Biological control of weeds on conservation land: priorities for the Department of Conservation

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ABSTRACT

The purpose of this study was to devise a system by which the New Zealand Department of Conservation (DOC) could determine those conservation weeds that are most suited to biological control, and to recommend a programme to identify and develop appropriate biological control agents for them. A scoring system was devised to predict the suitability for biological control of a group of weeds that achieved high scores for their impact on conservation values based on figures from DOC's database and results from a survey of conservancy staff. Suitability for biological control was assessed using information on potential conflicts of interest, successful management of the weed elsewhere, whether the weed has valued relatives, access to the weed's native range, and whether there are likely to be potential funding partners from other countries or other organisations. Recommendations were made to seek collaboration with regional councils to initiate a programme for biological control of *Asparagus asparagoides*, to initiate a programme for biological control of *Tradescantia fluminensis*, to contribute to the existing programme for biological control of *Hieracium* species, and to investigate the feasibility of biological control of *Salix cinerea*.

Keywords: biological control, environmental weeds, *Araujia sericifera*, moth plant, *Asparagus asparagoides*, smilax or bridal creeper, *Asparagus scandens*, climbing asparagus, *Calluna vulgaris*, heather, *Clematis vitalba*, old man's beard, *Hieracium* species, hawkweeds, *Lagarosiphon major*, *Pinus contorta*, contorta or lodgepole pine, *Salix cinerea*, grey willow, *Tradescantia fluminensis*, wandering Jew.

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1. Introduction

Invasive weeds pose severe threats to natural ecosystems in New Zealand. Weeds are one of the main threats to the survival of 61 threatened native vascular plant species, and have an impact on another 16 species. At many sites weeds also threaten the survival of native animals (Owen 1998a). If nothing is done to curb them, invasive weeds will threaten more than 580 000 ha of natural areas in 10–15 years and lead to inevitable extinctions of native species and degradation of native communities (Owen 1998a). A decline in threatened plant species has been associated with many exotic species (Reid 1998), while exotic grasses are hosts to new pests and diseases that are then transferred to native grasslands (Davis & Guy 2001) with potentially damaging effects on native flora and fauna. When invasive plants displace native plant species at a community scale they provide inferior food sources or habitat for endemic birds. Two examples that have been studied include barberry invading forest remnants (Williams & Karl 1996) and gorse where it displaces kanuka (Williams & Karl in press). Invasive plants such as *Tradescantia fluminensis* also disrupt plant successional processes by inhibiting regeneration of the full spectrum of forest understorey species (Standish et al. in press). Communities invaded by *T. fluminensis* also have an impoverished invertebrate fauna (Toft et al. 2001). Ogle et al. (2000) showed that *Clematis vitalba,* along with the strategies used for its control, has contributed to loss of forest structure and indigenous biodiversity both at ecosystem and species levels.

Classical biological control offers a long-term, sustainable solution to individual weed problems (Fowler et al. 2000). It is not site-specific, and does not require ongoing inputs. However, most of the Department of Conservation's (DOC's) management strategy for weeds is focussed on site-led projects (Owen 1998b). The objectives of the few weed-led projects are either eradication or preventing establishment, which are not achievable through biological control. DOC recognises the value of biological control for managing weeds of more widespread distribution, but has difficulty in prioritising among the very large number of weeds identified as invasive in natural ecosystems. The purpose of this report is to evaluate existing information on weed impacts and the feasibility of biological control including identification of potential collaborators for new projects.

2. Background

Froude (2002) undertook a review of biological control options for invasive weeds in natural ecosystems in New Zealand. Her brief was to assess the role that biological control might play in weed management for DOC, and she reported on all existing biological control projects for 174 invasive weed species identified by Owen (1997). Criteria which could be used to assess weeds for their suitability for biological control were developed. Froude (2002) also listed information that would be required to complete an assessment for an individual weed species under the following categories: weed population dynamics, impacts of the weed, control methods for the weed, existing biological control options, costs of biological control, and likelihood of success. She also listed 24 weeds that scored highly in DOC conservancy staff's 'top ten' weeds survey and, from these, selected seven weeds that warranted further investigation into their suitability as targets for biological control. Brief summaries of initial feasibility were presented for *Anredera cordifolia* (Madeira vine), *Cortaderia selloana* (pampas), *C. jubata* (purple pampas), *Lagarosiphon major* (lagarosiphon), *Lonicera japonica* (Japanese honeysuckle), *Salix cinerea* (grey willow), *S. fragilis* (crack willow) (see Appendix 1), and *Tradescantia fluminensis* (wandering Jew). Information on biological control was already available for eight of the remaining 17 species, and the others were judged to be unsuitable for biological control for a variety of reasons. Results from recent Landcare Research reports on feasibility of biological control for 10 weeds were summarised in an appendix.

Since the completion of Froude's (2002) report, Landcare Research has undertaken further feasibility studies on the prospects for biological control of *Alternanthera philoxeroides* (alligator weed) and *Pinus* spp. (wilding pines), and feasibility studies for *Berberis* spp. (barberry), *Lonicera japonica*, *Ipomoea indica* (blue morning glory) and the water weeds *Hydrilla verticillata* (hydrilla), *Egeria densa* (egeria) and *Ceratophyllum demersum* (hornwort) are in preparation. No information was presented in Froude (2002) on prospects for enhancing or extending existing biological control projects.

3. Objectives

- To complete feasibility studies for biological control of two weeds of conservation areas, *Tradescantia fluminensis* and *Lagarosiphon major*.
- To identify six further priority weeds and update their feasibility as biological control targets.
- To obtain information from regional councils on their priorities for funding weed biological control.
- To prepare recommendations to DOC on priorities for funding weed biological control projects.

4. Methods

Information was gathered from the literature and through personal contact (Appendix 1) to prepare the two feasibility studies for biological control of *Tradescantia fluminensis* and *Lagarosiphon major*.

