alternatives to garden escapes. Stopping the spread of problem plants". A local Weeds Coordinator (Garden Thugs Officer), Paul Lewis, has been appointed and is based in Sydney.
- NGIA contributed to a successful Horticultural Research and Development Corporation (HRDC) funding bid with the Weeds CRC and national Weedbuster Committee, to raise awareness about garden waste disposal nationally through the distribution of a poster and brochure through NGIA nurseries and garden centres (see below for other contributors).
- NGIA are developing a national program called "Flora for Fauna" to promote native plants in gardens to attract wildlife.

GOVERNMENT NATIONALLY

- Weeds CRC has done and continue to do numerous media interviews and articles nationally and locally.
- Weeds CRC coordinated the garden waste disposal poster and brochure project (noted above) with the assistance of HRDC funding along with the national Weedbuster Committee, NGIA, Council of Australian Weed Science Societies, Weed Science Society of Victoria, Weed Management Society of SA, SA Animal and Plant Control Commission, and NT Dept of Primary Industry and Fisheries.
- The Australian Weeds Committee discussed GPUTS at their Aug 2000 meeting.
- Donna Stoddart of Environs Australia (the local government environment network) is developing a proposal for a nationwide 'Bush Friendly Nursery Accreditation Scheme' as part of a 'Sustainable Nurseries Alliance' to give incentives to nurseries to not sell their local list of environmental weeds.

VICTORIA – The Victorian Department of Natural Resources and Environment (NRE) has implemented a strategy to assess and compile a list of invasive plants with high potential for further distribution by any means (including nursery trade, garden clubs, local government, soil movement, livestock, water, produce, etc). This list will be submitted to the nursery industry for collaboration in informing growers and having the species discontinued from propagation, ahead of a legislative ban. The project will include recommendations for alternative species, extension materials and guides for retailers to facilitate the transition process. Codes of practice will be developed with rural and transport industries to address issues of unintentional weed spread [Jack Craw, NRE pers com].

ACT - a short information forum for all local retail and wholesale outlets was held in Oct 2000 with the intention of getting more businesses to sign an agreement not to stock weed species. A sign for hanging in nurseries ("This Nursery is a bush friendly zone") has been prepared and these will be provided to all nurseries that sign on [Geoff Butler and Helen Peade pers com].

NORTHERN TERRITORY – The NT Department of Primary Industry and Fisheries (DPIWE) are putting a project proposal together for a NT Garden Thugs campaign. They will be using the draft national strategy "Garden Plants under the Spotlight" as a guideline. Leslee Hills will be meeting with the NIAA NT representative soon, and the Horticultural Association Executive Officer [Leslee Hills, NT DPIF pers com].

WESTERN AUSTRALIA - Bush Brokers is a collaborative project between World Wide Fund for Nature (WWF), Real Estate Institute of WA (REIWA), and Soil and Land Conservation Council (SLCC) supported by the National Heritage Trust (NHT). They held an information day for Real Estate Agents on October 30th 2000 at which garden thug information kits were handed out. The day was to help them appreciate the value of healthy native bushland (with some options for revegetation of cleared land). The organisers hope that this information day will lead to an accredited course and a series of regional workshops for Real Estate Agents [Sandy Lloyd, DOA pers com].

The Weeds CRC has funded a summer studentship to allow Sandy Lloyd from DOA to carry out a survey of nursery customers attitudes to the sale of weedy garden plants. This was broadened to include a survey of nursery proprietor's attitudes. Lorraine Duffy from Curtin Uni has been visiting nurseries to meet with customers and has mailed out questionnaires to nursery owners. Sandy Lloyd

had talks with NIAWA re joint 'garden thugs' display at Garden Week in April 2001, (ie joint between NIAWA, DOA, Environmental Weed Action Network, and Weeds CRC) [Sandy Lloyd, DOA pers com].

SOUTH AUSTRALIA - There is a Garden Escapees Committee chaired by David Cooke. This group assisted NGIA in 2000 with their list of 52 garden thugs published in 'The Nursery Paper' (listed above) [David Cooke, SA Animal and Plant Control Commission pers com].

TASMANIA - The Tasmanian Weed Education Officer is largely responsible for coordinating state level initiatives regarding invasive garden plants. The officer has a nursery industry representative on her steering group, another on the Weedbuster organising committee she convenes and has had preliminary discussions with the recently appointed NIAT Marketing Development Officer. Garden Thugs displays are used regularly at agricultural and garden shows, whilst state wide newsletters and other print media are used regularly to promote the issue. Three of the 100 events held in Tasmania during National Weedbuster Week Oct 2000 related to nurseries. An invasive garden plants brochure was produced for the Tamar region in 2000. 55 000 copies of this local government/NHT funded resource were distributed to all ratepayers and feedback has been encouraging [Cindy Hanson, DPIWE pers com].

QUEENSLAND - Garden thugs featured in Weedbuster Week activities in Oct 2000. A key outcome of the Qld *Environmental Weed Strategy* is to develop a list of plants, in association with the nursery industry, to remove from production and sale. A draft list of about 170 species based on environmental impact backed by scientific justification is in development and may be finalised with the nursery industry in May 2001. Legislation exists to prohibit the introduction to Qld, the keeping and sale of over 100 potential weeds, many of them garden thugs. This includes a number of genera such as all *Equisetum* species, *Striga* and *Mikania*. Declared plants are also prohibited from sale. This legislation is being reviewed and will contain an additional weed class of common environmental weeds (many garden thugs) to be banned from sale. There is a hit list of 87 plants to be targetted for eradication if they are found. Research on a number of garden thugs has been conducted including *Lantana montevidensis*, camphor laurel and two *Ligustrum* species [Helen Haapakoski, Steve Csurhes, Dane Panetta, Department of Natural Resources & Mines pers com].

NSW - NSW Agriculture have a representative on the steering group of the community awareness program in the Hawkesbury-Nepean Catchment of NSW. NSW Agriculture have sent information to nurseries on new weed incursions of prohibited species such as *Centaurea* species, *Hieracium* species and *Nassella tenuissima*. The 2000 launch of Weedbuster Week for NSW was held at Swane's Nursery with celebrity gardener Shirley Stackhouse. NSW NP&WS have done some media on *Gloriosa superba*, and local officers on the north coast have conducted some local training on bush regeneration with local government officers [Richard Carter and Bob Trounce, NSW Ag, and Andrew Leys, NSW NPWS pers com].

OVERSEAS - NZ are the global leaders on this issue followed by Australia. UK, USA and South Africa are all interested in how Australia is approaching the issue and seek our draft national strategy and awareness information. The draft GPUTS strategy and other material have been circulated widely around the world and will be available on the CRC web site sometime soon. [Sandy Lloyd, Kate Blood, and Jack Craw pers com]

NEW ZEALAND - is currently updating the 1997 Strategy that banned the sale and distribution of 130 taxa. Department of Conservation, Ministries of Agriculture and Health and Regional Authorities are preparing a list, possibly several hundred long, to be declared as Unwanted Organisms. This will extend the list of prohibited taxa.

UK - Jill Hamilton started Flora for Fauna in the UK in 1994. The project encourages people to grow their local native plants (see the website at the Natural History Museum - http://fff.nhm.ac.uk - people can type in their postcode and the program returns a list of the plants, butterflies and birds historically native to that area). Secondly, the project increases awareness of the need for real flowers (not modified breeds) in their right seasons when wildlife need food etc. As far as invasive garden plants go, there is no co-ordination between English Nature and the plant industry, and no national list or ban.

SOUTH AFRICA - are putting a Weedbuster strategy together for the next three years. They are tackling issues such as garden waste disposal. Prior awareness campaigns include a once-off Hack Day. The Working for Water program is considering the prevention of sale or subdivision of land that is infested with exotic weeds eg Aussie eucalypts and wattles. This has created considerable media attention.

USA - Seems to be a fair bit going on and look to Australia as a leader in this area. The Brooklyn Botanic Gardens are very involved in making information on invasive garden plants available to the public. They have been commissioned by World Wildlife Fund to update an out of print publication 'Gardeners Guide To Plant Conservation'. They want to highlight the weed problem. The Exotic Pest Plant Council's magazine 'Wildland Weeds', is interested in republishing at least part of Ian Atkinson's (the Nursery Industry Association of Australia's) 'Nursery paper' titled "Invasive plants not wanted in public or private gardens identified".

U.S. Fish and Wildlife Service are implementing a non-native invasive species outreach and education program in the San Francisco Bay-Delta area of California now partially targeted at the nursery/aquascape industry. The Washington State Noxious Weed Control Board are working and making progress on prohibiting the sale of some invasive species. The Virginia Native Plant Society is working on invasive alien issues and focussing on public information and education, and also liaison with the green industry. Australia's Woody Weed character (icon of national Weedbuster Week) has been taking part in the USA's first Weed Awareness Week.
Hawaii have been doing surveys and publishing work such as "Survey of invasive or potentially invasive cultivated plants in Hawai'i" (includes a list of 469 taxa of plants cultivated in Hawaii that are, or could become, invasive species), and "Environmental Impacts of Gardening in Hawaii". The USDA Forest Service wants to initiate a similar strategy to Australia for Hawaii.

ACKNOWLEDGEMENTS

Thank you to all the contributors to this information. Some of this information was printed in the April 2001 edition of *Nursery Marketer,* in *Australian Horticulture* magazine.

FURTHER INFORMATION

A national garden thug brochure and poster and the draft national strategy on invasive garden plants is available from the author at Kate.Blood@nre.vic.gov.au

WEED INCURSION AND RISK MANAGEMENT- a research agenda

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BACKGROUND

In addition to their direct and indirect effects upon Australia's economy, weeds and other pests are recognised as the second most important threat to Australia's biodiversity, exceeded in importance only by habitat destruction (Groves and Willis 1999). The weed problem is an ever-increasing one, as new plant species continue to be introduced, both accidentally and intentionally. Australia has around 2700 naturalised exotic plant species. Most of these are currently not harmful but a number have the potential to become invasive weeds. Early detection and action on invasive plants has been identified in the National Weeds Strategy (as well as in State and Territory Weed Strategies) as giving the highest economic and environmental returns. Considerable environmental and economic gains may be achieved if threatening incursions can be managed effectively before they become widespread.

The Cooperative Research Centre for Australian Weed Management commenced on 1 July 2001 and is funded for a period of 7 years. One of the three research programs in this CRC is entitled 'Weed incursion and risk management'. This program involves 22 researchers from 13 organisations in Australia and New Zealand. The overall objective for the program is to provide tools for a coordinated national approach to the assessment, management and prevention of newly emerging weed problems. Accordingly, the major anticipated outcomes are that by 2008 Australia has:

- A national system in place for the early detection of weed incursions
- A proven capability for rapid evaluation of and response to weed incursions
- A defensible, evidence-based system for identifying potential weeds beyond and within its borders

PROGRAM STRUCTURE

The program is divided into three tasks, which individually address different stages in the management of weed incursions. Each task in turn is further divided into a number of projects, giving a total of nine projects within the program. A number of these projects (identified by italicised subheadings) are described individually below.

Task 1: Detection of weed incursions

As stated earlier, weed incursions can be dealt with most effectively and cost-efficiently if they are addressed at their earliest stages, before they have spread to a significant extent. Recent work conducted in California has indicated that the eradication of exotic plant infestations smaller than one hectare is almost always possible, but it is unlikely that infestations larger than 100 ha can be eradicated, given a realistic amount of resources (Rejmanek 2000). Clearly, early detection is a critical determinant of the feasibility of eradication or containment of new incursions.

Sampling schemes

The problem of early detection is essentially one of sampling – where are the best places to search and what is the optimal frequency of surveillance? Sites of most probable introduction, including ports, roadsides and urban areas would appear logical starting points in the design of a searching strategy for new weed incursions. This project will evaluate the concept of 'sentinel sites', i.e. those sites that could be the most sensitive indicators of new incursions. The possibility exists, however, that a much broader approach, incorporating a range of people scanning much greater areas, will need

to be employed in detection. This points to the need to involve members of the community, in order to expand the scope of the surveillance effort.

Exotic species database

By far, the majority of weeds in Australia have arisen from plants intentionally introduced for gardening, landscaping and agricultural production (Groves 1998). Such plants have undergone a sequence of transitions, from growing in cultivation only, to becoming naturalised, to becoming weeds. Essentially, many of the future problem species for Australia are currently sitting in gardens, having yet to become naturalised. The purpose of establishing an exotic species database is to capture the totality of exotic species present in Australia and potentially invasive species in its nearby neighbours. This will enable us to calculate relevant transition probabilities (e.g. from introduced to naturalised and from naturalised to weedy) for different life forms (e.g. shrubs, trees and vines) and for different taxonomic groupings (plant families and genera). Such information will be useful in the determination of the risks posed by these plant groups and in highlighting what particular species or plant types to look for in surveillance efforts.

Task 2: Weed risk evaluation

Weed risk assessment is a rapidly developing field (Groves *et al.* 2001). Decisions concerning weed management must be based upon the degree of risk posed by individual species. Such decisions are made both at the border, when assessments are undertaken to determine whether plants can be safely allowed into Australia, and within the country itself, where priorities for managing a large number of invasive species must be determined (Virtue *et al.* 2001, Panetta *et al.* 2001). Climate matching programs (e.g. BIOCLIM and CLIMEX) have been employed in the assessment of invasiveness prior to the importation of plants. However, these models need to be refined in order to gain more accurate predictions of potential distributions as the latter are modified by competition with other plant species, and by soils and land use characteristics. Given the large numbers of naturalising species, it is important to identify the ones that could potentially have the greatest impact upon both natural and agricultural ecosystems. The identification of the types of weeds that are most damaging may be one way of determining the relative risks posed by different groups of naturalising species. Of course, the variety of types of damage that weeds cause (e.g. reduced agricultural production, depletion of biodiversity, harm to human health) will make this a particularly challenging task.

Sleeper weeds

Lag phases of several decades can occur between when a species is introduced and when it becomes a weed (Groves 1999). Such lag phases could be taken advantage of if it were possible to confidently identify and eradicate 'sleeper weeds' before they reached outbreak status. A number of hypotheses exist concerning the sleeper weed phenomenon. The most basic is that these species are, in fact, not 'sleeping', but are increasing at a rate that corresponds to a very early stage of an exponential relationship. An apparent lack of increase may, on the other hand, be due to the fact that a species has been introduced originally into a suboptimal habitat and would, in fact, show much stronger invasive behaviour had it been introduced elsewhere. Alternatively, the initial introduction may have been of a genotype that was non-invasive; other variants of the species may be more aggressive, or perhaps further natural selection may be required before the invasive potential of the species is fully realised. Yet another possibility is that sufficient discrete foci of infestation must be developed before the species enters a phase of rapid spread (Mack 1985). This project will critically examine these hypotheses and will aim to generate a 'probable sleepers' list for Australia.

Weed functional groups

Decisions on whether to allow importation of plant species generally have to be made on the basis of limited information. An understanding of the types of plants that pose the highest risk to agriculture and the environment would be an invaluable aid to decision making at Australia's border. It would

also assist in the prioritisation of species for coordinated control, since each year somewhere in the order of 15-20 species are newly recorded as naturalised in Australia (Groves 1998). This means that there is an ever-increasing pool of naturalised species from which serious plant invaders can originate, against a strictly limited backdrop of resources available for weed management. A number of alternative schemes for the definition of plant functional groups are in existence. These need to be evaluated and developed/adapted with reference to invasive plants.

Weed risk assessment systems
Since August 1997, a weed risk assessment (WRA) system has been operated by the Australian Quarantine and Inspection Service for decision making at Australia's border. During this period roughly 67% of the applications for importation have been accepted, 17% have been rejected and 16% have been referred for further evaluation (C. Walton, personal communication). Other States have employed various WRA systems for the purpose of prioritising incursions for coordinated control. While all of these systems appear to be operating effectively, they are based upon a number of assumptions that have yet to be validated scientifically. In the case of the system operating at the border, there is the possibility that some of the species that have been rejected are, in fact, 'false positives' – plants that have been evaluated as potential weeds that in reality would not have been invasive had they been permitted entry into Australia. This raises the prospect of an evaluation system that is overly conservative and that is excluding species whose potential benefits would have exceeded their potential costs to society. A fully validated WRA system would also preclude the possibility of successful legal challenges to the decisions made. This project seeks to evaluate the science underpinning WRA systems.

Cost-benefit analysis
There is an important economic component to the management of weed incursions, both at the preventative level (prior to introduction) and at the on-ground operational level for existing incursions. With regard to the former level, the existence of 'false positives' suggests that a WRA that is too restrictive will exclude plants that could provide substantial benefits to society without incurring harm. Alternatively, it can be argued that the majority of proposals to import new species relate to plants that would provide relatively little benefit, or would provide benefit to only a restricted sector of the Australian community, while posing substantial costs to other sectors. At the on-ground operational level, there is a need to assess the potential benefits of incursion detection and intervention (e.g. eradication or containment) in relation to the costs of these activities. This project will utilise a cost-benefit framework to assess both potential plant introductions and the alternative activities undertaken to detect and respond to weed incursions.

Task 3: Response to weed incursions
There are a number of response options to consider when dealing with incursions of serious weeds. Should the infestation be a small, localised one, total eradication may be attempted. If eradication is successful, management savings will accrue over the entire period during which the species remains absent. The difficulty of eradication will vary according to biological and ecological features of the species concerned and the conditions where the species is found growing, but the cost of eradication should not exceed the predicted costs of the potential impact should the weed be allowed to spread unhindered. Other conditions have been established as prerequisites for the eradication of animal pests – these conditions need to be explored in relation to the biology and ecology of weeds.

In addition to the need to determine the conditions that must be met for eradication to be attempted, there is also a need to define 'stopping rules'. These rules would define the conditions under which eradication should be abandoned and another management strategy undertaken. One such alternative is to prevent or restrict the spread of an incursion. This type of approach may involve the targeting of outliers of infestation at some distance from the core infestation, the reduction of the core infestation,

or some combination of both (Moody and Mack 1988). An understanding of the mechanisms and dynamics of plant spread are central to decision-making with regard to the management of weed incursions.

Eradication case histories

Information relating to eradication efforts in Australia is scattered and to a large extent anecdotal. There is a need to pull together all of the available information concerning the sizes of infestations that have been targeted for eradication, the amount of resources dedicated to the eradication effort and the degree of success achieved. The focus of this project will be on both past eradication efforts and those currently being undertaken (e.g. *Chromolaena odorata*, *Mikania micrantha* and *Mimosa pigra* in Queensland, *Cleome rutidosperma* in the Northern Territory and *Orobanche ramosa* in southern Australia). This information will be utilised in developing a model that can provide an estimate of eradication potential, given biological and ecological features of the weed, stage of invasion and the amount of resources that can be devoted to the eradication effort. An additional aspect of interest is the determination of when eradication has been achieved, i.e. at what point can we have confidence that an incursion has been eliminated?

Decision support tools

New incursions are often dealt with in an ad hoc manner. A decision to attempt eradication may be made with neither a full appreciation of the full extent of the incursion, nor a reliable estimate of the amount of resources that would be required to achieve this objective. Where eradication is not feasible, the default strategy may be to attempt to prevent or restrict the spread of the weed. It is quite possible that if the more modest goal of containment were attempted from the outset, the management actions would be different to those undertaken to achieve eradication. There is a clear need to develop and test rules that can govern choices between the various methods of dealing with incursions. Furthermore, there is a need to develop a rational procedure for switching between response types as the incursion proceeds.

CONCLUSIONS

The establishment of the CRC for Australian Weed Management has provided a golden opportunity to build a national capacity to deal with existing and future weed problems. A focus of the research effort on the detection, evaluation and management of weed incursions is not only a leading initiative from a worldwide perspective, but also bodes well for improved management of Australian weeds in the new millennium.

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PARTHENIUM WEED UPDATE - A Review of Parthenium Weed Education

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Narrabri

INTRODUCTION

Parthenium weed can cause serious problems for the community. This weed has created concern because it can have a devastating effect on agriculture, the environment and human health.
The threat of Parthenium weed establishment in New South Wales has been a concern for many members of the agricultural industry since it first established in Queensland. This threat has been given high priority by many authorities, including NSW Agriculture and the Namoi-Gwydir Noxious Weeds Advisory Committee.

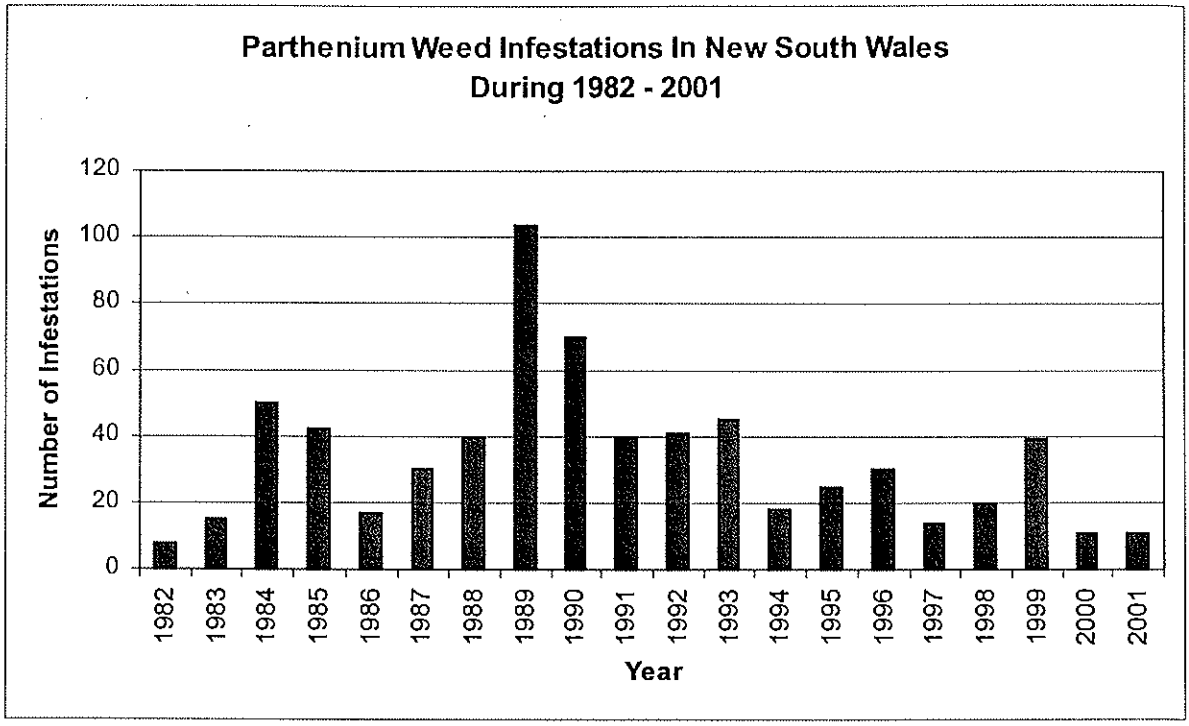
As Parthenium Project Officer for the Namoi-Gwydir committee, my role is to educate the public and weed managers about Parthenium weed.

Why Education?

The Parthenium Taskforce has anecdotal evidence that their publicity has created an awareness of the name Parthenium. This shows us that publicity and education is a tool that does raise public awareness. This evidence has also shown us that while people are now becoming familiar with the name Parthenium; they still do not know what the plant looks like. Therefore we need to continue the education process and take the public to the next step of identification.
Giving the public knowledge of this weed is one method that will help us stop this weed from becoming established in our state.

Parthenium Weed Infestations in NSW

The checking of harvesters at the boarder has to date been one of the main activities to keep Parthenium weed out of NSW. Over the years the cleanliness of these machines have been improving. Many of the owner/operators now clean their machines not only because they have to by law, but also so they can't be labeled as a company who spreads weeds.
The numbers of infestations across NSW have gradually been declining. The following graph shows the number of infestations in NSW from 1982 until July 2001.



Note: Parthenium weed infestation figures courtesy of NSW Agriculture.

This decline could be due to a number of reasons. Seasonal conditions affecting the weed's germination, strict checks of harvesting machinery at boarder crossings and an increase in the number of washdown facilities available to the public.

However, as efficient as the cleaning procedures for machinery and vehicles are, it is not a guarantee that Parthenium weed seed will be totally kept out of NSW. Therefore, by educating the public about this weed we are providing another vital weapon, which is needed in the fight against Parthenium taking over our state.

As Parthenium Project Officer I have started this education process in the Namoi-Gwydir area. Some activities have included publicity through newspaper articles, posters, identification cards, radio interviews, presentations and training sessions. I have also attended meetings for groups involved in Parthenium weed prevention.

Parthenium Weed Survey

My main activity has been conducting a Parthenium weed survey in the Namoi-Gwydir region. Appendix 1 shows this survey. The survey was to find out what people actually know about Parthenium weed and to check if our theory, that people have heard of Parthenium, but do not know what it looks like, was right.

The aims of this survey were:

- To carry out a survey to find out what level of knowledge the landholders of the Namoi-Gwydir region have on Parthenium weed.
- To find out what the council weed officers think the public should know about Parthenium weed.
- To use the survey results to develop an education program.
- To run the survey again in one years time, to check the progress of the education program.

The survey was carried out in six locations. These were:

AgQuip at Gunnedah
Narrabri Saleyards

Quirindi Prime Stock Exhibition
Quirindi Spring Show
Moree Saleyards
Inverell Saleyards.

Appendix 2 shows a map of the Namoi-Gwydir region and the position of each council.

After finishing the survey, people were then given a Parthenium weed identification card. I found this to be a good way to distribute the cards and it also gave people who didn't know what Parthenium weed was or what it looked like a chance to learn about the weed.

