Environmental Weeds Research Plan 1997–2006

Susan Timmins

Published by
Department of Conservation
PO Box 10-420
Wellington, New Zealand

ISBN 0-478-01951-3

This publication originated from work done under Department of Conservation Investigation no. 2203, carried out by Susan Timmins (Plant Ecologist), Science and Research Division. It was approved for publication by the Director, Science and Research Division, Science Technology and Information Services, Department of Conservation, Wellington.

Comments and enquiries to: Susan Timmins, Science, Technology, and Informatiion Services, Department of Conservation, PO Box 10-420, Wellington.
Phone: (04) 471-3234 Fax: (04) 471-3279 email: stimmins@doc.govt.nz

Cataloguing in Publication
Timmins, Susan M. (Susan May), 1957-
Environmental weeds research plan 1997-2006 / Susan Timmins.
Wellington, N.Z. : Dept. of Conservation, 1997.
1 v. ; 30 cm.
Includes bibliographical references.
ISBN 0478019513
1. Weeds--Control--New Zealand. I. New Zealand. Dept. of Conservation. II. Title.
632.580993 20
zbn97-092520

CONTENTS

1. Introduction

Environmental weeds are widespread in New Zealand and are having a major and increasing impact on conservation values. It is imperative that environmental weed management is strategic and is focused to achieve the greatest conservation gain. Weed management must also be based on ecological principles underpinned by sound research findings. This research plan establishes the priorities for the Environmental Weeds Research Programme for the Department of Conservation for the next decade. This plan is a component of the Department of Conservation Research Science and Technology Biodiversity Programme.

2. Overview

Environmental weeds alter the structure, function, species composition and extent of native communities sometimes permanently. The initial gradual rate of invasion and, at first, subtle impact of environmental weeds on native communities, can go largely unnoticed until the weeds have become a major threat to the conservation values of the invaded communities (Humphries *et al.* 1993). Weeds are often a symptom as well as the cause of a dysfunctional ecosystem; we must develop research that will expose the root of the problem so we can treat it rather than just the symptom.

Weeds have invaded practically all types of native community in New Zealand: terrestrial, freshwater and marine; and almost the full range of altitude, soil type, rainfall and temperature. In some cases we know little about these communities *per se*, e.g. ephemeral wetlands. There are just a few communities which are currently weed-free e.g. infertile, alpine areas. A few isolated northern islands are weed-free but only because of limited human activity on the islands to date. The subantartic islands have introduced plants present but none that pose a threat at the moment. Vulnerability of a site to invasion by weeds is associated with factors such as disturbance, human activity, and the presence of animal vectors. There are likely to be other factors as yet undetermined.

The potential for further spread of weeds in New Zealand's native communities is enormous. For example, although there are large tracts of intact native forest which have no weeds there are species already present and spreading in New Zealand which could readily invade these communities, e.g. vines such as ivy *Hedera helix*. There are no formal mechanisms, and perhaps it is not possible, to prevent the transport of weed species into these vulnerable, presently weed-free areas although some Regional Pest Management Strategy's restrict the sale of particular species.

There are about 20,000 introduced plant species in New Zealand, 2,000 of them are naturalised (reproducing unaided in the wild). About 20 new species naturalise each year and this number is increasing each decade. The rate is also predicted to increase with global warming. Most naturalised species will cause no problem: they will remain uncommon or they are an innocuous herb. However, it has been suggested that 10% of the newly naturalised species will become weedy. While it is not yet possible to reliably predict which naturalised species will become major environmental weeds, we can be suspicious about species which are already weeds overseas in other countries.

As at mid 1997, 247 species were recognised as weeds of conservation concern. This number is growing all the time with new naturalisations and better information about weed distribution and ecology. Only a few of these species have spread to the limits of available habitat. Some are just starting to spread now. Many are currently in the "lag" phase and their weedy potential is yet to be fully expressed (Panetta 1994). These "sleepers" need to be watched so that early control can be actioned if needed.

The majority of recently recognised environmental weeds are garden escapes. Many weeds first arise in the Auckland region, with its warm climate and large human population. Some groups of plants (genera, families) are more weedy than others and some growth forms (in particular, vines, shrubs and grasses) have a disproportionate number of weeds (Williams in press). Many weeds are generalists and invade niches in New Zealand different from those of their country of origin. Many grow better in New Zealand than in their native country. Only a few of the environmental weeds in New Zealand have been the subject of an autecological study; most species require this (study of a single species and its relationship with the environment).

Given the magnitude of the conservation threat caused by weeds and the difficulty and cost of controlling weeds once they become established, a fundamental principle of weed management is that prevention is better than cure. Invasions should be prevented from occurring and control should be initiated at an early stage. That said, the objective of weed control must be to conserve native species diversity, genetic diversity and ecological processes: weed control is not an end in itself. Establishing which weed species, and the situations in which they should be controlled, is a critical first step. Once a weed control programme is embarked upon, it must be seen through to completion. Persistence pays; it is ineffective to dabble. Consistent, rigorous performance monitoring is an essential element of any control programme.