Froude's (2002) report on biological control options for invasive weeds in New Zealand's protected natural areas listed 174 weed species with scores for weediness. One of these scores comprised an effect on natural systems (EOS) and a biological success rating (BSR), combined as (2 × EOS) + BSR (Owen 1997). Scores for threat to conservation and difficulty of control were obtained through a questionnaire to Department of Conservation conservancies. Froude (2002) selected her 'top 24' weeds from the results of the conservancy survey. In this report, we combined data from Owen (1997) and the conservancy survey to identify the weeds of greatest impact and highest suitability for biological control. So a table of weed species that scored ≥ 28 in 'Total (2 × EOS) + BSR', or 27 in 'Total (2 × EOS) + BSR' and a total of 9 in 'other scores' (Owen 1997), or ≥ 4 in 'top 10, threat + difficult to control' (Froude 2002) was constructed (Appendix 2). Comments were recorded on the weeds' invasiveness and resistance to control based on input from experienced weed researchers. By adding the scores for (2 × EOS) + BSR and the combined 'threat' score and 'difficulty to control' score, a total impact score was obtained. The 24 weed species scoring the highest were then identified (Appendix 3, Table 1). To see whether the list altered if three additional scores (fire hazard, competitive ability and resistance to management (Owen 1997)) were included, the process was repeated adding in these scores. Two additional factors were added to the weed impact score related to the likely benefits from biological control. These comprised a score to indicate the likelihood of the weed being replaced by other invasive species and the efficacy of alternative control methods. Each of the impact factors ((2 × EOS) + BSR score, distribution of impact (threat and difficulty to control information from conservancies), likelihood of other weeds replacing the target species following successful control, and availability of alternative control methods) was given a weighting according to their perceived importance.

For each of the 'top 24' the potential for biological control was examined using information from Froude (2002), updated and expanded where necessary. Each of the 'top 24' weeds was allotted scores indicating their suitability for biological control according to six attributes:

- Whether there were likely to be conflicts of interest over controlling the weed
- Whether effective agents were already known from work conducted elsewhere
- Whether the weed is closely related to valued plant species
- Whether its native range is easy and relatively cheap to access and operate within
- Whether there are prospective funding partners internationally, and within New Zealand

Each attribute was given a weighting according to its perceived importance (Appendix 3, Table 2).

The suitability for biological control score was plotted against the impact score to identify those species with the greatest potential to provide benefit from biological control.

To find out whether regional councils are likely to fund biological control projects for specific weeds, information was gathered from responses to projects proposed for funding in 2000/01 and by discussions between some regional council staff and Landcare Research staff (Appendix 4).

A meeting was held on 30 October 2001 at the Department of Conservation in Wellington between Science & Research staff (Susan Timmins and Kate McAlpine), conservancy staff (Graeme La Cock, Nick Singers, Melanie Newfield and Tony McCluggage) and Landcare Research staff (Pauline Syrett and Peter Williams) to discuss a draft version of this report.

5. Results

Rachel Standish prepared the report on *Tradescantia fluminensis* (Standish 2001) and Peter McGregor (with assistance from Hugh Gourlay) prepared the report on *Lagarosiphon major* (McGregor & Gourlay 2001).

5.1 PROSPECTS FOR BIOLOGICAL CONTROL OF *TRADESCANTIA FLUMINENSIS*

There is no existing programme for biological control of *T. fluminensis* and, currently, there are no obvious international collaborators to share costs of a brand new programme. However, some regional councils are also concerned about the weed, and the prospects of finding suitable control agents in South America are reasonably good. The weed has no close relatives in New Zealand, so the likelihood of potential control agents attacking desirable non-target plants is low.

5.2 PROSPECTS FOR BIOLOGICAL CONTROL OF *LAGAROSIPHON MAJOR*

No one else is currently working on biological control of *L. major* either, so this, too, would involve an entirely new programme. Again, regional councils also have concerns regarding the impact of this waterweed, and might share the costs of a control programme. Suitable control agents may be available, and as there are no close relatives of *L. major* among desirable plant species, the chance of control agents being sufficiently specialised is high. However, *L. major* is being displaced by some other exotic species in much of its North Island range, and may co-exist with native species under some circumstances. NIWA is not convinced that biological control of *L. major* would be beneficial, and suggested that there may be other invaders that should be accorded higher priority as biological control targets. *Ceratophyllum demersum* (hornwort) is considered by some to be a greater threat than *L. major*.

5.3 REGIONAL COUNCILS' PRIORITIES

Weeds that are currently the subject of biological control projects funded by regional councils include gorse (*Ulex europaeus*), broom (*Cytisus scoparius*), banana passionfruit (*Passiflora* spp.), bone-seed (*Chrysanthemoides monilifera*), Chilean needle grass (*Nassella neesiana*), nassella tussock (*Stipa trichotoma*), mist flower (*Ageratina riparia*) and, potentially, moth plant (*Araujia sericifera*) and woolly nightshade (*Solanum mauritianum*). Biological control projects that were funded by regional councils in 2001/2002 are described in Appendix 4.

5.4 DEVELOPING PRIORITIES FOR BIOLOGICAL CONTROL OF WEEDS OF CONCERN TO DOC

'Weediness' scores for 53 species are listed in Appendix 2 with comments as to their invasiveness, and the efficacy of existing, available control strategies. Table 1 lists the 'top 24' weeds that had the highest scores in Appendix 2 with comments on the prospects for their biological control. Table 2 lists an additional three species that were included in the 'top 24' if a slightly different method of scoring was used that took account of 'additional scores' (increased fire hazard, competitive ability, and resistance to management). As the inclusion of these additional factors made little difference to the overall priority selection and order, and the additional three species did not come out near to the top of the list, they were not considered further. The impact scores of the 'top 24' weeds are listed in Table 1 of Appendix 3, and the scores for the six factors influencing their suitability for biological control are listed in Table 2 of Appendix 3. The suitability score versus impact score has been plotted in Fig. 1. From this plot, the weeds having the highest potential for biological control (in the top right hand quadrant of Fig. 1) are *Asparagus asparagoides*, *Tradescantia fluminensis*, *Araujia sericifera*, *Lagarosiphon major*, *Hieracium* species, *Asparagus scandens*, *Pinus contorta* and *Calluna vulgaris*. *Salix cinerea* also rates highly for impact, although its suitability for biological control is rated lower than others.

5.5 PROSPECTS FOR BIOLOGICAL CONTROL OF OTHER SPECIES

Brief notes on the prospects for the biological control of eight species in addition to *Lagarosiphon major* and *Tradescantia fluminensis* have been prepared. They were selected from those species showing the highest potential for biological control on Fig. 1. *Calluna vulgaris* scored sufficiently highly to be included, but is already the subject of a biological control project that currently shows promise of being successful.

TABLE 1. PROSPECTS FOR SUCCESSFUL BIOLOGICAL CONTROL OF WEEDS RANKING IN THE 'TOP 24' FOR IMPACT ON NATIVE ECOSYSTEMS, COMPILED WITHOUT CONSIDERATION OF REPLACEMENT WEEDS OR OTHER CONTROL METHODS.