Weeds Officers Opinions

The chief weeds officers from each council in the Namoi-Gwydir region were also asked two questions. Appendix 3 shows these questions. This was to get their opinions of Parthenium weed education.

Most of the officers think the public needs to be educated about the health problems associated with Parthenium weed and the weed's identification.

The chief weeds officers identified farmers and landholders as the main target group for Parthenium weed education. This is the group most likely to come across Parthenium weed.

Survey Results

A total of 279 surveys were filled out. Appendix 4 shows a table with the results as an average of the six locations.

The most surprising result from the survey was:

- More than half of the surveyed landholders think they know what Parthenium weed looks like. However, from comments made, while filling out the survey it became clear that many people were actually thinking of the wrong weed when they answered yes.

There were some other issues brought to light, that the results do not reflect. These are:

- The issue of Parthenium weed spread. Many people said that water and birds spread the seeds. This is true; however, it is not the main form of Parthenium seed spread. People need to be aware of the most likely ways that Parthenium could be brought into NSW.
- Also, what people would do if they found a Parthenium weed plant is a concern. Some people said they would destroy the plant or just spray it with a chemical. This is incorrect, as they must report the weed to their local authority **first**.

These results show that we need to educate the community on:

Parthenium weed identification
Ways the seeds are spread
Practices to prevent Parthenium establishment
Effects the weed has on people and the environment
Control methods.

The individual results for each location also showed some issues that need to be addressed.

- The first issue is that the majority of farmers (the main percentage surveyed at saleyards) know about Parthenium weed. However not all these farmers knew who their LCA was and how to contact them. Considering farmers would be the main group requiring information and advice about noxious weeds, I believe this issue needs to be worked on.
- The second issue that became apparent was that the majority of people who haven't heard of Parthenium weed or who do not know much about the weed, were people who attend their local agricultural show. Therefore, by targeting these local shows, we would be reaching the members of the community with the least amount of knowledge on Parthenium weed and increasing public awareness.

Publicity

During my work as Parthenium Project Officer I have had many positive comments made about my work and the importance of the Parthenium weed message being spread. I have found that most people are interested and willing to learn about this weed and they are very receptive during presentations and training sessions.

The training sessions I have conducted for some council outdoor staff have focused on using live Parthenium plants for identification. From these sessions and displays at agricultural shows it has become apparent that most people benefit greatly from being able to look at a live Parthenium weed specimen. Displaying a live plant encourages people to approach for a look, which then leads to conversation and the relay of information.

As a lot of my work has incorporated live plant displays the local councils and myself have been able to pass on Parthenium information to many members of the public. Due to this work I believe that the publics' awareness of Parthenium weed is growing.

MESSAGES TO TAKE HOME

- Ensure you, as council weeds officers, include Parthenium weed education in your publicity activities.

- Teach people how to identify Parthenium weed. Distribute phamplets, identification cards and point out the main features of the weed. The easiest way to identify Parthenium is:
    1. The stems appear to be striped due to grooves or ridges
    2. The flowers have five distinct lobes.

- Make it known to the public that Parthenium weed can cause serious health problems for humans. In severe cases people have been forced to sell their property and move away from Parthenium infested areas in Queensland.

- Educate the residents of your shire on the procedures to follow if they find a suspected Parthenium weed plant (or any other W1 noxious weed of your shire). The steps to take are:
    1. **DO NOT** touch the plant
    2. **DO NOT** remove the plant
    3. Mark the area and request their Local Council Weeds Officer to come out and identify the plant.

- Good property hygiene is a very important factor in our fight against Parthenium weed. Simple prevention measures for all properties include:
  Be Aware of Parthenium weed
  Be Aware when purchasing stock feed (grain, hay etc) and crop or pasture seed
  Be Aware of the origin of stock
  Be Aware of the origin of machinery and vehicles
  Be Aware of pasture composition
  Be Aware of procedures for cleaning vehicles.

- Everyone needs to be aware of Parthenium and understand the importance of preventing this dangerous weed from establishing. So use every opportunity available to make this message known to all members of the public.

- ❖ Take any opportunities that may come your way to be able to see live Parthenium plants. This will keep your memory fresh, especially if you are in an area where Parthenium may not have been found yet.

CONCLUSION

The results from the survey show that the public needs to be educated about Parthenium identification, the way seeds are spread, the effects on people and the environment, prevention and control methods.

These are all things, which we know and are already making aware to the public, but as the survey shows there are still many people who don't know these things about Parthenium weed. Therefore, we need to continue sending out these messages. And in some cases intensify our educational activities in order to make it known to **all** that Parthenium weed is something we need to keep out of our state.

ACKNOWLEDGMENTS

I would like to thank all members of the Namoi-Gwydir Noxious Weeds Advisory Committee. Phil Blackmore and Alan Maguire of NSW Agriculture and the Chief Weeds Officers of the following councils for helping me conduct my survey.

Narrabri Shire Council
Gunnedah Shire Council
Central Northern County Council
Moree Plains Shire Council
North west Weeds County Council
NSW Agriculture

Appendix 1

Parthenium Weed Survey

The objective of this survey is to assess what knowledge landholders have on Parthenium weed. The results will help to develop an effective education programme to educate landholders on Parthenium weed. Please place a tick in the appropriate box.

Questions

1. Have you heard of Parthenium weed? Yes ☐ No ☐
2. Do you know what Parthenium weed looks like? Yes ☐ No ☐
3. Could you identify Parthenium weed in the field? Yes ☐ No ☐
4. Do you consider Parthenium weed to be a problem weed? Yes ☐ No ☐
5. Is Parthenium weed a declared noxious weed? Yes ☐ No ☐
6. Do you know how Parthenium weed is spread? Yes ☐ No ☐
7. Do you know how to control Parthenium weed? Yes ☐ No ☐
8. Do you know how to prevent Parthenium weed from establishing on your land?

   Yes ☐ No ☐
9. Do you know how Parthenium weed affects the environment? Yes ☐ No ☐
10. Do you know how Parthenium weed affects humans? Yes ☐ No ☐
11. Would you know what to do if you found a Parthenium weed plant or a suspect Parthenium weed plant?

    Yes ☐ No ☐
12. Do you know who your Local Council (LCA) for weed control is and how to contact them?

    Know LCA ☐ Don't know LCA ☐

    Know how to contact LCA ☐ Don't know how to contact LCA ☐

THANK YOU for taking the time to complete this survey.

This project is sponsored by
Namoi-Gwydir Noxious Weeds Advisory Committee

Appendix 3

Chief Weeds Officers - Questions

1. What aspects of Parthenium weed do you believe the people of the public need to be educated about? Please list in order of priority.

   1. _____

   2. _____

   3. _____

   4. _____

   5. _____

2. Which people do you believe are our main target group?
   Everyone or certain groups (e.g. farmers, town people, tourists' etc).

   _____

   _____

Appendix 4

Parthenium Weed Survey Results			
Questions	Yes	No	Didn't Answer
1	92%	8%	.0%
2	52%	48%	0%
3	39%	61%	0%
4	89%	10%	1%
5	92%	7%	1%
6	81%	18%	1%
7	23%	77%	0%
8	48%	52%	0%
9	44%	54%	2%
10	44%	56%	0%
11	79%	21%	0%
12a	78%	18%	4%
12b	73%	15%	12%

Table 1. Parthenium weed Survey averages.

PARTHENIUM WEED IN THE SOUTH

Geoff Portbury
Noxious Weeds Inspector
Jerilderie Shire Council
Jerilderie

Outbreaks

April 27th 2000 Deniliquin. 6 Plants
May 2000 Narrandera.
March 31st 2001 Hilston. Numerous other outbreaks in this area over the past 10 years.
May 2001 Deniliquin. 1 plant 7.5 cm high and in flower.

Problems for this area.

Weather

Conditions in the Riverina, although dry during summer are normally wet enough due to storm activity to support Parthenium Weed growth.

Travelling Stock Routes

The Southern Riverina is traversed by a very large system of travelling stock routes. Although not utilized to the extent that they were a few years ago they are still used to walk livestock around the country. Most of these routes extend along the edges of roadways. Combine the stock and motor vehicles, both potential carriers of seed, with the road edge, the perfect growing environment for Parthenium Weed and you have the ideal situation for the spread of the plant. All of these stock routes have watering points along their length. These locations are ideal for germination of Parthenium seeds with stock milling about the ground tanks and river banks, churning up the ground, pushing together and rubbing any seed that they may be carrying off onto the ground

Vehicular Movement

The Newell Highway and the Kidman Way provide direct routes from the Parthenium Weed areas in the north to the Southern Riverina. There are no inspections of private vehicles at the border or wash regulations that pertain to them
Vehicle movement through the area along these routes including caravans, livestock and grain transport vehicles aid in the distribution of seed. Sorghum seed is a prime example of seed being transported into and through the Riverina from the primary Parthenium Weed areas.

Property Size

Many large acreage properties often have stock delivered from northern areas of state and Queensland, the heartland of Parthenium Weed in Australia. Transport vehicles can travel for many kilometres through these properties to the delivery point, often over rough roads. With the rattling of the vehicle over these roads and cattle grids seed can be easily shaken loose and dropped from the vehicle. (It is suspected that this may have been the cause of the out-break in Deniliquin in April 2000 as the infestation was located just south of a railway crossing and extended South for several kilometers).

Much of the country associated with these properties is sparsely vegetated during the summer months. Conditions which suit PW.

A growing number of the larger dry land holdings in the area are being set up with sizable irrigation blocks on their country. The products produced include rice and cotton. These require the movement in and out of the property of large numbers if vehicles,

Seed life of up too 6 years could see outbreaks in isolated areas of large properties go undetected for extended periods enabling seed beds to be established. These seeds can be distributed readily by stock and wildlife that are prolific in this area.

Soil types in this area of the state are suitable for parthenium weed.

The Riverina has intensive wool, beef, vegetable, viticulture and rice growing industries, all of which are conducive in one way or another to the germination, growth and spread of Parthenium weed. For example, in 2000 the Murray Rural Lands Protection Board, covering an area of 1,338,000 hectares of the Riverina there were,
72,00 head of Beef cattle
31,771 head of Dairy cattle
1,167,512 sheep
2463 horses
1408 goats
And 4660 deer
Rice production in the Murrumbidgee, Coleambally and Murray Valley Irrigation Areas for 1999 covered 150,825 hectares of land and produced 1,381,823 tonnes of grain. This represents a dollar value return to the area, averaged over the seven (7) types of grain harvested of $264.71 a tonne after adjustments. That is a massive $365,782,366.33.
Tomato production in the Jerilderie, MIA-Hilston and Rochester-Moama growing districts covered 2,823 hectares and yielded 212,744 tonnes of product. Total income for the growing districts mentioned above in the 2000/01 season was $21,070,165.76.
By any standards these are big numbers and large areas. Any Parthenium Weed outbreaks have the potential to do serious harm to these industries in this area.

Large areas of the Riverina are now under irrigation. The irrigation season runs from September to May, the potential growing period of Parthenium Weed. Should Parthenium Weed seed be deposited into this system via ***any*** means, the spread of the weed would be uncontrollable if left undetected. The major rivers in the area are the Murray in the south and the Murrumbidgee in the north. Because of the interconnecting natural and man made waterway system between the two it is not inconceivable that seed dropped into the Murrumbidgee from a vehicle crossing a bridge could end up in the Murray. It may not be that exact seed but progeny grown from the germination of that seed in an out of the way back water of one of the interconnecting waterways.
Nearly all of the water used for irrigation in this area is drawn from either the Murrumbidgee or the Murray rivers. Imagine if you will the havoc caused if just a few Parthenium Weed seeds were to germinate and mature then drop their 15000 seeds a plant into these waterways. ABSOLUTE DISASTER!

It is of paramount importance that the Noxious Weeds Officers of the Riverina be constantly vigilant regarding the detection of Parthenium Weed.

It should be mentioned with appreciation that if it were not for the efforts of our counterparts in the north of the state and over the border in Queensland, we would almost certainly be under a more sustained attack from this terrible weed.

It goes without saying that we cannot let down our guard in regard to Parthenium Weed. It won't give up and neither should we.

Acknowledgments

- Murray Rural Lands Protection Board District, Jerilderie Office.
  Statistics for the Year 2000
- Rice Growers Co-operative. Grower Services.
  Statistical Summary Comparison & 1999 Crop Returns
- Barry Horn Consulting / Australian Processing Tomato Industry Council
  Annual Industry Survey 2001

NATIONAL ERADICATION PROGRAM FOR BRANCHED BROOMRAPE

Phil Warren[1], John Virtue[2] and Nick Secomb[2]
Animal and Plant Control Commission (APCC)
Primary Industries & Resources SA (PIRSA), Adelaide

Summary
Branched broomrape is a parasitic weed posing a serious threat to both broadleaf crop production (yield losses) and market access (seed contamination). PIRSA established a quarantine area in 1999 in which paddocks are inspected, produce certified and protocols on movement of produce, livestock and machinery are enforced. Extensive surveys in 1999 and 2000 have found a total of 236 infestations on 130 properties in a discrete area of the Murray Mallee. Canola, vetch, carrots, tomatoes and lettuce have so far been confirmed as host crops. An eradication program is being funded for the 2001/2002 financial year through ARMCANZ with assistance from all States and the Commonwealth. Research has commenced into improved control techniques and detection methods.

BRANCHED BROOMRAPE

Branched broomrape (*Orobanche ramosa*) is a parasitic plant that extracts all of its nutrient and water requirements via the roots of its plant host. Broomrape seed germinates when it receives chemical triggers from a host root. It then attaches to the host root and grows an underground storage organ called a tubercle. Only the flowering stem of branched broomrape emerges above ground, and seed set is complete within 3 weeks. Time from germination to flowering is 45 days in Texas, USA (Carter 1996). Seed is microscopic (approx. 0.2 mm in length) and individual plants can produce tens of thousands of seeds.

Broomrapes parasitise broadleaf plants, and typical crop yield losses are around 35% (Linke et al. 1989). Branched broomrape has a reputation amongst the broomrapes as a species with a very wide host range. Overseas it parasitises many pulse, oilseed, fibre and vegetable crops, as well as broadleaf weeds and native herbs. Yield losses of up to 75% in tomatoes (Hodosy 1981) and 90% in rapeseed (Perny 1989) have been measured. Probably a greater concern than crop damage itself is the risk posed to export and local markets from seed contamination. Even in non-host cereals, there is a risk of grain contamination where branched broomrape grows on broadleaf weeds within the crop.

CURRENT STATUS AND QUARANTINE MEASURES

Branched broomrape was discovered in 1992 in the Bowhill area by a landholder. It is not known how the weed came to the area, or indeed where it came from. The species is native to the Mediterranean region, but has spread to the USA, Chile, Cuba, South Africa, various Middle-Eastern and western Asian nations and now Australia.

Extensive surveys have been conducted in spring 1999 and 2000, and will occur again from September 2001 onwards. To January 2001, a total of 236 infestations on 130 properties had been found in the Murray Mallee (Figure 1). Known infestation area is around 2, 000 ha. All the known infestations are contained in an area of 70 km × 70 km.

In response to the threats posed by branched broomrape, PIRSA established a quarantine area in November 1999. A code of practise has been imposed to restrict the movement of seed and materials that would otherwise spread the pest to new areas. This includes paddock inspections, produce certification and protocols for movement for produce, livestock and machinery. Compliance by farmers with the quarantine conditions has been very good. A total of 1,327 movement orders were issued during the financial year 2000/01.

THE TRACEBACK PROGRAM

Branched broomrape seed can be transported as a contaminant in soil, and in the gut of livestock which have been grazing on infested pastures. The code of practise specifies a procedure which must be followed by landholders so that these risks are nullified. In order to increase confidence that all infestations of branched broomrape are found, PIRSA has implemented a Traceback Program which examines the historical movement of possible vectors for the spread of branched broomrape seed.

During spring 2000, in excess of 230,000 hectares of agricultural land was surveyed in South Australia from the State's mid north to the Victorian border. Approximately 5,000 hectares were also surveyed in Victoria. The 220 properties surveyed had some link through past business dealings with properties known to have an infestation of branched broomrape. Of the linked properties surveyed, 16% were infested with branched broomrape. The most frequent links came through machinery which was either used to penetrate the soil or was used in paddocks when branched broomrape is actively flowering and seeding (Figure 2). While the type of link was not geographically stratified, all positive links were found within a 70 km radius of the centre of the known infestation area. New infestations found in 2000 have been investigated and a further 185 properties have been targeted for survey in the 2001 traceback surveys. PIRSA is confident that the area containing most of the branched broomrape in South Australia has now been defined.

Observations from the 2000 survey suggest that branched broomrape:

- was present before 1992 (when it was first detected);
- favours hosts on light, sandy, neutral to alkaline soils; and
- does not grow on hosts on heavy, clay soils.

ERADICATION PLANS

Our objective is to eradicate branched broomrape using host denial, fumigation and other strategies such as selective herbicides. Infested roadsides are a high priority for treatment in 2001. An agronomist is also working with affected landholders to maintain and possibly increase farm productivity, whilst still controlling branched broomrape. Research has commenced on determining the most effective control techniques for landholders (see below).

During surveys in the spring of 2000 it became apparent that in some paddocks where an infestation was found in 1999 branched broomrape was not found again. Very clean cereal crops were being grown in these paddocks. This proved to be the case in around 50% of paddocks. This means that it is possible to maintain commercial cereal production with negligible risk of broomrape contamination and also cause a long-term decline in the branched broomrape seedbank by denial of hosts.

RAISING NATIONAL AWARENESS

During 2000, a total of about 130,000 farmer awareness pamphlets on broomrapes, including branched broomrape, were distributed to grain growers, horticulturalists, land management groups, crop consultants and extension officers in all States/Territories to encourage people to identify and report infestations of branched broomrape at a national level. The pamphlets have heightened the awareness of broomrapes as evidenced by several reports of clover broomrape (*Orobanche minor*), a less threatening species found in all southern states. No branched broomrape was reported.

RESEARCH - CURRENT AND FUTURE

Whilst branched broomrape parasitises a wide range of crops in other countries, there can be considerable variation in host range between strains of broomrape. Host testing of the SA branched broomrape strain and has so far confirmed canola, mustards, cabbage, lettuce, vetch, carrot and tomatoes as hosts.

Branched broomrape has very fine seed (0.2 mm in length) which is easily dispersed in soil attached to vehicles and machinery. Hence the need to decontaminate on leaving a paddock with a branched broomrape infestation. Exposure to a 1% solution of NiproQuat® (didecyl dimethyl ammonium chloride) has been shown to reduce branched broomrape seed viability to 8%. Whilst not a complete kill, the treatment is routinely used in conjunction with a high pressure washdown, so that the risk of moving viable broomrape seed on machinery/vehicles is extremely low.

There is considerable potential to use herbicides to selectively control branched broomrape within host broadleaf crops and pastures. The approach is to apply suitable herbicides after the branched broomrape has germinated and attached to the host, so that the herbicide concentrates in the broomrape tubercle and kills it before flowering. Glyphosate (at very low rates) and the sulfonylurea and imidazolinone herbicides have been used effectively overseas (Dhanapal et al. 1996), and particular crops/pastures that are tolerant or resistant to such herbicides may prove very useful. GRDC has funded a research agronomist to compare prospective control techniques in the quarantine area. A modeller is also being appointed by the CRC for Australian Weed Management to determine optimal strategies for dealing with new weed incursions, with a particular focus on branched broomrape.

A DNA probe to detect branched broomrape seed is being developed as a means of investigating potential contamination in produce (e.g. grain) and quantifying seedbank levels in soil.

PROGRAM MANAGEMENT AND FUTURE PLANS

The branched broomrape program has been in operation for two years, with funding through ARMCANZ from PIRSA, other States, the Commonwealth and industry funding. The 2001/2002 budget of $2.2m indicates its size. GRDC and HRDC supported the program, providing a total of $330,000 in 2000/2001 towards the field surveys. GRDC has also committed an additional $300,000 for research for the following two financial years.

A long-term eradication program is planned. At some stage industry in a more broad sense than the research bodies will be asked to contribute. This depends on the diverse range of plant industries being able to organise themselves through Plant Health Australia, perhaps in a similar fashion to the animal industries. The program will cost around $2 million, each year, for the next three years. Nobody is underestimating the nature of the task ahead but the farmers through the Community Focus Group, South Australian industry through the Ministerial Advisory Committee and the experts through the National Branched Broomrape Consultative Committee all agree. Given the potential threats, the known distribution of the weed and the sum of all the other factors, including the future judgement of Australian producers, we are obliged to aim for eradication.

ACKNOWLEDGEMENTS

This paper is a revision of a previous conference paper by Warren and Virtue (2000).

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Website for quarantine protocols:
www.pir.sa.gov.au (go to Sustainable Resources, then Animal and Plant Control, then Proclaimed Plants)

Figure 1 Known locations of branched broomrape, at January 2001.

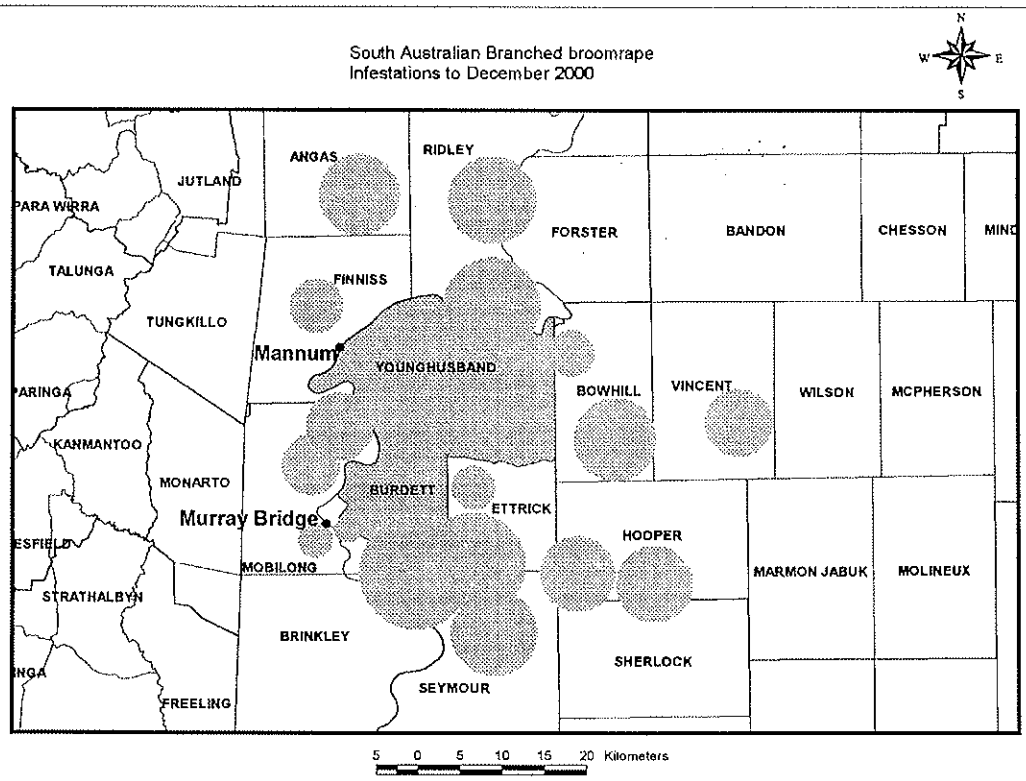
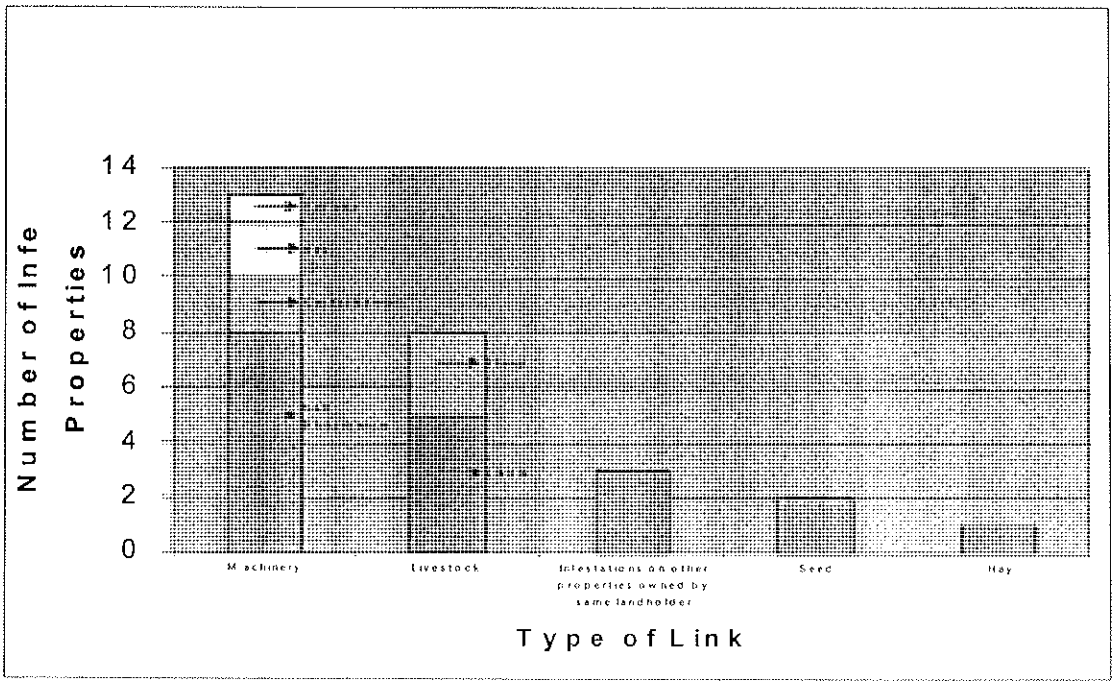


Figure 2 Relative significance of different vectors for the spread of branched broomrape seed.



