their undesirable attributes. Advisory products are being created to ease the transition period. Stakeholder and expert input has been utilized and submissions have been received from Catchment Management Authorities, Victorian Farmers Federation, producer groups, Landcare, Coastcare, Friends groups, Cities, Shires, Consultants, other DNRE Divisions and other States.

Inclusion of grass species

As stated above, the list of proposed taxa is currently confidential, to protect commercial interests. However the following taxa have been assessed, and it is anticipated that many of them will be declared as noxious weeds:

1. All *Nassella*, *Achnatherum*, *Aegilops*, *Cortaderia*, *Spartina* spp., i.e. these genera entirely.
2. Some *Aira*, *Alopecurus*, *Ammophila*, *Andropogon*, *Arundinaria*, *Arrhenatherum*, *Arundo*, *Avena*, *Briza*, *Cenchrus*, *Chloris*, *Critesion*, *Ehrharta*, *Glyceria*, *Jarava*, *Panicum*, *Pennisetum*, *Phyllostachys*, *Vulpia*, *Piptochaetum*, *Piptatherum*, *Sporobolus* spp.

Next steps

DNRE is currently considering if any of the proposed taxa have potential worth in primary production. Any values will then be offset against threats. The list of plants will then be offered to Nursery and Garden Industry Victoria for negotiation and phase-out from trade. It is anticipated that declaration will be effected early in 2003, however by that stage all key taxa should have long disappeared from trade.

Impacts and control of exotic stipoid grasses in Australia – what have we learnt since 1998?

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Summary

A comparison was made between the broad principles, outlooks and practical strategies for control of exotic stipoid species in Australia, as expressed in the outcomes of the 1998 Nassella workshop and the outcomes of the 2002 Exotic Stipoids workshop. All of the broad principles identified in 1998 were confirmed as still relevant for 2002. Some principles were extended. In addition several new key principles arose. In particular the need for education, training and coordination to identify exotic stipoids entering Australia, or new areas within Australia, was clearly identified. The need to develop risk analysis for each potential exotic stipoid species or groups of species was also identified, as was the need to integrate ecological and economic understandings of exotic stipoid control, so as to best direct available resources. All of the key strategies for management and control of exotic stipoids from 1998 were also still relevant in 2002. The need for targeted research, education and management that took account of the different stipoid species and the individual geographic and land management contexts for control was highlighted. Also identified was a need for effective coordination of effort, across species, land use types and regions.

Introduction

In 1998 a major two day *Nassella* Workshop was held at Victoria University, St. Albans to bring together current understandings about the biology and control of serrated tussock (*Nassella trichotoma*) and related species in Australia. The outcomes of the 1998 workshop were reported in a special edition of Plant Protection Quarterly (Volume 13 No. 2). In March 2002, a group of over 160 people representing a wide cross-section of stakeholders involved in the control of the south American *Nassella* and related species assembled at Victoria University, St. Albans to review what had been achieved, what had been learnt, and what new initiatives were required, since the 1998 workshop.

The original *Nassella* workshop in 1998 was notable for two key reasons. Firstly, although the major focus of the workshop was on control of serrated tussock, nevertheless other exotic stipoid grasses which had existing or potential weed attributes were included for discussion. Secondly, the workshop brought together for the first time representatives from agricultural and conservation backgrounds and attempted to identify a set of broadly common principles and preferred directions for all stakeholders. These were reported on page 103 of Plant Protection Quarterly, 13 (2).

The purpose of this paper is to review the outcomes of the 1998 workshop, to ask 'how far have we achieved our aims?' and to begin to identify any new key areas, issues and aims arising from the 2002 workshop.

At the beginning of the 2002 workshop, participants were reminded of the 1998 outcomes and provided with a questionnaire which asked them to reflect on these outcomes, and what new areas or issues they considered to be relevant. In total, at the end of the workshop and in the week following, thirty-six questionnaire responses were received, across a range of stakeholders. The responses in these questionnaires were compared with the summarized outlooks of participants at the 1998 Nassella workshop. The broad views expressed in the papers presented to the 2002 workshop, which are published in this volume of Plant Protection Quarterly, were also include in the analysis of outcomes and directions.