RATING	WEED SPECIES	COMMON NAME	COMMENTS RE PROSPECTS FOR BIOLOGICAL CONTROL
1=	*Clematis vitalba*	old man's beard	Existing biological control programme, further possibilities (Gourlay et al. 2000, and see below)
	Lonicera japonica	Japanese honeysuckle	Feasibility study being prepared for regional councils in 2001/02
3	*Salix cinerea*	grey willow	Possible biological control, insect fauna well known, and may be sufficiently selective to attack weedy forms preferentially
4	*Ammophila arenaria*	marram grass	Difficult target, especially to avoid damage to plants used for stabilisation
5=	*Cortaderia jubata*	purple pampas	Prospects for successful biological control poor (McGregor 2000a)
	C. selloana	pampas	
7=	*Asparagus asparagoides*	smilax, bridal creeper	Excellent prospects for control, through collaboration with Australia (Syrett 1999)
	Pinus contorta	contorta, lodgepole pine	Possible collaboration with South Africa to find suitable agents, but likely conflicts of interest (McGregor 2001)
	Elaeagnus × reflexa	elaeagnus	Insufficiently widespread to warrant biological control
10=	*Caesalpina decapetela*	Mysore thorn	Insufficiently widespread to warrant biological control
	Hedychium gardnerianum	kahili ginger	Reasonable prospects for biological control (Harris et al. 1996)
	Hieracium spp.	hawkweed	Existing biological control programme (Syrett et al. in press)
	Tradescantia fluminensis	wandering Jew	Feasibility study completed (Standish 2001, summarised above)
	Araujia sericifera	moth plant	Good prospects for biological control (Winks & Fowler 2000)
15=	*Asparagus scandens*	climbing asparagus	Reasonable prospects for biological control, but no developed programme as for *A. asparagoides* (Syrett 1999)
	Lagarosiphon major	lagarosiphon	Feasibility study completed (McGregor & Gourlay 2001, summarised above)
	Pinus spp.	wilding pine	Possible collaboration with South Africa to find suitable agents, but likely conflicts of interest (McGregor 2001)
	Rhamnus alaternus	evergreen buckthorn	None known
19=	*Ageratina adenophora*	Mexican devil	Existing biological control partially successful (Hill 1989)
	A. riparia	mist flower	Existing biological control programme promising (Fröhlich et al. 2000)
	Calluna vulgaris	heather	Existing biological control programme promising (Syrett et al. 2000)
	Chrysanthemoides monilifera	bone-seed	Regional-council-funded biological control commenced
	Ligustrum lucidum	tree privet	Good prospects for biological control (McGregor 2000b)
	Solanum jasminoides	potato vine	No known biological control prospects, projects for related weeds, also close relatives among cultivated plants

TABLE 2. PROSPECTS FOR SUCCESSFUL BIOLOGICAL CONTROL OF FURTHER WEED SPECIES IN 'TOP 24' IF ADDITIONAL 'OTHER SCORES' ARE TAKEN INTO ACCOUNT (OWEN 1997).

RATING	WEED SPECIES	COMMON NAME	COMMENTS RE PROSPECTS FOR BIOLOGICAL CONTROL
17=	*Pennisetum setaceum*	African fountain grass	None known
21=	*Jasminum polyanthum*	jasmine	None known
21=	*Ipomaea indica*	blue morning glory	Feasibility study being prepared for regional councils 2001/02.

5.5.1 *Clematis vitalba* (old man's beard): current status of biological control

Two biological control agents for *Clematis vitalba* have established in New Zealand, a leaf miner *Phytomyza vitalbae* and the fungus *Phoma clematidina*. A third agent, the sawfly *Monophadnus spinolae,* has been released but has not been recovered yet (Gourlay et al. 2000). The leaf miner and fungus were both released widely, and rapidly spread to old man's beard infestations throughout the country. A suggestion that a synergistic interaction between the two agents increases their impact has been shown to be unfounded. Currently, *C. vitalbae* is, at best, only partially controlled.

Future prospects

There are several further agents that have some potential for suppression of *C. vitalba*. The bark beetle *Xylocleptes bispinus* is the most damaging of these, but tests conducted so far, and some field records, indicate that it attacks species of *Clematis* other than *C. vitalba*. Although some damage to ornamental species may be tolerated, if the bark beetle damages native species, as tests indicate it might, its release in New Zealand would be unacceptable. Three moths, *Thryis fenestrella*, *Horisme vitalbata*, and *Melanthia procellata,* have been subjected to some host testing in Switzerland, but results have not been conclusive. Further testing may demonstrate that one or other is sufficiently host specific for introduction, but they have not yet demonstrated the potential to have substantial impact.

Seed-feeding agents would be useful to limit the spread of the weed and its re-establishment following control. However, original survey work revealed two bud-feeding insects, but no seed-feeding species (Groppe 1991). The conclusions of the report on potential control agents in Europe were that *C. vitalba* would be a difficult target for biological control because it did not seem to be