Weed control methods and approaches vary considerably with the weed species to be controlled, vegetation type and conservation status of the invaded area, density and size of the infestation, physical attributes of the site, and the desired outcome of the weed control programme. New methods, tailored to these varying situations and appropriate for native communities, need to be developed.

The reasons for doing weed control vary from meeting a statutory responsibility through to protecting a threatened native community or species. Likewise, weed control may be constrained by geographic isolation, practical difficulties, legal limitations or occupational safety and health requirements. Many weed control programmes require co-operation with other agencies if they are to be effective. Some weed control techniques require the Minister of Conservation's consent, e.g., biological control. Control of a weed species does not guarantee that the native community will return to its natural state; sometimes rehabilitation is necessary.

There is a growing concern, but limited understanding, about the long term and/or non target effects of weed control techniques, particularly chemical control which is usually non selective. The response of native communities to weed control is little understood and difficult to predict. Biological control, which is usually host specific, is increasingly being promoted as an alternative. Although it can be a powerful tool, it has not been accepted by all and realistically will not be a substitute for targeted chemical control for most of the weed species the Department needs to control. An investigation of the biocontrol method from a conservation perspective, including possible non-target effects, would allow its use to be appropriately advocated. Which ever method is used, control must be integrated with other restoration activities.

Weed invasions are principally associated with human activity such as landuse change, site disturbance and people moving about (Timmins and Williams 1991), yet public awareness of weeds is still limited. Thus, information collection, storage and dissemination must be a fundamental component of all weed research. It will be a key role of any new conservancy weed staff. While this plan documents a long list of weed research required, there is already a store of information, much of it anecdotal. Some information is not readily available. Other information is stored in various weed databases (e.g., conservancy databases, Owen 1997, Timmins and Mackenzie 1995), conservancy weed manuals and weed strategies. There is also an annotated bibliography of New Zealand environmental weed references (Swarbrick and Timmins 1997). Because the information is always changing, these sources of information, while useful, need to be maintained, updated and expanded to allow weed management to become more effective. In addition to New Zealand sources, there is a raft of useful information available overseas on the ecology and management of many of our weed species. This should be accessed. It is important that all information on weed ecology and control is collated for electronic access and interaction by weed managers, and other sectors, so that integrated management becomes a reality rather than a concept.

3. External programmes and linkages

3.1 OTHER INITIATIVES

Several initiatives both within and outside the Department make the development of this research plan timely, and indeed necessary. The Foundation for Research Science and Technology (1996) describes some key gaps in weed research:

> "Invasive weeds are causing increasing concern in forest, shrubland, grassland, wetland, duneland and freshwater ecosystems. There is a high diversity of adventive species which are currently restricted to Northland but which are poised to become major problems, particularly if climatic warming allows a southern extension of their range. Research is needed to enable us to predict the invasive impact of new and regionally restricted weeds and to manage their impacts. Sustainable control methods, based on a sound understanding of the ecology of problem weeds, will be needed to avert a major impact on indigenous biodiversity and sustainable land use."

The Biosecurity Act requires that the Department works co-operatively with other agencies to achieve weed control, a process that will be enhanced by a good understanding of the ecological impact of environmental weeds and their potential for control. The impending biodiversity protection priority setting process in the Department will require predictive models for forecasting the consequences of different weed management options at specific sites. The development of the mainland island management concept (Clout and Saunders 1995) will increase the need for sustained control and make efficient control options all the more desirable. Public attitudes to the use of chemicals also require that chemicals are used efficiently and sparingly and that alternative control options are investigated.

3.2 RESEARCH PROVIDERS AND STAKEHOLDERS

Some of the research listed below can be achieved in-house, particularly the information transfer, public relations and weed control through research-by-management. The opportunity for this will be maximised if the Departmental business planning and the Science and Research Division bidding round can be synchronised. Other research must be contracted out to Crown Research Institutes, universities or other providers (see Appendix 6). One of the major funders of environmental weed research is the Foundation for Research Science and Technology. Autecological studies may be best achieved by funding University graduate students.

The list of stakeholders in weed research, and particularly in weed management, is very long including a variety of land owners, plant users and recreationists plus administrators of policy which impinges on weed spread and control (see Appendix 7). The Department must work co-operatively with these stakeholders in developing, conducting and funding weed research.

4. Programme strategy

4.1 RESEARCH AREAS AND PRIORITY SETTING

A list of general weed research topics is given in each of five areas:

1. Native communities and species
2. Weed species ecology
3. Weed control methods
4. Public perceptions and actions
5. Information transfer.

Each of the topics has been ranked for urgency and importance:

Urgency

A Research information needed now (within 1–2 years)

B Research information needed in the medium term (5 years)

C Research information needed in the longer term (10 years)

Importance

1 Research essential before management can proceed

2 Management can proceed but will be sub-optimal without research

3 Nice to know

Ranks are given in **bold** at the end of each topic line.

