Review of control methods for pampas grasses in New Zealand

D.S. Gosling, W.B. Shaw, S.M. Beadel
Science for Conservation presents the results of investigations by DOC staff, and by contracted science providers outside the Department of Conservation. Publications in this series are internally and externally peer reviewed.
Publication was approved by the Manager, Science & Research Unit, Science Technology and Information Services, Department of Conservation, Wellington.

© November 2000, Department of Conservation

ISSN 1173-2946

Cataloguing-in-Publication data
Gosling, Derek
1 v. ; 30 cm. (Science for conservation, 1173-2946 ; 165).
Includes bibliographical references.
ISBN 047822012X
## CONTENTS

Abstract 5

1. Introduction 6

2. Objectives 6

3. Methodology 7

4. Pampas taxonomy and ecology 7

5. Pampas distribution 8

6. Impacts of pampas on indigenous plant communities 8
   6.1 Existing information 8
   6.2 Survey results 9

7. Control methods 9
   7.1 Physical removal 9
   7.2 Biological Control 12
   7.3 Grazing 12
   7.4 Oversowing 12
   7.5 Cutting 12
   7.6 Herbicides 12

8. Control techniques used in areas of limited access 14

9. Recommendations 14

10. Summary of key findings 15

11. Acknowledgements 15

12. References 16

Appendix 1

Pampas survey telephone interview 18

Appendix 2

Herbicide prescriptions for pampas control 21

Appendix 3

Pampas control techniques for sites with limited physical access 22
Review of control methods for pampas grasses in New Zealand

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Abstract

The Department of Conservation commissioned Wildland Consultants Ltd to carry out a review of pampas control techniques that are used in New Zealand, particularly in areas of difficult access. Information was obtained from literature and internet searches, and from key personnel involved in pampas control.

The South American pampas grasses (*Cortaderia jubata* and *C. selloana*) are ecological weeds particularly of low-growing and relatively open indigenous plant communities in New Zealand, in habitats such as dunelands, cliffs, and wetland margins. *Cortaderia selloana* is widely distributed throughout most of New Zealand whereas *C. jubata* occurs particularly in warmer parts of the North Island and the north of the South Island. The ecological effects of pampas on natural ecosystems are not well known, but pampas can displace native vegetation and dominate vulnerable sites, disrupt ecological processes, destroy habitat of native fauna, and cause a public nuisance. Few local authorities regard pampas as a significant weed, and only two require its total control.

Control methods include physical removal, biological control, grazing, oversowing, cutting, and herbicides. Details are provided on delivery systems for the application of herbicides to sites with limited physical access, including abseiling, aerial spot spraying, aerial gun spraying, helicopters and ‘human slings’.

Recommendations are made on monitoring the distribution of pampas and the results of control programmes.

**Keywords:** pampas, *Cortaderia*, weed control methods, pampas control techniques.
1. Introduction

Pampas grasses (Cortaderia spp.; hereafter referred to as pampas) are a serious ecological weed in some ecosystems and habitats with significant conservation values. Nevertheless, most New Zealand Regional Councils do not regard pampas as a priority weed in Regional Pest Management Strategies. However, Environment Waikato has declared pampas a total control plant in parts of the Waikato Region. In the Nelson-Marlborough District, C. jubata is a total control plant but C. selloana is not. This distinction between the species is apparently based on an assessment made by Forest Research Institute assessment in 1984 (Forest Research Institute 1984). This assessment concluded that C. jubata, which has an unusual breeding system whereby every plant is able to produce seed without the need for pollination, has the potential to become a greater problem than C. selloana.

Various herbicides can be used to treat pampas infestations successfully, but, to date, information on specialised herbicide delivery systems has not been readily available to conservation managers.

A review of pampas control techniques presently used throughout New Zealand was undertaken for the Department of Conservation. Particular note was taken of specialised techniques that have been developed to treat pampas infestations in situations where physical access is limited.

2. Objectives

1. Review pampas control methods used in New Zealand (and elsewhere).
2. Identify control methods that are effective in difficult habitat types, collate details of these techniques and note the scale of the operation and ecosystems for which the different techniques are useful.
3. Collate and report details of success rates for control programmes/techniques where information is available.
4. List the range of impacts cited for pampas in different communities and the conservation objective expected from pampas control.
3. Methodology

Relevant literature and information on the internet was searched for methods used in the control of pampas, particularly in natural ecosystems.

A telephone survey of key personnel involved in pampas control throughout New Zealand was undertaken. A standard form was developed and used to record interview responses (see Appendix 1).

Interviews were carried out with the following:

- Department of Conservation, Regional Council and forestry company staff involved in pampas control.
- Lynley Hayes, a Landcare scientist contracted to undertake pampas biocontrol research.
- Heidi McGlone, a university student whose MSc thesis is ‘Quantifying the threat that pampas poses to the Waikato environment’.

4. Pampas taxonomy and ecology

The grass genus *Cortaderia* is represented in New Zealand by four native and two introduced species (Gadgil et al. 1984). The native species, *C. toetoe*, *C. fulvida*, *C. splendens*, and *C. richardii*, are collectively referred to as toetoe. The introduced South American species, *C. selloana* and *C. jubata*, are collectively known as pampas. *C. jubata* is commonly referred to as purple pampas, but *C. selloana* can sometimes also have purple flower heads.

The native species are superficially similar in appearance to pampas, but are readily differentiated, even at the seeding stage, by a white waxy bloom at the base of the leaves and prominent secondary veins on the leaves. The native species flower between October and January, whereas *Cortaderia selloana* flowers between mid-March and May and *C. jubata* from January to March. *C. jubata* has stiff, purplish flower heads that also distinguish it from the native species.

Both pampas species have become naturalised in many parts of New Zealand and are now considered serious plant pests in some indigenous ecosystems. They can rapidly colonise disturbed land and will grow on a wide variety of soils, from sea level to 800 m (Knowles & Ecroyd 1985). Dunelands, coastal cliffs, offshore islands and wetlands all contain plant communities dominated by indigenous species that are vulnerable to pampas invasion. Once established, pampas can disrupt these communities and dominate sites for many years.