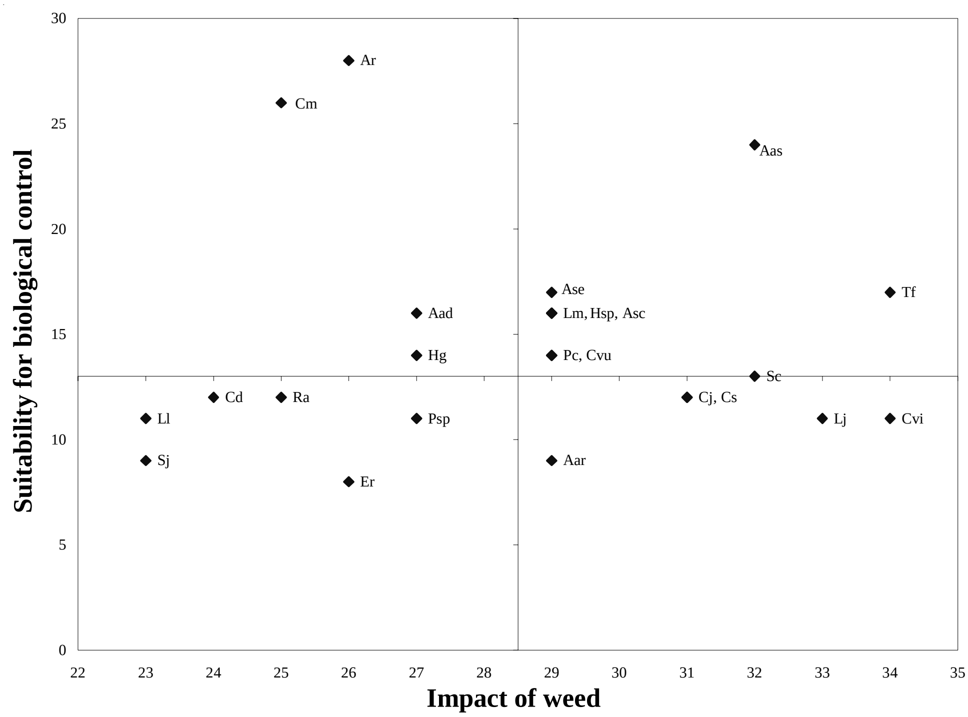

Figure 1. Potential for biological control of 24 weed species according to their impact on the environment and suitability for biological control. Aad: *Ageratina adenophora*, Aar: *Amophila arenaria,* Aas: *Asparagus asparagoides*, Ar: *Ageratina riparia*, Asc: *Asparagus scandens*, Ase: *Araujia sericifera*, Cd: *Caesalpina decapetela*, Cj: *Cortaderia jubata*, Cm: *Chrysanthemoides monilifera*, Cs: *Cortaderia selloana*, Cvi: *Clematis vitalba*, Cvu: *Calluna vulgaris*, Er: *Elaeagnus* × *reflexa*, Hg: *Hedychium gardnerianum*, Hsp: *Hieracium* species, Lj: *Lonicera japonica*, Ll: *Ligustrum lucidum*, Lm: *Lagarosiphon major*, Pc: *Pinus contorta*, Psp: *Pinus* species, Ra: *Rhamnus alaternus*, Sc: *Salix cinerea*, Sj: *Solanum jasminoides*, Tf: *Tradescantia fluminensis*.

under effective control within its native range, and there appeared to be few potential agents that were likely to be sufficiently host specific for introduction into New Zealand (Groppe 1991).

5.5.2 *Lonicera japonica*: prospects for biological control

Regional councils are funding a feasibility study for biological control of this weed that will be available in July 2002. There are some potential conflicts of interest with the use of *Lonicera* species as ornamentals and, currently, there are no existing biological control agents available. However, there is a possibility of collaboration with the United States, which would make a field survey in the native range (eastern Asia) a more economic proposition. (Further information in Appendix 1).

5.5.3 *Salix cinerea*: prospects for biological control

Pests and diseases of willow trees are well known from the northern hemisphere where many willow species are highly valued trees. In New Zealand, too, willows are valued for land stabilisation and shelter. Two willow sawflies are now established in New Zealand, and one causes substantial damage to crack willow, *S. fragilis*. There is likely to be opposition to the intentional introduction of further biological control agents, or even to the enhancement of existing species, unless they are confined to willow species that have no commercial value. *Salix cinerea* seeds freely, and is probably the weediest willow species in New Zealand. It is no longer favoured for planting so an agent that was specific to *S. cinerea* might be acceptable, as might a seed-feeding agent with a wider host range encompassing other *Salix* species. (Further information in Appendix 3).

5.5.4 *Asparagus asparagoides*: prospects for biological control

Australia has an active programme for biological control of *A. asparagoides* and has released two agents, a leaf hopper, *Zygina* sp., and a rust fungus, *Puccinia myrsiphylli*. Host range tests showed that these agents pose no significant threat to cultivated asparagus, *Asparagus officinalis*. Initial indications are that both agents are likely to be highly effective. Within 2 years of release the leaf hopper has increased to very high levels and shows almost total defoliation of patches of *A. asparagoides* at release sites. The rust fungus is established in the field, and laboratory experiments showed that it performed far better than had been anticipated. Below-ground reserves and regrowth potential were drastically reduced in a glasshouse experiment, and in the field the rust has killed plants (L. Morin, pers. comm.).

5.5.5 *Asparagus scandens*: prospects for biological control

The only known potential agent for *A. scandens* at present is a seed-feeding wasp, *Eurytoma* sp. However, field surveys could be conducted in South Africa, and it is likely that further species would be found that would be effective biological control agents. Following the model that was used by Australian researchers for *A. asparagoides*, surveys could be conducted in South Africa fairly economically, and a similar fauna might be identified (further information in Syrett 1999).

5.5.6 *Araujia sericifera*: prospects for biological control

Araujia sericifera is a promising target for biological control. Its fauna in Southern Brazil and Argentina includes a number of potential agents that are restricted in their host range and damaging effects to *A. sericifera*. We have potential collaborators in Argentina who could assist with the project, but it would be helpful to identify agencies in other countries that might be interested in sharing costs of a biological control programme. (Further information in Winks & Fowler 2000).

5.5.7 *Hieracium* species: current status of biological control

Five insect species have been introduced into New Zealand under a programme funded by the Hieracium Control Trust. Two have been released in the field, a plume moth and a gall wasp, and the gall wasp is now established at a number of sites. Three further insect species, two hover flies, and a gall fly, will be released during 2001/02. In addition, an accidentally introduced rust fungus attacks some forms of *Hieracium pilosella*. The five insect biocontrol agents attack different combinations of *Hieracium* species, affecting most of the weedy species. However, *H. lepidulum* is not likely to be affected as much as the others, so more agents are to be sought for this weed.

5.5.8 *Pinus contorta*: prospects for biological control

A feasibility study has been prepared for control of wilding conifers (McGregor 2001), but this project is hampered by potential non-target impacts on commercial species of pine trees. Seed-feeding insects have been suggested as potentially limiting the spread of the weed, but the forestry industry has some concern that such an agent might be a disease vector.

5.6 OUTCOME OF MEETING

At the meeting held on 30 October 2001, following discussion of methods used to construct Fig. 1, and discussions on individual weeds, the decision was made to concentrate on the group of weed species that featured in the top right-hand quadrant of Fig. 1, and *Salix cinerea*, which was just outside the group. Each weed in this group was considered separately, and the combined wisdom of the people present applied to decide how to proceed with each weed species (Table 3).

6. Discussion

The Department of Conservation has already funded biological control of *Calluna vulgaris*, and the heather beetle, *Lochmaea suturalis*, has been imported from Europe. The beetle has established, and early indications are that it is already having a substantial impact on heather plants and has the potential to be an effective control agent.

TABLE 3. RECOMMENDATIONS FROM A MEETING HELD AT THE DEPARTMENT OF CONSERVATION, 30 OCTOBER 2001. NOTE: WEED SPECIES IN BOLD ARE THOSE RECOMMENDED FOR PRIORITY ACTION.