Broad principles and outlooks of the 1998 workshop – how relevant for 2002?

The 1998 workshop identified seven main principles and outlooks, and these are considered in turn below in light of what arose at the 2002 workshop.

1. Exotic stipoids have high seedbank and recruitment – so these species need special control strategies. Is this still relevant? What approaches are needed?

There was a mixture of feeling between the importance of coming to terms with the population dynamics of exotic stipoids, and its variations across south-eastern Australia, and implementing the common elements of integrated weed control, which are largely know already, and which can be applied for exotic stipoids. Planning is currently under way to determine population dynamics for serrated tussock and Chilean needlegrass (Kriticos this volume). These data for other widespread exotic stipoid species are also required. The outcomes of these studies

need to be included in agreed management plans for each species. Most of these points were foreshadowed by Gardener and Sindel (1998) and Campbell (1998). The need for competitive replacement of exotic stipoids with desired species to counteract the high seedbank capacity, suggested by Hocking (1998) has been shown to be relevant (see point 3 below). Several respondents expressed the hope of finding ways to stimulate germination of exotic stipoids in the seedbank, so that this can be rapidly reduced by chemical control. Reports of the viability of seed in the seedbank and total seedbank number seemed to be more variable and perhaps less extensive than reported by Campbell (1998). This is worthy of further investigation, some of which is planned (McLaren this volume).

2. When stipoid populations are peripheral/localized – need rapid eradication. Is this still relevant? How achievable is this today for all exotic stipoid species?

There was broad agreement on this point, and several suggestions about how this might be achieved. There was strong emphasis on the need for training and literature to assist with identification of exotic stipoids, especially those in addition to serrated tussock (including Chilean needlegrass), as a precursor to implementing rapid eradication. Jack Craw (this volume) outlined how rapid responses to infestation of new species are likely to be undertaken, but pointed out that centrally organized rapid response would be limited, and therefore needed to be prioritized. The importance of planning, coordination and ongoing commitment to achieve eradication in new areas was emphasized. The value of having Chilean needlegrass and other exotic stipoids declared as weeds was also emphasized. There still does not appear to be a central coordinating body, or sufficient resources, to achieve rapid eradication in all situations. Several respondents suggested that, because of the high seed-banking capacity of exotic stipoids, rapid eradication might be more difficult than might appear after first treatment.

3. Where stipoid populations are well established, there is the need competitive replacement with desired species. Is this still relevant? For which species? What approaches are needed?

The importance of competitive replacement with desired species for effective control in highly infested localities (Hocking 1998) was widely recognized, as was the importance of not relying on chemical or physical removal alone for effective control. There is a need to identify which species (native and exotic) are most appropriate for competitive replacement. Comprehensive information for both agricultural and conservation/non-arable land contexts are still lacking for effective competitive replacement. The possibility of using a combination of methods (physical, chemical, biological) in a mix with competitive replacement was raised several times (e.g. herbicide resistant sterile crop species). The value of native grasses for long-term competitive replacement, especially in non-arable areas, was acknowledged (Mason and Hocking this volume).

4. Serrated tussock is out of control despite recent major efforts at control. Is this still relevant? Are there patterns to where control is successful, and where it is not?

In some areas, it would appear that control of serrated tussock is being very successful (for example, see Boyle this volume). Control of serrated tussock on low productivity and non-ploughable land, where replacement with competitive crop or pasture species is difficult or not possible, would appear to be a particular problem. There would also appear to be a limitation in terms of political will, and more success where there is community buy in. Economics appears to play a significant part in influencing success of control (for economic modelling, see Morfe this volume), including the positive influence of rate rebate schemes (Brennan this volume). Where success has been achieved for serrated tussock, these should be documented (for examples of proposed documentation under Weeds of National Significance funding, see McLaren this volume). Other factors are also important, including cultural diversity of landowners, and the percentage of hobby farmers and other non-agricultural landowners. Other stipoids, including Chilean needlegrass, still present major problems for control, even at the rudimentary level of limiting the rate and extent of spread.