NB: Many of the links inside of the Quarantine Area were infested in previous years, many were also in very close proximity to known infestations. This analysis was conducted on links outside of the Quarantine Area to reduce the impact of other factors being involved in seed dispersal. The suspected vector may not be the actual means of seed dispersal. For example, extensive testing of cereal seed presented for sale at Ausbulk silos showed no evidence of contamination of cereal seed.

BIOLOGICAL CONTROL OF *LANTANA CAMARA* IN NSW

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Introduction

Biological control of *Lantana camara* began in Australia in 1914. Twenty-nine agents have been released and 15 of these have established. A number of the established agents are widespread and cause substantial damage to lantana on a seasonal basis (Day & Holtkamp 1999). However, *L. camara* is still a problem in many regions of eastern Australia and is not considered to be under adequate control. Several factors including lantana varieties, climate and release techniques have been identified as influencing the successful biological control of lantana (Day & Neser 2000). In 1996, the NSW Lantana Taskforce was set up following discussions between various NSW Government Departments and the Queensland Department of Natural Resources (QDNR). The Taskforce consists of members from NSW Government Departments, Shire Councils and Catchment Groups and is run by a committee comprising personnel from some of the participating organisations.

The aim of the Taskforce is to raise funds through contributors to assist QDNR, now the Queensland Department of Natural Resources and Mines (DNR&M) in the research on biological control of lantana. The project was funded initially for three years, with the aim of releasing new biocontrol agents onto lantana infestations throughout NSW.

This paper details the activities of the project and its achievements.

Benefits of the Taskforce

There are a number of benefits in establishing and conducting a project under a multidisciplinary collaboratory banner. The main contributing factor was that the Queensland Government already had an active project researching the biological control of lantana. A separate project based in NSW would have been uneconomical, as quarantine facilities to import and test agents weren't readily available. Also, the cost in establishing a project in terms of rearing facilities and staff would have been very high.

By receiving relatively small contributions from various government departments, councils and catchment groups, a significant amount of funds can be generated to support the Queensland-based project. This combined effect far exceeds individual organisations could have achieved in terms of actual biocontrol.

The money generated partially funded a technician based in Queensland who was appointed to rear and release agents for NSW. The project also partially funded the Queensland-based project leader, travel to release and monitor biocontrol agents, and the construction of cages or supply of laboratory equipment. A small amount was used to fund research or to collect and import agents from overseas.

Co-ordination

In 2000, the Taskforce consisted of over 30 participating organisations. The main organisations were the NSW National Parks and Wildlife Service, who contributed over a third of the funds and NSW Agriculture who supplied in-kind contributions of a senior entomologist, Royce Holtkamp from

Tamworth, a technical officer, Phil Stephenson from Grafton and glasshouse facilities at Grafton. Bruce Scott from the Far North Coast County Council volunteered to act as secretary and was responsible for the co-ordination of the participating organisations, maintaining the accounts and producing a newsletter.

The release of agents in NSW was co-ordinated by Royce Holtkamp who was accompanied by, or liaised with staff from the Alan Fletcher Research Station (AFRS), Brisbane who advised on site and plant requirements of the particular agents. Releases were usually conducted with the assistance of NPWS staff and/or council weed officers so as to provide training in site selection and the identification of lantana varieties and biocontrol agents. This allowed future releases of agents in the same area to be conducted by local personnel rather than staff from Tamworth, Grafton or Brisbane. Staff from the regions were then able to provide release details in addition to lantana specimens and samples of existing agents present on the plant. As well as releasing agents reared at AFRS, Phil Stephenson maintained small colonies of agents at Grafton and some releases were conducted around northern NSW.

Achievements

Five new biocontrol agents have been released in NSW over the first four years. Many other significant benefits and achievements arose from the project, both for NSW and Queensland. All those involved with the field release of agents gained knowledge of the existing lantana biocontrol agents and the morphological features that help distinguish similar species. Surveys located 12 existing biocontrol agents in NSW. (Three other agents that have established in Australia were not found in NSW, being confined to the tropics of north Qld.). Officers also gained a greater appreciation of the types of habitats and areas that lantana could grow in and how the distribution and abundance of existing biocontrol agents varies between areas.

Along the coast where conditions were warm, a greater number of agents were present. However, at higher altitudes or in the southern parts of the State, there were fewer agents present. This information was used to decide where to release the new agents. There was also knowledge gained in the identification of the different varieties of lantana, how their distribution is affected by altitude and latitude and the preference that some agents show for some varieties over others.

Specific achievements in the first four years are outlined below.

Aconophora compressa

This stem-sucking bug from Mexico has been the main focus of the project and has been released at over 50 sites throughout NSW. Staff from NPWS, NSW Agriculture and many Shire Councils have been involved in the release of this agent. A heatwave in northern NSW in early 2000 killed insects at several sites. Two floods during early 2001 destroyed release sites near Cangai west of Grafton where *A. compressa* had established and spread, causing significant damage to many lantana plants.

At last report, *A. compressa* was still present at 11 sites, with insects performing very well at Terrigal on the central coast. Insects have also persisted at Wiangaree, Iluka and Baryulgil in the north and Kiama in the south. At Terrigal, *A. compressa* has spread over 100 m causing substantial damage to many plants in the form of dead branches and reduced flowering.

Aerenicopsis championi

There have been two attempts at releasing this Mexican stem-boring beetle in NSW. In early 1999, a small number of mature adults were released into a large field cage near Wiangaree in the north. The cage was left on the plants for about two months to contain the adults while they laid eggs and to protect the developing larvae from predators and parasitism. Adults fed and eggs were laid on a number of plants and branches in the cage. However, by late 1999 only a few larvae remained and the area was possibly too cool and wet for this insect.

In addition to releasing adults, approximately 70 larvae were placed in holes drilled in stems of plants at a warmer and drier site near Grafton. Over 70% of the larvae initially fed in the stems but many didn't reach adulthood. The site is still being monitored. CLIMEX modelling suggests that coastal northern NSW should be acceptable for *A. championi* but future releases may need to be conducted further north.

One of the problems working with this insect is that it has a very long (six months) developmental time from egg to adult and only has one generation per year. Consequently, this causes difficulties in rearing the insect in the laboratory where mortality can be quite high. Further shipments of *A. championi* have been imported and field trials will continue later in the year at sites still to be determined.

Alagoasa parana

The leaf-feeding beetle, *A. parana* is another insect having just one generation per year. This insect originated from Brazil and was previously released by CSIRO in the early 1980s. However, only a few field releases were conducted and the insect failed to establish. *A. parana* was re-imported several times in the late 1990s and was released at sites near Grafton which were thought to have a similar climate to that in southern Brazil. Both adults and mature larvae were released separately at two sites but there are no signs of these insects now.

It is unlikely that this insect will be imported again. The long time from egg to adult suggests that population growth will be slow.

Ectaga garcia

E. garcia is the latest in a number of leaf-feeding moths to be released on lantana. Several other species of moth have established and have been observed causing seasonal damage to plants in various areas. This moth originated in Brazil and was released at 12 sites from southern NSW to northern NSW. The insect was released as larvae, pupae and adults using open and cage releases. However, it has not been found at any site in NSW or in Qld.

E. garcia was collected from *Lantana fucata* which is in a different taxonomic group to that of *L. camara*. While the insect can be reared on the latter species in the laboratory, it has not performed well on this plant under field conditions. Several other moth species have failed to establish despite large numbers being released at a large number of sites. Consequently, there are no further plans to import this agent again.

Falconia intermedia

This tiny sap-sucking bug from Jamaica is the latest agent to be released on lantana. The insect has similar actions to another sap-sucking agent, *Teleonemia scrupulosa*, which causes seasonal damage to lantana in many areas of eastern Australia. The difference between the two insects is that *F.*

intermedia prefers warm, humid areas while *T. scrupulosa* prefers the drier areas. *F. intermedia* has only been released at one site to date but more releases are planned for the summer.

The potential for this agent to severely damage lantana is high. In South Africa, this insect has been released in large numbers and damage to lantana infestations has been widespread. In some regions of South Africa, plants have become leafless and devoid of flowers. It is hoped that similar results will occur here as well.

Prospodium tuberculatum

P. tuberculatum is a fungal pathogen from Brazil. It is the first pathogen to be approved for release on lantana in Australia. While it is too early to determine how this agent will perform, there have been a number of pathogens released on other weeds that have been very successful. The noogoora burr rust has virtually controlled the weed in Queensland, while the rubber vine rust has proved a most useful agent in north Queensland.

The two main benefits of introducing a rust on lantana is that control by insects alone has had limited success in most regions. Secondly, the rust attacks the pink flowering lantana that is the dominant and most widespread variety and one that is generally attacked less by the insects.

Some potential release sites have already been identified with the aid of NPWS staff and releases have been planned for most sites over the summer of 2001/2002. The pathogen appears to have a wide tolerance of climates and so may establish in areas where there are very few agents already present.

Other Agents and Activities

As well as concerted efforts to release new agents throughout the State, a number of established agents have been re-distributed into areas where they were not previously present. The leaf-mining beetle *Octotoma scabripennis*, which is abundant in the north and has been severely damaging lantana plants around Grafton on a seasonal basis, was released around Myall Lakes and Lake Macquarie. At both sites, the insects quickly established and built up into large numbers. Further re-distributions of this insect are planned.

Two other leaf-mining beetles were also redistributed. *Octotoma championi*, which is present around Sydney, was released near Port Macquarie and *Uroplata fulvopustulata* was released near Wiangaree. It is too early to determine if either of these species has established in the new areas.

Some of the funds from the Taskforce paid for overseas research. The Plant Protection Research Institute (PPRI) in South Africa was responsible for testing the suitability of Australian lantanas for *F. intermedia* prior to importation into Australia for host testing. More recently, PPRI has been engaged to conduct host specificity testing of the budmite *Aceria lantanae*. This mite causes substantial damage to plants in Florida, Jamaica and Mexico. PPRI has already tested the susceptibility of Australian lantanas to this agent. Results from this work were varied but promising.

PPRI is also working on a number of other agents, including a leaf-feeding beetle *Alagoasa quadrilineata*, a petiole-galling beetle *Coelocephalapion camarae* and a root-feeding beetle *Longitarsus* sp. Whether one or more of these agents is imported depends on their performance.

During the course of the project, researchers have conducted or attended eight field days, presenting information on biological control of lantana.

Future Activities

A review of the lantana project in Queensland is being held in September 2001 and participants from various agencies in NSW and Qld have been invited to attend. The aim of the review is to decide on the direction of the project for the next 3-5 years and to identify some key areas of research. In the immediate future, the field release of *F. intermedia* and *P. tuberculatum* will continue in an attempt to get the agents established in as many places as possible. The continued field release of *A. compressa* will be discussed in light of both the massive effort in attempting to get this agent established and the partial success that has been achieved to date.

The host testing of *A. lantanae* will continue and it is hoped that the agent will be ready for release in late 2002. Other agents being considered are the three agents currently being studied in South Africa, together with the possible re-importation of the stem galling fly *Eutreta xanthochaeta*. This fly is causing widespread damage to lantana in Hawaii. However, it has failed to establish in other countries, including Australia. Its potential effectiveness has been questioned as it is readily attacked by parasites in Hawaii.

In addition to these additional insects, there are two other pathogens currently being studied. Pathologists at CABI Biosciences in the UK have suggested both *Puccinia lantanae* and *Mycovelosiella lantanae* could be very damaging agents.

A field guide to the identification of lantana biocontrol agents is currently being prepared and will make a useful reference tool for project staff and field officers in both states.

Studies on some of the aspects of the biology of lantana and the biological control of lantana have been included in the new Co-operative Research Centre for Australian Weed Management and in the lantana strategy as part of the Weeds of National Significance (WONS) program.

While the project has made a number of advancements in introducing new biocontrol agents for lantana, there is still a long way to go to achieve successful biological control of the weed. Continual monitoring of release sites, assessments of existing agents and research on potential new agents should increase our knowledge and therefore improve the overall effect of biocontrol of lantana.

Acknowledgements

The authors wish to thank Bruce Scott and staff from the Alan Fletcher Research Station for their helpful comments on this paper.

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ROADSIDE LANDCARE IN BELLINGEN SHIRE - Public Relations/Personal Experiences

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INTRODUCTION

Bellingen Shire was troubled by conflict in the mid 1990s over the use of herbicides for weed control on Council land. The 9th Biennial Noxious Weeds Conference at Dubbo saw three speakers on the subject, each with differing perspectives of the issues. Changing population demographics, a reduction in the use of land for traditional agricultural pursuits, "grey" areas of legislation and the mixing of personalities and perhaps even politics saw the issue reach its climax. An injunction on Council by a coalition of environment and community groups saw the use of all herbicide cease in the shire for a number of months.

Council has now moved on from those days and has an integrated weed control program for its roadsides. Part of this integrated approach involves the volunteer labour provided by the newly formed Bellingen Shire Roadside Landcare group. This group has formed from a reactive group who had serious concerns over past roadside management practices, especially in relation to vegetation management and noxious weed control, to a proactive group caring for their roadsides to Council's guidelines. Council reached this point through a number of conflict resolution opportunities.

CONFLICT RESOLUTION

As an initial step a number of actions were initiated to try and resolve the conflicts. These included

- Alternative Giant Paramatta Grass trials conducted by NSW Agriculture.
- A spray trial simulating the impact of a sudden rain event following herbicide application conducted by the Environment Protection Authority
- Development of a Management Plan for noxious weeds in the shire
- "No Spray Zone" agreements between concerned residents and Council
- Development of a Roadside Management Plan.

Each of these programs has provided direction for the current noxious weeds program being implemented in the Shire. They have provided Council with a firm basis to which it can implement a noxious weed control program with the support of the community.

Alternative Giant Paramatta Grass (GPG) Control Trial

This trial was conducted by NSW Agriculture agronomists and was reported to delegates of the Ballina conference. The combination of selectively spraying GPG and slashing tall-unwanted species has been the chosen form of roadside vegetation control across the North Coast. Bellingen adopted these methods for a number of years but found that the extremely high growth rate of tall-unwanted species on its roadsides, combined with the issue of herbicide spraying were not a suitable match for the shire. The slashing was cost prohibitive to keep roadside vegetation height at a suitable level, and the visual distress caused by the sight of the spray truck was not met favourably. The introduction of the Weedbug (now Centrogen) on Council's roadsides has somewhat reduced the community concern over using herbicides.

The reductions in taller growing species, including Giant Paramatta Grass and the decreased dependence in slashing, have proven beneficial in the shire. This was particularly evident when

Flupropanate, previously sold as Frenock® (the primary herbicide used for selective control of giant Paramatta Grass), went off the market for two seasons.

Council has resolved to progressively implement a wickwiping program within the shire.

Environment Protection Authority (EPA) Spray Trial
This trial showed that under a simulated rain event there was still a low level of herbicide detected in the runoff from spray activities. This result was enough for the environmental groups to maintain that Council was in breach of the Clean Waters Act and would pursue legal action should the spray program continue. The results also stated that the levels were well below the national guidelines for the protection of aquatic ecosystems and drinking water.

Council applied to the EPA in 1996 for a License to Pollute under the old Clean Waters Act but were not provided with one until 1999. The EPA was obliged to supply Council with a Miscellaneous Discharge license when it changed over to the Protection of the Environment and Operations Act 1999. This license is still kept active by Council should an infestation of alligator weed or something as serious find its way into our waterways.

The EPA has now released a Guideline for the use of herbicides near water. This guideline is not enforceable however, they provide some information on best management practices for use of herbicides and possible alternatives.

Noxious Weeds Management Plan
The review of this plan in 1999/2000 and its subsequent implementation has given Council a community accepted basis for the current Noxious Weeds program. The management plan outlines the myriad of external influences that impact on weed programs. The document gives a strategic yet holistic view of what Council is trying to achieve taking into consideration available resources. This plan is directly related to regional weed plans as developed by the North Coast Weeds Advisory Committee thus providing regional support for the program.

No Spray Zone Agreements
These agreements were made between Council and community members through the purchase of No Spray Zone signs from Council. The signs were to be erected on the roadside frontage of properties that did not wish their frontage to be treated with herbicide. These included certified organic properties, properties seeking certification, people wishing to undertake their own weed control and others. The "zone" was not be sprayed (or wiped) and the purchaser of the sign was to control the noxious weeds by whatever means they saw fit. Council has a mechanism whereby follow up treatment of these areas is undertaken if residents do not control the weeds. In many situations this was a suitable compromise. Problems arose such as signs being removed by pro-herbicide neighbours, lack of conviction to remove the weeds and the increasingly prevalent issue of public liability. If a resident, whilst undertaking weed control works on the road reserve, was injured or caused an injury the liability would inevitably rest with Council. This exposed Council to a risk of litigation it was not comfortable with.

Roadside Management Plan
90% of Victorian shires have a roadside management plan, the 10% that don't are suburban shires with no rural urban interface. Many NSW Councils are now discovering the benefits of having a roadside management plan. These benefits range from savings on construction works, having a comprehensive database of threatened species and sites of aboriginal significance to an increased awareness of Council staff on weed and native vegetation management issues.

Bellingen Shire Council's Roadside Management Plan provides a coordinated approach to all activities that are undertaken on roadsides, it also introduces a long-term management approach to council's roadsides.

The management plan consists of Management Guidelines, including a priority list and ownership of each guideline, a list of policies, laws and legislation that already impact on roadside activities that have been incorporated into the plan. The Working Document consists of computer generated maps that highlight vegetation categories (High, Medium & low Conservation), special management areas (which support rare plants, cultural/heritage items or high conservation areas) and other relevant features. The working document also consists of environmental guidelines for Council's construction and maintenance crews in an easily understandable form.

One of the key recommendations from the roadside management plan is the development of "adopt–a–road" groups to undertake works on the roadside. This initiated the formation of the Bellingen Shire Roadside Landcare Group.

BELLINGEN SHIRE ROADSIDE LANDCARE GROUP

This group was formed in 2000 following a public meeting of interested persons and a written invitation to all no spray zone holders. Around 60 people attended with as many apologies received. The meeting formed an executive committee consisting of Council's Vegetation Officer, one Councillor and community representatives.

Guidelines

The executive committee has written guidelines for members to undertake works on Council's road reserves. Issues such as Occupational Health and Safety requirements, traffic control issues, weed control techniques, and reference to the Roadside Management Plan are all addressed in the two page guidelines. These guidelines were produced so as to be easily read and understood by members. The guidelines have been reviewed and endorsed by Council's Engineering and Operations Division.

Incorporation

The committee has received Public Liability insurance coverage (after some delay) and incorporation for its activities. This provides some autonomy for the group with reference to Public liability, as members are not covered under Council's voluntary workers policy. Membership to the group is currently a $2 joining fee and a $2 annual membership fee.

Site induction

A Council representative inducts members into their respective worksites. Occupational Health and Safety requirements, vegetation management practices and traffic issues are discussed. Weed control reference material will be available to members combined with the possibility of training days.

CHANGE IN COMMUNITY ATTITUDES

The majority of the community has met the implementation of these respective programs with a positive response. Residents on roads that have not been sprayed for many years have welcomed the use of a wickwiper. The community is aware of Council's commitment to the Roadside Management Plan and its implementation. The noxious weeds inspectorial program has seen the increased awareness of the impact of noxious weeds not only on agriculture but the environment. Council is open to suggestions for alternative control techniques and supports the differing views of its residents. The community has the opportunity to become a part of possibly the first Landcare group in Australia responsible primarily for roadside vegetation, not just litter collection. The opportunity for Council to be assisted by its residents who are adopting a piece of public land is also welcomed. Council acknowledges the support it has received from NSW Agriculture and the North Coast Weeds

Advisory Committee. Key community members should also be acknowledged for their commitment and persistence in steering the future of their environment whilst dealing with the realities of Local Government.

THE FUTURE

The Roadside Landcare Group is at the stage where the period between the writing of this paper and the Moama conference will see members begin works on roadsides. No doubt there will be some teething problems but with good management (what is luck?) the initiative will see the removal of No Spray Zones from the shire. Those who do not wish to have their frontage treated may join the Landcare group and work on the roadside with assistance made available from Council and the group. The aim is for a working relationship between Council and the community including a two-way flow of information.

The incorporation of this proactive group into Councils weed control program will be another tool available for the management of weeds in the shire. There will always be some conflicting views on the management of weeds in relation to economics and environment but the resolutions must be assisted through a holistic view of the situation and working together.

ACKNOWLEDGEMENTS

Bellingen Shire Noxious and Environmental Weeds Committee
Bellingen Shire Roadside Management Plan Committee
Bellingen Shire Roadside Landcare Group

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THE FUNDING PROCESSES - how to make the most of them.

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Background
Funding submissions are now a way of life in most areas of Natural Resource Management. Most weed and land management organisations should be familiar with the National Heritage Trust process. All councils will be familiar with the Noxious Weeds Grant process.

It's time to get some general skills in your toolbox to make sure you can write a good submission and increase your chances of receiving the money.

One idea is to approach a funding submission as though it was a weed you need to manage. It needs time, clear thinking and a plan of attack. Know your enemy and how best to deal with it.

You will need:
A plan
A timetable
Some essential tools and ingredients
Sufficient time to allow for preparation
Support from your organisation and community networks.

You must follow the rules of the funding organisation
The funding organisation does not owe you a grant. The funding organisation invites applications to meet its purposes. If you consider that there will be mutual benefit by jointly investing in a project with the funding organisation then you should prepare an application.

Your application will be assessed against criteria. One of the most basic criteria that the assessors will consider is: 'have all the rules of our grant process been followed'. Commonly, errors are made in this area.

The NHT funding process has been in place now for five years, and their published guidelines clearly set out the parameters you must meet in your submission. Copies of the guidelines are available on the net (www.nht.gov.au) and the first thing you should do is read them. The whole thing. It's important. It doesn't help your case if you spend a month writing a fabulous proposal but don't meet the criteria. A common error I found in submissions I facilitated on Serrated Tussock was in the in-kind staff time contributions. NHT will only accept staff input if 20% or more of the employee's time is spent on the project. Another common mistake was in requests for fencing. The amount per kilometre depends on whether the area to be fenced is protected by a covenant or other agreement.
The following is a brief checklist you can follow to make sure you increase your chances of success with your funding submission.

1. A Plan.
You need to develop a good plan of attack for your funding submission. Find out the contact person for the funding body and the due date for submissions. Obtain a copy of the guidelines and the application form. Find out what else you will need. This may include letters of support from other organisations and your local community groups, technical advice and expertise, and approval and sign-off within your own organisation. Keep in mind some of these requirements will take time to get. Also make sure you know where and to whom the submission needs to be sent, the presentation

and introductory requirements (eg three copies, no staples, or electronic version, covering letter in front, spiffy colour cover etc.) and how you will get the finished submission to its destination. Mailing from Deniliquin will not get there overnight!

2. A Timetable.

Then set out a timetable to guide your process. Make little milestones to give a sense of achievement along the way. It generally takes three times longer than you expected to write a good submission, and it also has to be proof read by someone, so don't leave it till the last minute.

I'll say that again. Don't leave it till the last minute. Funding is a major source of the money to carry out our work, so give the process the time it deserves. To get letters of support and hierarchical sign-off, the application will need to be in at least a draft form for peer appraisal well before the deadline.

3. Essential Tools and Ingredients.

Apart from supportive friends, an unlimited phone budget, copious amounts of restorative fluids and a daily replenished drawer-full of lollies, there are some other essential items you will need to develop a sound application.

A strategy or more than one. This is your local, regional, state or national management strategy for that particular weed.

A well designed project which fulfils part of that strategy, is technically sound, economically feasible, and able to successfully deliver the desired outcomes in the stated time, has sufficient in-kind contribution, community and organisational support, links with other projects and strategies, preferably on-ground activities, a framework for ongoing maintenance and an evaluation procedure.

Work out where your project fits with its overriding strategy. Write your own clear description of your project, clearly defining not only what you want to do, but how you will do it, step by step.

Include:

The background to the project. Justify why is it needed and why your's is the best organisation to do it, and the consequences if it is not undertaken,

Clear aims and objectives,

Who's actually involved and their role,

A list of all stakeholders,

A clear timeframe of what gets done when and by whom, define when major milestones will be reached, how are the outcomes measured, and include the evaluation process and costs, and future plans.

By writing out all this in advance, you can see more clearly how the whole thing fits together and can appraise the project as a whole. This is often difficult to see in the application format, and when you come to carry out the work with the money you receive, you may find you have left out vital components. I had a revegetation project funded in the first round of NHT, but we left out the costs of the trees we were going to plant!!

Clear Links. It helps if you can show that your project not only fills a gap in work currently being done, and is clearly fulfilling a requirement of your local, regional, state and national strategy for your weed, but also shows clear links to other regional, state or national plans and strategies. For example, in dealing with a local problem that impinges on an endangered species or ecological community, obviously you must link in with the relevant recovery plan and actions within that. Do you have a Regional Organisation of Councils (ROC) Plan you can fit in with, Agenda 21, Green Web, Roadside Management Plans or any other suitable framework for your area. This shows it's not just you out there on your own crusade, but a concerted, coordinated effort in a community or regional context.

Even better, design a regional project that involves all the other councils, agencies, community groups etc in your area in a BIGGER project. This shows that you are taking an holistic view, and

there is coordinated concerted multi-disciplinary effort which are the essential buzz words for successful funding bids. It also spreads the load and is generally a more efficient way to go, if you can get the consensus.