WEED SPECIES	IMPACT	SUITABILITY FOR BIOLOGICAL CONTROL	EXISTING PROGRAMME	FEASIBILITY STUDY PREPARED	CONSERVATION OUTCOME IF WEEDS SUPPRESSED	RECOMMENDATION
Araujia sericifera	4=	2=	no	yes	moderate	Pick up at later date
Asparagus asparagoides	**2=**	**1**	**no**	**yes**	**moderate**	**Introduce agents developed by Australia**
A. scandens	4=	4=	no	yes	moderate	Pick up at later date
Calluna vulgaris	4=	7=	yes	no	high	Promising programme already in place
***Hieracium* spp.**	**4=**	**4=**	**yes**	**no**	**high**	**Support existing programme**
Lagarosiphon major	4=	4=	no	yes	low	Many other weeds would replace the weed if successfully controlled
Pinus contorta	4=	7=	no	yes	high	Problem with potential conflicts of interest, maintain contacts with Forest Research and South African programme
Salix cinerea	**2=**	**9**	**no**	**no**	**high**	**Feasibility study**
Tradescantia fluminensis	**1**	**2=**	**no**	**yes**	**high**	**Initiate programme**

The weeds *Lonicera japonica* and *Clematis vitalba* scored highly for impact, but not so well in terms of suitability for biological control. *Clematis vitalba* has already been a target for biological control, and agents have been released that are only partially effective. Previous surveys have shown that the prospects for identifying further species that could be useful are low. Successful control of *L. japonica* is likely to lead to its replacement by other weed species, reducing the benefits of control.

The weeds *Ageratina riparia* and *Chrysanthemoides monilifera* score highly for suitability for biological control, but less highly for impact. *Ageratina riparia* is already a biological control target in the north of New Zealand, and two agents have been released. This programme is already showing excellent results (Fröhlich et al. 2000, J. Fröhlich pers. comm.). Regional councils are funding host range tests on a moth that is highly damaging to *C. monilifera* in South Africa and is a promising biological control agent in Australia.

Recent information from NIWA suggests that, if successfully controlled, *L. major* might be replaced by other submersed waterweeds. There is also a suggestion that in some freshwater systems most exotic macrophytes are more beneficial than detrimental, so until more information is available on the ecology of this weed it should not be a priority target for biological control (P.G. McGregor pers. comm.). *Asparagoides scandens* has a lower score than *A. asparagoides* for both impact and suitability for biological control. The lower score for impact may be partly because *A. scandens* is a less conspicuous species. The higher score for *A. asparagoides* in terms of its suitability for biological control is because the Australian researchers have already developed two very promising control agents. There are good prospects for biological control of *Araujia sericifera* although, currently, there is little known about potential agents, which is why it rates lower priority than *A. asparagoides*. It also rates lower priority than *T. fluminensis* because the latter weed scores higher for its impact, largely because it is more widespread. *Hieracium* spp. are weeds of concern to conservation and to pastoral agriculture. The species that currently warrants further effort to identify suitable agents is *H. lepidulum*, a major threat to many higher altitude and wetter areas of grassland and alpine vegetation.

Salix cinerea is a difficult target for biological control because willow species are widely regarded as useful trees for land stabilisation and shelter. It would be useful to review existing information on willows, the pest species known from willows including the two sawflies established in New Zealand, and the degree of conflict likely to be encountered by a programme aimed at introducing biological control agents for *S. cinerea*. With the information gathered through such a feasibility study we would be in a better position to assess the potential for biological control of this weed.

The two weeds that currently score most highly for their potential for biological control, both in terms of suitability and impact, are *Asparagus asparagoides* and *Tradescantia fluminensis*. Risks associated with a project on *A. asparagoides* are very low because very good agents are available already that are likely to be both safe and effective. The risks associated with a project for *T. fluminensis* are higher, because agents are unknown, making the costs consequently higher. However, the potential benefits are very great because the impacts of *T. fluminensis* occur over a wide range. A good balance would be achieved by funding both of these projects, one low risk, moderate benefit, the other higher risk, but high benefit.

7. Recommendations

- Initiate a biological control programme for smilax (bridal creeper), *Asparagus asparagoides*.

ACTION	APPROXIMATE COST
1. Seek collaboration with regional councils	nil
2. Survey established populations of *Asparagus* species for insects and diseases already present in New Zealand, investigate impact (if any) on cultivated *Asparagus* species	$50,000
3. Complete host range tests for the leaf hopper *Zygina* sp.	$50,000–$65,000
4. Complete host range tests for the rust *Puccinia myrsiphylli*	$50,000–$65,000

  Total cost of programme likely to be $300,000 over 3 years including ERMA costs

- Initiate a biological control programme for wandering Jew, *Tradescantia fluminensis*.
  Total cost of programme likely to be about $2 million over 8 years
- Contribute to the existing programme for biological control of *Hieracium* species.
  Cost of contribution might be approximately $50,000 per year
- Investigate the feasibility of a biological control programme for *Salix cinerea*.
  Total cost of investigation approximately $15,000
- Possible budget:

	YEAR 1	YEAR 2	YEAR 3
Asparagus asparagoides	$100,000	$100,000	$100,000
Tradescantia fluminensis	$250,000	$250,000	$250,000
Hieracium spp.	$50,000	$50,000	$50,000
Salix cinerea	$15,000		
Totals	$415,000	$400,000	$400,000

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Appendix 1

INFORMATION ON *LONICERA JAPONICA*, *SALIX CINEREA* AND *S. FRAGILIS* SUPPLIED TO VICTORIA FROUDE IN 1999

Weed species: *Lonicera japonica* Thunb.

Family: Caprifoliaceae

Common name: Japanese honeysuckle

Distribution in New Zealand, and region of origin

There are about 200 species of *Lonicera* in northern temperate regions. Three species have naturalised in New Zealand, as well as one hybrid. *Lonicera japonica* was first recorded in New Zealand in 1926, and is now abundantly distributed in and around disturbed forest, except in southern parts of the South Island. It originates from eastern Asia. The family Caprifoliaceae contains 12 genera, with 400–450 species mainly from north temperate regions. *Lonicera japonica* is also regarded as a potential target for biological control in southern USA, and as a potential pest in the Juan Fernandez Islands (Chile).

Previous biological control attempts

None known.

Insect and pathogen fauna in New Zealand

Two *Lonicera*-specific pathogens are established in New Zealand: *Pseudocercospora lonicericola*, which was originally described in Taiwan, and *Herpobasidium deformans*, a leaf blight originally described from the USA. An exotic powdery mildew has also been recorded from *Lonicera*. It is not known whether the mildew is *Lonicera*-specific or not. The honeysuckle aphid, *Hyadaphis foeneculi*, is established on honeysuckles in New Zealand, including *L. japonica*, but is most damaging on cultivated varieties. The generalist insect species *Ctenopseustis obliquana* (brown-headed leafroller), *Graphania ustistriga* (a noctuid moth), *Planotortrix excessana* (green-headed leafroller), *Costelytra zelandica* (grass grub), and *Lecanium persiceae* (a scale insect), have been recorded from other species of honeysuckle.

Insect and pathogen fauna in region of origin

Lonicera japonica has been recorded as an alternative host of the pest moth species *Heliothis virescens* and *Helicoverpa zea*. These insects are serious pests, and their use as biological control agents would not be contemplated. Although there are few reports in the literature of potential control agents, it is likely that field surveys in eastern Asia would yield possible candidates.