The production of huge numbers of seeds (an estimated 100 000 per flower head), which can be windborne over an estimated distance of at least 20 km, provides an enormous potential for spread of pampas, particularly on disturbed soil.
5. Pampas distribution

The distribution of pampas throughout New Zealand is recorded in the Department of Conservation database of ecological weeds on Conservation land in New Zealand (DOC Database; Owen 1997). *Cortaderia selloana* and *C. jubata* are widely naturalised in Auckland and Waikato Conservancies, and widespread and still invading new areas in Northland and East Coast Conservancies. They are established and spreading to new areas in Bay of Plenty, Wanganui and Nelson-Marlborough Conservancies, and are recorded as being established, but with isolated distribution, in Wellington and West Coast Conservancies. *C. selloana* is recorded as naturalised but only just starting to spread in Tongariro-Taupo, Canterbury and Southland Conservancies, and is present, but not naturalised, in Otago Conservancy. *C. jubata* is naturalised and starting to spread in Tongariro-Taupo Conservancy.

6. Impacts of pampas on indigenous plant communities

6.1 Existing Information

There is little published information on the ecological impacts of pampas on indigenous ecosystems in New Zealand. Gadgil et al. (1984), and an anonymous author (Anon. undated) concentrated on the weed potential of pampas in plantation forests. Timmins & Mackenzie (1995) briefly outlined pampas impacts on indigenous biota and ecosystems, and Owen (1998) listed pampas as a wetland weed and a threat to forest mire and forest-shrubland ecotone associations. Williams (1997) considered pampas to have some capacity to invade scrub and forest margins and saline wetland habitats. Atkinson (1997) listed pampas as a problem weed on forty New Zealand islands: it is second only to gorse (*Ulex europaeus*) in the number of islands it has colonised. Dense infestations of *C. selloana* have been noted in heavily logged indigenous forest (Wardle 1991) and *C. selloana* can form large clumps in developing indigenous forest, where it is only slowly replaced by native plants (Esler 1988).

An undated Department of Conservation Pests and Weeds Fact Sheet notes that pampas competes with and smothers other vegetation. A website developed for Auckland Regional Council and adapted for use by Environment BOP (http://envbop.govt.nz/www1/green/weed90.htm) describes *C. jubata* as particularly affecting plants growing in rockland, gumland and coastal dunes. It is also seen as a threat to islands because it forms dense colonies that preclude the establishment of indigenous species. Owen (1997) records pampas as becoming a common riverbank species in the Mokau river catchment and considers that, if it invades the lower reaches (of the catchment), it could potentially obliterate one of the best estuarine edge vegetation sequences remaining in the North Island.
Both *Cortaderia selloana* and *C. jubata* have been included in the DOC weeds database (Owen 1997). The database records pampas as sometimes invading disturbed forest and as often invading shrublands and herbfields. Bare ground and short tussockland communities are reported to offer no barriers to invasion by pampas. The degree of impact pampas has in natural areas is recorded in the database. In Northland, Auckland, Waikato, Bay of Plenty, East Coast, Wellington, Nelson-Marlborough and West Coast Conservancies, both *C. jubata* and *C. selloana* are known to be affecting the structure, species composition or regeneration of several sites with high conservation value. The database also includes a comparative ‘weediness’ score for each species, based on the effects the species has on natural systems, and a ‘biological success rating’ that ranks seeding ability, maturation rate, persistence of seedbank, effectiveness on dispersal, establishment/growth rate and vegetative reproduction ability. Both *C. selloana* and *C. jubata* have been assigned a ‘weediness’ score of 28. Only 27 other taxa, from a list of 160, were assigned a higher ‘weediness’ score.

Both pampas species are also weeds of natural ecosystems in North America, South Africa and Australia. Duckett (1989) described pampas as a major threat to Tasmania’s forests and National Parks, and noted that *C. jubata*, which was spreading more rapidly than *C. selloana*, was receiving higher priority for control.

6.2 **SURVEY RESULTS**

Ecosystems that survey respondents listed as vulnerable to the effects of pampas were dunelands, offshore islands, coastal cliffs, river flats, geothermal sites and wetlands. Pampas control is required in these areas.

Respondents were asked to provide details of their pampas control plan objectives and the impacts of pampas on vulnerable ecosystems, and this information is summarised in Table 1.

7. **Control methods**

A number of methods have been used by survey respondents to control or remove pampas. A brief outline of these methods is provided below.

7.1 **PHYSICAL REMOVAL**

Physical removal methods include hand pulling the seedlings, hand grubbing or digging, and the use of earth moving machinery.

Hand removal of plants is slow and labour intensive, but can be very effective for the removal of light infestations of seedling plants at sites where access is limited, e.g. coastal cliffs on Moutrahora (Whale) Island.