Value Adding
How does your project show it is good value for money. How does it show that a few drops from the Commonwealth or State bucket can make a real on-ground difference.

Project Rating
The following checklist was one I developed as a guide for the steering committees to assess the projects we submitted to the latest round of National Weed Program funding in May this year. Each question was rated from 1 to 5 as to how well it addressed the criteria, and this process ranked the projects. It is a good idea to run through this exercise with your project, and see if you can't improve your overall score by better addressing these aspects. The checklist is based on information received from the Commonwealth and in their guidelines. It's not new.

Does the project address:
1. The National Weeds Program national goal and objectives
2. Strategic priority issues in the relevant National Weed Strategy
3. Show long term commitment beyond Commonwealth funding?
4. Involve partnerships with the community, state agencies or regional organisations?
5. Demonstrate practical on-ground achievements?
6. Demonstrate there is the technical and financial ability to support the project?
7. Show linkages between strategie plan priorities, individual projects, and actions to be undertaken by landholders, land managers, industry, community groups and state/territory and local govts?
8. Fill a strategic gap that provides input to further improvements in weed management, or future work to improve management options?
9. Assist in the establishment of community processes for ongoing work?
10. Address the basic cause of the problem as opposed to just the symptoms?

It is also worth noting that some criteria act **against** the priority rating of a project. These include
1. Does the project carry out activities that are the core business of an agency or other organisation?
2. Does the project carry out activities that are the normal expected responsibility of the landholder or manager without any additional benefits accruing from the activity?

Research Activities
In that last NHT round, we were also told that funding for research activities would be limited to:
- Filling critical gaps; and
- Activities that are identified in the national strategy that are classified as a high priority and have a reasonable probability of achieving long-term success.

Environmental Trust Grants
As many of us recognise that research may be the only way we are going to find effective control and management options, this can be frustrating. However, NHT is not the only funding around. The EPA has funding for research under their Environmental Trust grants. To access this money you have to draw up an expression of interest, which this year was due at the end of June. Projects that satisfy the first round are then requested to fill out a detailed application for further consideration. Unfortunately, there is no mailing list for these grants – you need to remember when they are coming up and ring them to get sent information. So remember in May next year to do that!

Certain types of grants are also available through the ET for community groups and council projects. These are generally for relatively small amounts of money and overall the ET buckets are much smaller than NHT and hotly contested, but you can only try. The ET is a good source for pilot projects and seed funding to get started on new projects ideas.

Summary

To sum up, it is important to reinforce the need for planning, organisation and timing to get in a good submission that gives you the best chance for success.

Buzz words used in funding processes; such as strategy, outcomes, linkages, value adding, objectives, SMART, milestones, or performance indicators; seem shallow and like jargon on the surface. To be successful, you must discover the meaning of these words and deliver what the funding organisation wants.

It won't happen overnight, but it can happen!

EVALUATING THE EFFECT OF SEVEN FOLIAR APPLIED HERBICIDES ON *CAESALPINIA DECAPETALA* (MYSORE THORN)

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Introduction

Mysore Thorn (Caesalpinia decapetala) is a robust, thorny sprawling shrub 2-4m high or a climber up to 10 m or higher forming dense impenetrable thickets over native vegetation and suppressing pastures.

In the Wollongong area, Mysore Thorn has invaded kikuyu and natural pastures and as a scrambler has grown over many natural woodlands making control almost impossible. In 1982 it was estimated that approximately 100 hectares were infested in the Wollongong district. A number of thornless species in this genus are grown as ornamentals and it is believed that A. decapetala may have been mistakenly introduced as one of these species.

Thought to be a native of Indonesia, it was first reported in NSW at Ryde Station in 1911 and at Mt. Kembla near Wollongong in 1953 mixed with Lantana in a creek bed. The plant currently extends from Port Kembla on the South Coast of NSW north into Queensland and has naturalised in many tropical regions and islands of the world.

The Trial

Early observations in 1982 indicated that the main barrier in controlling Mysore Thorn was its ability to drop its leaves, following the application of the only registered herbicide at that time which was 2,4,5-T, before translocation into the canes and root system had occurred. In December 1994 a trial was undertaken, at Port Kembla, and duplicated in 1996, between the Illawarra District Weeds Authority and NSW Agriculture to evaluate the effects of seven woody weed herbicides on Mysore Thorn.

Trial Details

The plots were cut out from one continuous bush of approximately ½ km long. Each plot was approximately 5m2 with two replications. Please note that this was a demonstration trial only as the site did not provide enough material for a fully randomised replicated trial but the results do give a clear indication of the performances of each of the herbicides trialed.

Location: Cordeaux Road Mt Kembla

Assessment Method: Regular visual assessments were undertaken of all treatments over the intervening period and were scored as a % regrowth and seedling germination as compared to bushes in the control plot.

TREATMENTS: Per 100 Lt Water

Herbicide	*Rate*	*Surfactant(Agral) mls*
STARANE	350 mls	200
	700 mls	200
BRUSHOFF	10 gms	200
ROUNDUP	1.0 Lt	200
	1.3 Lt	
GARLON 600	1.0 Lt	

GRAZON DS	350 mls	
	500 mls	
*CUT-OUT	95 gms	200
*TROUNCE	865 gms	200
CONTROL		

* ONLY APPLIED IN TRIAL 2

FINAL ASSESSMENT FROM TRIAL 1.

Spraying Date: 6-7 December 1994

Assessment Date: 13th September 1996 – 19 months after spraying.

Growth stage at spraying: Bushes healthy in full leaf with only some minor yellowing on mature leaves, no flowers present, bushes were heavily laden with seed pods

Brush-Off (10 gms + Agral) gave best control of Mysore Thorn (99%) whilst maintaining pasture. Residual component may have also inhibited seedling regrowth to some extent.

Roundup (1.0 Lt + Agral and 1.3 Lt) also gave good control (90 %). Being non selective Roundup destroyed the competitive effect from the pasture base allowing reinvasion of Mysore Thorn seedlings and other exotics.

Grazon DS (500 mls and 350 mls) gave good residual control of seedling regrowth however regrowth from existing rootstock/canes was extensive at (60-80 % respectively). Flowering and seed set of regrowth was noted within 12 months of spraying.

Starane (700 mls + Agral and 300 mls + Agral) and Garlon 600 (170 mls) gave reasonable control at (40-50 %). Odd seedling regrowth was noted.

FINAL ASSESSMENT FROM TRIAL 2

Spraying Date: 19th September 1996

Assessment Date: 21st May 1997 – 8 months after spraying.

Growth Stage at Spraying: Duplicate treatments were undertaken on all treated bushes. Untreated bushes in the Cut-Out and Trounce plots were in full flower.

Brush – Off again gave excellent control (98 %) with all mature plants effectively controlled and limited seedling regrowth.

Roundup also gave excellent control (95 %) on mature growth. However seedling regrowth was extensive.

Grazon DS appears to reduce leaf shed however regrowth from rootstock is extensive at (30-40 %) after eight months and two applications.

Starane and Garlon 600 continue to give reasonable control with regrowth from existing rootstock at (5-10 %).

Cut-Out (95 gms + Agral) and Trounce (865 gms + Agral) gave excellent results with no regrowth from existing rootstock noted to date. Some seedling growth was present under both treatments.

SUMMARY

Currently there are no herbicides registered in NSW for the control of Mysore Thorn.

* Mysore Thorn is poisonous to stock and also unpalatable.

It should be noted that this was a demonstration trial only, however the results from both applications do appear to give an indication that Metsulfuron and Glyphosate based products can be effective herbicide options for Mysore Thorn control.

Treatments used on this site have shown that herbicide application results in quick leaf shed however, this does not appear to have a significant effect on uptake.
Brush Off appears to give the best results of mature bushes while at the same time gives suppression on seed germination and maintains the pasture base where grasses are the major component.
Roundup also gave excellent results on mature bushes but having no residual component did not have any effect on seedling growth. Commercial mixtures of the above two herbicides in the form of Cut-Out and Trounce are also looking promising at the completion of this trial.
Seedlings do not exhibit their thorny nature until about eight weeks old, older thorns are straight but young thorns are curled back or barbed.

Other options for consideration could be to mechanically remove large bushes and then treat regrowth.

Cut stump treatment where access to the main trunk is possible.

Repeated Slashing

ACKNOWLEDGEMENTS

We would like to extend our thanks and appreciation to Du-Pont Australia, Monsanto Australia, Dow Agro Chemicals for the supply of herbicides and Western Suburbs Leagues Club for the trial site.

A special thanks also to David Pomery Tony Martin for setting up the trial, spraying and all the assessments.

ADVANTAGES OF COORDINATING NOXIOUS WEED AND VERTEBRATE PEST CONTROL

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WAGGA WAGGA

Introduction

Noxious weed control, in principal, is no different to pest animal control. By definition, both noxious weeds and pest animals are unwanted organisms occurring in undesirable situations. Where any organism is unwanted for whatever reason, there are three options. The first option is to ignore it, the second is to remove it or the third is to manage it. This paper deals with the third option and then discusses the probability that the spread of noxious weeds is more likely because pest animals occur in the same environment and *vice versa*.

The potential transporters

In this section I describe what I consider to be the primary organisms implicated in the movement of weeds from a site occupied by host plants to another location that could be relatively 'clean'. In this paper, I only deal with some of the "potential transporters" or pest animals. This list is by no means extensive but provides an overview of some of the pest animals that land managers deal with regularly.

Fur bearers: Foxes, rabbits kangaroos and many marsupials are fur bearing animals that can carry the seeds of many plants such as Bathurst Burr (*Xanthium spinosum* L.), Noogoora Burr (*Xanthium occidentale* Bertol.), Spiny Burr Grass (*Cenchrus spp.*) and Horehound (*Marrubium vulgare* L.) to name just a few.

Foxes are probably the most prevalent free ranging animals in the southern part of Australia. Current estimates (Linton Staples, Animal Control Technologies *pers.com.)* are that there would be on average 4-6 foxes km^2 throughout the agricultural lands of New South Wales and Victoria. If we use a density of 4 foxes km^2 and the knowledge that foxes have the ability to travel quickly and search an area of at least a 10km radius, then in that circle there are 1,250 foxes. That means there are a lot of potential transporters of weed seeds.

Seed eaters: Again the fox is implicated in the spread of weed seeds. In a study of the food habits of foxes during the 1970's (Ryan & Croft 1974, Croft & Hone 1978), it was found that at certain times of the year, foxes were predominantly fruit eaters. Many fruits were consumed such as blackberries, watermelons, rock melons, grapes and pome fruit. The seeds of these fruits were easily identified well down the gastro-intestinal tract and regularly found in scats.

Feral pigs are known to eat a range of plants including bulbs, tubers roots, stems, foliage, fruits and seeds (Choquenot *et al.* 1996). The actual extent to which feral pigs eat or disperse seed is unknown but hard seeds have been reported germinating in feral pig faeces. This would indicate that a plant with a relatively hard seed could pass through the intestinal tract undamaged to germinate elsewhere. The home range of feral pigs is approximately 4 to 8 km^2 and would contribute to some dispersal.

Feral horses have a far greater ability to cover large distances than most other pest animal species. In a recent discussion on the management of feral horses (Dr Tony English, Faculty of Veterinary Science, Uni. Of Sydney), it was demonstrated that most weed seeds including blackberry and other hard seeds, avoid the gut fermentation process and will successfully germinate in a pile of manure. In

this instance, the manure provides the optimum medium for germination and shows that horses have the ability to spread weed seeds..

Cultivation and seed beds
In a research trial to gauge the effects of rabbits on pasture it was noted that as rabbit density increased, the proportion of weed species, such as thistles, and bare ground also increased proportionately to the density of rabbits. Rabbits had a substantial effect on pasture composition, reducing the percentage of legumes and increasing the grass and weed components (Croft *et al.*2001). Rabbits have been actively observed scratching for clover burr and other seeds, leaving an ideal, well scarified seed-bed.

Similarly, feral pigs rooting up ground or pasture also create an ideal seed-bed. Not always will weeds colonise this turned soil but as most weeds are prolific seeders, this turned earth is very conducive to wind borne seeds. Choquenot *et al.* (1996) state that feral pigs have been found to carry various organisms and material such as weeds on their hooves and the mud on their skin. To protect themselves from the heat, pigs need to cover themselves with mud, which then acts as a carrier agent and a growth medium.

Manage your pest animals and control some of your weeds
As discussed previously, there are many ways pest animals and weeds interact. Those of us responsible for the control of pest animals and plants tend to be focused singularly and often fail to think that with a little more effort, the control of both problems may be reality. Consider rabbit control. There has been sufficient work done to show that rabbits severely impact on a pasture, on agricultural enterprises and on the environment. Good management dictates that rabbit numbers need to be reduced, that all harbour is destroyed or modified and that some form of vegetative repair commenced to minimise invasion by weed species.

We need to always consider pest management as a whole, never in isolation. It is not good pest management to consider one pest species (plant or animal) without looking at the other existing or potential pests. One example would be the control of woody weeds, blackberry, sweet briar and others, which may provide harbour for feral pigs. We should not attempt the control of either the pigs or the weeds without considering the long-term consequences. It may be that a feral pig problem could be resolved by removing the weeds (harbour) or that by removing the pigs, it may limit the further spread of a potentially invasive weed species.

As a further example, a land manager decides to protect a lambing flock from fox predation just prior to lambing. He may choose to either crisis bait just prior to lambing or opt to use a strategic baiting technique. Crisis baiting is usually done by an individual when there is a threat to an enterprise such as prior to lambing. Strategic baiting is mostly done by groups and would occur in late February to early April (which removes juveniles and breeding pairs) or late August to late September (to remove pregnant vixens prior to whelping). Although a baiting program would be the most cost-effective, den destruction may need to be followed as part of a strategic campaign.

A strategic fox control program may protect the sheep enterprise but may have also removed an important predator of those rabbits present. Without complimentary rabbit control, the rabbit population may explode and create greater areas for thistles to invade. This in return reduces the area of sustainable pasture, which could lead to a reduced stocking rate and subsequent lower returns per hectare from the sheep. Yet, wasn't it the increased productivity of the sheep enterprise that prompted the fox control initially?

It is not always the pests: Although the discussion has been mostly about pest animals, one should not dismiss the other animals such as the native mammals, birds and reptiles. These species may not be pest animals nor able to be controlled but should always be considered as carriers and distributors of seed. It is not uncommon to find scats and pellets (the contents of a bird's crop that is coughed up) containing a myriad of seeds. The discovery of olive seeds in a water trough carried by currawongs should be proof enough that many birds can transport seeds a vast distance.

Quite a number of lizard scats contain seeds from fruiting plants and not always in the area of the consumption. Also, we should not discount hunters; their vehicles, their clothes and their animals such as dogs. How many weeds are moved from place to place in the mud on vehicles and boots, caught in the grill or on the tyres of a vehicle that has been involved in pest animal control?

Conclusion

The control of any pest should never be in isolation. Observation and proper planning will result in good management no matter what the problem. The final outcome of any pest control program should be that there was effective control or removal of the target pest, that there was effective control of the dependent pests and that there was the maximum return for the minimum effort.

In summary, this means that the control techniques used for all pest control must be applied fully and properly with sufficient time for assessment. The process should include:

* proper documentation of the problem
* a plan of the control techniques
* some form of census, population or density assessment
* liaison with all neighbours and other stakeholders surrounding the target area
* conducting the control program
* assessment and documentation of the result of the program, and
* a final assessment of the outcomes.

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BIOLOGICAL CONTROL OF BROAD-LEAFED PASTURE WEEDS (Paterson's curse, *Onopordum* and Nodding thistles)
What have we achieved and where to from here?

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Introduction

CSIRO Entomology initiated biological control projects against the broad-leafed pasture weeds *Echium plantagineum* (Paterson's curse), *Onopordum illyricum* and *O. acanthium* (scotch and illyrian thistle) and *Carduus nutans* (nodding thistles) in the late 1980's. Up until 1996 / 1997 Australian Wool Innovation and Meat and Livestock Australia funded the three projects independently, with the work focusing mostly on the importation, host-specificity testing and initial establishment of agents at a small number of nursery sites. From 1997 / 1998 the three projects were placed under one funding umbrella with a fourth project on the biocontrol of *Cirsium* thistles (run by DNRE, Victoria). The project focuses on the establishment, redistribution and monitoring of agents across temperate Australia, with the main objective being the fast tracking of the delivery of biocontrol to the end user. The project was to broadly follow the structure laid out by Briese (1996), where first insects are released on a regional basis creating a nursery site from which agents may be collected and redistributed to other regions and on a local a scale. The process involves officers from CSIRO Entomology, State departments of Agrieulture, local government and Landcare, who work to engage members of the community in the release and redistribution process, with the aim of handing over the final responsibility for local redistribution to them.

Monitoring of agent performance is carried out parallel to the release process. Monitoring has been developed around a three tiered structure, where level three monitoring provides data on broad scale establishment and initial spread, level two provides data on plant density and attack rate, and level one provides detailed data on the impact of agents on seed production and seed bank dynamics (see Briese *et al*, 1998). Data collected provide information that supports management decisions for the future priorities of the project, as well as providing feed back to everyone from landholders to funding partners on the progress of the project.

Achievements to date

During the life of the broad leaf pasture weed biological control projects, 17 species of agent have been released against the three target weeds (Briese *et al* 2001, Sheppard *et al* 1999, Woodburn 1997, Woodburn & Cullen 1995,Woodburn 1993). Of these 17 species, three agents were established prior to the inception of the redistribution project and were not included in it. They are the Paterson's curse leaf-mining moth (*Dialectica scalariella*), the stem boring weevil (*Phytoecia coerulescens*) and the nodding thistle seed weevil (*Rhinocyllus conicus*). The leaf miner was the first agent to be released on Paterson's curse following the lifting of the high court injunction in 1988 (Delfosse & Moorhouse 1995), this agent quickly became established across the range of its host, and was therefore not considered for redistribution. In the case of the stem borer a post release impact study was carried out which indicated that it would have little impact of Paterson's curse (Smyth & Sheppard 2000). A decision was therefore taken not to redistribute it away from initial sites. Releases of the nodding thistle seed weevil (*R. conicus*) were completed prior to the advent of the current project (Woodburn & Cullen 1995). The seed weevil has dispersed naturally across the range of nodding thistle from a limited number of initial release sites in the three main regions of infestation, the Monaro, Central/Southern and the New England tablelands.

Table 1 lists the 12 agents that the project has focused on since 1997 / 1998. Of these, ten are established in the field, while it is too early to confirm the establishment of the *Onopordum* rosette fly and seed fly. The number of species established is high compared to the average establishment

rate of 60-70% for biocontrol programs globally (Syrett *et al*, 2000). This reflects the value of funding the development of effective release and redistribution strategies.

Two species have failed to establish; the first species of seed fly (*Tephritis postica*) released on *Onopordum* thistles, and a second species of flea beetle (*Longitarsus aeneus*) released on Paterson's curse. Failure of the seed fly to establish has been attributed to the inability of the species to overcome the effects of small initial release numbers or Allee effect (Hopper and Roush, 1993, Grevstad, 1996) associated with releasing a new species. Failure of the flea beetle to establish has been attributed to our inability to resynchronise the species to southern hemisphere seasons.

Table 1. Agents released against the three broad leafed pasture weeds in NSW.

Weed	Agent (Latin name)	Agent (Common name)	Number of releases
Onopordum thistles	*Larinus latus*	Seed weevil	227
	Lixus cardui	Stem borer	549
	Eublemma amoena	Petiole moth**	40
	Trichosirocalus sp. nov.	Crown weevil*	3
	Botanophila spinosa	Rosette fly*	2
	Urophora terebrans	Seed fly*	1
Nodding thistle	*Urophora solstitialis*	Seed Fly	101
	Trichosirocalus horridus	Crown weevil	102
Paterson's curse	*Mogulones larvatus*	Crown weevil**	537
	Mogulones geographicus	Root weevil*	46
	Longitarsus echii	Flea beetle*	12
	Meligethes planiusculus	Pollen beetle*	6

* Agents requiring further regional and local redistribution effort after April 2002.
** Agents requiring only further local redistribution effort after April 2002.

Current status of agents

ONOPORDUM THISTLES

Stem boring weevil and Seed Weevil

With 227 and 549 releases for the *Onopordum* seed weevil (*Larinus latus*) and stem-boring weevil (*Lixus cardui*) respectively since 1992, the redistribution process is considered complete from a professional standpoint. That is, the agents have been released and established on a regional and, subsequently local level across the range of *Onopordum* thistles. Some local redistribution is ongoing with these agents. However, the technology transfer has been successful and the process is now in community hands.

Petiole moth

The first release of the petiole moth (*Eublemma amoena*) was made during 1998; to date 40 releases have been made. At this time it is envisaged that the release process at the regional level will be completed during spring 2001. The future for the process at the local level is unclear for two reasons. The life cycle of the petiole moth does not include a life stage which lends itself readily to field collection for redistribution by community groups. This means that if we want to speed up the delivery process, the insects will need to be reared at CSIRO Entomology for release, rather than being redistributed from nursery sites, as was the case for the seed weevil and stem borer. Current funding comes to an end in April 2002. If funding for an additional period is not forth coming, petiole moth populations will only build up on a local scale through natural dispersal. It will be hard to predict how long this will take as there has been no funding for such basic research.

The Crown weevil

The crown weevil (*Trichosirocalus* sp. nov.) has been released at three sites to date. At this stage none of the nursery sites has a population of a suitable size to allow collection for redistribution. The number of releases of *Trichosirocalus* sp. nov., will only begin to increase rapidly once we have at least one field site to redistribute from. This work will need to be ongoing beyond the life of the current project.

The rosette fly

The two releases of the rosette fly (*Botanophila spinosa*) that have been made to date appear to have failed, although there is still some hope that they have survived but are at too low a density to allow detection. We have reimported the rosette fly, and are currently rearing it for releases planned for winter 2002.

The seed fly

The seed fly (*Urophora terebrans*) was first released during spring 2000. It is too early to determine the establishment of this species.

Nodding thistle

Seed Fly

Releases of the seed fly (*Urophora solstitialis)* were largely completed prior to the advent of the current project, although ad hoc releases are occasionally made when requested.

Crown Weevil

Releases of the crown weevil (*Trichosirocalus horridus*) were completed during the current project. Occasional ad hoc releases are made upon request.

Paterson's curse

Crown weevil

The crown weevil (*Mogulones larvatus*) has now been released across the range of Paterson's curse at the regional level and the extension of this process to the local level is well under way. Effective technology transfer to community collaborators will now be required to complete of the release process at the local level.

Root weevil

The root weevil (*Mogulones geographicus*) has been released across temperate Australia at the regional level. At this stage further work is required to finish the regional process before handing over to community collaborators.

Flea Beetle

The flea beetle (*Longitarsus echii*) has been released across temperate Australia at the regional level. At this stage further work is required to finish the regional process before handing over to community collaborators.

Pollen beetle

Establishment of the pollen beetle (*Meligethes planiusculus*) is still patchy across the range of Paterson's curse. Further rearing, release and redistribution of this species is required.

A glimpse of some monitoring data

Nodding thistle

The release and redistribution phase of the nodding thistle project has come to a conclusion during the past three years. However, the monitoring of the performance of the agents and their host plant has continued. Figure 1 illustrates that the *Carduus* seed bank at Kybeyan has declined from a high of 12,000 seeds/m^2 in 1990 to 370 seeds/m^2 in 2000, a density that is comparable with European seed banks. These seed bank data were collected at Kybeyan last year because we observed continued low plant density through time in the presence of continually bare ground available for germination (i.e. an indication that seeds might be limiting). This year we hope to attract support to measure the seed bank at the other key research sites where we have historical seed bank data, to determine the effect

of the biocontrol agents on the *Carduus* seed bank across all sites on the Monaro, Central/Southern and the New England tablelands.

Figure 2 further supports the hypothesis that seed banks are being depleted across the Monaro and Crookwell tableland areas as a result of biological control. Plant densities have significantly declined since 1998 ($p < 0.05$), while *T. horridus* attacked 60% of plants this year. Figure 3 shows how plant densities varied over 1989 – 1995 compared to the last 4 years 1998 – 2001; these differences are significant ($P < 0.05$, 93.1 plants/m^2- 8.3 plants/m^2).

Figure 1. The *Carduus* soil seed bank at Kybeyan 1988-2000.

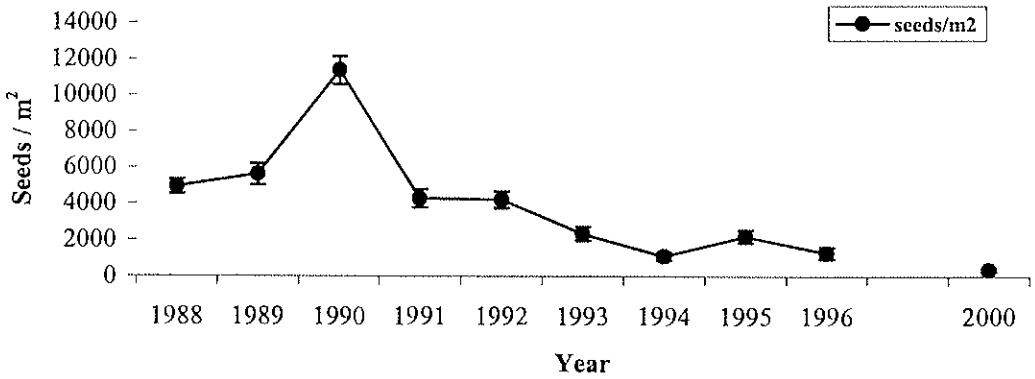


Figure 2. *Carduus nutans* rosettes / m^2 and *Trichosirocalus horridus* attack rate at eight sites, 1998 - 2001.