Are potential control agents likely to be sufficiently host-specific for introduction into New Zealand?

Some damage to cultivated *Lonicera* species is likely to result from the introduction of biological control agents. A study in the USA showed that indigenous insects caused more damage to native *Lonicera* species than to the weedy exotic *L. japonica*. However, there is only one native New Zealand genus in the family Caprifoliaceae, *Alseuosmia*, with eight species.

Feasibility of project

There is some scientific support for the medicinal value of extracts of *L. japonica* as an anti- inflammatory treatment. The plant is traditionally used for this purpose in Korea. However, there are many more effective products, and this is unlikely to be an impediment to biological control in New Zealand. It would need to be shown that the environmental and economic costs of the weed outweighed the value of *Lonicera* spp. to the horticultural industry. The viability of the project would be increased if a field survey in the native range of the weed were jointly supported by New Zealand and the USA.

Conclusions

If the nursery industry and gardeners can be convinced that the benefits of controlling wild honeysuckle outweigh the damage caused to cultivated plants, then the prospects for finding sufficiently host specific and effective biological control agents are excellent. Even if this is not possible, a convincing demonstration that the damage the weed does to conservation values greatly outweighs the value of cultivated honeysuckle to gardeners should allow the project to succeed.

Weed species: *Salix cinerea* L.; *S. fragilis* L.

Family: Salicaceae.

Common names: grey willow; crack willow.

Distribution in New Zealand, and region of origin

There are about 300–500 species of *Salix* from north temperate regions. Eleven species and five hybrids are naturalised in New Zealand. Grey willow (*S. cinerea*) was first recorded in New Zealand in 1925, and has extensively naturalised in damper areas throughout the country. The taxonomy of the genus is complex, and *S. cinerea* includes two subspecies, one of which is sometimes accorded specific status. Plants reproduce vegetatively and by seed. Crack willow (*S. fragilis*) was first recorded in New Zealand in 1880, and is now widely established on both main islands, Stewart Island and the Chatham Islands. It is native to Europe and western Asia and, following naturalisation, quickly demonstrated weedy behaviour. Regeneration from brittle, easily broken shoots has caused blockage of streams and drains. Nearly all the trees growing in New Zealand are male, probably from a single clone. Crack willow hybridises with two other species of *Salix*: *S. alba* and *S. babylonica*. There are four genera in the family Salicaceae, *Salix* and *Populus* from north temperate regions, and two from the Andes.

Previous biological control attempts

None known.

Insect and pathogen fauna in New Zealand

A number of generalist insects, or pest species, have been recorded feeding on various willow species in New Zealand. These include *Cavariella aegopodii* (carrot aphid), *Costelytra zealandica* (grass grub), *Eriococcus coriaceus* (gum tree scale), *Icerya purchasi* (cottony cushion scale), *Lepidosaphes ulmi* (apple mussel scale), *Liothula omnivora* (common bag moth), *Planotortrix excessana* (green-headed leafroller), *Pseudococcus obscurus* (obscure mealy bug), and *Quadraspidotus perniciosus* (San Jose scale). Other generalist species that have been recorded from crack willow are *Ctenopseustis obliquana*, *C. herana*, *Planotortrix octo*, *Epiphyas postvittana*, and *Cnephasia jactatana* (Tortricidae).

Two specialised willow feeders are established in New Zealand: *Pontania proxima* (Tenthredinidae), willow gall sawfly, and another recently introduced galling sawfly, *Nematus oligospilus* (Tenthredinidae) that is now severely defoliating willow trees. The latter species has also recently established in South Africa. Two species of rusts that attack willows are also established in New Zealand. One of them, *Melampsora epitea*, attacks grey willow. Neither is thought to have significant impact on crack willow.

Insect and pathogen fauna in region of origin

Pests and diseases of willow species in the northern hemisphere are well known because species of willow are grown commercially. There are many pest species, and some of these have a narrow host range, attacking only one, or several, species of *Salix*. A considerable amount of work has been done to develop cultivars of *Salix* resistant to various pest species.

A selected list of some willow-feeding species is presented in Table 1.

Are potential control agents likely to be sufficiently host-specific for introduction into New Zealand?

Although there are no native New Zealand species that are close relatives of willows, willows are regarded as valuable plants. They are frequently used in shelter-belts, for erosion control, and river stabilisation. Therefore, any control agent for grey and crack willow would have to be specific to these species, and not attack desirable species of willow. However, if cultivars were available that were resistant to attack by the potential control agent, then introduction might be possible.

Feasibility of project

Several exotic pest species have established recently on willows in New Zealand, raising concerns for the protection of willows grown for commercial purposes. A biological control programme for *Salix* spp. is likely to come under intense scrutiny to ensure that commercially grown plants are not at risk. However, there is an enormous amount of literature on the relationship between *Salix* species and their herbivores, so the information is available to determine whether potentially useful biological control agents for *S. cinerea* and *S. fragilis* exist.

Conclusions

It would be worth undertaking a thorough literature survey, followed up by discussions with relevant researchers, to identify whether suitable biological control agents are available. It is also necessary to determine the extent of commercial use of willow species in New Zealand.

TABLE 1. INSECT HERBIVORES RECORDED FROM *SALIX* SPP. (WILLOWS) IN THEIR NATIVE RANGES.

WILLOW SPECIES	INSECT HERBIVORE	DAMAGE/SPECIFICITY
Salix americana	*Phyllobius oblongus*	
	Polydrusus corruscus	
	P. sericeus	
	Lepyrus palustris (Curculionidae)	
Salix spp.	*Phratoria* spp. (Chrysomelidae)	important pest
Salix spp.	17 *Cacopsylla* spp.	
	(Psylloidea)	
Salix spp.	*Phratoria vulgatissima*	
	Galerucella lineola	
	Lochmaea capreae	
	(Chrysomelidae)	
S. lasiolepis	*Euura lasiolepis* (Tenthredinidae)	shoot galls
S. sachalinensis	*Plagiodera versicolora* (Chrysomelidae)	bivoltine
Salix spp.	*Pontania* spp. (Tenthredinidae)	
S. fragilis	*Nematus* (=Pteronidea) *melanocephalus*	
	(Tenthredinidae)	
Salix spp.	*Tuberolachnus salignus*	
	Plerocomma salicis (Aphididae)	
Salix spp.	*Phyllonorycter* sp.	
	Phyllocnistis sp.	
	Aculops tetanothrix	
	Phyllocolpa nigrita	
	P. elcanorae	
	P. terminalis	
	(Pyralidae)	
S. viminalis	*Cryptorynchus lapathi* (Curculionidae)	
S. cinerea	*Euura mueronata* (Tenthredinidae)	
Salix spp. including	*Nematus salicis*	
S. fragilis	*N. pavidus* (Tenthredinidae)	
Salix spp. including	*Phyllopertha horticola*	no species or cultivar completely resistant
S. fragilis	*Melasoma vigintipunctatum*	
	(Chrysomelidae)	
Salix spp.	Rust fungus	highly damaging
	Melampsora spp.	