Mechanical excavation of mature plants has been attempted (in the Whanganui area) but was unsuccessful because of the damage caused to the surrounding vegetation. Soil disturbance also encourages pampas re-establishment.
<table>
<thead>
<tr>
<th>ECOSYSTEM</th>
<th>IMPACTS</th>
<th>OBJECTIVE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Off-shore islands</td>
<td>Disruption of vulnerable ecosystems</td>
<td>Remove pampas from ecosystem</td>
</tr>
<tr>
<td>Off-shore islands</td>
<td>Pampas replaces native vegetation</td>
<td>Eradicate population</td>
</tr>
<tr>
<td>Off-shore island</td>
<td>Disrupts vulnerable ecosystems on island</td>
<td>Eradicate pampas from easily accessible parts of the island</td>
</tr>
<tr>
<td>Island</td>
<td>Potential to inhibit natural regeneration of indigenous canopy where management objective is to establish a naturally functioning ecosystem</td>
<td>Prevent pampas from establishing in reverting pasture, scrub, dunes and shrubland</td>
</tr>
<tr>
<td>Island sea cliffs</td>
<td>Potential to dominate sites and limit natural regeneration</td>
<td>Remove pampas from island cliff faces</td>
</tr>
<tr>
<td>Dune lands</td>
<td>Disruption of ecosystem</td>
<td>Remove pampas to zero density</td>
</tr>
<tr>
<td>Dune lands</td>
<td>Impacting on archaeological sites, shore bird nesting sites and threatened plant habitat</td>
<td>Control pampas spread</td>
</tr>
<tr>
<td>Dune lands</td>
<td>Potential threat to threatened plant populations and faunal habitat on dune lands</td>
<td>Control spread of pampas</td>
</tr>
<tr>
<td>Dune lands</td>
<td>Disrupts natural functioning of ecosystem</td>
<td>Control pampas</td>
</tr>
<tr>
<td>Dune land, coastal cliffs, wetlands</td>
<td>If left unchecked pampas will dominate site</td>
<td>Control spread</td>
</tr>
<tr>
<td>Wetland—dense infestation covering small island in former lake</td>
<td>Preventing regeneration of native species</td>
<td>Eliminate population</td>
</tr>
<tr>
<td>Road margins</td>
<td>Prevent spread into dune lands</td>
<td>Control spread of pampas</td>
</tr>
<tr>
<td>Road margins</td>
<td>Reduces road visibility and drainage, creates fire risk, haven for animal pests</td>
<td>Clear road margins of pampas</td>
</tr>
<tr>
<td>Road margins</td>
<td>Potential spread to sensitive ecosystems. Pampas has been found at given waste site</td>
<td>Mee landowner obligations—pampas is a total control plant in Regional Pest Management Strategy (RPMS). Also to control spread</td>
</tr>
<tr>
<td>Road margins, waste areas</td>
<td>Potential to dominate dune land vegetation</td>
<td>Contain spread of pampas to ecologically sensitive reserves</td>
</tr>
<tr>
<td>Road margins and waste areas</td>
<td>Potential to spread to heathlands where it would displace indigenous vegetation</td>
<td>Prevent spread of pampas</td>
</tr>
<tr>
<td>Reserve and road margins</td>
<td>Potential to spread into vulnerable ecosystems</td>
<td>Eradicate populations</td>
</tr>
<tr>
<td>Track and road margin</td>
<td>Potential to spread to sensitive ecosystems in district, e.g. dune land</td>
<td>Control pampas—C. jutjala. Total control plant in RPMS but C. selagoana also treated</td>
</tr>
<tr>
<td>Plantation forest</td>
<td>Competes with planted seedlings</td>
<td>Eradicate pampas</td>
</tr>
<tr>
<td>ECOSYSTEM</td>
<td>IMPACTS</td>
<td>OBJECTIVE</td>
</tr>
<tr>
<td>----------------------------------</td>
<td>-------------------------------------------------------------------------</td>
<td>--------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Plantation forest</td>
<td>Competes with planted seedlings</td>
<td>Oversowing with grass minimises competing weed germination while planted seedlings are established</td>
</tr>
<tr>
<td>Plantation forest</td>
<td>Prevents planted seedlings from establishing</td>
<td>Control competing weeds while pine/eucalypt seedings establish</td>
</tr>
<tr>
<td>Plantation forest</td>
<td>Restricts planted seedling establishment</td>
<td>Reduce competing weeds during establishment phase of afforestation</td>
</tr>
<tr>
<td>Plantation forest</td>
<td>Competes with planted seedlings, increases silvicultural costs</td>
<td>Prevent establishment of pampas</td>
</tr>
<tr>
<td>Plantation forest cutover</td>
<td>Competes with planted seedlings for water and nutrients. Can limit access for silviculture and creates fire risk</td>
<td>Prepare site for pampas planting by killing all vegetation</td>
</tr>
<tr>
<td>Plantation forest road margins</td>
<td>Reduces road visibility and drainage, can increase silvicultural costs</td>
<td>Contain pampas spread</td>
</tr>
<tr>
<td>Pine cutover</td>
<td>Hinders development of woody plants</td>
<td>Control until woody canopy develops</td>
</tr>
<tr>
<td>Coastal cliffs</td>
<td>Dominates site and provides seed source for infestation of duneland. Displaces threatened plants</td>
<td>Contain pampas spread</td>
</tr>
<tr>
<td>Coastal cliffs</td>
<td>Potential for pampas to establish in this vulnerable ecosystem</td>
<td>Trial aerial spray technique</td>
</tr>
<tr>
<td>Coastal cliffs and reserve margins, mineralised wetlands</td>
<td>Colonisation of vulnerable ecosystems where it may maintain itself indefinitely</td>
<td>Comply with RPMS requirements</td>
</tr>
<tr>
<td>Coastal dunes and river margins</td>
<td>Disruption of natural functioning of ecosystem</td>
<td>Limit spread of pampas</td>
</tr>
<tr>
<td>Lake margins</td>
<td>Prevents public access and dominates ecosystem</td>
<td>Total control</td>
</tr>
<tr>
<td>River flats</td>
<td>Acts as a seed source for the spread of pampas to slips and stream margins within the area</td>
<td>Eradicase infestations</td>
</tr>
<tr>
<td>Estuary</td>
<td>Disrupt naturalness of site. Could displace indigenous community</td>
<td>Remove all visible pampas</td>
</tr>
<tr>
<td>Wetland</td>
<td>Seeds into surrounding scrub and shrubland</td>
<td>Eliminate small population of mature plants</td>
</tr>
<tr>
<td>Wetland margin</td>
<td>Could dominate drier parts of wetland</td>
<td>Exterminate small infestation before it establishes</td>
</tr>
<tr>
<td>Geothermal area</td>
<td>Minor infestation which could become established and disrupt indigenous plant communities</td>
<td>Destroy pampas plants</td>
</tr>
<tr>
<td>Steep inaccessible sites</td>
<td>Spreading to sensitive sites with limited access</td>
<td>Small scale trial of aerial spot spraying of pampas</td>
</tr>
</tbody>
</table>
7.2 Biological Control

Williams & Timmins (1990) considered pampas species to be unsuitable for biological control because of their close relationship to the four native species of *Cortaderia*. Nevertheless, Manaaki Whenua-Landcare Research has been contracted by a group of Regional Councils to undertake a feasibility study of biocontrol prospects for pampas.