For some research topics, more detailed investigation proposals are given in appendices. The topics are a guide to the priorities for weed research. The investigations that are subsequently developed should be designed so that the results can be interpreted generically. For example, although a research investigation may focus on a particular weed species in a particular community, the investigation should be designed so that it can cover a range of temporal and geographical scales.

4.2 RESEARCH TOPICS

4.2.1 Native communities and native species

1. Identify which vascular plants and vertebrate animals are threatened specifically by weeds and are a priority for research investigations. Demonstrate the effects of particular weeds on particular threatened plants and animals. Develop the ability to forecast the effects of weeds on threatened plants and animals **A1**
2. Model the short and long term impacts of weeds on the species composition, structure and functioning of native communities.

Are the effects cumulative over time? Do weed impacts vary depending on the suite of weeds or the suite of native species? Are weed impacts limited or modified by climatic or other variables? Can a predictive model of the long term impacts of weeds in different communities be produced?

In particular, investigate the impacts of weeds in threatened native communities (i.e., threatened by weed invasion or other factors), i.e., gumfield, duneland, ephemeral wetland, lake, tussockland (especially lowland-montane), estuarine saltmarsh, coastal shrubland, braided riverbed, riparian communities, dry shrubland, communities on lowland limestone, calcareous base rock, ultramafic, cliff and colluvial deposits **A2**

Some specific research topics in these threatened communities are listed in Appendix 1, e.g., the effects of nitrogen fixers on gumland, the impact of bone-seed in duneland, the characteristics of ephemeral wetlands vulnerable to weed invasion.

3. Predict the weed species composition and distribution of New Zealand in 100 years time **A2**

4. Quantify and forecast the relationship between weediness and activities such as wild animal control, grazing, removal of stock, oversowing, fertilising, fencing, drainage, flooding, burning, fire control, fire breaks, track construction and recreation in native communities.

   Develop a predictive model of weed response to animal control. Mainland islands could be used as part of a study to compare the weediness of sites with and without animal control. **B1**

5. Investigate what attributes and processes make particular native communities vulnerable to weed invasion. Identify other causal mechanisms for weed invasions into protected natural areas. Apply the information from the existing computer-based weed risk assessment models to native communities **B2**

6. Monitor the process of weed invasions on islands where there are lower re-invasion rates and thus potential for eradication. **C3**

7. Monitor selected, low conservation value, weedy native communities to study the long term effects of weeds when left uncontrolled. This item offers a method for achieving research topic 4.2.1 (no.2) above, using reserves which would not attract control funds **C3**

8. Identify lichen and moss communities in which weed species pose the greatest threat; detail the impacts of weeds. **B2**

9. Study the impact of weeds on invertebrates: identify which invertebrate species are threatened by weeds, quantify the impacts. It is recognised that for some invertebrate species, general ecological investigations must precede the study of weed/invertebrate interactions. **B2**

4.2.2 Weed species ecology

1. Determine which weed species will spread to which part of the country, region, community type, protected natural area. Refine the weed risk assessment model developed for border control to better suit weeds of conservation concern and test it in different parts of New Zealand. **A1**

2. Develop early warning diagnostics for the recognition of potential weed species. **A1**

3. Determine for which species information is lacking but required for management. Establish priorities for literature review and further autecological research using Effect on System and Biological Success ratings. Some potential candidates for ecological research are given in Appendix 2.

   Undertake autecological studies of weeds of conservation land for which ecological information is lacking, but required for effective management. **A1**

   Studies should include: distribution, spread, dispersal mechanisms, reproductive ecology, seed bank existence and longevity, impact of weed species on native communities and behaviour of species at the invasion front. Studies should report of work done on the same species in other countries.

   Feed information from autecological studies into the weed database promulgated through topic 4.2.5 (no.1).

4. Investigate the lag phase which most weed species exhibit; determine if it is a real phenomenon and what factors control it. **C2**

5. Identify which native species have the potential to behave as weeds in native communities, and which land management practices might promote weediness of native species. **C3**

6. Determine the potential of northern *native* species to extend beyond their natural range as a result of particular land management practices. **C3**

4.2.3 Weed control methods

1. Identify which weed species of conservation concern have no suitable, or only sub-optimal, control methods. Establish priorities for research on the basis of conservation imperative. Appendix 3 lists some potential candidates **A1**

2. Review biological control from a conservation perspective including consideration of factors such as: host specificity of biological control agents, protection of native biodiversity, potential for interbreeding between biocontrol agents and native organisms. Develop criteria for assessing under what circumstances the Department of Conservation should initiate or support biological control programmes **B2**

3. Develop a robust, simple protocol for monitoring the effects of weed control operations so that normal Departmental weed management activities can be used as scientific experiments and the results can be applied widely. **A2**