Appendix 2

LIST OF WEED SPECIES. SPECIES THAT SCORED ≥ 28 IN 'TOTAL 2 × EOS + BSR SCORE'; ≥ 27 IN 'TOTAL 2 × EOS + BSR SCORE' AND 9 IN 'OTHER SCORES' (OWEN 1997); OR ≥ 4 IN 'TOP 10, THREAT + DIFFICULT TO CONTROL' (FROUDE 2002).

WEED SPECIES	COMMON NAME	TOTAL 2 × EOS + BSR SCORE (a)	TOP 10 THREAT + DIFFICULT TO CONTROL (b)	a + b	ADDITIONAL SCORES* (c)	a + b + c	COMMENTS RE INVASIVENESS, EXISTING CONTROL
Ageratina adenophora	Mexican devil	29	3	32	6	38	Under partial control from biological control agents
Ageratina riparia	mist flower	31	1	32	6	38	Invades streamsides, forest understorey, biological control promising
Alternanthera philoxeroides	alligator weed	28	0	28	6	34	Under partial control from biological control agents
Ammophila arenaria	marram	32	6	38	9	47	Planted for soil stabilisation, potential conflict
Anredera cordifolia	Madeira vine	25	5	30	6	36	Does not spread by seed, so not high priority
Araujia sericifera	moth plant	27	7	34	5	39	Invasive in coastal scrub habitats
Arundo donax	giant reed	29	0	29	7	36	Invasive in wetlands
Asparagus asparagoides	smilax	30	6	36	7	43	Spreading southwards, seed spread by birds, seeds persistent.
Asparagus scandens	climbing asparagus	28	5	33	7	40	Effective control with glyphosate
Caesalpinia decapetala	Mysore thorn	34	0	34	6	40	A problem on Raoul Island, target for eradication
Calluna vulgaris	heather	27	5	32	9	41	Highly invasive in low-fertility grasslands, subalpine vegetation, biological control promising
Cestrum elegans	red cestrum	28	0	28	5	33	Rapid recent invader, replacing other submerged water weeds
Chrysanthemoides monilifera	bone-seed	28	4	32	7	39	Invasive in coastal and drier areas, great potential for further spread
Clematis vitalba	old man's beard	33	7	40	7	47	Highly invasive vine, strangling native trees on forest margins Biological control partially effective
Cobaea scandens	cathedral bells	30	0	30	7	37	Chemical control probably effective, but ongoing surveillance required
Cortaderia jubata	purple pampas	28	9	37	8	45	Widespread and invasive in open and disturbed sites
Cortaderia selloana	pampas	28	9	37	8	45	
Crataegus monogyna	hawthorn	31	0	31	5	36	Invasive, increasing problem in some dryland ecosystems
Cytisus scoparius	broom	25	6	31	6	37	Increasing problem in high country. Biological control partially effective
Ehrharta villosa	pyp grass	29	0	29	6	35	Invasive in dune systems, chemical control effective, eradication prospect
Elaeagnus × reflexa	elaeagnus	31	5	36	7	43	Very invasive, chemical control effective
Equisetum arvense	horsetail	21	4	25	5	30	Highly invasive, target for local eradication or containment, but no control method
Festuca arundinacea	tall fescue	29	0	29	6	35	Invasive in both saline and freshwater wetlands, conflict of interest
Glyceria fluitans	floating sweetgrass	28	0	28	6	34	Invasive in wetlands and waterways
Gymnocoronis spilanthoides	Senegal tea	29	0	29	3	32	Not widespread, and known infestations are being successfully controlled

Hedychium gardnerianum	kahili ginger	31	3	34	7	41	Widespread and serious problem. Smaller infestations successfully controlled by chemical and mechanical means
Hieracium spp.	hawkweed	29	3	32	7	39	Widespread and invasive. Biological control target. *H. lepidulum* an increasing problem
Hydrodictyon reticulatum	water net	28	0	28	6	34	Invasive in water bodies, some controls available, not as serious as previously thought
Ipomoea indica	blue morning glory	30	1	31	7	38	Widespread in the north, and invasive. Chemical control possible
Jasminium polyanthum	jasmine	30	1	31	7	38	Highly invasive, capable of smothering very large areas of canopy/ shrub layer
Juncus articulatus	jointed rush	27	0	27	9	36	Little information on impact in natural ecosystems
Juncus bulbosus	bulbous rush	27	0	27	9	36	
Lagarosiphon major	lagarosiphon	27	6	33	6	39	Invasive, difficult to control chemically
Lantana camara var. *aculeata*	lantana	28	0	28	7	35	Widespread in the north, still cultivated. Difficult target because of complex genetics
Ligustrum lucidum	tree privet	32	0	32	6	38	Major and widespread problem in the north. Persists in canopy of secondary vegetation, but can be chemically controlled
Lonicera japonica	Japanese honeysuckle	31	9	40	7	47	Widespread, currently occupying early successions and forest margins. Has potential to greatly increase its range.
Pennisetum clandestinum	kikuyu grass	29	0	29	8	37	Important stock food in dry northern areas
Pennisetum macrourum	African feather grass	31	0	31	8	39	Chemical control is effective
Pennisetum setaceum	African fountain grass	32	0	32	8	40	Chemical control possible, but seed is long-lived, so ongoing control required
Pinus contorta	lodgepole pine	28	8	36	7	43	Highly invasive, but important commercial relatives
Pinus spp.	wilding pine	27	6	33	7	40	Important commercial crop plants
Rhamnus alaternus	evergreen buckthorn	29	4	33	7	40	Widespread on northern islands, but otherwise very limited in distribution
Rosa rubiginosa	sweet briar	28	0	28	6	34	Low-grade problem
Rubus fruticosus agg.	blackberry	31	0	31	7	38	Problem in disturbed and open sites. Biological control target by forestry
Salix cinerea	grey willow	32	7	39	6	45	Highly invasive in wetlands. Difficult to control chemically
Salix fragilis	crack willow	28	6	34	6	40	Moderately invasive, vegetative reproduction only, also cultivated plant
Sedum acre	stone crop	28	3	31	4	35	Invading dryland environments, rock ledge habitats
Senecio angulatus	Cape ivy	29	1	30	5	35	Moving southwards, chemical control very effective
Solanum jasminoides	potato vine	32	0	32	5	37	Vigorous invading climber, moving southwards. Favoured garden plant
Stipa trichotoma	nassella tussock	27	0	27	9	36	Highly invasive in grasslands
Tradescantia fluminensis	wandering Jew	25	9	34	6	40	Vigorous invasive ground cover, prevents regeneration of native seedlings
Tropaeolum speciosum	Chilean flame creeper	23	6	29	4	33	Invasive on forest edges. May have potential to be more destructive. Difficult to control
Ulex europaeus	gorse	28	3	31	7	38	Existing biological control partially effective, little prospect for further control

* Sum of scores for increased fire hazard, competitive ability and resistance to management (Owen 1997).