5. Other exotic stipoids (than serrated tussock) constitute high threats to agriculture and/or conservation. Is this till relevant? What evidence do we have for impacts of species other than serrated tussock and Chilean needlegrass? Is it likely that identification of conservation impacts will precede identification of agricultural impacts?

For stipoid grasses, the answer to these questions may depends on who is defining what a weed is, that is, unwanted for conservation reasons or for economic reasons. There is a need to find a convergence between these two definitions of 'weeds'. As identified in 1998, there is a strong crossover in these interests where eradication and control of exotic stipoid grasses is considered for non-arable land. For serrated tussock, for example, it would appear that control is achievable on cropping land, with competitive replacement by crop species. However, on adjacent non-ploughable land and land with significant biodiversity values, effective control within economic limits is more difficult to achieve. These areas then become sources of seed for re-invasion of productive farmland. There is a need to develop integrated farming and landscape wide approaches to deal with the problems of exotic stipoid grasses across the range of land use types in which they occur.

6. Effective methods are available to kill mature serrated tussock plants. However, it is unsure how effective these are against other exotic stipoids. Is this still relevant? What information or indications do we now have for chemical control of stipoids?

Methods are available for effective removal of serrated tussock across a range of conditions and contexts are still under way (Pritchard this volume). The outcomes of this work may be affected by the possibility of a range of types of serrated tussock, with several independent introductions, in Eastern Australia (Casonato this volume). Methods for effectively killing mature plants of exotic stipoid species other than serrated tussock is only in its infancy (Mason and Hocking this volume, Pritchard this volume) and further research and training is urgently needed. For example, there are no herbicide label recommendations for any exotic stipoid except serrated tussock, and in a limited instance, for Chilean needlegrass. The possibility that there may be more than one introduction to Australia of some of the other exotic stipoid species, and that therefore there may be more than one type of these species, with possibly differing responses to chemical agents, makes this task even more urgent and daunting. Balancing the need for expending resourcing in this area against the need for research and development in other areas outlined above and below, is urgently in need of resolution. A rapid early strategy may be to draw together what information is available into a series of non-guaranteed recommendations, which can then be circulated and updated as new information and approaches become available.

7. Methods for eradication and control in agricultural and conservation contexts may have relevance for one another – however we cannot assume common applications. Is this still relevant? What examples do we have of differences and transference of strategies?

Despite this being a major focus for the 1998 conference, there are virtually no examples of published works which compare the relevance of eradication and control methods in agricultural and conservation/non-arable contexts (for an example, see Mason and Hocking this

volume). The importance of developing comprehensive and integrated strategies for control across this range of contexts was re-iterated many times throughout the workshop, and several of the proposed Weeds of National Significance projects for serrated tussock and Chilean needlegrass contain elements which span across and compare this range of contexts. Several other suggested projects, including the Grow West project (Buntine this volume) have proposals for dealing with exotic stipoid across their range of locations and contexts in the landscape. Economic approaches, such as the rate rebate scheme of Melton (Brennan this volume) are not yet sufficiently flexible to allow land owners to control exotic stipoids according to their landscape contexts. There needs to be developed a range of strategies which can be offered to land owners to effect eradication and control which are particular to the circumstances of the land owner and to the range of contexts within which exotic stipoids are growing.

New key issues since 1998

In addition to the consolidation or changes in outlook of the seven principles from 1998 outlined above, several new key issues were identified and these are detailed in this section.