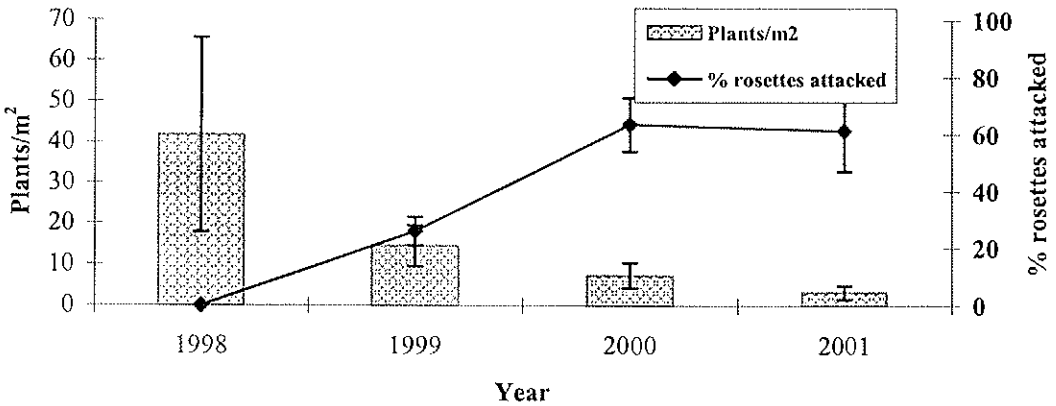
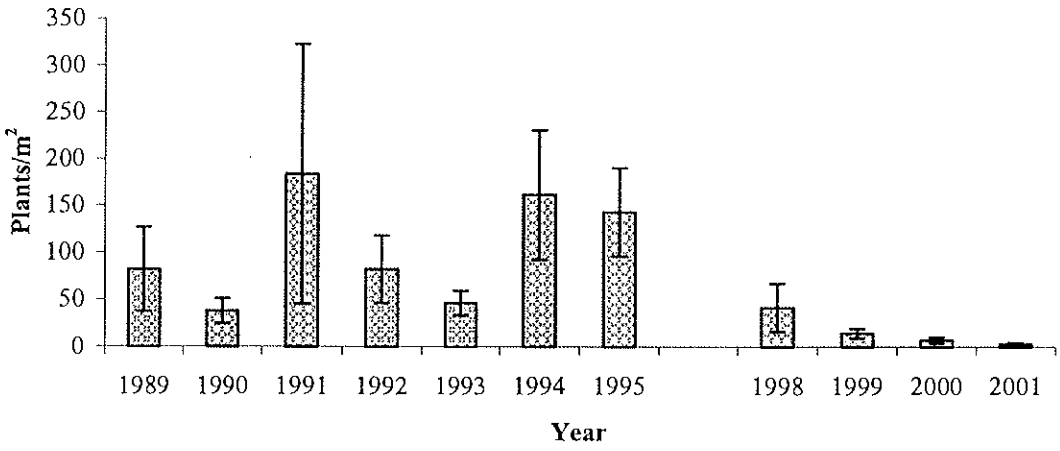


Figure 3. Average plants / m^2 at eight *Carduus* level two monitoring sites, 1989 – 2001.



***Onopordum* thistles**

Level two monitoring of the performance of the *Onopordum* seed weevil indicates that local population densities at older release sites have now reached levels that are significantly suppressing seed production (Figure 4) and that this suppression is increasing with time (Figure 5). If these trends continue a reduction in the soil seed bank will result. Another positive indication of the performance of the seed weevil is that populations are routinely being found at isolated sites tens of kilometres from the nearest release.

Figure 4. The effect of *Larinus latus* on seed rain at level two monitoring sites, 2001.

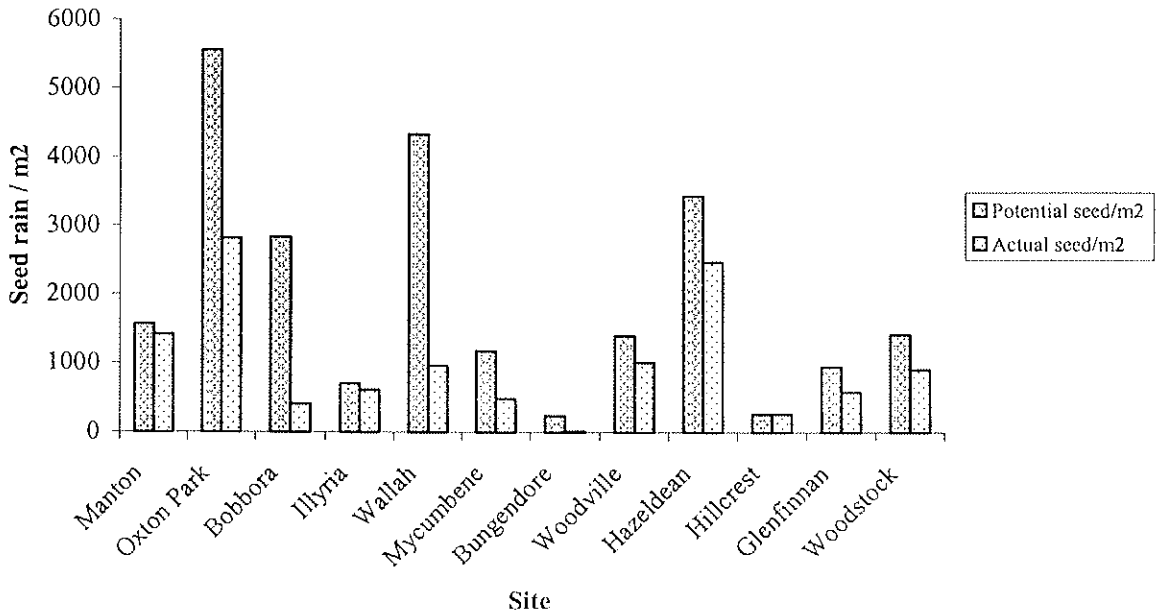
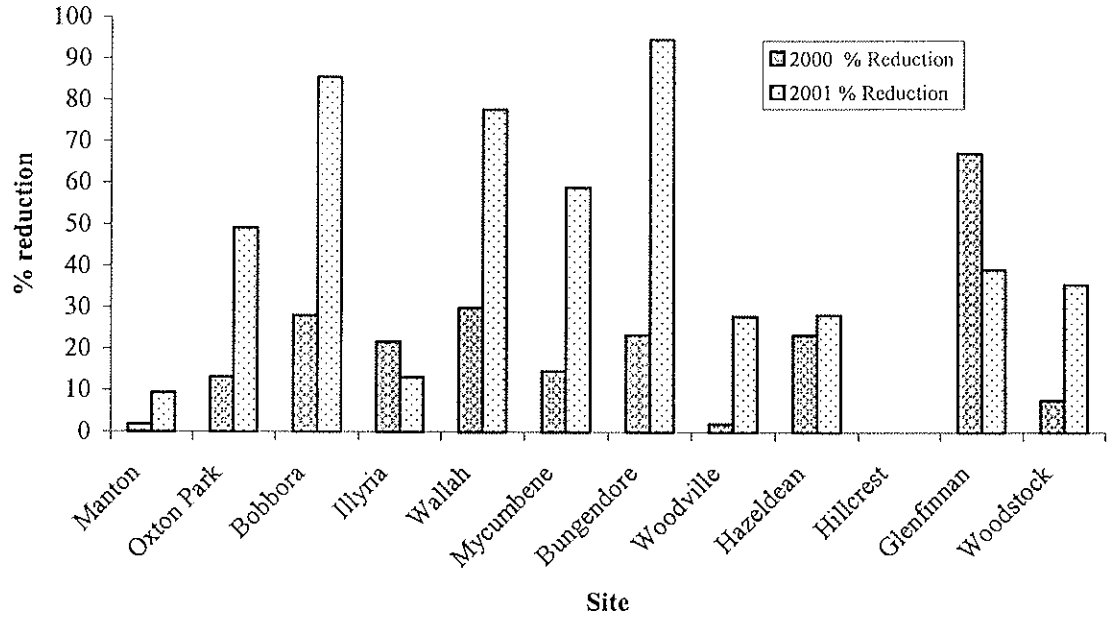


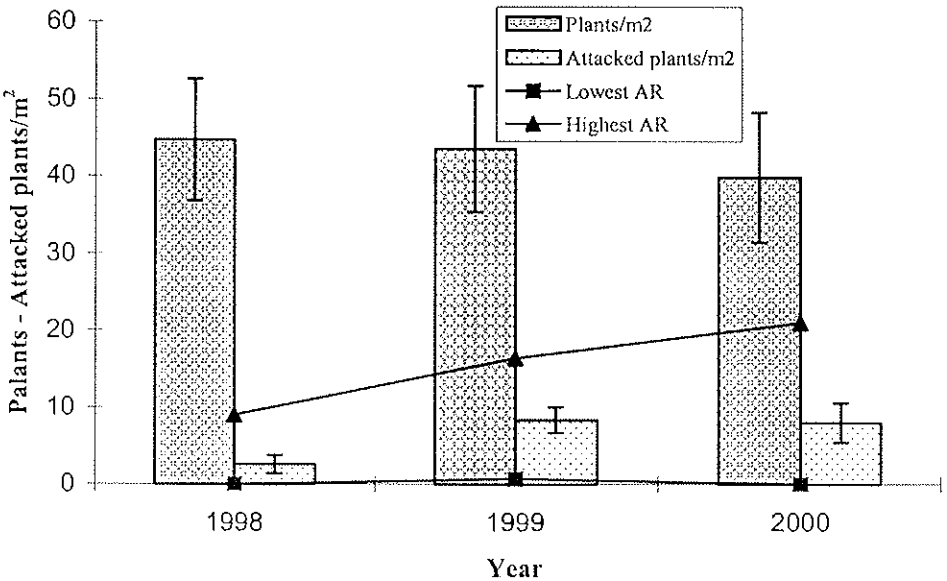
Figure 5. The percentage reduction in seed production caused by *Larinus* at level two sites 2000 and 2001.



Paterson's curse

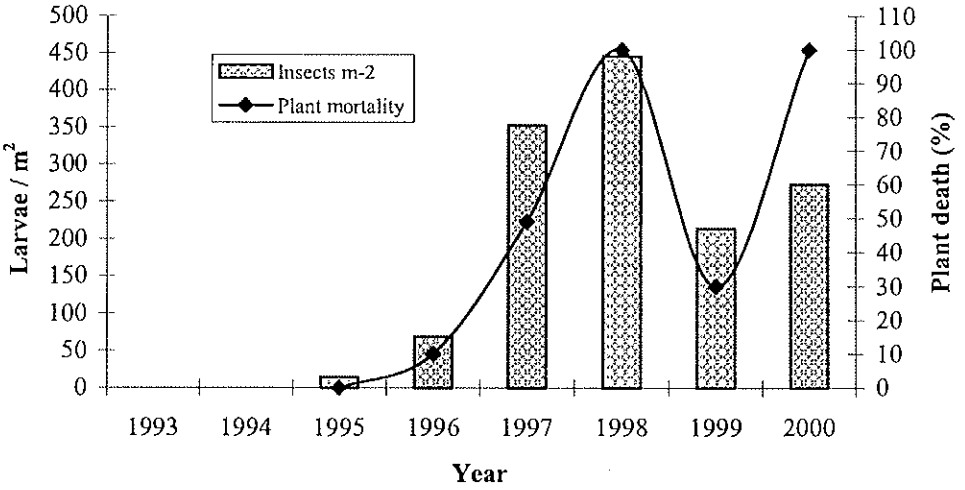
Figure 6 represents the mean plant densities and Paterson's curse crown weevil attack rates from nine level two sites sampled in NSW from 1998 – 2000. Lowest AR (attacked plants/m^2) and highest AR have been included to illustrate the full range of results being achieved at level 2 monitored sites.

Figure 6. Paterson's curse and *M. larvatus* attack / m^2 at nine level two monitoring sites in NSW 1998-2000.



The overall trend is that crown weevil attack rates across NSW are on the increase, although there are still a number of sites where little or no attack is being detected by the monitoring protocol. The weevils have established at these sites with low attack rates and it is anticipated that attack rate will increase with time, to the point where impact is detectable by the monitoring protocol.

Figure 7. Crown weevil population and impact on Paterson's curse, Yanco NSW, 1993-2000 (Ungrazed site).



At a separate monitoring site near Yanco, where the weevils were first released in synchrony with Paterson's curse, the weevils have done remarkably well (Figure 7). Free from the interference of pesticides and grazing the weevil reached densities of over 450 larvae/m^2, killing every rosette of Paterson's curse (at a density of 320 plants/m^2) over several hectares. The results from this site illustrate the potential of this insect in the years to come.

Discussion

Where to from here?

At this stage the current project will conclude at the end of April 2002. There will be a need for ongoing redistribution effort in both the *Onopordum* (four agents, see table 1) and Paterson's curse (four agents, see table 1) sub projects so that the maximum benefit of the full biocontrol suite may be realised across the distribution of the target weeds.

How do we know when we've made enough releases?

The *Onopordum* stem-boring weevil is one of two agents for which the regional and local redistribution process may be considered complete. This decision was reached once requests for releases within the local network groups began to decline. The successful transfer of release protocol technology to the community, which has produced ongoing local redistribution, also supports this decision. In contrast a simple numerical comparison of that release effort versus the release status of the Paterson's curse crown weevil illustrates the amount of work required to achieve complete local redistribution. *Onopordum* thistles infest one million hectares across NSW (Briese *et al* 1990), and 549 releases of the stem borer have been established in 30 local government areas through out this area. Paterson's curse infests 14.7 million hectares in NSW (IAC Report 1985), and to date there have been 189 releases of the crown weevil established (Nordblom *et al*, 2001) in 90 local government areas. In simple terms the stem borer has nine times as many established releases per local government area as the crown weevil. The technology transfer process for the crown weevil lags behind due to there being only a small number of nursery sites from which collection for redistribution is possible. Continued effort on the redistribution of the crown weevil should focus on the speeding up of the technology transfer process to local community groups supported by local government officers and Landcare.

The remaining seven agents (Table 1) that require ongoing release effort have not yet been released and established on a scale that will allow for the continued redistribution to be taken on by local collaborators. In the case of the three Paterson's curse agents the technology and rearing facilities are in place to provide a complete regional release network over the next three to five years. The four

Onopordum agents requiring ongoing release work are not in such an advanced state as the Paterson's curse agents, as there is still technical detail surrounding the release protocols to be finalised in coming seasons before regional redistribution can begin.

Conclusions

This project has provided a benchmark for the delivery of biocontrol in Australia. We are on the verge of success in the control of nodding thistle, have achieved significant impact on the seed production of *Onopordum* thistles and are witnessing population increases in Paterson's curse agents across a broad scale. Despite this, future funding for the project is in doubt, even though a recent economic analysis (Nordblom *et al*, 2001) has demonstrated that investment in the speeding up of biocontrol delivery has a high benefit-cost ratio and substantially increases the economic returns of biocontrol.

ACKNOWLEDGMENTS

The Authors would like to thank Australian Wool Innovation, Meat and Livestock Australia and the CRC for Weed Management systems for their funding support of this project. We would also like to acknowledge the contributions of the officers from the biocontrol unit, NSW Agriculture and the many local government and Landcare officers who have made the coordination of the release process at the local level possible.

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CABOMBA MANAGEMENT OPTIONS

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Introduction

Australia is a dry country, its water resources are limited and precious.
Cabomba *Cabomba caroliniana,* (family Cabombaceae), is a Central American submerged water plant, which was introduced into Australia by the pet industry as early as 1930.
At present there are no effective long-term management options for cabomba. A special case needs to be made for elevating the importance of submerged pest plants such as cabomba based on:

- the value of water as a precious resource,
- the serious problems cabomba causes,
- and the lack of any practical control methods.

In recent years cabomba has attained 'weed of national significance' status. Infestations range from Victoria in the south to Papua New Guinea in the north. Its potential for spread is enormous as it can tolerate cold as well as tropical conditions. The problems caused by cabomba are:-

- Degradation of potable water quality,
- Destruction of conservation/wildlife values,
- Serious public safety risk,
- Economic burden on the general community.

This paper outlines cabomba identification, growth requirements, management options and a case study.

Identification

From a distance, the flowers are seen as a white patch on the water. Closer inspection reveals that it has white flowers with 6 petals, held just above the water surface. Stems and leaves are covered in epiphytic algae and mud. Stems are red or green and can reach a length of 11m. Leaves have a distinct petiole and the overall shape resembles a flat fan made up of some 200 finely divided sections. Each plant has a single growing point raised 30 cm above the substrate. From here, fine roots descend into the mud and 3-90 reddish stems (2-6 mm thick) rise to the surface. Under water, the plant forms an erect flexible bundle of strong stems capable of entangling a diver. Key features are white flowers, opposite leaf insertion plus a leaf petiole and being slimy to the touch. Apparently Australian cabomba is sterile, as no evidence of viable seed has been found yet. Propagation is vegetative being mainly by stem tips. There are no rhizomes or regenerative root structures.
Depending on water quality, cabomba grows at depths of 0.5-5 m. It is at home in fast flowing or still waters, dams, rivers, swamps and drains.
It quickly forms a monoculture. Standing crops of 110 t/ha have been recorded. Best growth occurs in slightly eutrophic water (nitrogen 0.5-1.2 ppm, phosphorus 0.02-0.06 ppm, pH 5 - 8, highly coloured 50 true colour units, low hardness and low alkalinity). It tolerates high turbidity and prefers high organic substrates. Optimum water temperature is 20-30°C. Plants over winter when temperatures get below 15°C by laying on the bottom. In windy conditions continued wave action will suppress growth.

Management options.

Drawdown or the deliberate lowering of water levels is a management tool widely used in the USA. Man made dams and weirs often have stable water levels that stay nearly full for long periods. Many

exotic water plants thrive in stable impoundments. By reducing water levels between 1-3 m and allowing the exposed banks to dry out, cabomba is adversely affected.
In an integrated pest management strategy, drawdown is a very useful method of killing exotic species growing in shallow areas. It also reduces the area of infestation needing further treatment. Understandably, in a dry country, water engineers resist using drawdown, preferring to keep dams full to the brim.

Chemical control
Cabomba is a difficult plant to control using chemicals. Screening trials conducted by the Alan Fletcher Research Station revealed only a few compounds effective against cabomba and 2,4-D ester gave the best results.
A mucilage film that prevents chemical penetration protects the plant. Public concern about the use of chemicals, especially in water storages and densely populated areas means any chemical program would be subject to controversy and in my opinion just plain foolish.

Classical biological control
Biological control involves reuniting the plant with its natural enemies. In cabomba's case, the plant has been spread as an aquarium specimen and its pathogens and insect fauna have been left behind in its country of origin. Other South American water plants have been controlled using biological agents, for example alligator weed, salvinia and water hyacinth. Other submerged plants eg hydrilla and Eurasian milfoil have also been controlled by insect enemies. Introducing natural enemies is a long term solution and one can only hope that CSIRO or DNR&M is funded to carry out a cabomba program in the near future.
All of the public groups with which the author works see biological control of cabomba as an important management goal.

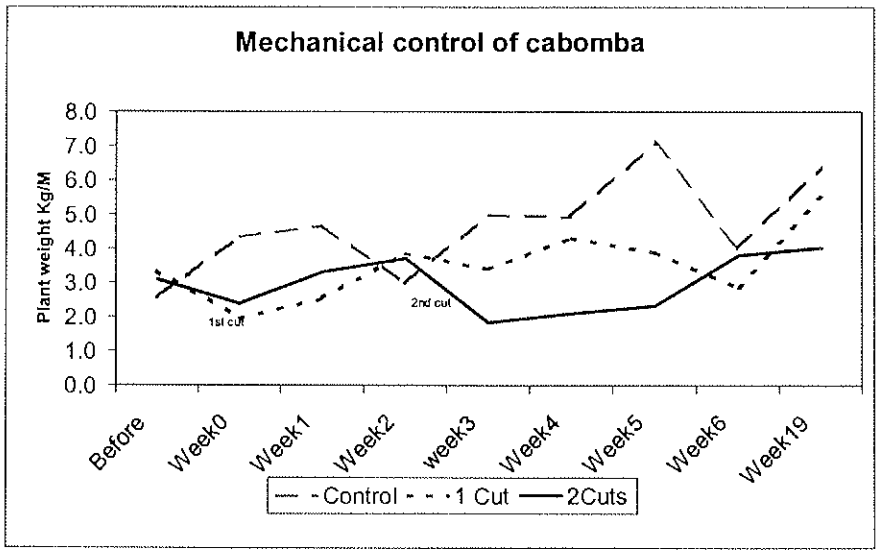
Scuba Diving
Cabomba can be effectively removed by hand using professional divers. Cabomba can be grabbed by the stem and pulled out entirely. Removal by diver would be applicable to small infestations or as a window dressing operation. It is extremely expensive and very dangerous. There are two laws controlling diving in the work place: Code of practice for recreational Diving at a Workplace, and Code of practice for Recreational Snorkelling at a Workplace.

Mechanical control
This approach is in its infancy in Australia. But as public opposition to chemical control increases, plus the recreational demands on waterways and public safety responsibilities placed on water managers, mechanical removal will become common in the future. The appeal of mechanical removal is that the results are immediate, instant clearing of the weed giving water managers complete control. Another important consideration in polluted waters is the removal of nutrients from the system.

Case study of mechanical control
In 1999 the Lake Macdonald Catchment Care Group carried out a pilot study into mechanical control using a model HV2600 harvester supplied by Aquatic Weed Harvester Pty Ltd .
Before cutting, the cabomba standing crop averaged 47 t/ha. The machine operated at a cutting depth of 0.8 m and removed about 13 t /ha.
The harvested cabomba was loaded directly into a compactor truck. This procedure is a big step forward in secure and safe transport of a pest plant.

The results are summarised in figure 1. Each value is the average of 9 samples gathered from three subsites at each of three replications. Plant weights kg. per square metre are shown in figure 1, To convert these to tonnes per hectare they can be multiplied by ten. Mechanical removal started on the 19th October for the single cut and was repeated on the 8th November for the second cut of the 2 cut treatment. Observations taken on the 1st March are 19 weeks after the first cut.

Figure 1. The effect of mechanical harvesting on cabomba biomass.



The solid line in Figure 1. represents a cut twice treatment which shows that the cabomba infestation took a long time to recover after the second cut.

Native plants

Plant samples have been routinely gathered from Lake Macdonald for the last 6 years. In that time no native submerged plant has been observed. There once was an underwater plant community of hydrilla, najas, potamogetons, bladderworts and stoneworts. Towards the end of this study, 2 hydrilla plants were brought up in the diver's samples. These plants were in the cut twice areas, which is very encouraging.

Pollution abatement

During the 19 days of mechanical control, 360 tonnes of cabomba were removed.
Water plants have the ability to soak up pollutants. In this study 1,500 kg of nitrogen, 122 kg phosphorus, 380 kg manganese, 1360 kg iron, 9.4 g mercury, 216 g lead and 33.8 g cadmium were removed from the water.
Cabomba has an epiphytic growth of algae and bacteria plus silt covering its surface. The plant is not affected or harmed by this muck; it may even be some sort of synergistic relationship. The high mineral content in the harvested cabomba may be due to this epiphyte load.

The Lake Macdonald Catchment Care Group's pilot study indicated that:

- Cabomba can be effectively controlled using mechanical means.
- Results showed that cabomba is sensitive to repeated cuttings.
- A native plant species, *Hydrilla verticillata*, appeared in the second cut areas after a six year absence.
- Aesthetic improvements to the dam after cutting brought about favourable community comments.
- Public safety issues were addressed by mechanical removal of the weed.
- Significant amounts of nutrients and heavy metals were removed from the cut areas.

- Wind speeds above 25knots interfered with the machine's operation.
- Transport and weed disposal regulations were complied with by using a garbage compactor truck.
- Wind and dirty water inflows had a detrimental effect on cabomba growth.
- Water clarity improved after mechanical control.
- Wave height increased in the cut areas, which increased dissolved oxygen levels.

The Lake Macdonald Catchment Care Group had evaluated all available cabomba management methods. Drawdown was trialed and was unsuccessful. Herbicides were not an option in this potable water storage. Biological control was the Group's favoured approach but was beyond their resources and is not their role. Mechanical control was the only appropriate method of managing cabomba in this case.

Mechanical control while suitable for Lake Macdonald is not applicable to many water situations.

The weed industry needs to re-evaluate the value of the country's waterways, elevate cabomba as a serious weed and support long term control initiatives, especially biological control.

Acknowledgments
I thank members of the Lake Macdonald Catchment Care Group for their support and direction. I am grateful for the assistance received from Dr B Palmer in preparing this paper.

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ALLIGATOR WEED: TASTEY VEGETABLE IS NASTY WEED

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INTRODUCTION

Alligator weed is originates from the Parana River region of South America (Maddox 1968). It is a member of the dicotyledon family Amaranthaceae. Alligator weed is a perennial an emergent semi aquatic species. But it has the ability to grow in both aquatic and terrestrial habitats and in conservation and agricultural systems of tropical, subtropical and temperate regions.