4. Investigate the potential of managing ecotones, including suppression planting, to minimise weed invasions into reserves and control existing infestations. Review existing experimental work. **B2**

5. Investigate the post-control response, such as vegetative resprouting and emergence from seed banks, of problematic species, e.g., willow species, lantana. **A2**

6. Develop a set of criteria for judging under what circumstances (species, places, time span) active weed control is not appropriate because natural

succession can suppress weeds OR weed control is not possible because it is intractable **B2**

7. Develop the best control methods (i.e., cost effective, practical, environmentally acceptable) for the priority species identified in research item 3.2.3 (no.1). See Appendix 3 for specific examples. **B2**

8. Identify potential weed species as candidates for biological control programmes on the basis of no effective control method available (see research topic 4.2.3 no.1), priority for control (see topic 4.2.5 no.1), and availability of suitable biological agents and programmes already in existence overseas. Some potential candidates for biological control are listed in Appendix 4.

   Contribute to funding to biological control research programmes initiated by other agencies where the weed species is of conservation significance. Give highest priority to those species for which control is the most intractable and/or for which a biocontrol programme has already been developed elsewhere **B2**

9. Develop models of integrated management incorporating weed control with other practices such as animal control, fencing, burning and planting **B1**

10. Investigate the specific effects of weed control chemicals on non target native plants animals and soils. **B2**

11. Investigate weed control strategies for specific weed species/situations and record generic as well as specific results in the weed database (4.2.5 no.1). See Russell lupin example in Appendix 3. ..... **B2**

12. Investigate the potential of active management techniques, such as grazing, flooding and control of exotic birds to improve the long term viability of lowland forest fragments invaded by weeds. **B2**

13. Investigate the efficacy of non chemical weed control technologies for application on conservation land, e.g., steam, loppers **B2**

4.2.4 Public perceptions and actions

1. Investigate the public's understanding and perception of the threat posed by weeds to conservation values. What advocacy is required and how could this be effected? **A2**

2. Establish the impact of visitor activity on weed distribution and density, in high value reserves including islands, e.g., weed ingress via roads, rubbish dumps, helicopter pads, huts, and concessionaires) **A2**

3. Investigate the impact of subdivision of coastal shrubland on weed spread. Do weed invasions vary with the demography and socio-economic status of the subdivision inhabitants? **B3**

4. Seek to understand the basis of chemophobic fears. **B1**

5. Assess the effectiveness of weed advocacy campaigns **B3**

6. Assess the cost and ecological effectiveness of community groups doing weed control. **C3**

4.2.5 Information transfer

National co-ordination

Co-ordinate nationally the gathering and dissemination of weed information, i.e., develop well maintained, on line database(s). Information must include:

1. Distribution of weed species in New Zealand; e.g., collected by 10 km grid square **A1**
2. A "black list" of species **A1**
3. New species of conservation concern **A1**
4. Identification material including photographs and line drawings **A1**
5. Control methods (recipes) for all weeds of conservation concern: best techniques, chemicals and concentrations, optimum season for control, non-effective methods, methods used overseas **A1**
6. Results of field trials and research by management experiments **A1**
7. Ratings for Effect on System and Biological Success for all environmental weeds, scored for each ecological region **A2**
8. Ecological information for black list species **A2**
9. Chemicals: species effective on, application rate, non-target effects, residual effects (connect into local authorities' databases) **B2**
10. Agencies and individuals involved in weed ecology, management and control **B2**

The databases which already exist contain some of the information listed above for some of the relevant species and places. The data collection and dissemination must be formalised and the coverage of the databases expanded. For other items, a mechanism for systematic collection, recording and dissemination is needed, e.g., for new species of concern.

Information transfer

Develop systems for information transfer within the Department between head office, Science Technology and Information Services Division, conservancies and field centres and between relevant agencies, e.g., universities, research providers. This includes development of databases (see item 4.2.5 no.1 above), but also dissemination of the information in a timely and useable fashion (e.g., by Email), and generating action on weeds from the wider community **A1**

Some specific public relations ideas are listed in Appendix 5.

5. Acknowledgements

Thanks go to the participants in a two day workshop where the overview information, research topics and rankings were developed: Chris Buddenhagen, Shannel Courtney, Lisa Forester, Bruce Kyle, Colin Miskelly, Colin Ogle, S-J Owen, Chris Richmond, John Sawyer, Susan Timmins, Dick Veitch, Carol West and Chris Woolmore. Helpful comments on earlier drafts were gratefully received from Peter Williams (Landcare Research Nelson) and S-J Owen, Carol West, Colin Ogle and Chris Richmond (Department of Conservation) and Dane Panetta (Department of Natural Resources, Queensland).

6. References

Clout, M.N.; Saunders, A.J. 1995. Conservation and ecological restoration in New Zealand. *Pacific conservation biology* 2: 91–98.