Appendix 3

THE SUITABILITY FOR BIOLOGICAL CONTROL SCORE VERSUS THE WEED IMPACT SCORE

TABLE 1. SCORES FOR 'TOP 24' WEED SPECIES REPRESENTING THEIR IMPACT ON THE ENVIRONMENT AND DIFFICULTY TO MANAGE. NOTE: THE 'TOP FIVE' WEED SPECIES ARE IN BOLD.

WEED ATTRIBUTE/ WEED SPECIES	IMPACT: 2 × EOS + BSR SCORE ÷2 (20)	DISTRIBUTION OF IMPACT (10)	REPLACEMENT WEEDS (8)	OTHER CONTROL METHODS (8)	TOTALS (46)
Ageratina adenophora	15	3	3	6	27
Ageratina riparia	16	1	3	6	26
Ammophila arenaria	16	6	1	6	29
Araujia sericifera	14	7	2	6	29
Asparagus asparagoides	**15**	**6**	**3**	**8**	**32**
Asparagus scandens	14	5	2	8	29
Caesalpina decapetela	17	0	1	6	24
Calluna vulgaris	14	5	4	6	29
Chrysanthemoides monilifera	14	4	3	4	25
Clematis vitalba	**17**	**7**	**4**	**6**	**34**
Cortaderia jubata	14	9	2	6	31
Cortaderia selloana	14	9	2	6	31
Elaeagnus × reflexa	16	5	1	4	26
Hedychium gardnerianum	16	3	4	4	27
Hieracium spp.	15	5	1	8	29
Lagarosiphon major	14	6	3	6	29
Ligustrum lucidum	16	0	3	4	23
Lonicera japonica	**16**	**9**	**2**	**6**	**33**
Pinus contorta	14	8	3	4	29
Pinus spp.	14	6	3	4	27
Rhamnus alaternus	15	4	2	4	25
Salix cinerea	**16**	**7**	**3**	**6**	**32**
Solanum jasminoides	16	0	1	6	23
Tradescantia fluminensis	**13**	**9**	**4**	**8**	**34**

TABLE 2. SCORES FOR WEED SPECIES INDICATING THEIR SUITABILITY FOR BIOLOGICAL CONTROL. NOTE: THE 'TOP FIVE' WEED SPECIES ARE IN BOLD.

WEED ATTRIBUTE/ WEED SPECIES	CONFLICTS OF INTEREST (4)	SUCCESS ELSEWHERE/KNOWN AGENTS (8)	VALUED RELATIVES (5)	ACCESS TO NATIVE RANGE (5)	FUNDING PARTNERS, INTERNAT. (3)	FUNDING PARTNERS, LOCAL (3)	TOTALS (28)
Ageratina adenophora	4	2	5	5	0	0	16
Ageratina riparia	4	8	5	5	3	3	28
Ammophila arenaria	1	0	5	3	0	0	9
Araujia sericifera	4	0	5	5	0	3	17
Asparagus asparagoides	**4**	**8**	**1**	**5**	**3**	**3**	**24**
Asparagus scandens	4	2	1	5	1	3	16
Caesalpina decapetela	4	0	5	3	0	0	12
Calluna vulgaris	3	4	3	3	0	1	14
Chrysanthemoides monilifera	4	6	5	5	3	3	26
Clematis vitalba	**4**	**0**	**1**	**3**	**0**	**3**	**11**
Cortaderia jubata	2	0	1	5	1	3	12
Cortaderia selloana	2	0	1	5	1	3	12
Elaeagnus × *reflexa*	3	0	5	0	0	0	8
Hedychium gardnerianum	4	2	3	3	1	1	14
Hieracium spp.	4	0	5	3	1	3	16
Lagarosiphon major	4	0	3	5	1	3	16
Ligustrum lucidum	3	0	3	3	1	1	11
Lonicera japonica	**3**	**0**	**3**	**1**	**1**	**3**	**11**
Pinus contorta	4	2	1	3	1	3	14
Pinus spp.	1	2	1	3	1	3	11
Rhamnus alaternus	4	0	5	3	0	0	12
Salix cinerea	**4**	**2**	**1**	**3**	**0**	**3**	**13**
Solanum jasminoides	3	0	1	5	0	0	9
Tradescantia fluminensis	**3**	**0**	**5**	**5**	**1**	**3**	**17**

Appendix 4

BIOLOGICAL CONTROL PROJECTS THAT WERE FUNDED BY REGIONAL COUNCILS IN 2001/02

1. Evaluate the feasibility of developing biological control for Japanese honeysuckle (*Lonicera japonica*), blue morning glory (*Ipomaea indica*), and three aquatic weeds (hornwort (*Ceratophyllum demersum*), *Egeria densa* and *Hydrilla verticillata*).
2. Liaise with other weed research organisations in countries where moth plant (*Araujia sericifera*) is a problem to investigate the possibility of collaboration.
3. Develop biological control for banana passionfruit (*Passiflora* spp.) by:
   - Establishing the identity and status of *Septoria passiflorae* (an agent released for the biological control of banana passionfruit in Hawaii) in New Zealand.
   - Conducting preliminary host-range tests on one insect agent in Hawaii and writing an application to import four insects into quarantine for testing here.
   - Liaising with Hawaiian researchers about progress towards developing biological control for this target.
4. Develop biological control for bone-seed (*Chrysanthemoides monilifera*) by:
   - Completing host-range testing of the defoliating moth, *Tortrix* sp.
   - Liaising with Australian researchers about progress towards developing biological control for this target.
5. Develop biological control of mist flower (*Ageratina riparia*) by:
   - Monitoring the distribution and health of mist flower in the Waitakere Ranges.
   - Monitoring mist flower fungus and gall fly release sites.
   - Continuing trials to find out what replaces mist flower at release sites.
6. Collect, test, and import the superior Spanish strain of gorse thrips (*Sericothrips staphylinus*) from Hawaii.
7. Develop biological control for Chilean needle grass (*Nassella neesiana*) and nassella tussock (*N. trichotoma*) by:
   - Contributing towards funding for a plant pathologist in Argentina to look for suitable pathogens.
   - Liaising with Australian researchers about progress towards developing biological control for this target.