7.3 Grazing

Grazing by cattle has been used for pampas control in plantation forests. Cattle provide pampas control if they are introduced at an early stage in the tree rotation and graze the stand three or four times per year (New Zealand Forest Service 1985). However, grazing can be limited by terrain, fencing, access to water for livestock, and the availability of suitable livestock.

7.4 Oversewing

Oversowing with pasture species following logging or site preparation is commonly used to control pampas and other weeds in plantation forests.

7.5 Cutting

Hand tools and power saws have been used to cut pampas, generally followed by herbicide application to regrowth.

7.6 Herbicides

Herbicide treatment of pampas has been undertaken widely, using a range of chemicals and application techniques. A summary of the herbicides commonly used for pampas control is provided in Appendix 2.

Glyphosate (glyphosate isopropylamine salt), Touchdown (glyphosate trimesium salt) and Trounce (glyphosate amine salt) are effective non-selective herbicides commonly used to treat pampas. Gallant NF (haloxyfop) or Targa (quizalofop) are monocot-specific herbicides which limit non-target impact. Velpar (hexazinone) is commonly used to treat pampas in plantation forests, and Velpar granules have been used successfully to treat isolated plants in natural areas where access is difficult or limited (e.g. coastal cliffs, remote tracks). However, in light or sandy soils Velpar can come into contact with the roots of non-target plants, and can cause unwanted damage or mortality.

Herbicides are applied by knapsack pump, motorised spray equipment, hand application of granules, by aircraft fitted with a spray boom, or specialised spot application equipment. Table 2 summarises the methods used to control pampas.
<table>
<thead>
<tr>
<th>METHOD</th>
<th>WETLANDS</th>
<th>ISLANDS</th>
<th>COASTAL CLIFFS</th>
<th>GEOTHERMAL</th>
<th>DUNELANDS</th>
<th>RIVER FLATS/ESTUARIES</th>
<th>Rf</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knapsack spray</td>
<td>2&lt;sup&gt;1&lt;/sup&gt;</td>
<td>3</td>
<td>1</td>
<td></td>
<td>6</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Gunspray</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Physical removal</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Aerial boom spray</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Aerial spotspray</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Herbicide granules</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Access by abseiling</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oversowing</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Grazing</td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>

<sup>1</sup> Number of respondents using method.
8. Control techniques used in areas of limited access

Several specialised delivery systems and application techniques have been developed to overcome physical access limitations to pampas infestations in some ecosystems.

Aerial gunspraying has been used successfully for many years in the Tokoroa area to treat isolated pampas populations in plantation forests. Aerial gunspraying trials have also been carried out in Northland. Aerial spotspraying by helicopter has been used successfully to treat pampas and other weed infestations, using a range of delivery systems.

Abseiling has been successfully used to provide access for pampas control on rocky cliffs in two areas. There are obvious limitations with this technique, but it can be very effective in combination with other control methods.

A helicopter and ‘human sling’ have been used in two areas for both rescue work and wilding pine control. A national Department of Conservation Standard Operating Procedure is being developed to standardise safe working practice when using this approach. Respondents using this technique considered it would be effective in controlling pampas in places with limited access.

Details of these techniques and delivery systems are provided in Appendix 3. Information is included on delivery systems used for treating other weeds in areas of limited access, and that are considered by the operators to be potentially suitable for pampas control.

9. Recommendations

Because there is little published evidence on the effectiveness of pampas control, we recommend that formal trials should be used to compare the effectiveness and cost efficiency of the various herbicides and their delivery systems.

Control programmes should be formally monitored to assess their success. Several survey respondents emphasised the need for follow up spraying of pampas after initial treatment. Mature plants in particular will often resprout following initial treatment Reinvasion of vulnerable ecosystems from seed dissemination is likely to be an ongoing problem, particularly in some areas where substantial populations of pampas occur on sites where control is not feasible for various reasons. To help reduce these problems, follow-up monitoring and early treatment is essential. Simple monitoring techniques developed in Wanganui Conservancy (Whanganui Area Office), Bay of Plenty Conservancy (Whakatane Field Centre), and Waikato Conservancy (Hauraki Area Office) could be adopted for national use.
10. Summary of key findings

- Native *Cortaderia* species (toetoe) can be distinguished from pampas grass by their white, waxy leaf bases and different flower heads and flowering times. Care must be taken not to accidentally target these species.
- Both pampas species are widespread weeds in the North Island and northern South Island, and *Cortaderia selloana* also further south.
- Both pampas grass species can invade most New Zealand indigenous ecosystems with serious consequences for ecological processes and biodiversity.
- Reinvansion of vulnerable ecosystems from seed is likely to be a continuing problem in some areas as substantial populations of pampas occur in sites where control is not feasible, for various reasons.
- Most plantation forest owners generally only regard pampas as a problem for the first few years after establishment planting.
- Most Regional Councils do not regard pampas as a priority weed in Regional Pest Management Strategies.
- Pampas infestations in road metal quarries are a significant problem as pampas seed can be transported throughout a district in roading aggregate. Regional Councils are working with the Quarry Owners Association to address this issue.
- A range of herbicides are available that are suitable for the effective control of pampas. Other methods—physical removal, biological control, grazing, oversowing, and cutting—are of limited effectiveness.
- Various delivery systems, including abseiling, aerial spot spraying and aerial gun spraying, have been developed for the application of herbicide in areas of limited physical access.
- Follow up spraying of pampas is needed because mature plants in particular will often re-sprout following initial treatment.
- Comparative trials to test the relative effectiveness and cost efficiency of the various herbicide delivery systems would be useful.
- Formal monitoring of pampas control programmes would be useful. Simple techniques developed in Wanganui Conservancy (Whanganui Area Office), Bay of Plenty Conservancy (Whakatane Field Centre), and Waikato Conservancy (Hauraki Area Office) could possibly be adopted for national use.