Foundation for Research, Science and Technology 1996. Research strategy for the Public Good Science Fund 1996/1997 to 2000/2001: Land and freshwater ecosystems. 30p.

Humphries, S.E.; Groves, R.H.; Mitchell, D.S. 1993. Plant invasions: homogenising Australian ecosystems. Pp. 149–170 *in* Montz, C.; Kikkawa, J. (Eds): Conservation Biology in Australia and Oceania. Surrey Beatty and Sons, Chipping Norton.

Owen, S.J. (Comp.) 1997. Ecological weeds on conservation land in New Zealand: a database. January 1997 working draft. Department of Conservation, Wellington.

Owen, S.J.; Scobie, S. 1995. Conservancy guidelines for preparing a strategic plan for the management of ecological plant pests. (Unpublished manuscript, Department of Conservation, Wellington.)

Panetta, D. 1994. Identifying and managing the next century's problem weeds. Pp. 9–31 *in* Popay, A.I.; Hartley, M.J. (Eds): Potential problem weeds. *Proceedings of a New Zealand Plant Protection Society Seminar*. New Zealand Plant Protection Society, Rotorua.

Swarbrick, J.T.; Timmins, S.M. 1997. Annotated bibliography of environmental weeds in Australia and New Zealand. Environment Australia Biodiversity Group, Canberra, Australia. (713 references, hard copy and soft copy of Access 2 database.)

Timmins, S.M.; Mackenzie, I.W. 1995. Weeds in New Zealand protected natural areas database. *Department of Conservation Technical Series* 8. (Department of Conservation, Wellington.)

Timmins, S.M.; Williams, P.A. 1991. Weed numbers in New Zealand's forest and scrub reserves. *New Zealand journal of ecology* 15: 153–162.

Williams, P.A. (in press). Ecology and management of invasive weeds. *Conservation sciences publication no.7*. Department of Conservation, Wellington.

Appendix 1

Specific research topics on the impacts of weeds in particular native communities

Priority rankings reflect such factors as the scarcity of the community in New Zealand, its rate of ecological change, and vulnerability to invasive weeds.

- The effects of nitrogen fixers on low fertility communities of gumland, pakihi and dunelands **A1**
- The attributes that make ephemeral wetlands vulnerable to weed invasion (e.g., grazing, inundation cycle, fluctuating lake edges). **A1**
- The impact of bone-seed in coastal communities (considerable autecological and synecological work has been, and is being, done in Australia) **A2**
- The successional pathway of dry land shrubland invaded by woody shrubs such as sweet brier. What impact do factors such as exotic fauna or weed control have on succession? **B1**
- The successional pathway of lowland limestone and ultramafic communities invaded by weeds; what is the "climax" community?. **B1**
- The effects of grasses and herbs on native species in sand dune hollows. **B2**
- The short and long term effects on threatened native species of the ubiquitous weeds such as clover, browntop, sweet vernal, Yorkshire fog and soft rush, which are often not regarded as weeds of conservation concern. **B2**
- The impact of heavy pine infestations on the invertebrates, plant composition, soil and water of tussock grasslands. **B2**
- The ability of native salt marsh communities to regenerate after spartina control. **B2**
- The effects of weeds on the biodiversity and hydrology of dune slacks, and the potential of buffers as a control technique. **B2**
- Comparative, long-term studies with a conservation focus on plant / animal relationships in tussock grasslands (much of the past work has focused on agricultural systems). **B2**
- In riparian zones, the effect of weeds on native species richness and in-stream plant production (from shading). **B2**
- The successional pathways of dune slacks invaded by weeds. **B2**
- The impact of water flow changes (reduction) on potential for weed invasion. **B2**
- The vulnerability of ephemeral dry hydro lake margins to weed invasion. **B2**

The following topics are in communities not considered to be as threatened as those above:

- The potential for broom and other woody shrubs to invade alpine areas above the native tree line. **B2**
- The long term viability of fragmented, lowland alluvial forest close to urban areas and invaded by vines or shade tolerant woody species. **B2**
- The potential of shade-tolerant woody species to invade lowland forest .. **C2**
- The potential for Douglas fir to invade beech forest; what could make the beech forest vulnerable to invasion? **C2**

Appendix 2

Suggested candidates for literature review and/or autecological study

SCIENTIFIC NAME	COMMON NAME
Anredera cordifolia	Madeira vine
Celastrus orbiculatus	climbing spindleberry
Ceratophyllum demersum	hornwort
Chrysanthemoides monilifera	bone-seed
Cotoneaster spp.	cotoneaster
Echium vulgare	viper's bugloss
Homalanthus populifolius	Queensland poplar
Juncus acutus	sharp rush
Juncus bulbosus	bulbous rush
Iris pseudacorus	yellow flag iris
Lonicera japonica	Japanese honeysuckle
Lythrum salicaria	purple loosestrife
Muehlenbeckia australis	pohuehue
Myrica faya	Chilean guava
Pennisetum setaceum	African fountain grass
Pyracantha angustifolia	orange firethorn
Senecio glastifolius	
Solanum jasminoides	potato vine
Tropaeolum speciosum	Chilean flame creeper

Nitrogen-fixers in general; this group of species deserve autecological study as many are a problem in low-stature or shrubby vegetation.