Alligator weed is a problem weed in 10 crops in 30 countries, a serious or principal weed in eight of these countries and a major weed in others. The range of impacts that alligator weed can have effects the community in a number of ways. As an aquatic plant, it produces large mats of stem and leaves, which are anchored by roots to the bank and extend across the water. So weed disrupts the aquatic ecology by forming a blanket over the surface of water. It interferes with waterways, drainage, displaces native species, boat traffic, water quality and effects flow and sedimentation rates (Julien 1999). In terrestrial, it forms large leafy materials and dense mats of lignified root materials under the soil. Alligator weed is highly competitive with other plants and displaces pasture and other plant species (Julian and Bourne 1988).

Alligator weed initially introduced into Australia near New Castle, New South Wales when ship ballast was dumped in 1946 (Hockley 1974). It has since become established in rivers and their tributaries and on flood plans in NSW. Alligator weed is a declared a noxious weed in all Australian states and territories and prohibited weed in Victoria and Tasmania. Under the Victorian Catchments and Land Protection Act (1994), the species has been targeted for eradication. The importance of alligator weed in Australia is reflected in its listing among the 20 Weeds of National Significance nominated by the commonwealth government (Thrope 1999).

In December 1995, alligator weed was found in the vegetable garden of a neighbor by one of the weed scientist in Queensland, Australia. Follow up work over the next five years by the state weed authorities has led to the discovery of cultivated plots of alligator weed growing all Australian states and territories. The weed was being grown as a leafy vegetable by the Sri Lankan community mistakenly believing it to be the popular leafy vegetable Mukunuwenna or Sessile Joy Weed, very popular leafy vegetable in Sri Lanka (Gunasekera and Rajapakse 1998). The similarities between the highly invasive alligator weed and the traditional Asian vegetable Mukunuwenna have resulted in a case of mistaken identity with the weed being grown as a vegetable. The Department of Natural Resources & Environment in Victoria developed an innovative partnership with Victoria's Sri Lankan community in order to eradicate, control and prevent re-infestation of alligator weed. The project also looked at to identify and introduce an alternative vegetable plant for alligator weed.

PROCEDURES

An alligator weed weed task force was established in 1996 to initiate, plan, manage and coordinate and monitor the progress of the program to eradicate alligator weed from Victoria. The main priorities of the plan were to identify the problem, raise public awareness and develop a management plan to eradicate the weed.

Weed distribution

The first stage of the program was to survey the distribution of alligator weed in Victoria. In 1996, an alligator weeed identification leaflet was produced and distributed amongst Sri Lankans visiting Buddhist temples, Sri Lankan groceries and local libraries. Sri Lankan names were identified from Victoria telephone directories and nearly 4000 people were surveyed about whether the weed was

grown on their property. Discussion with community groups in establishing community-council partnership in weed management also helped to collect further information on the distribution of alligator weed in Victoria.

Awareness

A public awareness program was important part of the project. Alligator weed was new story for Victorians because they hadn't seen this before. Thus the distribution of five different leaflets, a bookmark and a fridgemagnet, 100 articles in newspapers, newsletters, magazines and journal, six TV segments, ten radio programs and seven information workshops helped to created the necessary public awareness and collect further information.

Management

An alligator weed control program started in December 1997. All identified infestations were prioritized according to the risk of naturalization using proximity to waterways, size of the infestation and land situation as risk factors.

There is no registered herbicide to control alligator weed in terrestrial in Victoria. Thus following herbicides were used as an experimental basis in backyards, with the consent and knowledge of property owners

Roundup (glyphosate)
Casaron (dichlobenil)
Brushoff (metsulfuron methyl)

Herbicides were applied as a spot- spray using a 5L knap sack sprayer. The herbicide used depended on the type plants associated with alligator weed in home gardens situation. Mainly dichlobenil at 60kg/ha^{-1} was used the 1998/1999 and 1999/2000 summer, as it was successful during 1997/1998. All naturalized sites associated with water were treated with roundup bioactive at the rate of 9L/ha^{-1} in 2 monthly intervals for three times.

Alternative vegetable

Providing a replacement vegetable was the key to public participation in the eradication program. One of the Australian native species, common joy weed (*Alternanthera denticulate*) was selected, tested for nutritional value and distributed to Sri Lankan families for trial as a suitable replacement. There were two forms (larger and small leaf) of this species. Both forms were evaluated as replacement vegetable for alligator weed. To encourage the adoption of the alternative vegetable, more than 5000 seedlings were distributed to Sri Lankan families throughout the state and an Asian vegetable grower was supplied with 3000 seedlings (large leaf form) to develop the vegetable commercially.

RESULTS AND DISCUSSION

The mail survey was successful. Nearly 50% of those who surveyed responded and more than 300 backyard infestations of alligator weed were discovered within four months of the campaign start. All properties with alligator weed were visited to develop control options. As results of public awareness campaign, an additional 484 alligator weed infestations have been located including 15 naturalized sites in 130 suburbs of Melbourne by June 2000. Infestations continue to be reported although at a much reduced rate that at the beginning of the program. Majority (98%) of the backyard infestations were associated with Sri Lankan families.

The control program treated 784 sites including all fifteen naturalized alligator weed infestations with herbicides from 1997 - 2000. Naturalized sites in waterways were treated with roundup bioactive. Rrgrowth was occurred in some places but repeated treatments helped to suppress the weed successfully.

Year	No. of treated sites
1997/1998	225
1998/1999	207
1999/2000	337
2000/2001	15

All previously treated sites were closely monitored throughout the program signs of regrowth. Sites treated with casoron at 60kg/ha^{-1} rate provided satisfactory control of alligator weed with very limited non-target impact on garden ornamentals or fruit trees. Metsulfuron methyl and mixture of metsulfuron methyl and glyphosate showed good results in backyard situation but non-target damage and persistence in soil occurred with the use of metsulfuron methyl. Most people wanted to grow other vegetables in their gardens soon after treatment, thus reducing the suitability of these herbicides.

The introduction of replacement vegetable species for alligator weed has been important to participation in the control program. The Sri Lankan community accepts both forms of common joy weed. The larger leaf form is more popular than smaller leaf form because it has higher growth rate, leaf size, leaf yield, better taste and easy to grow. Joy weed has proven extremely successful as a replacement. More than 5000 seedlings have been given out through Buddhist temples, personal contacts, information centers and Sri Lankan grocery shops.

Commercial grower supplied about 2700 cut bunches per month and was sold by twenty-five shops around Melbourne during 1998/1999 summer. But his sales were fallen down in 1999/2000 (400 bunches/month) and 2000/2001 (100 bunches/month) summers, as most of the Sri Lankans established the vegetable in their home garden and started to distribute among their friends and relatives since it's introduction.

Supply of new seedling will be continued (about 500 seedlings) in next summer 2001/2002. Public awareness campaign, monitoring and control program also in progress. Importantly the majority of Sri Lankans in Victoria can now recognize the difference between their real vegetable plants. This is extremely good as it means the risk of reinfestation is much lower.

The program demonstrates that preventive management can be undertaken with active community involvement and support. Participation in the eradication program by Sri Lankan community was high because accessible information on the problem was broadly distributed, because the program had the support of religious and community groups, and the trust developed between government and community, which enabled an accurate assessment of the problem. This is good example for community-government partnership to control noxious weed.

ACKNOWLEDGMENTS

The author's wishes to express appreciation for the financial assistance provided by the Victorian Weeds Initiative program of the Department of Natural Resources & Environment, Agriculture Victoria. The friendly support and kind assistance given by David McKenzie, Patrick Pigott, Eligo Bruzzese, Ian Faitfull and Janaka Wijewardena of Department of Natural Resources and Environment in Victoria is also gratefully acknowledged.

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WILLOW MANAGEMENT The Identification of Willow Species Which Willows need to be removed

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INTRODUCTION

In relation to other weed species, it is only comparatively recently that willows, *Salix spp,* widely planted throughout temperate Australia, have been recognised for their weed potential. Some particular willow species reproducing either by sexual or asexual means are now acknowledged as being highly invasive when growing in or near favourable environments. The resulting populations can rapidly dominate riparian vegetation often with irreversible ecological consequences, changes to stream morphology, aesthetics, amenity values, water quality and hydrology.

Observations and analysis of such invasive willow populations have confirmed the threat that they pose to the overall health of riparian systems. This, along with the threats posed to infrastructure, has led to state and territory legislative controls being introduced to curb their spread. At the national level, willows have been included as one of the twenty Weeds of National Significance resulting in the development of a National Willow Strategy.

The scale of the problem confronting land and river managers is such that there is now a need for a strategic approach to willow management at the local and regional level, preferably on a hydrological catchment or subcatchment basis. An inherent part of this strategic approach is the prioritisation of willow management actions to most effectively use available funding. There are currently a number of examples of large scale willow management programs that are moving towards successful completion.

IDENTIFICATION OF WILLOW SPECIES

There are approximately 32 willow taxa naturalised in Australia and although some of these are benign, nearly all have invasive capability either individually or when hybridising with other species. Willows belong to either the subgenus *Salix*, which are trees, or *Vetrix*, which are shrubs. There is negligible interbreeding between tree and shrub willows and virtually all willow trees or shrubs are present as either male or female. Accurate identification of willow species and their gender is only possible during spring when the flowers emerge briefly over a 2 - 3 week period and before the catkins brown off and fall. Various species flower at different times with hybridisation and seed production possible between species with overlapping flowering times. Trees vary from single to multi-stemmed forms with all shrub willows developing with age into a multi-stemmed cluster.

Willows are able to propogate both vegetatively and by seed. The vast majority of willows spreading in Australia are from a number of brittle species by vegetative means. This occurs where propogules such as twigs or branches detach and relocate in a suitable environment. This dispersal is generally downstream.

The most rapid form of willow spread however and that of most concern, is by seedling establishment from parents with compatible flowering times. Seed dispersal is by water or wind and

can be possibly up to 100kms in any direction. However the prevailing winds at seed shed time are a large influence.
Detailed examination of the flowers, leaves, bark and form are the best guide to true identification of a willow. This may need a hand lense and reference to identification literature, such as *Willow Identification for River Management in Australia, 1995 by KW Cremer.*

Attempting to give a comprehensive identification guide is not the aim of this paper, rather to highlight the fact there are many different willow species and their hybrid offspring now present in our riparian systems. However, a few of the most invasive species and how to identify them are outlined below:

Salix fragilis, var. fragilis, crack willow is the most widespread willow in Australia. It is present as a late flowering male tree that is very brittle and is also implicated in seed production with late flowering female trees such as *Salix alba, var. vittelina,* golden upright willow. Crack willow is usually in a multi-stemmed form with an upright crown. All brittle species such as *Salix fragilis* and it's hybrid offspring can easily be determined by attempting to break off a finger thickness branch which will detach easily with a cracking sound.

Salix nigra, black willow was imported to Australia in the 1960s as seed and is present as male and female trees. Seed production within the species is prolific however very little evidence exists of hybridisation with other species. It is a very late flowering species. Identification is relatively easy as the tree has a single stem and an upright form, the bark is roughly fissured to the top of the trunks. Both male and female flowers are very long and the leaves are even coloured on both sides. This tree species is of great concern as it is spreading rapidly in favourable areas.

Salix cinerea, grey sallow or pussy willow is a shrub willow that is widespread in Australia and considered to be the most invasive willow species. It has readily invaded wetlands and swamps and moist subalpine areas by seed production and establishment and is not restricted to riparian zones. The most noticeable identifying features are the small ridges on the stem and trunk and the spreading crown from an early age. The leaves are broad with irregular margins and hairy underneath.

WHICH WILLOWS NEED TO BE REMOVED

A strategic approach is needed when planning a successful willow management program. The key is to focus on the outcome, which in most cases is a riparian vegetation community with a non invasive willow population. To achieve this, all willows causing or likely to cause problems should be removed. These are usually the invasive species but can also include benign willows threatening infrastructure or diverting flows.

The most successful approach to date is to implement a control program commencing at the top of the catchment and working downstream. This may take a number of years on major projects and may require a number of backup control sweeps especially in seeding and difficult control situations.

To implement a strategic approach, there are 2 important steps. Firstly, a survey to determine the nature an extent of the willow population is needed. This gives baseline data on numbers, species, sex and possible infrastructure at risk. This survey does not need to be too detailed but is vital to the planning of the control phase and can be used for estimating financial needs, environmental assessments and approval processes.

Secondly, the control phase can be implemented using the top down approach with a trained and competent control team. Willow control techniques are now well understood with a very high success rate and minimal backup needed. Costs vary from a few hundred dollars per kilometre to a hundred thousand per kilometre where full removal is needed. Revegetation can commence during the willow control phase if needed.

USING GLYPHOSATE FOR SERRATED TUSSOCK (*Nassella trichotoma*) MANAGEMENT IN SOUTHERN TABLELANDS OF NEW SOUTH WALES

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Introduction

Since its introduction in 1978 flupropanate (Frenock®) has been the major herbicide used in the fight against serrated tussock. When it was removed from sale in Australia in October 1998 land managers were left with no viable herbicide option to manage serrated tussock. In response research efforts were renewed to find a replacement herbicide. While glyphosate products have been shown to be effective, results were often variable, with effective rates of application ranging from 2 to 15L/ha (360g a.i.)(Campbell, Miller & Michalk 1999).

In October 2000 flupropanate became available again under a number of registered names. Monsanto have registered Roundup Max® and Roundup Biactive® for serrated tussock control. Also since 1998 extensive experiments have been conducted on a range of glyphosate products, rates and spray adjuvants in order to gain more data on the efficacy of glyphosate on serrated tussock. These experiments were conducted over a number of seasons and sites on the Monaro and southern tablelands of New South Wales. This paper summarises this study and highlights the situations in which glyphosate can be used most effectively for serrated tussock management.

MATERIAL AND METHODS

Herbicides were applied with a 2 or 3 metre hand held boom. Water volume per hectare ranged from 100–108L/ha. Plots were 10 meters long, arranged in randomised complete blocks of 3 replicates. An unsprayed control and Frenock® (2L/ha) treatments were included in all experiments. Efficacy of treatments was assessed 12 months after herbicide application. Percent control for each treatment is the average across three replications at each site. The effect of herbicide on background pasture was also assessed. This was achieved by recording every species within a $0.1m^2$ quadrat at twenty random locations in each plot in the spring following herbicide application. Results are expressed as number of quadrats with species present out of the total 20 quadrats (% occurrence).

Apart from the burnt experimental site at Michelago herbicide was applied to heavy infestations (> 50% ground cover) of mature serrated tussock.

Experiment 1: Spring 1998 – Sites at Bredbo, Yass and Michelago. At Michelago treatments were imposed on a) serrated tussock that was burnt approximately eight weeks prior to spraying and b) where the serrated tussock was not burnt.

Aim: To evaluate a number of rates and glyphosate formulations for serrated tussock control (Roundup Biactive® @ 4, 6, 8, 10, 15 L/ha, Touch Broadacre Herbicide® @ 3.5, 5.2, 7, 8.7, 13.5 L/ha and Roundup CT Xtra® + 0.2%v/v Wetter TX® @ 2.9, 4.4, 5.8, 7.3 & 11L/ha).

Experiment 2: Spring 1998 – Sites at Bredbo, Yass and Michelago. At Michelago treatments were imposed on a) serrated tussock that was burnt approximately eight weeks prior to spraying and b) where the serrated tussock was not burnt.

Aim: To evaluate addition of a number of spray adjuvants to Roundup CT Xtra® for serrated tussock control. (Roundup CT Extra® @ 2, 3, 4, & 5 L/ha with addition of 0.2% v/v Wetter TX®, 1% v/v Hasten® or 1% v/v SprayPlus® at each rate. One rate of Roundup Biactive® at 6L/ha).

Experiment 3: Autumn 1999 – Sites at Bredbo, Yass, Maffra and Michelago. At Michelago treatments were imposed on a) serrated tussock that was burnt approximately eight weeks prior to spraying and b) where the serrated tussock was not burnt.

Aim: To evaluate the addition of a number of spray adjuvants to the low rates and autumn application timing of Roundup CT Xtra® for serrated tussock control (Roundup CT Xtra® @ 1, 1.5, 2, 3, 4, 5, & 10L/ha with addition of 0.2% v/v Wetter TX®, 1% v/v Hasten® or 1 % v/v SprayPlus® at rates of 1, 1.5 and 2L/ha; - 3, 4, 5, & 10L/ha applied with 0.2% v/v Wetter TX® only).

Results

Experiment 1: All treatments gave excellent control (>98%) where serrated tussock had not been burnt prior to herbicide application, except at Bredbo where 4 and 6L/ha Roundup Biactive® gave 92% and 96% control respectively. Regardless of herbicide rate or formulation there were a few plants with regrowth after 12 months. Generally these were smaller plants that were shielded by larger plants at the time of herbicide application. Where serrated tussock had been burnt prior to herbicide application control was still very good for all treatments (> 90%) however here there where a number of plants in each plot that were regrowing after twelve months, irrespective of the glyphosate formulation or rate of application. The probable conclusion being that the serrated tussock did not have sufficient time to recover after the burning to fully translocate the herbicide. At this site there was no advantage to burning the serrated tussock prior to herbicide application.

Experiment 2: All treatments gave 100% control where serrated tussock had not been burnt prior to herbicide application. However where serrated tussock had been burnt prior to herbicide application, all treatments gave over 95% control except for Roundup Biactive® at 6L/ha which gave 92% control. Reduced control on the burnt serrated tussock was similar to results for experiment one and as stated above there was no advantage to burning the serrated tussock prior to spraying.

Experiment 3: As application rates dropped below 2L/ha of Roundup CT Extra® regardless of spray adjuvant added, control of serrated tussock declined. At 1 and 1.5L/ha, with all additive combinations, an average of 73% and 89% control respectively was achieved over all sites. At 2L/ha control improved to give comparable results to the spring application (Experiment 1) at Yass (97%), Bredbo (99%) and Michelago sites (97% unburnt and 94% burnt). However at Maffra 2L/ha only achieved 80% control, at 3L/ha control increased to 97%. A possible explanation for this decline in efficacy could be attributed to the highly fertile basalt soil at the Maffra site. Campbell (2001) also found that serrated tussock was more difficult to kill on fertile soils. At all experimental sites the lower rates of Roundup CT Xtra® prevented the serrated tussock from seeding the following spring.

Time of Application and it's Effect on Pasture Composition

The results of this study have shown that glyphosate was very effective at killing heavy infestations of serrated tussock at relatively low rates in both spring and autumn. The most striking difference between autumn and spring application and even the timing of each of these applications, was the effect glyphosate had on background pasture species. The non-selective nature of glyphosate presents limitations on its use in managing serrated tussock, being best suited for total vegetation control pre-sowing or for spot spraying isolated plants. However this study has shown that many

useful pasture species can be retained when using glyphosate for serrated tussock control, by carefully timing glyphosate application. Glyphosate applied in an annual pasture situation after the annual species have set seed in late spring and before they emerge in autumn, will have no effect on these species. Likewise damage to perennial species such as phalaris may be minimised by applying glyphosate when they are dormant in summer or with some native species, when they are frosted in winter.

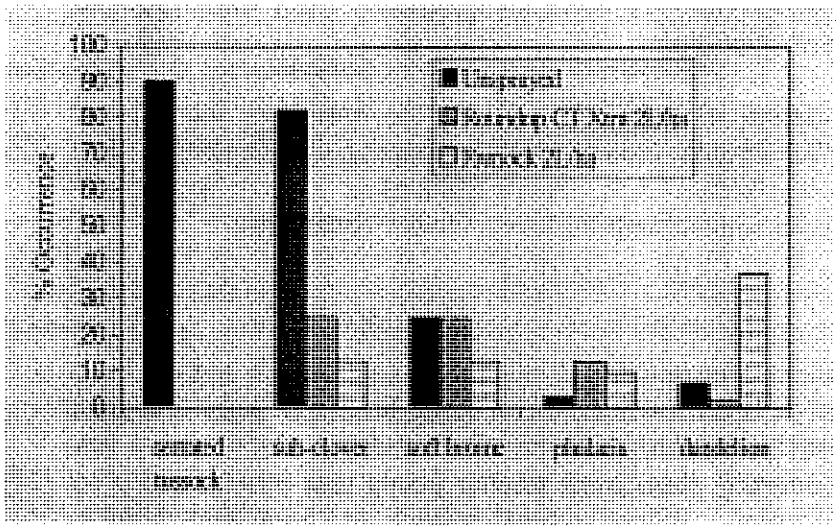

Figure 1. Percent occurrence of pasture species at Yass 6 months after herbicide application (April 1999).

For example at the Yass site, pasture species were not disadvantaged by using glyphosate when compared to the then standard treatment of Frenock® (Figure 1). Note the equivalent levels of serrated tussock control with both treatments. Subterranean clover had already germinated at the time of spraying which accounts for it's reduced occurrence in the sprayed plots. If spraying had occurred earlier this damage may have been avoided. At the rates used at this site a saving of approximately $56.00/ha in herbicide cost could be achieved by using glyphosate instead of flupropanate. It should be noted that neither herbicide would be adequate in preventing considerable reinfestation of serrated tussock because of the low occurrence of competitive perennial species at this site.

Glyphosate is becoming more and more popular as an alternative herbicide for spot spraying or as a total knockdown herbicide in preparation for winter cereals or pasture. On the Monaro some landholders that have previously used recommended flupropanate rates broadacre in the spring, have found the residual is detrimental to the establishment and growth of winter cereals sown in February and March. Pasture legumes and grasses are also effected by the flupropanate residual if inadequate rainfall has fallen between the time of spraying and the time of sowing. Producers are encouraged to plan ahead and select the most appropriate herbicide for the situation. They are also being encouraged to use all weed management tools available and not to rely on a herbicide only option.

The use of a herbicide only strategy for serrated tussock control will in the long term be unsuccessful, since without competition from pasture, serrated tussock will re-infest. It is preferable that herbicides are used in conjunction with establishing and maintaining a perennial grass based pasture to prevent reinvasion of serrated tussock.

However where the cost of establishing a pasture is beyond economic reach, a well timed application of glyphosate may enable some level of pasture production as well as controlling serrated tussock in the short term. The authors are currently conducting further experiments to evaluate these options. Campbell and Nicol (2001) provide further information regarding the use of glypohosate for serrated tussock control.

Take home messages

- Glyphosate is effective at killing serrated tussock in spotting and boom spray situations.

- Associated useful pasture species can be retained when using glyphosate for serrated tussock control. However landholders considering this option need to develop a good understanding of the growth cycles of the species present including both target and background plants to time the glyphosate application for maximum efficacy while minimising the effect on desirable species.

- Glyphosate will be most effective when applied to serrated tussock plants that are actively growing and only when weather conditions are conducive to spraying. Higher rates are required to kill tussock on high fertility soils such as basalt.

- In grazing country replacing serrated tussock with competitive species, conservative grazing and **ongoing** pasture management is the long-term answer to serrated tussock management.

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INTEGRATED WEED MANAGEMENT - What is it and does it exist?

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INTRODUCTION

Weed management remained relatively unchanged around the world from the first sedentary (agricultural) cultures until the development of the petrochemical industry around the early1900's. At this time "western" countries began replacing draft animals with tractors, reducing the amount of labour required to grow crops.

Following World War II synthetic herbicides entered the market enabling the timely controlling weeds to maximise yield. These herbicides were cost effective and using them made good economic sense. Also at this time there were also fears of food shortages driving western agriculture following two world wars so their was a major emphasis on increasing agricultural production.

The late 1970's-early 1980's saw the release of some highly effective herbicides (selective grass herbicides - Group A and, the sulfonylureas - Group B, glyphosate – Group M) which were rapidly adopted by the farmers and agronomists in industrialised countries. Figure 1 shows the development of herbicide resistance across the industrialised world, which mirrors the increased reliance use of herbicides in western agriculture.

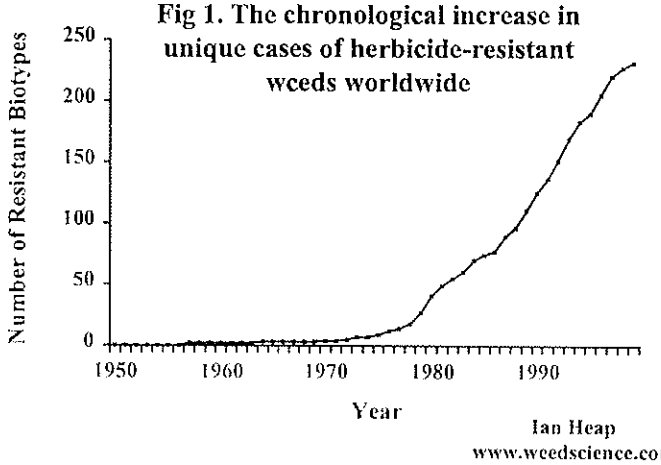

Fig 1. The chronological increase in unique cases of herbicide-resistant weeds worldwide

Despite the vast amounts of money spent on herbicides each year, weeds are still a major problem in farming systems. In Australia alone, *Avena* spp. annually cost the cropping industry approximately $80M, with $60M being spent on herbicides (Medd, 1996). This annual problem results from sufficient *Avena* seeds being produced each season following herbicide treatment to maintain the soil seed bank.

During this "industrial agriculture" phase farmers and weed scientists shifted their focus towards relying on herbicides as the main, if not only, weed control strategy. A review of the weed management literature over the past 40 years highlights this trend.

This focus on herbicides is natural as they are effective in the short term and they suit the reactionary management styles of most people. Pesticides are the magic bullet for risk averse agriculturalists (Ehler & Bottrell, 2000).

Many weed scientists, agriculturalists and land managers now realise that weed science must place more emphasis on population biology and ecological principles as greater pressure is exerted on the world environment by the increasing influence of mankind (Zimdahl, 1995, Powles, 1997, Hall *et al*, 2000).