11. Acknowledgements

This report originated from work carried out under Department of Conservation investigation 2467.

We thank the survey participants who gave so willingly and freely of their time and views.
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Anon. 1999: Pampas grass (*Cortaderia jubata* and *Cortaderia selloana*). USGS. http://www.hear.org.*


New Zealand Forest Service 1985: Pampas grass, a weed of plantation forests. 6 p.


* Indicates additional literature which may be of interest.


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* Indicates additional literature which may be of interest.
Appendix 1

PAMPAS SURVEY TELEPHONE INTERVIEW

Name: ____________________________________________________________
Organisation: __________________________________________________________________
Position: ____________________________________________________________________
Telephone: _______________________ Fax: ___________________________
Email: ______________________________________________________________________
Address: ____________________________________________________________________

1. Is pampas a problem in your Conservancy/Region?
   [ ] Yes   [ ] No

2. Have you done any pampas control work?
   [ ] Yes   [ ] No
3. Details of control work/techniques:

Location: _____________________________________________________

Control Method: _______________________________________________

Ecosystem/Landscape: _________________________________________

<table>
<thead>
<tr>
<th>Scale of operation:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Objective(s):</td>
<td></td>
</tr>
<tr>
<td>Herbicide/Application Rate:</td>
<td></td>
</tr>
<tr>
<td>Time of operation:</td>
<td></td>
</tr>
<tr>
<td>% Kill:</td>
<td></td>
</tr>
<tr>
<td>% Regrowth:</td>
<td></td>
</tr>
<tr>
<td>Non-target impacts:</td>
<td></td>
</tr>
<tr>
<td>Monitoring method and details (e.g. frequency, % sample, etc)</td>
<td></td>
</tr>
<tr>
<td>Objective(s) met?</td>
<td></td>
</tr>
<tr>
<td>Comments:</td>
<td></td>
</tr>
</tbody>
</table>
4. Who else do you suggest I contact?

5. Do you know of any research/trial work that has been undertaken?

6. General Notes:
# Appendix 2

**HERBICIDE PRESCRIPTIONS FOR PAMPAS CONTROL (FROM Davenhill et al. 1997)**

**Pampas grass and toetoe (Cortaderia spp.)**
(r) = releasing, (p) = pre-pruning treatment

<table>
<thead>
<tr>
<th>Herbicide</th>
<th>Spot treatment using knapsack, spotgun, Weed-a-Metre or other hand-held applicator, e.g. Pine Starta, Meterjet, Target Master, etc.</th>
<th>Aerial spraying (rate/ha)</th>
<th>Scattered larger weeds on roadsides, forest boundaries etc.</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>AGPRO Valzine or Velgard</strong></td>
<td><strong>Spotgun or other application (r). Refer to labels for application rates.</strong></td>
<td>15-20 L in 200 L (r)</td>
<td>• Controls seedlings up to 50 cm in height</td>
<td></td>
</tr>
<tr>
<td><strong>Gallant NF</strong></td>
<td><strong>Knapsack or other applicators (r) 225 ml in 15 L. Spotgun 60 ml in 1 L (r)</strong></td>
<td>7.5 L in 100 L (r)</td>
<td><strong>Brushgun 500 ml in 100 L.</strong></td>
<td>• Best results if plants are &lt; 1 m</td>
</tr>
<tr>
<td><strong>Glyphosate (36% formulations). Refer to label or for other than 36% a.i.</strong></td>
<td><strong>Knapsack (15 L) 150 ml (p) Knapsack or other applicators (r) 225ml in 15 L. Spotgun 75ml in 1 L (r)</strong></td>
<td>9-12 L in 150 L (p)</td>
<td><strong>Brushgun 1 L in 100 L.</strong></td>
<td>• Apply during active growth (spring to autumn)</td>
</tr>
<tr>
<td><strong>Targa</strong></td>
<td><strong>Knapsack or other applicators (r) 225ml in 15 L. Spotgun 75ml in 1 L (r)</strong></td>
<td>10 L in 150 L (r)</td>
<td><strong>Brushgun 750 ml in 100 L.</strong></td>
<td>• Best results if plants are &lt; 1m</td>
</tr>
<tr>
<td><strong>Touchdown</strong></td>
<td><strong>Knapsack (15 L) 150 ml (p)</strong></td>
<td>9 L in 200 L (p)</td>
<td><strong>Brushgun 1 L in 100 L.</strong></td>
<td>• As for glyphosate</td>
</tr>
<tr>
<td><strong>Trounce</strong></td>
<td><strong>Knapsack (15 L) 75 g (p)</strong></td>
<td>5-7 kg in 200 L (p)</td>
<td><strong>Brushgun 500 g in 100 L.</strong></td>
<td>• Apply any time of year</td>
</tr>
<tr>
<td><strong>GooseKiller</strong></td>
<td><strong>Knapsack (p) 450 g other applicator (r) 105 g in 15 L</strong></td>
<td>7-10 g in 200 L (p, r)</td>
<td><strong>Brushgun</strong></td>
<td>• For aerial spraying seeding pampas only</td>
</tr>
<tr>
<td><strong>Velpar DF</strong></td>
<td><strong>Velpar 20G</strong></td>
<td></td>
<td></td>
<td>• Avoid releasing with Velpar DF on light or sandy soils</td>
</tr>
</tbody>
</table>
Appendix 3