1. New exotic stipoid species are still entering Australia and new outbreaks of existing species are still occurring.
Two key questions identified by the workshop were: What are we going to do to prevent more entries of exotic stipoids? How are we going to rapidly identify new entries? Methods for control of entry and for early detection and eradication of exotic stipoids are clearly inadequate. What is clear is that exotic stipoids, especially those from South America, as a group poses a larger threat to both agriculture and biodiversity than envisaged in 1998. One suggestion was that all exotic stipoids should be banned from Australia, and applications for entry should be based on making a case for why each species should be let in, rather than the current system of making a case for why they should be banned or restricted. The time from detection of new entries to response has been good in a few instances; for example, control of *Nassella tenuissima* at Mt. Macedon; and rapid response teams are now being put in place to consolidate this type of response (Craw, this volume). The methods for relatively easy identification of exotic stipoids have already been worked up (Walsh 1998, Stajic this volume). However, for new outbreaks of species currently in Eastern Australia that are not detected early and that become established quickly in small patches, there is a sense that the methods and mechanisms for response are not adequate. This lack of adequate response is compounded by the short-term nature of much of the funding directed in one way or another towards weed control, and the experience of many participants at the workshop was that this type of funding was discontinued or shifted elsewhere just at the time when strategies to achieve exotic stipoid control were becoming effective. There is a need for comprehensive community-based programs to detect and eradicate new occurrences of exotic stipoids. What responses there have been to date have often been top-down and not adequately engaging and informing for the communities who have been asked to carry out the bulk of the control and eradication work.

2. Economic modelling needs to be integrated with ecological modelling.
There needs to be better developed and better informed risk analysis for each exotic stipoid species. The potential of each species, or at least of groups of species, not yet in Australia, to become either an environmental or agricultural pest needs to be assessed, so that the focus for exclusion can be sharpened. This analysis also needs to include a cost-benefit analysis for each species or group of species identified as a potential threat, so that resources can be effectively directed towards those species or species groups that constitute the highest and most probable threat, and for which identified control and treatment are cost effective, as judged against probability and extent of potential invasive effects. For species currently in Australia, there needs to be a cost-benefit analysis for each species or group, incorporating costs of most effective (or best guess) treatment balanced against the potential impacts. These types of risk analysis would sharpen the programs for exclusion, containment and control, and provide more effective planning for those species not yet causing major problems.

Strategies for management and control

The 1998 workshop identified five broad areas for outlining strategies for management and control of exotic stipoids: education/extension; research; resources; management; and coordination. The 1998 workshop presented a summary outcome of recommended strategies in each area. These were circulated to the 2002 workshop for comment and suggested modification or extension. A small number of responses were received on distributed questionnaires, and the general trends in these are outlined below.

Research needs to focus on integrated solutions, and also to focus on the circumstances or context of the problem, rather than a one size fits all approach. For example, specific solutions need to be investigated for each of the major exotic stipoids affecting grazing land, cropping land and conservation reserves. Many species extend across a range of soil types and climates, and tailored solutions for each of these edaphic circumstances may be needed in some cases. Tailored solutions for land owners and managers with different land uses may also be needed. For example the solution to serrated tussock control for a crop and grazing production property are likely to be different than for a lifestyle property.

Education/extension programs will also need to take account of the differing land uses and edaphic contexts of the land manager. It would appear that for lifestyle farms, including large and small landholders, there is less incentive to use the current management systems for serrated tussock and Chilean needlegrass control than there is for farms engaged in agricultural production. This is because the income of the latter is more likely to be directly affected by inaction. As discussed above, there needs to be a concerted education and training effort with targeted audiences to promote the identification of new invasions of exotic stipoid grasses, both into Australia, and into areas within Australia where the species has not been previously recorded.

Resources for exotic stipoid control are about to receive a major boost with support from the National Heritage Trust Weeds of National Significance funding for research and best practice management. However, sources of funding or other support for research, education and management, other than from WONS, appear thin, despite the large number of stakeholders with interest in controlling existing infestations and preventing new ones. One factor which may help explain this narrow resource base is the lack of an effective coordinating body for exotic stipoids – see 'Coordination' below.

Management of exotic stipoids has seen some good results in some contexts, and lack of effective programs in other areas. There needs to be a review of the current strategic approaches, including the development of context specific management plans (as discussed also under 'Research' and 'Education/extension' above). The issue of enforcement of control measures needs to be addressed to make management effective across a landscape. This includes the need to have all or most exotic stipoids declared as noxious weeds. Management strategies that have proven successful in some contexts need to be investigated and documented so that the learning from these can be incorporated appropriately into programs in other areas.