This list is not the result of careful analysis of all potential species. The availability of information in New Zealand and internationally on species of concern should be tabulated. The Effect on System and Biological Success ratings should also be used to determine priorities for study. The species above are some suggestions made by the participants at the workshop where this Research Plan was developed and are not in priority order. The list is a start but a comprehensive, ranked list is needed.

For some of these species a full autecologial investigation will be required. For others, such as bone-seed, much relevant work is in progress, or has already been completed, in other countries.

Appendix 3

Weed control research priorities

1. Candidates for development of a suitable control method

The species listed are difficult to control because either there is no known effective control method or the available control methods damage non target plants. This draft list was not developed in the systematic way suggested in research topic 3.2.3. (no.1) and is thus not comprehensive. Final priorities for control research must take into account the nature and level of the environmental impact of the weed species and the urgency for its control.

SCIENTIFIC NAME	COMMON NAME	COMMENTS
High Priority		
Araujia sericifera	moth plant	hard to kill with herbicides
Asparagus asparagoides	smilax	patchy control, underground tubers
Asparagus scandens	climbing asparagus	tubers, twines around natives
Cobaea scandens	Cathedral bells	methods tried have been ineffective
Cortaderia spp.	pampas grasses	how to kill large popns in difficult sites
Festuca arundinacea	tall fescue	problem in grass/ sedge swards
Juncus squarrosus	heath rush	intermingled with natives
Lantana camara var. *aculeata*	lantana	no method but much international work
Passiflora mollissima / mixta	banana passionfruit	chemical control not selective enough
Salix cinerea	grey willow	control on large scale; nontarget effects
Solanum mauritianum	woolly nightshade	methods ineffective or expensive
Tropaeolum speciosum	Chilean flame creeper	vine method effective?
Lower Priority		
Ageratina adenophora	Mexican devil	mistflower biocontrol agent might work
Anredera cordifolia	Madeira vine	vine method works; conservation weed?
Arundo donax	giant reed	very hard to kill; conservation weed?
Berberis darwinii	Darwin's barberry	how to kill on a large scale?
Buddleja davidii	buddleia	versatile weed; biocontrol?
Chrysanthemoides monilifera	bone-seed	Australian methods; large infestations?
Cotoneaster spp.	cotoneaster	very hard to kill
Crassula multicava	fairy crassula	an ecological problem?
Elaeagnus x reflexa	elaeagnus	impossible to control; serious threat?
Equisetum arvense	horsetail	no effective method available
Erica lusitanica	Spanish heath	
Erigeron karvinskianus	Mexican daisy	widespread plastic species
Glyceria fluitans	glyceria	occurs only in degraded wetlands
Hakea spp.	hakea	South African research could help
Lonicera japonica	Japanese honeysuckle	how to control large infestations?
Lythrum salicaria	purple loosestrife	methods available USA
Mimulus guttatus	monkey musk	only found in degraded wet areas
Sedum acre	stone crop	a succulent; how to control?
Senecio angulatus	Cape ivy	very invasive
Tamarix chinensis	Chinese tamarisk	how to contain?
Tradescantia fluminensis	wandering Jew	semi-effective methods available
Zizania latifolia	Manchurian rice grass	many methods tried

2. Generic problems

The above list shows that four groups of plants/ situations seem to be a particular problem:

(a) weed species with rhizomes, thick root stock or tubers that are hard to kill, e.g., *Asparagus* spp., *Alstroemeria pulchella*, *Tropaeolum speciosum*, *Passiflora* spp.

(b) weedy grasses, herbaceous legumes and flat weeds growing in close association with native species, e.g., tall fescue *Festuca arundinacea* or veld grass *Ehrharta erecta* growing with native grasses or small threatened plants, marram *Ammophila arenaria* growing with spinifex *Spinifex sericeus*.

(c) exotic and native rushes and sedges growing intermingled together, e.g., *Juncus acutiflorus, J.acutus, J.canadensis, J.squarrosus.*

(d) riparian trees which have effective water dispersal and long-lived seeds, e.g., brush wattle *Paraserianthes lophantha, Acacia* spp., walnut *Juglans regia*, buddleia *Buddleja davidii.*

(e) situations where control methods exist but where it is currently impracticable to apply them over large natural areas or where the effects on non target species are intolerable, e.g., bone-seed, pampas grass, Darwin's barberry, cotoneaster, wandering Jew.

(f) How much weed control is required to achieve the desired conservation outcome? For example, Russell lupin *Lupinus polyphyllus* and willow *Salix* spp. in braided river beds can hide predators. How much of the weed cover must be removed to improve native bird nesting? Is it better to eradicate small, discrete areas or do patchy weed control over a large area?