**Pampas Control Techniques for Sites with Limited Physical Access**

**Control method: aerial spot spray**

**Contact Person(s):** Dave Paine

**Address:** Department of Conservation, Rangitaiki Area Office, Murupara

**Telephone:** (07) 366-1080  **Fax:** (07) 366-1082

**Ecosystem/Landscape:** Moutohora (Whale) Island

<table>
<thead>
<tr>
<th>Scale of operation:</th>
<th>Medium scale.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Objective(s):</strong></td>
<td>Remove pampas infestations from sites where access and water supplies are limited.</td>
</tr>
<tr>
<td><strong>Herbicide/Application Rate:</strong></td>
<td>2% Roundup.</td>
</tr>
<tr>
<td><strong>Additives used:</strong></td>
<td>Pulse and spray marker dye.</td>
</tr>
<tr>
<td><strong>Time of operation:</strong></td>
<td>January.</td>
</tr>
<tr>
<td><strong>% Kill:</strong></td>
<td>100%.</td>
</tr>
<tr>
<td><strong>% Regrowth:</strong></td>
<td>Nil.</td>
</tr>
<tr>
<td><strong>Non-target impacts:</strong></td>
<td>Very minor impact on surrounding rushes and sedges.</td>
</tr>
<tr>
<td><strong>Monitoring method and details (e.g. frequency, % sample, etc.)</strong></td>
<td>Visual checks after 3, 6 and 9 months.</td>
</tr>
<tr>
<td><strong>Objective(s) met?</strong></td>
<td>Yes.</td>
</tr>
</tbody>
</table>

**Comments:**

This spraying was carried out in 1988 using equipment developed by Tasman Forestry Ltd (now Fletcher Challenge Forests), and Ron Taylor of Wishart Helicopters in Rotorua. A 2 m pivoted spray wand was mounted on one of the spray boom attaching brackets beneath the helicopter. The terminal end of the spray wand was fitted with a diaphragm shut off and spray rose. Up to 120 plants were treated per load at an effective spray volume of approximately 220 L per ha. The equipment is now owned by Lakeland Helicopters.
Control method: aerial spot spray

<table>
<thead>
<tr>
<th>Contact Person(s):</th>
<th>Henry Dorian</th>
</tr>
</thead>
<tbody>
<tr>
<td>Address:</td>
<td>Department of Conservation, Mangaweka Field Centre, Private Bag, Mangaweka</td>
</tr>
<tr>
<td>Telephone:</td>
<td>(06) 382-5824 Fax: (06) 382-5824</td>
</tr>
<tr>
<td>Ecosystem/Landscape:</td>
<td>Forest</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Scale of operation:</th>
<th>Medium.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Objective(s):</td>
<td>Aerial spray inaccessible areas of old man’s beard in forest areas.</td>
</tr>
<tr>
<td>Herbicide/Application Rate:</td>
<td>N/A.</td>
</tr>
<tr>
<td>Additives used:</td>
<td></td>
</tr>
<tr>
<td>Time of operation:</td>
<td>After flowering.</td>
</tr>
<tr>
<td>% Kill:</td>
<td>80%</td>
</tr>
<tr>
<td>% Regrowth:</td>
<td>.</td>
</tr>
<tr>
<td>Non-target impacts:</td>
<td>Very little except directly underneath infestation.</td>
</tr>
<tr>
<td>Monitoring method and details (e.g. frequency, % sample, etc.)</td>
<td>Not noted.</td>
</tr>
<tr>
<td>Objective(s) met?</td>
<td>Yes.</td>
</tr>
</tbody>
</table>

Comments:
This unit is a 44 gallon drum on a 20 m chain below a helicopter. A 12 volt pump and four spray roses are used at low pressure to spray old man’s beard. The equipment will also be used to spray pampas this year. It has been used on an operational basis for four years, is very reliable, and has been used a lot on cliffs. The equipment was developed by Wanganui Aeroworks.
## Control method: abseiling

**Contact Person(s):** Dave Byers  
**Address:** Department of Conservation, Whakatane Area Office  
**Telephone:** (07) 308-7079  
**Fax:** (07) 308-8798  
**Ecosystem/Landscape:** Motuohora (Whale) Island cliff faces

<table>
<thead>
<tr>
<th>Scale of operation:</th>
<th>Medium.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Objective(s):</strong></td>
<td>Remove isolated pampas from cliff faces to eliminate seed source.</td>
</tr>
<tr>
<td><strong>Herbicide/Application Rate:</strong></td>
<td>Nil—hand pull seedlings.</td>
</tr>
<tr>
<td><strong>Additives used:</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Time of operation:</strong></td>
<td>Summer.</td>
</tr>
<tr>
<td><strong>% Kill:</strong></td>
<td>100%.</td>
</tr>
<tr>
<td><strong>% Regrowth:</strong></td>
<td>Nil.</td>
</tr>
<tr>
<td><strong>Non-target impacts:</strong></td>
<td>Minor damage from human impact of abseiling.</td>
</tr>
<tr>
<td><strong>Monitoring method and details (e.g. frequency, % sample, etc.)</strong></td>
<td>Surveillance for new infestations.</td>
</tr>
<tr>
<td><strong>Objective(s) met?</strong></td>
<td>Yes.</td>
</tr>
<tr>
<td><strong>Comments:</strong></td>
<td>This technique is used in conjunction with climbing and aerial spot spraying. All plants on the cliffs are small and can be readily removed by hand. Not all plants can be reached by abseiling. In some places there are no tie off points and in others the cliffs are too high, but this method has been successful in places a helicopter could not reach. Both SAS and Police Search and Rescue teams have been used. Aerial spot spraying, climbing and abseiling will continue to be used in combination and a human sling will be trialled in 1999/2000.</td>
</tr>
</tbody>
</table>
Control method: helicopter sling

Contact Person(s): Dave Rothschild
Address: Department of Conservation, Ruapehu Area Office, Private Bag, Whakapapa Village
Telephone: (07) 892-3729 Fax: (07) 892-3814
Ecosystem/Landscape: Various