Co-ordination requirements were a key issue identified by a number of workshop participants. Currently coordination appears to be fragmented across species, across regions and across land use types. Key issues for effective control, including enforcement, learning from best practice and targeted education and research need a level of coordination that is currently lacking. Several responses warned against the danger of adding another layer of administration and talking instead of action, but also emphasized the need to identify where coordination was required. One suggestion for coordination was to take a landscape approach, based around better information and planning delivered through catchment management authorities, and to coordinate efforts for exclusion and control of all exotic stipoids in a catchment (subject to risk analysis), not just those with current high economic impact. At the end of the workshop, who the best overall coordination body or group might be was still unidentified. The issue of how overall coordination of efforts to exclude and control exotic stipoids will be achieved is likely need follow through in the near future.

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Economics of serrated tussock and Mexican feather grass in Victoria: Why we need to act now

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Summary

The likely economic outcomes of government's pro-active and reactive-type weed control strategies to avoid the long-term 'external' cost of serrated tussock (*Nassella trichotoma* (Nees) Arechav.) and Mexican feather grass (*Nassella tenuissima* (Trin.) Barkworth) infestation in Victoria are assessed and compared from the viewpoint of the community. Partial industry-level analysis of financial costs and benefits is also explored. The potential loss avoided in agricultural production on private lands, and the savings in future control costs on both public and private lands are the long-term benefits of public investment considered and valued. Net benefits are calculated given four land-productivity and product price level scenarios.

The net economic benefits to the community of a pro-active strategy i.e., immediate eradication of Mexican feather grass within five years, would be about $41 million to $102 million depending on the scenarios tested. In present value terms, this is a potential saving to the community of about $1.2 million to $3.2 million per year over the next 30 years. On the other hand, in all scenarios tested, the cost to government of a reactive strategy i.e., suppressing serrated tussock within 20 years using chemical method alone outweighs the benefits to the community by about $260 million to $1140 million.

Introduction

In an era of increasingly scarce public funds and competing uses for limited funds, it is important that government obtains the best 'value for money' from its investments. Public investment in weed control strategies in the past has been assessed and priorities based primarily on the soundness of the control technology and other non-economic criteria. The economic impact of any pest, however, is a vital aspect in establishing priorities to direct government resources. In Victoria, government investment in weed control largely occurs through the Department of Natural Resources and Environment (DNRE) funding of Catchment Management Authorities (CMAs) Weed Action Plans. The CMAs are charged with ensuring the protection and restoration of land and water resources, the sustainable development of natural resources-based industries and the conservation of the State's natural and cultural heritage (Department of Natural Resources and Environment 1998).

Associated with the weed problem and its control are the existence of 'market failure' situations such as lack of information and externalities (Pannell 1994). In theory, externalities may be either positive or negative. If a farm worker is trained say, in weed control at the expense of farm A and after completion of the training moves to farm B where his training is of use, then farm A generates a positive externality on farm B. An example of a negative externality occurs when the failure of a private landholder to control weeds on his land causes damage to production on adjoining properties since the rate of weed spread to those properties may be increased. Acting in his/her own self-interest e.g., to maximize profit, the private landholder only has regard to the consequences of weed control on his/her own property. Thus, the weed may not be controlled or may be less intensively controlled than would be optimal from the community's viewpoint taking into account the impact of weed control on other landholders (Auld *et al*. 1987). Therefore, in the absence of public intervention in weed control, 'market failure' arising from the negative externality would lead to the best outcome for society not being provided, as insufficient effort or resources is allocated to control the weed spread by the profit-maximizing private landholder. For simplicity, the spread of weeds from farm to farm and from natural ecosystems to farm or vice versa are considered as the forms of negative externality relevant to this study.

'Market failure' is one necessary but not sufficient condition for government to intervene in weed control on private and public lands. For instance, weeds that infest public land can be important for three reasons (Eigenraam *et al.* 1997) (Table 1). First, the potential for weeds to invade and modify the natural ecosystems and to significantly alter the flora and fauna habitat; weeds diminish the value of natural capital for biodiversity purposes. Second, weeds can diminish the commercial value of public lands, for example, where