Appendix 4

Potential candidates for future biological control programmes

Some of the species which could be considered for biological control programmes are listed below. The list is not comprehensive and it does have a northern bias; it was not derived by rigorous investigation as suggested in research topic 3.2.3.(no.8).

SPECIES	NOTES / RATIONALE
moth plant *Araujia sericifera*	Weed of disturbed forest and shrublands spreading rapidly. No effective control technique currently available.
climbing asparagus *Asparagus scandens*	Weed of forest remnants and shrublands which is spreading rapidly. No effective control technique currently available. Dominates sub-canopy, affects forest floor and ringbarks seedlings and saplings. Effective, host-specific agents are already being used in Australia which could dramatically reduce research costs.
smilax *Asparagus asparagoides*	Chemical control ineffective because of bulk of underground tubers. Agents are already being used in Australia which will dramatically reduce research costs.
buddleia *Buddleja davidii*	Dominates low-growing native plants in riverbeds where it invades. Difficult to achieve control in this community. A problem for forestry industry as well as of conservation concern.
bone-seed *Chrysanthemoides monilifera*	Grows on sand dunes and coastal cliffs where access for control is often difficult. Biocontrol agents are already being used in Australia which will dramatically reduce research costs.
Mexican daisy *Erigeron karvinskianus*	Widely used in gardening, rapidly spreading in natural open communities.
kahili ginger *Hedychium gardnerianum*	Major weed of northern lowland forest and shrubland and spreading south. Current control techniques are labour intensive, expensive, use high concentrations of chemicals and have mixed success.
lantana *Lantana camara* var. *aculeata*	Localised but rapidly spreading weed of northern shrubland and lowland forests which is allelopathic and can outcompete gorse. Effective host-specific biocontrol agents are already being used in Australia.
Japanese honeysuckle *Lonicera japonica*	Weed species which is already widespread and continuing to spread rapidly making constraint with other control techniques difficult, perhaps already impossible. Biocontrol agents may have been developed overseas.
Banana passionfruit and northern banana passionfruit *Passiflora edulis, P. mixta*	No effective control technique currently available. Biocontrol agents may have been developed overseas.
Selaginella *Selaginella kraussiana*	Current techniques labour intensive and the weed is a widespread in lowland forest floors.
Wandering Jew (*Tradescantia fluminensis*)	Current techniques labour intensive, most chemicals are only marginally effective and the weed is very widespread in New Zealand lowland forest.

Appendix 5

Some public relations ideas

- Ensure media takes up weed topics and gives them prominence.
- Prepare material for the media which casts weeds as villains.
- Promote the weed cause in botanical gardens, e.g., with plant labelling.
- Publish weed information in botanical society newsletters and DoC or regional council sponsored pamphlets. Work co-operatively with local authorities on weed publicity.
- Publication of material advocating non weedy gardening practices, e.g., Good Plant Guide.
- Publish and publicise the results of all weed research.
- Inform land owners of the significance of the environmental weed threat and improve their understanding of weed invasion processes.
- Learn from herbicide programmes with successful public relations.
- Develop effective means to inform the public of the importance of scrupulous hygiene practices when visiting islands, or "weed-free" mainland sites, to avoid transporting weed propagules
- Inform riparian land owners of the effects of leaf fall on eutrophication of streams.
- Disseminate information of the effectiveness of community groups at controlling weeds; encourage groups to adopt a cause, be it a reserve, a native plant community or a weed species.

Appendix 6

Research providers for weed research

AgResearch

Cawthron Institute

Chemical Companies

Consultants

Department of Conservation (Science Technology & Information Services staff)

Environmental Research Associates of New Zealand (ERANZ)

Foundation for Research Science and Technology (FRST)

Hort+Research

Manaaki Whenua – Landcare Research

National Institute of Water and Atmospheric Research (NIWA)

New Zealand Forest Research Institute (NZFRI)

Universities, staff and students

Appendix 7

Stakeholders in environmental weed research and management

Apiarists

Boat operators

Department of Conservation

Ducks Unlimited

ECNZ

Federated Farmers

Fish and Game Society

Forest Owners Association

Foundation for Research, Science and Technology

Hieracium Trust

Institute of Noxious Plants Officers

Maori as tangata whenua

Ministry for the Environment (MfE)