<table>
<thead>
<tr>
<th>Scale of operation:</th>
<th>About 40 hours per annum.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Objective(s):</td>
<td>Remove <em>Pinus contorta</em> from bluffs, slips etc. where access is limited.</td>
</tr>
<tr>
<td>Herbicide/Application Rate:</td>
<td>Nil.</td>
</tr>
<tr>
<td>Additives used:</td>
<td>N/A.</td>
</tr>
<tr>
<td>Time of operation:</td>
<td>Summer.</td>
</tr>
<tr>
<td>% Kill:</td>
<td>-</td>
</tr>
<tr>
<td>% Regrowth:</td>
<td>-</td>
</tr>
<tr>
<td>Non-target impacts:</td>
<td>None.</td>
</tr>
<tr>
<td>Monitoring method and details (e.g. frequency, % sample, etc.)</td>
<td>-</td>
</tr>
<tr>
<td>Objective(s) met?</td>
<td>Yes</td>
</tr>
<tr>
<td>Comments:</td>
<td>The human sling has been successfully used by DOC in Tongariro-Taupo to remove wilding pines from areas where access is limited. It is Civil Aviation approved and a standard operating procedure is being developed for the operation. It has not been used for pampas control to date, but operators consider that it could be readily adapted for this work.</td>
</tr>
</tbody>
</table>
Control method: aerial gunspray

<table>
<thead>
<tr>
<th>Control method: aerial gunspray</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Contact Person(s):</strong></td>
</tr>
<tr>
<td><strong>Address:</strong></td>
</tr>
<tr>
<td><strong>Telephone:</strong></td>
</tr>
<tr>
<td><strong>Fax:</strong></td>
</tr>
<tr>
<td><strong>Ecosystem/Landscape:</strong></td>
</tr>
<tr>
<td><strong>Scale of operation:</strong></td>
</tr>
<tr>
<td><strong>Objective(s):</strong></td>
</tr>
<tr>
<td><strong>Herbicide/Application Rate:</strong></td>
</tr>
<tr>
<td><strong>Additives used:</strong></td>
</tr>
<tr>
<td><strong>Time of operation:</strong></td>
</tr>
<tr>
<td><strong>% Kill:</strong></td>
</tr>
<tr>
<td><strong>% Regrowth:</strong></td>
</tr>
<tr>
<td><strong>Non-target impacts:</strong></td>
</tr>
<tr>
<td><strong>Monitoring method and details (e.g. frequency, % sample, etc.)</strong></td>
</tr>
<tr>
<td><strong>Objective(s) met?</strong></td>
</tr>
<tr>
<td><strong>Comments:</strong></td>
</tr>
</tbody>
</table>
Control method: pressurised drum under Hughes 500 helicopter

Contact Person(s): Mike Andrews
Address: Department of Conservation, New Plymouth Area Office
Telephone: (06) 758-0433 Fax: (06) 758-0430
Ecosystem/Landscape: Coastal cliffs

<table>
<thead>
<tr>
<th>Scale of operation:</th>
<th>Small scale trial.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Objective(s):</td>
<td>Evaluate technique to see if it can be used to treat pampas in areas with limited access.</td>
</tr>
<tr>
<td>Herbicide/Application Rate:</td>
<td>1% Roundup (glyphosate).</td>
</tr>
<tr>
<td>Additives used:</td>
<td>Spray marker dye.</td>
</tr>
<tr>
<td>% Kill:</td>
<td>80-90%.</td>
</tr>
<tr>
<td>% Regrowth:</td>
<td>Not assessed yet.</td>
</tr>
<tr>
<td>Non-target impacts:</td>
<td>Not assessed yet.</td>
</tr>
<tr>
<td>Monitoring method and details (e.g. frequency, % sample, etc.):</td>
<td>Seven sites were sprayed, with varying infestations of pampas. Ten native plants at each site were tagged.</td>
</tr>
<tr>
<td>Objective(s) met?:</td>
<td>Too early to tell. Sites and non-target impacts will be reassessed in March.</td>
</tr>
<tr>
<td>Comments:</td>
<td>This equipment was developed by a New Plymouth pilot, Matt Newton. Previously tried aerial boom spraying but too many non-target plants were killed. If this trial is a success, operational spraying will be undertaken in the Mokau area later in 1999.</td>
</tr>
</tbody>
</table>
Control method: aerial spot spray

Contact Person(s): Murray Nieuwenhuyse or Roger Cochrane

Address: Department of Conservation, Southland, or Kitto Helicopters (99) Ltd (Ph: (03) 418-0158)

Telephone: (03) 214-4589  Fax: (03) 214-4486

Ecosystem/Landscape: Various

<table>
<thead>
<tr>
<th>Scale of operation:</th>
<th>Medium.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Objective(s):</td>
<td>Spray isolated weed infestations in areas of limited access.</td>
</tr>
<tr>
<td>Herbicide/Application Rate:</td>
<td>Various.</td>
</tr>
<tr>
<td>Additives used:</td>
<td>-</td>
</tr>
<tr>
<td>Time of operation:</td>
<td>-</td>
</tr>
<tr>
<td>% Kill:</td>
<td>-</td>
</tr>
<tr>
<td>% Regrowth:</td>
<td>-</td>
</tr>
<tr>
<td>Non-target impacts:</td>
<td>Minimal.</td>
</tr>
<tr>
<td>Monitoring method and details (e.g. frequency, % sample, etc.):</td>
<td>-</td>
</tr>
<tr>
<td>Objective(s) met?</td>
<td>Yes.</td>
</tr>
</tbody>
</table>

Comments:
The boom equipment is removed from the spray tank and a short length of hose attached to the tank. The end of the hose is attached to the skid on the pilot’s side of the helicopter and a standard variable spray nozzle attached. The nozzle is set at fan or jet, depending on the operation. The system is simple and cheap to make. The same company has also developed a skid-mounted spotgun, operated by a hydraulic ram for spot spraying.
Control method: aerial spot spray

Contact Person(s): Murray Nieuwenhuyse or Roger Cochrane
Address: Department of Conservation, Southland, or Kitto Helicopters (99) Ltd (Ph: (03) 418-0158)
Telephone: (03) 214-4589 Fax: (03) 214-4486