WHAT IS IPM/IWM?

Weed control and weed management should not be confused with each other. Weed control is the killing of a population of weeds, while management includes strategies for prevention of reproduction, reducing re-establishment and minimising competition (Zimdahl, 1991).

Integrated weed or pest management is generally a term for a wider view of pest management, not focussing on a single species.

There are many definitions of integrated pest management, however they all contain two key elements:

1. The use on multiple control tactics
2. The integration of knowledge of pest biology into the management system (Buhler *et al*, 2000)

Integrated pest management has primarily focussed on the management of insect pests and diseases. Insect pests and weeds have a number of different characteristics that mean the management strategies for each will be different and not always directly transferable (Buhler *et al*, 2000). Developing integrated management strategies demands a wider approach than relying on herbicides and cultivation (Navas, 1991).

Weeds are highly responsive to changes in the environment. Therefore, focussing on the control of a single species often leads to a species shift which may have implications for other parts of the environment, such as changes to the food chain affecting other species, or a worse species takes it's place. An excellent example of this is the control of bitou bush (*Chrysanthemoides molinifera*) with glyphosate by air on sand dunes with no follow-up strategies. Often the bitou bush either re-establishes or is replaced by a worse weed such as glory lily (*Gloriosa superba*).

Ehler and Bottrell (2000) state that there is not much "I" in integrated pest management, despite 30 years of research and extension. They state that currently only four to eight percent of the U.S. crop area would be under true IPM and what most people call IPM is actually better described as "supervised control", with little monitoring and understanding of interactions between control techniques. It is often aimed at the management of pesticide residues and pesticide resistance, and not pest management.

Bottrell *et al* (2000) considers integrated pest management must be based on:

1. Potentially harmful species continue to exist (forget eradication except at the very early stages of infestation
2. The ecosystem is the management unit
3. The use of natural agents is maximised
4. Any control measure may produce unexpected and undesirable effects
5. An interdisciplinary approach is essential

With these issues in mind it is time to step back and look at a range of weed management techniques which must be integrated to produce a sustainable system, while keeping weeds in the background.

PREVENTION - HYGIENE AND QUARANTINE

The easiest weeds to manage are the ones you don't have.

Because weed problems are relatively sedentary within a season, quarantine, early detection and hygiene techniques are extremely important, yet often the most ignored.

Most of the weeds in Australia come from other countries and arrived as seed in grain, hay, filling for saddles, on or in livestock, or as garden plants. The current ability of humans to rapidly move around the world has only heightened the risk of new weeds entering Australia.

Trade agreements such as those regulated by GATT can reduce a country's ability to impose restrictions on the movement of goods increasing the chances of undesirable pest species entering the country. This compounds the trend towards "down-sizing" of quarantine services.

Droughts

Droughts are one of the times of greatest weed spread due to the vast volumes of fodder and numbers of stock are being transported. Fodder and manure are then spread across bare soil.

Maiden (in Thomas *et al*, 1984) realised this fact in 1914, following the influx of a large number of weed species in fodder from South America during the 1890's drought. The problem is obviously not a new one.

Thomas *et al* (1984) conducted a study of weeds in fodder being brought into the Yass, Young and Gundagai pasture protection districts in the 1980-81 drought. During this 2 year period 42,000 tonnes of fodder was brought in, with half being hay. Fodder came from all corners of the eastern grain belt.

In the grain samples collected, 22 seed types were found, with an average of 3.7 per sample.

Average number of seeds per sample was 555 kg^{-1}, with a range of 1 to 1797 seeds per ½ litre.

The hay samples produced 105 species. There were 10 to 33 seed types per bale, with no apparent correlation between appearance of hay and weed seed numbers. Numbers of seeds per bale ranged from 104 to 364,000, averaging 68,700.

Seed for sowing is another common entry point for weeds on the farm.

Seed for sowing

Moerkerk *et al* (1997) conducted a "seed-box survey" in Victoria and southern NSW, where samples were collected from sowing machines or groupers. Table 1 shows the percentage of samples and levels of contamination.

Table 1 Contamination levels of sowing seed (% of Samples)

Crop	Number of samples	Weed Free	0-19 seeds/kg	20-99 seeds/kg	> 1000 seeds/kg
Wheat	106	33	38	22	7
Barley	62	10	32	35	23
Oats	18	6	0	44	44

The level of contamination was as high as 16,600 annual ryegrass seeds per kilogram. Many farmers are sowing large numbers of weed seeds moving weeds from paddock to paddock and from farm to farm.

Another related problem is the misunderstanding of the certified seed scheme by purchasers of seed. A survey of growers' understanding of the certified seed scheme showed the majority thought that certified seed was free of weeds. The growers were surprised to find out that all certified seed had a percentage of weed seeds, which are named on the label. Retailers of seed are not being informing the purchaser that this is how the system works.

Quarantine of livestock

Quarantining of newly purchased livestock is also important. A significant proportion of weed seeds will remain viable as they pass through the gut of an animal. Most seeds will clear the gut of a ruminant within 7 days, so new livestock should be kept in a small paddock during this period. The paddock should then be continually monitored for new weeds.
Another option is to purchase stock from "clean" areas that are free of problem weeds.
Harvesting and cultivation equipment should be properly cleaned before moving to a new property to remove soil, plant parts and grain.

MOWING, HAY CUTTING AND SILAGE

Mowing, hay cutting and silage have been used for hundreds of years to manage weed seed banks, however, timing of operations and repetition is critical.
Mowing of weeds in pasture too early leads to regrowth that requires further treatment, while too late leads to the formation of viable seeds. Hay cut too late is full of viable weed seeds which are readily dispersed.
Much of the success of these techniques is dependent on the local conditions and the species being targeted.
Beck & Sebastion (2000) found that the effect of mowing alone on *Cirsium arvense* was different depending on the vigour of the thistles. At a site where there was a high watertable and thistle roots were restricted, mowing reduced ground cover by half to two thirds over a 2 year period, while at a better drained upland site, mowing alone had no effect on thistle ground cover.
Mowing is often used to "manage" tussocky grasses. However, work by Storrie and Cook (1999) on the mid north coast of NSW shows that slashing can reduce the percentage of the target species, giant Parramatta grass or GPG (*Sporobolus fertilis*), although the mowing frequency required to achieve this result is impractical under most circumstances.
In 1998 the Brisbane City Council reduced the mowing frequency of recreational parks. This led to a shift in botanical composition from green and blue couch (*Cynodon dactylon* (L.) Pers.) to bahia grass, (*P. notatum*). Bahaia grass grows up to 250 mm high, and is not suitable as a recreational turf (E. Stevens pers. com. 1999).
Tinklin (1988) surveyed 50 roadside verges in England and found that high intensity mowing led to a reduction in the total number of species present, with a shift towards low growing species such as flat weeds.
Mowing height also strongly influences botanical composition of swards. A number of studies in the turf industry have shown that mowing heights over 7 cm improve turf competition with weeds and reduce weed invasion
Low slashing heights can lead to increased frost damage to desirable species, (Davies & Hunt 1989), and open the sward to invasion by undesirable species.
Hay cutting can induce rapid changes in botanical composition, particularly a reduction in annual species.
Cutting of hay when annual grasses are beginning to flower maintains hay quality, minimises hay contamination with viable weed seeds, and maximises dry matter production.
Silage making is often more reliable than hay cutting because cutting occurs earlier in the spring than is possible for hay cutting. Follow-up weed control may be necessary for both hay and silage production.

"FLAME" CULTIVATION

There are a number of different "high energy" weed control systems from ultra-violet light through steam and hot water systems, to gas-powered radiant heat and liquid propane flame systems. These systems are highly specialised and will have a place in areas such as urban areas or organic production. All of these systems use substantial quantities of fossil fuel energy.

Propane flaming has been used to some extent for over 40 years and has seen its widest application in US corn and cotton production systems and European organic farming. It is also used to some extent in the Australian teatree industry for post harvest weed control.
Effective control with propane flaming is highly dependent on plant age (size) and species. Species most easily controlled have unprotected growing points and thin leaves, such as *Chenopodum album* and *Stellaria media*, while those with protected growing points such as *Capsella bursa-pastoris* and *Poa annua* will regrow (Ascard, 1995).
Ascard (1995) also found that softer broadleaves up to 4 leaf would be controlled with 10 to 40 kg propane ha^{-1}, while 4 to 12 leaf plants require 40 to 150 kg propane ha^{-1}.
Perennial grasses rapidly regrow following treatment with high rates of propane (Storrie & Cook, 1999).
Other issues to be considered with the use of high-energy systems are the low operating speeds required, irregular weed control, fire risk, smoke or vapour hazards and operator safety issues.

CULTIVATION

Cultivation has been around as long as agriculture, but has had some bad press.
Like the use of herbicides, much of the use of tillage has been indiscriminate.
In the '80s we had tractor "bigism", and before that we had "recreational tillage". What we need is appropriate tillage that looks after soil structure, soil organic matter, and minimises both wind and water erosion.
Bowman (1977, in Forcella, 2000) found that the decision by farmers to inter-row cultivate was usually made on the number of days after sowing, and not how many weeds were present, or weed development stage.
Tillage also has the problem that when used alone, depending on soil moisture content and rain, from 50 to 75% control of weeds can be expected to be controlled (Buhler et al, 1995; Forcella, 2000).

CROP/PASTURE COMPETITION

A good deal of work on crop competition with weeds was conducted in the 1960's and 1970's, (Colwell,1963; Nalewaja, 1978; Philpotts, 1975) and the research findings still apply. It is apparent however, that the results from that work has not been adopted by the majority of farmers or their advisers.

Plant population

McNamara (in Martin, 1983) found that lower densities of wheat were more susceptible to competition from wild oats when compared with higher densities. At wheat sowing rates of 20 to 40 kg ha^{-1}, 100 wild oat plants m^{-2} reduced yield by 50%. Competition between wheat up to 200 plants m^{-2} and wild oats up to 300 plants m^{-2} did not lead to mortality. Wild oats predominantly cause yield loss by reducing the number of wheat tillers. Serious consideration must therefore be given to increasing seeding rates to make crops more competitive (Felton & Martin, 1987).
Sowing rates of at least 60 kg ha^{-1} (150 plants m^{-2}) are shown to be suitable for southern Queensland conditions. (Radford *et al*, 1980).
The optimum sowing rates for a range of environments should be established and an effective extension program conducted to sell the benefits to farmers. Climate risk modelling should also be incorporated into the management decision system.

Species competitiveness

Nalewaja (1978) found that there are differences in competitive ability between crop species.
Table 2 Effect of crop type on wild oat seed production

Crop	Wild oat seeds per ha ($x10^6$)	
	No herbicide	Triallate
Wheat	38	11
Barley	27	5
Winter fallow/	1	-

Summer crop

Barley is clearly more competitive than wheat and the extra competition from barley improves herbicide efficacy. In the Ethiopian highlands barley or tef (*Eragrostis tef*) traditionally follows a pulse crop due to their ability to compete with weeds which may have increased in the pulse phase. Wheat is then sown after the barley or tef (J. Van Leur pers. comm.).
Cultivar differences also exist. Research in Canada have shown that semi-dwarf winter wheats suffered 14 to 30% greater yield reduction from *Bromus tectorum*, than did taller cultivars (Saskatchewan Ag & Food farmfacts).
Other factors affecting crop and pasture competition include:

- time of sowing
- seeding depth
- nutrition
- disease and pest management
- quality of seed
- rotation

The same principles will apply for natural ecosystems.

GRAZING

Grazing is a balance between maintaining sufficient ground cover with pasture to prevent or reduce establishment and growth of weeds while meeting the nutritional requirements of the animals.
Pastures have been the poor relation of the agricultural system in Australia, being the minimal input periods between the cropping phases or a resource to be mined.
Low intensity set stocking has been the predominant grazing strategy with large paddocks and low numbers of watering points leading to overgrazing near the watering points and under-grazing over the rest of the paddock. Allowing stock to selectively graze leads to elimination of palatable species and domination of the sward with less palatable species, predominantly tussocky grasses and monocotyledons. Many of these species have been shown to have reasonable feed qualities if kept short, and not meet animal requirements when allowed to become rank.
Quality assurance and animal welfare concerns are also impacting on the use of livestock for weed management, particularly when used to control weeds high in alkaloids such as Paterson's curse, fireweed, heliotropes and St John's wort. Great care must now be exercised when using stock in weed management programs.

BIOLOGICAL CONTROL

Biological control of weeds is seen as the "holy grail" of weed management and has held a mythical status since the control of *Opuntia stricta*. with the insect cactoblastis.
The urban community considers biological control safe (no terrible toxins), and many in the agricultural community see it as a means of abrogating weed management responsibilities to the gods (or their local control authority).
Since cactoblastis, biocontrol of weeds in Australia has only achieved minor success, despite impressive propaganda campaigns by some organisations.
One reason for this lack of success is the stringent restrictions on the import and release of control agents into Australia.
Biocontrol also has the limitation that it focuses on single species.
Efforts into biological control should continue, however this technique should be kept in perspective, with moderation of propaganda.

CONCLUSION

Integrated weed management should be seen as a management process that looks at long-term benefits and aims to maintain the ecosystem in question in equilibrium.

Weed control mindsets must be abandoned and a culture of management of weed "propagules" promoted. Techniques that reduce production, survival and establishment of propagules must be integrated in an ecosystem context.
There are many cultural weed management techniques available for the modern agriculturalist to rediscover, however we must be ready to lobby for research and extension dollars to develop real integrated weed management programs in Australia.
Better management of droughts, or climatic variability, would be a great start, focussing on the problem and not the symptoms.
Better monitoring and assessment methods need to be developed in conjunction with practical and reliable decision-support systems will allow real IWM to be implemented.
Ehler and Bottrell's (2000) suggested a good place to begin is to develop some achievable goals such as:

1. Implement supervised control with vertical integration of tactics
2. Shift the debate to pesticide reduction, as this is readily quantifiable

Maybe then, IWM will follow.

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NON CHEMICAL CONTROL OPTIONS FOR PATERSON'S CURSE
The effect of spring defoliation and perennial pasture competition

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Introduction

Riverina bluebell, Salvation Jane, Paterson's curse, 'Pato' or *Echium plantagineum* – call it what you will, this winter annual plant is the producer of the purple paddock spring spectacular and recognised as a noxious weed in Australia.

Introduced from the Mediterranean as a garden flower, the earliest record of Paterson's curse in this country was at the Camden gardens of John Macarthur near Sydney in 1843. It then appeared in nursery catalogues and by 1890 was recognised as a potentially serious weed at Cumberoona near Albury New South Wales (where it was introduced by the Paterson family) and nine years later, was considered a threat to pastures in the Port Pirie region of South Australia.

How has this weed managed to roam around the country? Probably moved with soil, hay, grain, vehicles and livestock. Weed seeds are very adept at finding ways to be carried from place to place – you may not even know they have hitched a ride! Now one of the most dominant pasture weeds of temperate Australia, Paterson's curse covers over 33 million hectares and costs Australian agriculture $30 million annually. Although valued as a pasture plant in some states and also utilised by honey bees, this plant contains toxins that can severely affect grazing animals and may even lead to their death.

Paterson's curse starts appearing in autumn and winter. However, plants can be found during most times of the year. The oval shaped, hairy leaves form a rosette that hugs the ground tightly and can grow larger than a dinner plate. In spring, a branched stem, covered in stiff hairs, emerges from the centre of the rosette and produces tight clusters of trumpet shaped flowers. The flower colours can vary from unusual pure white to common deep purple and many shades of pink and mauve. Each flower can contain up to four seeds. A single plant could produce 10 000 seeds if not controlled. In fact, in a typical pasture, there would be between 250 and 1250 Paterson's curse seeds just waiting for a chance to come up in an area the size of this open proceedings.

Reducing weed seed production or entry of seeds into the soil seed bank is important as this will reduce the numbers of potential weeds in the future. A combination of methods or integrated weed management (IWM) can be used to help limit the numbers of weeds which reach seed production e.g. strategic use of herbicides, cutting, grazing, burning, cultivation, growing competitive pastures and introducing natural enemies such as specific insects.

This paper (based upon results obtained during my PhD research) describes the effect of two non-herbicide techniques that could be used in conjunction with herbicides or other IWM methods to more adequately control that invasive purple hue in pastures.

Perennial pasture competition

The abbreviated methods and results presented here are part of a larger field experiment that was established at Wagga Wagga, New South Wales (rainfall: 572 mm per annum) to investigate competition between annual weeds and perennial pasture species.

In autumn 1998, Paterson's curse seeds were sown into a number of perennial pasture plots. The perennial pastures had been hand planted as seedlings the previous year to achieve a plant density of

25 plants per m^2. A representative perennial grass, legume and broadleaf species was chosen and all possible sowing combinations were planted i.e. no perennials, perennial grass only, perennial grass plus perennial legume, perennial grass plus perennial broadleaf etc. and a mixture of all three perennial species. The perennial species chosen were *Phalaris aquatica* (phalaris), *Medicago sativa* (lucerne) and *Cichorium intybus* (chicory). Plots were not grazed and minimal defoliation occurred (mowed to a height of 5 cm two or three times during winter).

Established Paterson's curse rosette diameters in late winter are shown in Table 1. Individual plant dry matter, plant density and estimated seed production per plant for mid- spring 1998 are also presented. It can be seen that the rosette size, individual dry matter of Paterson's curse plants and the estimated seed production for a plant were greatly reduced when phalaris or chicory was present.

Table 1. The impact of perennial pasture species on Paterson's curse plant size and potential seed production.

Paterson's curse sown with a selected perennial combination	**Late Winter 1998**	**Mid-spring 1998**		
	Pato diameter (cm)	**Individual Pato plant DW (g)**	**Pato per m2**	**Potential seed number per plant**
Pato only (no perennial)	16.8	9.77	131	779
Phalaris	4.8	0.16	112	56
Lucerne	14.9	1.54	165	274
Chicory	4.7	0.42	64	63
Phalaris + Lucerne	6.6	0.44	104	59
Phalaris + Chicory	5.1	0.24	143	44
Lucerne + Chicory	8.4	0.59	128	75
Phalaris + Lucerne + Chicory	6.0	0.35	139	71

Although the introduction of perennial pasture species can severely reduce Paterson's curse seed production, this strategy should not be used in isolation as some seed is still produced for the following seasons. Therefore, utilising a competitive perennial pasture with another form of management could potentially provide an improved means of reducing seed rain.

Spring defoliation

A trial site was selected at Wagga Wagga, NSW. Plots were established in a degraded phalaris, cocksfoot and subclover pasture and subjected to one of four strategic spring defoliations or to continuous grazing by sheep (7 DSE). At the beginning of August, sheep were excluded from plots which were to be mechanically defoliated in spring. Herbage was removed from these plots using a forage harvester (cutting height 7 cm). The mechanically defoliated plots were either cut once in early October, late October, early November or late November for two successive years.

The composition of the plots prior to spring defoliation and after two years of cutting is shown in Table 2. It can be seen that cutting in early November or continuously grazing, can substantially reduce the contribution of Paterson's curse to the pasture. Seed production and subsequent autumn seeding emergence (Table 3) is also significantly reduced when subjected to a strategic spring cut or

continuously grazed. Minimising seed rain and regrowth of defoliated weeds relies on understanding their developmental stages - **the timing of a defoliation for weed management purposes is critical.** The most advanced phenological stage of the majority of Paterson's curse plants at each cutting time is included in Table 3 and the most advanced stage reached after defoliation is also recorded. Paterson's curse was able to regrow and produce seed if cut too early in spring.

Table 2. Impact of 2 years of grazing or cutting on the contribution of annual species to early spring botanical composition (proportion of annual ryegrass, vulpia, subclover and Paterson's curse).

Defoliation method	**Change in Composition: Initial vs Final (%)**			
	Annual ryegrass	**Vulpia**	**Subclover**	**Pato**
Grazed (Set stocked)	26 to 18	20 to 26	23 to 18	4 to 0.3 ⇩
Cut early October	25 to 28	17 to 2	31 to 36	4 to 7 ⇧
Cut late October	26 to 52	13 to 10	37 to 12	3 to 4 ⇧
Cut early November	22 to 10	16 to 53	33 to 16	4 to 0.4 ⇩
Cut late November	26 to 9	13 to 41	32 to 20	3 to 1.5 ⇩

Table 3. Impact of 2 years of grazing or strategic spring cutting on seed rain and autumn seedlings of Paterson's curse.

Defoliation method	*Pato seed rain (m^2)*		**Pato seedlings in autumn (m^2)**	
(Paterson's curse stage of development)	**1997**	**1998**	**1998**	**1999**
Grazed (<5% of plants reached seed drop each year).	20^{a}	22^{a}	$< 1^{a}$	< 1
Cut early October (majority stem elongation and flowering; regrowth reached seed drop)	973^{b}	877^{bc}	276^{b}	512^{b}
Cut late October (majority flowering/post flowering; regrowth reached seed drop)	303^{b}	86^{ab}	104^{b}	150^{a}
Cut early November (majority forming green seed; no regrowth after cutting)	7^{a}	223^{b}	9^{a}	27

Cut late November (majority beginning to drop seed; no regrowth after cutting)	208[b]	2153[c]	118[b]	308[ab]

(values within each year followed by the same letter are not significantly different at P<0.001)

When a weed is removed, a space is created for another species e.g. annual grasses replaced subclover or Paterson's curse after certain spring defoliations (Table 2). Thus it is important that the space becomes filled by a desirable pasture species and not by another undesirable broadleaf weed or an annual grass such as vulpia. Long term management decisions and inputs must take this into consideration.

Conclusions

If mechanical defoliation or grazing is to be successfully used as a means of weed management, it is important to first establish which weed is to be targeted and its most vulnerable stage of growth. The most appropriate time of defoliation will differ for each weed and for the desirable pasture species. Cutting and removing herbage later in spring when Paterson's curse is producing green seed can reduce Paterson's curse in pastures. However, it will provide space and opportunity for other undesirable species such as vulpia and therefore management must ensure that desirable species utilise the majority of the space available.

This may mean over sowing with e.g. subclover as if a number of late spring cuts are implemented they negatively impact on natural subclover seed bank regeneration and the number of seedling which emerge to compete against the Paterson's curse.

If a good quality pasture silage is to be produced, then Paterson's curse will most likely be cut too early and regrow to produce seed after the cut herbage is remove and ensiled (e.g. the plots cut in early October or late October). Using this conservation technique in association with other weed management options could manage the regrowth (e.g. a strategic herbicide application and/or introduction of grazing) and may substantially reduce Paterson's curse seed production.

Successful weed management requires an integrated approach. Therefore using a combination of management techniques can have a significant impact on the contribution that weeds such as Paterson's curse make to pasture composition.

ACKNOWLEDGEMENTS

This research was part of a PhD conducted through Charles Sturt University (Wagga Wagga), funded by the Cooperative Research Centre for Weed Management Systems (Weeds CRC) and undertaken at NSW Agriculture's Wagga Wagga Agricultural Institute as part of their continued commitment to weed research.

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ST JOHN'S WORT CONTROL - A Case Study At Walcha

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ABSTRACT
This report outlines actions taken by the District Weeds Officer at Walcha to manage St John's Wort (SJW) infestations in his area. It contains three case studies covering a range of land titles from farmland to suburban blocks and public land on which the SJW is occurring.

The New England Weeds Authority has adopted a policy of working with landowners to develop management plans that provide lasting solutions to weed problems. The control measures discussed rely heavily on the principles of integrated weed management and could be adapted to many other weed species.

INTRODUCTION
St John's Wort is not a new weed in the Walcha area. It was first introduced as a garden plant onto a property at the western edge of the shire near Woolbrook during the 1950s. It escaped from the garden and quickly established on the granite soils on this property. From here it has spread by a variety of methods.

St John's Wort is currently established in three main areas of Walcha shire. The initial outbreak at Woolbrook migrated to the township of Walcha during the 1970s and a separate introduction in the south of the shire at Nowendoc also occurred around this time. The major vectors of the plant's movement have been livestock, fodder and vehicles. Traveling livestock have been demonstrated as very effective distribution agents for this weed.

Scattered plants and patches occur along most stock routes and roads in the area. This requires an extensive control program to prevent the plant's establishment over a much wider area.

The plant has demonstrated an affinity for a wide range of soil types and will flourish in most agricultural or natural environments if given the opportunity. Particularly at risk are the large areas of National Park along the eastern escarpment of the New England area. The continued control of St John's Wort is seen as very important to maintain the viability of the agricultural sector and the conservation value and biodiversity of natural environments.

THE NEW ENGLAND WEEDS AUTHORITY'S CONTROL STRATEGIES:
St John's Wort is a W2 category weed in this northern region of NSW. All occupiers are obligated to fully and continuously suppress and destroy this weed. The New England Weeds Authority takes this obligation very seriously and conducts a control program on all areas of its responsibility with great diligence.

The infestations on council controlled areas are mostly single plants or small patches and are very widely scattered along the road network. We attempt to find and treat all of these plants in their first weeks of flowering before any viable seed is set. Plants are very difficult to locate until they flower during the summer months, which makes several patrols of all roads necessary.

This diligent approach, using Grazon DS, has reduced the amount of SJW to be found on roadsides at Walcha to the current maintenance levels of around 14,000 litres of spray mix each season. We have been at this point for several seasons now and cannot seem to reduce this level of infestation.

All private property is inspected regularly. An inspection program ensures that each property is inspected at least every third year. If a new infestation of SJW is located the owner is notified and a control plan is implemented. Treating small infestations with an appropriate herbicide is the quickest and most effective initial response. Follow-up inspections are carried out to ensure that control is continued. Where necessary the owner is convinced of the importance of control with the threat of legal action. No compromise is made at this level of infestation; you are doing nobody a favor by taking this early infestation situation lightly.