Ministry of Agriculture

Ministry of Forestry

Ministry of Fisheries

New Zealand Botanical Society

New Zealand Conservation Authority (NZCA)
and its regional conservation boards

New Zealand Ecological Society

New Zealand Plant Protection Society

Non-government organisations

Nursery and Garden Association

Private landowners

Railways

Regional councils and territorial local authorities

Royal Forest and Bird Society of New Zealand

Royal Horticultural Society of New Zealand

Telecom

Tourism New Zealand

Transit New Zealand

Appendix 8

Science and Research investigations in Key Output 4.33 (weeds) 1987–1997

TITLE	LEADER	AGENCY*	STATUS†
Undaria in Wellington Harbour, distribution and spread rate	Hay	DoC	A
Nutritional requirements of Clematis vitalba	Hume	SIRLR	A
Weed invasion in protected natural areas	Timmins	DOCSR	A
Distribution, ecology and weed status of buddleia in Urewera	Smale	MOFFR	A
Growth of Lagarosiphon major in Lake Taupo	Howard-	SIRMF	F
Review of weeds in New Zealand's protected natural areas	Williams	SIRBO	A
Bracken phytosociology and ecology	Partridge	SIRBO	A
Fruiting in Darwin's barberry	Allen	SIRBO	A
Penetrability of reserves to weeds	Williams	SIRBO	A
Seedling establishment of exotic conifers in snow tussock	Allen	SIRBO	A
Ecology of sycamore	Buxton	SIRBO	D
Seed longevity in Spanish heath	Buxton	SIRBO	A
Gallant herbicide: dune slack adventive grasses	Ogle	DOCWG	C
Biological control of Clematis vitalba	Speirs	SIRPP	A
National database of weeds in protected natural areas	Timmins	DOCSR	A
Hydrodictyon - a problematic invasive alga	Hawes	NIWA	W
Control, demography, and post control response of heather	Rogers	LRNZ	A
Assessment of a heather biocontrol agent - Tongariro NP	Keesing	MU	A
Reserve vegetation management by grazing	Ogle	DOCWG	W
Weed invasion in protected natural areas	Timmins	DOCSR	A
Research by management of frost flats invaded by hieracium	Smale	LRNZ	DP
Dynamics of Scotch broom seed banks and regeneration following control	Williams	LRNZ	DP
Wetland weed control trials	Timmins	DOCSR	C
The potential impacts of biological control of old man's beard	Hill	LRNZ	A
Weed eradication programme on Raoul Island	West	DOCSO	C
New chemical application technique to control old man's beard	Ward	HORT	A
Economic control of willows in environmentally sensitive areas	Ray	NZFRI	DP
Ecological effects of Spartina eradication with Gallant	Roper	NIWA	DP
Review of the biology, ecology and control of problem weeds	Williams	LRNZ	A
Aquatic weed invasions - effects of invasion and control in Rotorua Lakes	Richmond	DOCBP	D
The response to control of bone-seed, climbing dock, J. honeysuckle	Williams	LRNZ	C
Development of a prototype chemical lopper weed control system	Ward	LRNZ	CR
Development of biological control of mistflower	Hill	LRNZ	CR

(Continued next page)

TITLE	LEADER	AGENCY*	STATUS†
Release of an old man's beard sawfly population on DoC estate	Hill	LRNZ	C
Japanese honeysuckle biology, ecology, impacts and control	Williams	LRNZ	A
Preparation of a departmental weed research plan	Timmins	DOCSR	A
Weed ecologist - technology transfer and weed database	Buddenhagen	DOCSR	C
Weed research programme	Timmins	DOCSR	C
Weed impacts on threatened native plants	Reid	DOCSR	C
Environmental weeds with no effective control method	Buddenhagen	DOCSR	C
Legume weed invasion of northern gumland soils	Silvester	WU	C
Effects of Gallant for Spartina control	Turner	NIWA	C
Bone-seed and climbing asparagus	Reid	DOCSR	C
Line drawings of weed species	Timmins	DOCSR	C
Photographs of weed species	Buddenhagen	DOCSR	C
Weed risk assessment workshop	Timmins	DOCSR	C

* Agency abbreviations:
DOCBP = Department of Conservation Bay of Plenty, DOCSO = DoC Southland, DOCSR = DoC Science and Research Division, DOCWG = DoC Wanganui, HORT = Hort+Research, LRNZ = Landcare Research, MOFFR = Ministry of Forestry Forest Research Institute, MU = Massey University, NIWA = National Institute for Water and Atmospheric Research, NZFRI = Forest Research Institute, SIRBO = Department of Scientific and Industrial Research Botany Division, SIRLR = DSIR Land Resources, SIRMF = DSIR Marine and Freshwater, SIRPP = DSIR Plant Protection, WU = Waikato University.

† Status abbreviations:
A = accomplished, C = current, D = delayed, F = failed, P = publication, R = received, W = withdrawn, no outputs.

Appendix 9

Current (1997/98) investigations in weed research

(FRST funded weed research investigations)

TITLE	LEADER	AGENCY
Invasive weeds of natural ecosystems	Lee	Landcare
Biological control of weeds	Hill	Landcare
Management strategies for invasive aquatic weeds		NIWA
Environmental impact assessment of biological control agents		AgResearch

Research currently funded by Science and Research (Department of Conservation) under Key Output 4.33 (weed research) is listed in Appendix 8 with a "C" status.