Ecosystem/Landscape: Various

<table>
<thead>
<tr>
<th>Scale of operation:</th>
<th>Medium.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Objective(s):</td>
<td>Spray isolated weed infestations in areas of limited access.</td>
</tr>
<tr>
<td>Herbicide/Application Rate:</td>
<td>Various.</td>
</tr>
<tr>
<td>Additives used:</td>
<td>-</td>
</tr>
<tr>
<td>Time of operation:</td>
<td>-</td>
</tr>
<tr>
<td>% Kill:</td>
<td>-</td>
</tr>
<tr>
<td>% Regrowth:</td>
<td>-</td>
</tr>
<tr>
<td>Non-target impacts:</td>
<td>Minimal.</td>
</tr>
<tr>
<td>Monitoring method and details (e.g. frequency, % sample, etc.):</td>
<td>-</td>
</tr>
<tr>
<td>Objective(s) met?</td>
<td>Yes.</td>
</tr>
<tr>
<td>Comments:</td>
<td>The boom equipment is removed from the spray tank and a short length of hose attached to the tank. The end of the hose is attached to the skid on the pilot’s side of the helicopter and a standard variable spray nozzle attached. The nozzle is set at fan or jet, depending on the operation. The system is simple and cheap to make. The same company has also developed a skid-mounted spotgun, operated by a hydraulic ram for spot spraying.</td>
</tr>
</tbody>
</table>
Control method: helicopter and under-slung bucket

Contact Person(s): Jim Campbell
Address: Department of Conservation, Whanganui Area Office
Telephone: (06) 345-2402 Fax: (06) 345-8712
Ecosystem/Landscape: Steep inaccessible sites

<table>
<thead>
<tr>
<th>Scale of operation:</th>
<th>Small scale trial.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Objective(s):</td>
<td>Treat pampas infestations in steep or inaccessible areas with minimum overspray.</td>
</tr>
<tr>
<td>Herbicide/Application Rate:</td>
<td>1% Roundup (glyphosate).</td>
</tr>
<tr>
<td>Additives used:</td>
<td>Pulse and spray marker dye.</td>
</tr>
<tr>
<td>Time of operation:</td>
<td>Spring/early Summer.</td>
</tr>
<tr>
<td>% Kill:</td>
<td>100%.</td>
</tr>
<tr>
<td>% Regrowth:</td>
<td>Too early to tell.</td>
</tr>
<tr>
<td>Non-target impacts:</td>
<td>Some minor overspray but within acceptable limits.</td>
</tr>
<tr>
<td>Monitoring method and details (e.g. frequency, % sample, etc.):</td>
<td>Visual assessment.</td>
</tr>
<tr>
<td>Objective(s) met?</td>
<td>Preliminary results are good but the trial will be reassessed in November/December.</td>
</tr>
</tbody>
</table>

Comments:
The system is a 60 l bucket and pump suspended on a 60 m strop below the helicopter. A Robin motor drives a low-volume high-pressure pump. The system was developed by Peter Rob of High Country Helicopters, and is an adaptation of a system used on the East Coast. It allows individual plants and small infestations to be targeted.
**Control method: abseiling**

**Contact Person(s):** Jason Roxburgh  
**Address:** Department of Conservation, Hauraki Area Office, P.O. Box 343, Thames  
**Telephone:** (07) 867-9180  
**Fax:** (07) 867-9181  
**Ecosystem/Landscape:** Coastal cliffs—Cuvier Is.

<table>
<thead>
<tr>
<th>Scale of operation:</th>
<th>Medium.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Objective(s):</td>
<td>Contain pampas infestation on island.</td>
</tr>
<tr>
<td>Herbicide/Application Rate:</td>
<td>Velpar granules.</td>
</tr>
<tr>
<td>Additives used:</td>
<td>Nil.</td>
</tr>
<tr>
<td>Time of operation:</td>
<td>November and March.</td>
</tr>
<tr>
<td>% Kill:</td>
<td>About 95%.</td>
</tr>
<tr>
<td>% Regrowth:</td>
<td>Too early to tell.</td>
</tr>
<tr>
<td>Non-target impacts:</td>
<td>None.</td>
</tr>
<tr>
<td>Monitoring method and details (e.g. frequency, % sample, etc.)</td>
<td>All treated plants tagged with cruise tape and these will be monitored using binoculars.</td>
</tr>
<tr>
<td>Objective(s) met?</td>
<td>Yes.</td>
</tr>
</tbody>
</table>

**Comments:**  
There are significant safety issues with abseiling. An experienced mountain safety instructor heads an experienced staff team. Further monitoring is carried out using fixed photopoints.
Control method: helicopter sling

<table>
<thead>
<tr>
<th>Scale of operation:</th>
<th>Medium.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Objective(s):</td>
<td>Remove wilding pines from natural areas.</td>
</tr>
<tr>
<td>Herbicide/Application Rate:</td>
<td>Nil.</td>
</tr>
<tr>
<td>Additives used:</td>
<td>N/A.</td>
</tr>
<tr>
<td>Time of operation:</td>
<td>Summer.</td>
</tr>
<tr>
<td>% Kill:</td>
<td>100%.</td>
</tr>
<tr>
<td>% Regrowth:</td>
<td>Nil.</td>
</tr>
<tr>
<td>Non-target impacts:</td>
<td>None.</td>
</tr>
<tr>
<td>Monitoring method and details (e.g. frequency, % sample, etc.)</td>
<td></td>
</tr>
<tr>
<td>Objective(s) met?</td>
<td>Yes.</td>
</tr>
</tbody>
</table>

Comments:

The human sling has been successfully used by DOC in Hawkes Bay to remove wilding pines from areas where access is limited. It is Civil Aviation approved and a standard operating procedure is being developed for the operation. It has not been used for pampas control to date, but operators consider that it could be readily adapted for this work.