In other situations where the SJW is extensively spread and infestations have been established for extended periods of time, the New England Weeds Authority has, with the approval of its elected councillors, adopted a longer view management approach. This is a common sense approach, which recognizes the difficulties of implementing a management plan over large areas within a short period of time.
The Weeds Officer actively works with the individual landowners to develop control plans that will work in each situation. The priority is to prevent further spread of the weed, and implement control measures that will reduce the incidence of SJW on the property over time. Plans are developed, to suit each property, which will achieve a lasting change in weed control practices.
Landholders often need to be educated about control strategies and convinced to change current management practices. This process can be time consuming for the Weeds Officer involved and in the initial stages may involve a substantial one on one commitment to achieve the desired result. This is, however, seen as an essential investment of resources to provide lasting solutions to these ongoing problem properties.

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ST. JOHN'S WORT CONTROL DEMONSTRATION (Walcha Township)
Background: St John's Wort infestations are common on small urban holdings in the Walcha township, being spread mainly by horses. The spread of these urban infestations poses a serious threat to the surrounding grazing land.

The first infestations became established over twenty-five years ago. Control work has been regularly carried out by most landholders during the summer months; often, however, only after repeated requests from the local Weeds Officer.

Control efforts to date have largely relied on spraying selective herbicide or hand pulling during the flowering period. These measures alone only give temporary control.

The SJW plant is very persistent. Disheartened landowners often give up until the local Weeds Officer again pushes them into action. This is very time consuming and also disheartening for the Weeds Officer involved.

Aims of a demonstration: The primary aims when setting up this demonstration site were to achieve a lasting solution to this long term problem, and the education of urban landowners about alternative control strategies for St John's Wort infestations.
A secondary aim is to encourage more integrated control programs for this weed that will result in better control of SJW being achieved and a slowing of its spread through the district.

The Site: The St John's Wort on the 4ha Hill Street trial site had been treated with herbicide most summers for at least ten seasons, leading up to a bumper SJW crop in November 1998.
Obviously it was time to consider other control options.
Pasture improvement, to increase competition to the SJW, was the option chosen.
Timing of Events:
Boom sprayed early March 1999 with Glyphosate 360 @ 2.5ltr/ha
Boom sprayed mid May 1999 with Glyphosate 360 @ 2.0ltr/ha
Sown early June 1999; seed thrown on top of ground with fertilizer.
Seed Mix:

3kg	Tetilia Ryegrass
4kg	Vic. Ryegrass
5kg	Demeter Tall Fescue
1kg	Porto Cocksfoot
2kg	Haifa White Clover
1kg	Woogenellup Sub Clover
2kg	USA Red Clover
2kg	Aurora Lucerne
20kg	Total seed/ha

175kg/ha DAP + Znl 0.5%@$550.00/tonn	$78.00/ha
Spraying and sowing costs (donated approx.)	$96.24/ha
Seed, fertilizer and agronomic advice were also donated.	$50.00/ha
TOTAL COST	$224.24/ha

After the paddock was sown it was locked up until late November 1999. It has since been continuously lightly grazed by one horse. The seed mix used was designed for a horse paddock.

Results: A vigorous pasture was established using this technique. This is important to note, as urban landholders require an easy method such as this, without substantial machinery requirements, if they are going to improve pastures. Visitors to the site agree that the improved pasture is much more productive and palatable than the original native pasture.
By January 2001 the adjoining 'control' paddock, which has been regularly hand sprayed for SJW, was again showing a moderate level of infestation similar to that seen in 1998.
Regeneration of SJW in the new pasture was minimal until the second summer after sowing. Even then the infestation was considerably lighter than before the trial commenced. The whole infestation was treated in January 2001 using around 30% of the amount of mix required in 1998.
This demonstration showed that pasture improvement alone will reduce but not fully control a SJW infestation.

Discussion: Stocking of the area has been very conservative with nowhere near the potential stocking capacity being carried. This has allowed the grasses to become tall and rank, and plant density at ground level is reduced because of this. Effective stocking could have maintained the new pasture as a dense sward around 10-15 centimeters high that would be considerably more resistant to weed invasion. Horses are very selective feeders and almost any other form of stock would have exerted more even grazing pressure, and included some young SJW as part of their diet.

The Future: Management of the pasture into the future will determine how successful this approach will be in the longer term. Care will be taken not to overgraze the pasture, which would allow gaps to appear and the SJW to return.

Further applications of fertilizer will probably be required to maintain the vigor of the pasture, although a system that takes very little out in terms of produce may require less input to maintain it. Future spot spraying of SJW will be required; however, it should be greatly reduced on past levels. A well-maintained vigorous pasture is, without doubt, one of the best defences against weed invasion.

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Another property where SJW has been managed over an extended period, and many lessons in weed control learned through experience, is "Tressa Vale", a property in the Woolbrook area. Following is an outline of that experience.

ST JOHN'S WORT CONTROL "TRESSA VALE"

Background:

"Tressa Vale" is a 1340ha grazing property near the village of Woolbrook, west of Walcha, on which SJW had been present since the 1950s. It is gently undulating country with fine granite soils. When purchased by the present owners in 1995 pastures were weak, after five years of dry conditions and very little fertilizer.

Under previous management sheep and cattle were seen to be having a major controlling influence on the SJW. Flowering plants could only be found in sheltered positions where stock could not graze.

With the change of ownership, the property was very lightly stocked with only a few cattle during the spring and summer of 1995. This coincided with the drought breaking and resulted in a dramatic increase in weed populations. Flowering SJW was suddenly evident over most of the property.

Following is a summary of the management decisions that have controlled this infestation.

Management:

- **Fertilizer:** A strong commitment to rectify deficient soil nutrients has been made. An initial application of 250kg/ha of single superphosphate over the whole property has been followed up with annual applications of 125kg/ha over most areas. Clover seed was also spread to help encourage grass density and production levels.
- **Stocking:** A major change from cattle to sheep has occurred over the last few years.
- It was decided that the property must be kept fully stocked to keep grazing pressure on the SJW. In addition to the core stock numbers, some opportunity stocking with cattle to use extra spring feed has been used to achieve this.
- Recently dry sheep in large mobs have been used to prevent SJW from flowering. Rotational grazing is being used to help achieve this, particularly in steeper gully areas where other control is more difficult.
- **Spraying / Control:** A model spray program, with due attention to follow-up treatment later in the season, has steadily reduced the amount of SJW on this property. Priority has been given to boundaries and watercourses to limit the spread of seed.
- An area with a heavy Blackberry infestation covering the SJW has been cleared with a bulldozer prior to being sown to an improved pasture.

Discussion: A very effective integrated weed control program is now being conducted on this property. Fertilizer to improve the pastures, appropriate stocking management to use the feed grown, and an effective spraying program have combined to produce a dramatic turn around in the SJW infestation.

It has required a dedicated commitment to management and resources to achieve this result. The owner estimates well over $100,000 have been spent on herbicide and labour over the last five seasons. A similar amount has been spent on fertilizer.
The change of enterprise mix, including the return of sheep, has made a substantial impact on the management of weed problems. This change was instigated largely by economic factors rather than as a weed control consideration. The owner now recognizes that any future removal of the sheep will be likely to result in an increase in the amount of flowering SJW on his property.
The fertilizer program, and the return of more favorable seasons, has helped the vigour of the pastures immensely. Rotational grazing is now also contributing to pasture management. The use of opportunistic stocking to control exceptional pasture growth also aids in controlling the amount of SJW. In the owners words "The SJW doesn't worry us any more. We know we can handle it, and it doesn't effect the stock too much as long as they have plenty of other grass to go with it."

The Future: Undoubtedly there is still a large reserve of SJW seed on the ground and if given the opportunity it will germinate when seasonal conditions are suitable and pastures are weak. The challenge now is to be ready for those conditions and have the appropriate strategies in place to minimize their impact.

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Another area of concern with the management of SJW is its control on, and spread from, public land not under the management of the local control authority. One such problem area at Walcha is the town common. Following is a synopsis of the problems associated with control in this situation and details of steps taken to resolve this issue. Also included is a brief outline of the situation on RLPB land.

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WALCHA COMMON, ST JOHN'S WORT CONTROL PLAN

Background: Walcha common is an area of approximately 100ha on the northern side of the Walcha township. It is gently undulating country with light basalt soils and is managed by a board of trustees comprised of local people with an interest in the area.
A major weed concern is the rapid increase in the amount of SJW in recent seasons. Despite attempted control efforts using herbicide, the problem has grown to a point where it is beyond the trustee's financial capacity to continue to treat in this way. The threat of the SJW spreading from the common is very real and is of great concern to adjoining landowners. In recent years a donation from the Rodeo Association for the use of the common over a three-day period in January, has paid for most of the spray program. While the trustees have welcomed these funds, the use of the area by a large mob of cattle at this time of year, when SJW is seeding, is only multiplying the threat of spreading this weed.
A solution to the SJW problem is crucial to the continued ongoing operation of the common.
The trustees cannot afford to spray the SJW.
The community cannot afford to have the common providing a source of weed infestation for the surrounding area.

Control Plan: The New England Weeds Authority has drawn up a fully integrated control plan involving stocking management, pasture management, biological control agents and conventional physical control measures. The control plan has as primary aims:

- The prevention of further spread of SJW from the Common.
- The control of SJW infestations within the Common.
- Meeting the community objectives and functions of a town Common.
- Securing economic viability of the Common's operations into the future.
- Educating the Trustee's and users of the Common in appropriate SJW management strategies for ongoing control.

The DLWC have been approached to provide the funding required to commence this improvement program. They have approved sufficient funding to establish a trial.
The initial plan involves renting one of the two paddocks at the Common to a suitably committed sheep owner. The grazing will provide a controlling influence on the SJW in one paddock and also provide the necessary funds in agistment fees for a spray program to be carried out in the other paddock. Development of pastures within this area to provide ongoing competition to the invading SJW is a second phase of the plan.
Livestock can have a major impact on SJW. Merino sheep in particular can be used to suppress the amount of SJW that reaches flowering. It is important in summer rainfall areas to maintain grazing pressure through the winter, spring and summer to achieve the best possible results.
Improved pastures are the best defence against the re-infestation of SJW seedlings. A vigorous healthy pasture will suppress SJW seedlings. The addition of fertilizer and clover seed is a proven cost-effective way to build up the production and resistance of a native pasture to weed invasion in this area.
Biological control agents were released on SJW in the Walcha area during the early 1990s. Testing has shown that they are now established in the Common. Further monitoring will hopefully show some substantial impact of these agents in the coming seasons.
Traditional spot treatment with herbicide of the more heavily infested areas may be required initially to knock down the mature stands of SJW. Some scattered plants may manage to reach flowering despite the presence of sheep and will be treated prior to setting seed.
A long-term commitment to managing this problem needs to be made if control is to be effective. Seasonal variation of conditions will require close monitoring to fine tune and address any issues as they arise.

Discussion: Initially the Trustee's have taken some convincing that management practices on the common needed to change. The difficulties in dealing with individual personalities can be substantially increased when dealing with a group of trustee's. In particular they have been opposed to the introduction of sheep to the Common, as it was believed that this would not leave any feed for the larger stock. At this time only one of the two paddocks is proposed to have sheep running in it, which in part addresses this concern.
The New England Weeds Authority has drawn up an agreed grazing plan between the Trustees and a sheep owner. We will continue to have an active role in monitoring results and directing management decisions.

The Future: This plan has created a winning situation for all parties involved with the Common. All of the main aims of the plan will be satisfied.

- The SJW will be controlled much more effectively than before.
- The risk of further spread of SJW is greatly reduced.
- The Common Trust now has a secure income stream.
- The commitment to providing a facility for regular users of the Common has been maintained, and these users will become trained in the correct procedures to prevent the spread of weeds.

RLPB's: Traveling stock routes and reserves are also public land areas with substantial SJW infestations in the Walcha area. To date weeds issues have mostly been dealt with at staff levels where we enjoy a good working relationship with the Boards in our area. In recent seasons SJW infestation levels have escalated rapidly and this is threatening to overwhelm the resources available for control. Negotiations are currently underway with the elected Board representatives to try to turn this situation around. Integrated management plans similar to that instigated at the Walcha Common are being recommended as the most viable approach to this situation particularly in fenced areas.

Conclusions:

- St John's Wort is a major noxious weed problem in Walcha. Its control, while difficult, is still a reasonable expectation in this area, with substantial benefits to be gained by the community in achieving success.
- Prevention is the most cost effective control measure available. Finding and controlling new infestations early must remain as a top priority.
- In areas where it is already established eradication is not possible so the adoption of integrated management techniques is essential. Having a SJW problem to manage in New England is challenging, however, with the correct approach it is possible to have a profitable grazing operation and achieve a high level of control with this weed.
- Experience has shown that if control efforts are limited to a single measure, such as spraying or heavy grazing then no long-term benefits will be obtained. The infestation will quickly return to previous levels when conditions are suitable.
- Educating land managers to implement effective long-term control strategies is the best way to achieve lasting success in control of this persistent weed. Extension activities such as field days and demonstration areas are a large part of this process. This approach within the New England Weeds Authority is achieving far greater success than the relatively easy option of prosecuting landowners.
- The most effective biological control agent available in New England at this time is still a mob of merino sheep. Other agents are yet to prove their value in this summer rainfall environment, where SJW plants regenerate rapidly under favorable conditions.

ACKNOWLEDGMENTS

The establishment of control demonstration site was made possible by the generosity and cooperation of several people. The costs associated with establishing this demonstration were donated. Thanks must go to the owner Mrs. J Asmus, "Elders" Walcha, for supplying seed, fertilizer, and agronomic advice; Chapman's Boom Spraying, and Chandlers Ground Spreading. Without the help of all of these people this demonstration would not have been possible.

Thanks also to the owner of "Tressa Vale" Woolbrook, Mr. T Portas, for his cooperation in compiling the case study on his property.

The author also wishes to acknowledge Mr. P Blackmore and Mr. J Gordon for their comments on the content and assistance with editing this paper.

UNDERSTANDING HERBICIDE RESISTANCE

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Genes and Genetic Variation

Think about Paterson's curse. Normally, if this is suggested, the colour purple comes straight to mind because purple is the "normal" colour for Paterson's curse flowers. However, if you take a closer look at an area of Paterson's curse you will see that not all the flowers are the "normal" colour at all. In fact, if it's a big enough patch of curse, you will find occasional white flowers.

The second interesting thing to note is that the ratio of white:purple is always about the same. That is, for every 5-10 hectares of purple flowered plants, there will be about one white flowered plant.

There are two questions to ask:

1. Why do the white flowers exist?
2. Why does the ratio of purple to white flowers stay the same?

Genes carry the code for the characteristics of all living things, including flower colour. All genes are subject to mutation. Mutations are taking place all the time. Some mutations make the organism more able to compete. That is, they are fitter than the other plants and so they will increase in number (the old survival of the fittest story). Some mutations make the organism less fit so they decrease in number. Still other mutations have no impact on fitness so they stay at a low level *unless selection pressure is applied in favour of that mutation.*

White flower colour in Paterson's curse occurs due to a mutation on the gene coding for flower colour. Since the proportion of white Paterson's curse flowers remains fairly constant, its clear that is has a neutral impact on fitness.

Selection Pressure

Think about how you would go about converting a Pato field from mainly purple to mainly white flowered plants. It's not too hard to work out. You can see the flower colour. All you would need to do would be to remove all the purple flowered plants before they make seed and retain the white ones. If this process were repeated over a few seasons, the field would be one of white Pato plants. That is, you will have applied selection pressure in favour of the white flowered Paterson's curse plants.

Herbicide Resistance in Brief:

The normal response of a previously unsprayed weed (say annual ryegrass) to a herbicide like Hoegrass ® is that the great majority of plants die.

However, since genes control the ryegrass's response to Hoegrass®, there is genetic variation, just like there is in Paterson's curse flower colour. While the great majority is susceptible, there are individual plants that have a mutation in their genes, which makes them resistant to the Hoegrass®. An obvious difference here is that while the white Pato flowers are visible, resistant weeds look just like all the susceptible weeds.

Just like the white flowered Pato plants, the Hoegrass® resistant ryegrass plants in an unsprayed population occur at a low frequency of about 1:1,000,000. Since the mutation does not confer any fitness advantage, this frequency stays low unless a selection pressure is applied.

Hoegrass® acts as a very strong selection pressure for the resistant plants. So, if a producer sprays the paddock for between 5 and 9 times with Hoegrass®, he will change the weeds from mostly

susceptible to mostly resistant and the herbicide will fail. That is, the producer will have applied selection pressure in favour of the Hoegrass® resistant plants.
The same story can be told for other weeds and other herbicides, although herbicide failure occurs quickly with some (say Glean®) and much more slowly with others (say glyphosate).
In all but a couple of cases, resistance carries no significant fitness penalty. Therefore, once the resistant to susceptible ratio is changed through herbicide use, the change in ratio is for all practical purposes, permanent.

Herbicide Resistance in More Detail:
There are several mechanisms by which plants can reach the point where herbicides fail. This discussion will concentrate on two of these mechanisms, namely **target-site resistance** and **enhanced metabolism resistance.**

(i) Enzymes and herbicide mode of action.
Enzymes are molecules that carry out work in plant cells. The work they carry out is essential to the normal growth of the plant.
A herbicide molecule binds to a particular enzyme in such a way that the enzyme can no longer perform its work and as a result, the plant dies. The manner in which a herbicide molecule impacts on the enzyme is referred to as the **mode of action** of the herbicide.
There are 14 mode of action herbicide Groups, labelled A through to N. The two most problematic are Groups A & B. The mode of action of all Group A herbicides is to disrupt the functioning of the ACC'ase enzyme. However, each Group A herbicide has its own very specific **target site** on ACC'ase. Similarly, the normal function of the Group B herbicides is to disrupt ALS enzyme and each herbicide does so by binding to its specific target site on ALS.
For example, a diclofop molecule (The a.i. in Hoegrass®) can only bind to the diclofop target site on ACC'ase. It has no impact on any other Group A herbicide's target site. A clethodim molecule (the a.i. in Select®) can only bind to the clethodim target site on ACC'ase and it has no impact on any other Group A herbicide's target site. Similarly, a chlorsulfuron molecule (the a.i. in Glean®) can only bind to ALS at the chlorsulfuron target site and it has no impact on any of the other Group B herbicide target sites.

(ii) Target site resistance.
Genes **code** for the shape of enzymes and the way in which they respond to the presence of a herbicide molecule. The "normal" response is that the herbicide binds to the enzyme which then can't function and the weed dies.
Some plants have a **mutation** on the gene that codes for the enzyme. This mutation causes a change on the enzyme at the herbicide target site. This change to the target site prevents the herbicide molecule from binding. The weed is said to have **target site resistance** to the herbicide. A weed can have target site resistance to one herbicide from a particular mode of action Group but still be susceptible to all of the other herbicides in that Group.....in the majority of cases.
Target site resistance makes the plant able to resist very high herbicide rates so increasing the herbicide rate will not work.

(iii) Target site cross resistance
Genes code for the positioning of the various target sites on enzymes. In the majority of cases, the herbicide binding sites are independent of each other. However since genes code for the positions, mutations do occur that place two herbicide target sites very close together on the enzyme.
Occasionally, two target sites can be close together (call them target sites No.1 and No.2). Target site No.1 may be resistant to its herbicide. The change that alters target site No.1 can overlap onto the nearby target site No. 2. This overlapping can prevent herbicide 2 from binding correctly. That is, the

plant is functionally resistant to both herbicides. This situation is described as **target site cross resistance.**
Lets say that the No1 herbicide is Hoegrass® and the No2 herbicide is Achieve®.

(iv) Enhanced metabolism resistance
The Group A herbicides Hoegrass®,Topic® and Achieve® all disrupt the ACC'ase enzyme. The Group B herbicides Glean®, Logran® and Ally® all disrupt the ALS enzyme. Wheat plants have ACC'ase enzyme. Wheat plants also have ALS enzyme. The question is "under normal circumstances, what prevents all these herbicides from killing the wheat plants?"
The answer to this is another set of enzymes called **P450** enzymes. The function of the P450 enzymes in wheat is to detoxify the herbicide molecules by breaking them up (**metabolising**) into harmless parts.
The vast majority of weeds that these herbicides will kill have low levels of P450 activity. That is, the "normal" situation is that the herbicide molecules can get to their target site without being metabolised.
The genes that code for P450 activity are subject to mutation. Some weed plants have a mutation that codes for greater than normal P450 activity. These weed plants have sufficient P450 activity to metabolise standard rates of herbicide so that the plants can then be described as having **enhanced metabolism resistance.** In the same way that P450 activity protects wheat from a number of herbicides from different mode of action Groups, the weeds with enhanced metabolism resistance have **cross resistance** to all these herbicides.
Since the P450 enzymes have a limit to how many herbicide molecules they can detoxify, increasing the herbicide rate will kill many of these plants (except for individuals with even greater P450 activity).

Resistance Defined
Herbicide resistance is often described as "The failure of a previously successful rate of a herbicide to achieve commercially acceptable control".
The reason that the failure situation was reached is that herbicidal selection pressure changed the weeds from mainly susceptible to mainly resistant.

Which Herbicides are at Risk?
The quick answer to this is that all of the herbicides are susceptible to the development of resistance. One practical difference between the herbicide Groups is the speed at which herbicide resistance develops.
Table 1 below compares some of the Groups to which resistance has developed.

Table 1

Estimated number of years of application to develop resistance (Preston)		
Herbicide Group	**Example herbicides**	**Number of years**
B	Glean®, Logran®	<5
A	Hoegrass®, Achieve®	5-9
C, D, F	atrazine, trifluralin, Brodal®	10-14
L, M	paraquat, glyphosate	>15

A glance at the table shows that the Group B herbicides are much more of a problem than the others because failure can occur in less than 5 years.
A compounding factor is that the Group A and B herbicides tend to be used very frequently by farmers because of their cost-effectiveness. This applies especially to the Group B herbicides.

Which Systems are at Most Risk?

Any weed management system that relies on the same method year in, year out can select strongly for resistance.
Some examples are as follows:

- An orchardist who used glyphosate exclusively between the tree rows developed glyphosate resistant ryegrass in between 10 and 15 years.
- Many farmers have used Hoegrass® in all their crops (say wheat, lupin and canola) and have developed resistance in as little as 5 years.
- A wheat farmer who used Spray.Seed® over a 15-year period of continuous wheat production developed resistance to Spray.Seed® in barley grass.

In other words, simple (and or easy) systems are most prone to the development of herbicide resistance.
Many production systems rely almost exclusively on herbicides for weed control. If these systems are simple as well, the risk of resistance is very high.

Are Herbicides the Only Problem?
Many non-herbicidal weed control measures can be selective. For example, mowing golf fairways year in, year out has selected for plants that have prostrate tillers.
Many producers are using chaff carts and other means of weed seed collection at harvest time to very effectively manage resistant weed numbers. We are fearful that this process carried on year in, year out will select for weed types that shed all their seed before harvest.

Weed Seed Contamination
A very common means by which resistance has reached problem levels in paddocks is via contamination. This happens quite often when machinery (most often headers) are moved from paddock to paddock. Producers have noted that "the problem started from the old header trail"
There is one documented case where a farmer grew lupin for the first time. He bought seed from a neighbour that was heavily contaminated with resistant ryegrass and so he went from very low levels of resistance to problem levels in one year!
Better levels of hygiene are essential if other management approaches are to be successful.

The Solution Lies in Diversity
Complex systems of weed management are less prone to the development of resistance and this notion is the basis for the two "golden rules". The name given to a system for managing herbicide resistance is "integrated weed management" (IWM).

1. The two golden rules for IWM are:
2. Rotate herbicide Mode of action Groups.

Treat small numbers of weeds when herbicides are applied.

In order to rotate herbicide mode of action groups, a producer needs to have a diverse crop rotation. The more different crops that can be included, the more scope there is for using different herbicides. This applies to paddock preparation as well. Glyphosate is the herbicide of choice of the majority of producers. Each producer needs to consider using paraquat in some sort of rotation in order to diversify. It the crops are being grown using no-till techniques, producers aught to consider using some tactical cultivation at or immediately prior to sowing.

In many ways, "treating smaller weed numbers" requires producers to suppress weeds using means other than herbicides. For example:

- Establish competitive pastures quickly in order to suppress weeds.
- Don't have very long pasture phases that invariably become weedy and or need greater herbicide inputs.

- Grow competitive crops so that weed seed production is reduced. This involves everything from choosing a competitive variety and high sowing rate to ensuring that the seeding depth is spot-on.
- Be prepared to occasionally grow crops suited to later sowing times, allowing for more pre-sowing weed control.
- Apply fertilisers so that the crop obtains more advantage from it than the weeds
- Be prepared to have a short pasture phase or forage crop phase where grazing if weed numbers start to rise.
- Be prepared to put in extra work, such as a weed seed stimulating tickle during the pasture phase so difficult weeds like radish can be managed.
- At harvest, avoid spreading weed patches out with the header.
- Harvest clean areas before weedy ones.
- Use clean seed and equipment.

Nearly all of the above information is orientated to the on-farm situation. However, much of it is applicable to the non-crop areas where for example noxious weeds are controlled.

Even though herbicides like 2,4-D are less prone to the development of resistance, it can happen so thought should be given to other options, such as alternative herbicides and if possible, non-herbicidal methods.

The objective of this paper has been to set out some facts about herbicide resistance. Hopefully, it will be a basis for further research and a better approach to weed management in the future.