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, over-sowing, 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.

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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. Ducket (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 Moutohora (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-establisment.

TABLE 1. SUMMARY OF CONTROL PLAN OBJECTIVES AND PAMPAS IMPACTS FROM SURVEY RESPONSES.

ECOSYSTEM	IMPACTS	OBJECTIVE
Off-shore islands	Disruption of vulnerable ecosystems	Remove pampas from ecosystem
Off-shore islands	Pampas replaces native vegetation	Eradicate population
Off-shore island	Disrupts vulnerable ecosystems on island	Eradicate pampas from easily accessible parts of the island
Island	Potential to inhibit natural regeneration of indigenous canopy where management objective is to establish a naturally functioning ecosystem	Prevent pampas from establishing in reverting pasture, scrub, dunes and shrubland
Island sea cliffs	Potential to dominate sites and limit natural regeneration	Remove pampas from island cliff faces
Dunelands	Disruption of ecosystem	Remove pampas to zero density
Dunelands	Impacting on archaeological sites, shore bird nesting sites and threatened plant habitat	Control pampas spread
Dunelands	Potential threat to threatened plant populations and faunal habitat on dunelands	Control spread of pampas
Dunelands	Disrupts natural functioning of ecosystem	Control pampas
Duneland, coastal cliffs, wetlands	If left unchecked pampas will dominate site	Control spread
Wetland—dense infestation covering small island in former lake	Preventing regeneration of native species	Eliminate population
Road margins	Prevent spread into dunelands	Control spread of pampas
Road margins	Reduces road visibility and drainage, creates fire risk, haven for animal pests	Clear road margins of pampas
Road margins	Potential spread to sensitive ecosystems. Pampas has been found at giant weta site	Meet landowner obligations—pampas is a total control plant in Regional Pest Management Strategy (RPMS). Also to control spread
Road margins, waste areas	Potential to dominate duneland vegetation	Contain spread of pampas to ecologically sensitive reserves
Road margins and waste areas	Potential to spread to heathlands where it would displace indigenous vegetation	Prevent spread of pampas
Reserve and road margins	Potential to spread into vulnerable ecosystems	Eradicate populations
Track and road margin	Potential to spread to sensitive ecosystems in district, e.g. duneland	Control pampas—*C. jubata*. Total control plant in RPMS but *C. selloana* also treated
Plantation forest	Competes with planted seedlings	Eradicate pampas

ECOSYSTEM	IMPACTS	OBJECTIVE
Plantation forest	Competes with planted seedlings	Oversowing with grass minimises competing weed germination while planted seedlings are established
Plantation forest	Prevents planted seedlings from establishing	Control competing weeds while pine/eucalypt seedlings establish
Plantation forest	Restricts planted seedling establishment	Reduce competing weeds during establishment phase of afforestation
Plantation forests	Competes with planted seedlings, increases silvicultural costs	Prevent establishment of pampas
Plantation forest cutover	Competes with planted seedlings for water and nutrients. Can limit access for silviculture and creates fire risk	Prepare site for pine planting by killing all vegetation
Plantation forest road margins	Reduces road visibility and drainage, can increase silvicultural costs	Contain pampas spread
Pine cutover	Hinders development of woody plants	Control until woody canopy develops
Coastal cliffs	Dominates site and provides seed source for infestation of duneland. Displaces threatened plants	Contain pampas spread
Coastal cliffs	Potential for pampas to establish in this vulnerable ecosystem	Trial aerial spray technique
Coastal cliffs and reserve margins, mineralised wetlands	Colonisation of vulnerable ecosystems where it may maintain itself indefinitely	Comply with RPMS requirements
Coastal dunes and river margins	Disruption of natural functioning of ecosystem	Limit spread of pampas
Lake margins	Prevents public access and dominates ecosystem	Total control
River flats	Acts as a seed source for the spread of pampas to slips and stream margins within the area	Eradicate infestations
Estuary	Disrupts naturalness of site. Could displace indigenous community	Remove all visible pampas
Wetland	Seeds into surrounding scrub and shrubland	Eliminate small population of mature plants
Wetland margin	Could dominate drier parts of wetland	Exterminate small infestation before it establishes
Geothermal area	Minor infestation which could become established and disrupt indigenous plant communities	Destroy pampas plants
Steep inaccessible sites	Spreading to sensitive sites with limited access	Small scale trial of aerial spot spraying of pampas

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 OVERSOWING

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 2. SUMMARY OF METHODS USED BY SURVEY RESPONDENTS TO CONTROL PAMPAS

METHOD	ECOSYSTEM/HABITAT TYPE						
	WETLANDS	ISLANDS	COASTAL CLIFFS	GEOTHERMAL	DUNELANDS	RIVER FLATS/ ESTUARIES	R
Knapsack spray	2[1]	3	1		6	3	
Gunspray			1		4	1	
Physical removal		2			1		
Aerial boom spray					1	1	
Aerial spotspray	1	1	2		1		
Herbicide granules				1			
Access by abseiling		1	1				
Oversowing							
Grazing							

[1.] 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.
- Reinvasion 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.

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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: _____

Scale of operation:	
Objective(s):	
Herbicide/Application Rate:	
Time of operation:	
% Kill:	
% Regrowth:	
Non-target impacts:	
Monitoring method and details (e.g. frequency, % sample, etc)	
Objective(s) met?	
Comments:	

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

Herbicide	Spot treatment using knapsack, spotgun, Weed-a-Metre or other hand-held applicator, e.g. Pine Starta, Meterjet, Target Master, etc.	Aerial spraying (rate/ha)	Scattered larger weeds on roadsides, forest boundaries etc.	Comments
AGPRO Valzine or Velgard	Spotgun or other application (r). Refer to labels for application rates.	15–20 L in 200 L (r)		• Controls seedlings up to 50 cm in height
Gallant NF	Knapsack or other applicators (r) 225 ml in 15 L Spotgun 60 ml in 1 L (r)	7.5 L in 100 L (r)	Brushgun 500 ml in 100 L	• Best results if plants are < 1 m • Include Uptake spray oil • No control of broadleaf weeds • Versatil and/or terbuthylazine should be added if broadleaf weeds are present
Glyphosate (36% formulations). Refer to labelif for other than 36% a.i.	Knapsack (15 L) 150 ml (p)	9–12 L in 150 L (p)	Brushgun 1 L in 100 L	• Apply during active growth (spring to autumn) • Use clean water • For toetoe add Pulse or Freeway
Targa	Knapsack or other applicators (r) 225ml in 15 L Spotgun 75ml in 1 L (r)	10 L in 150 L (r)	Brushgun 750 ml in 100 L	• Best results if plants are < 1m • Add crop oil • No control of broadleaf weeds • Versatill and/or terbuthylazine should be added if broadleaf weeds are present
Touchdown	Knapsack (15 L) 150 ml (p)	9 L in 200 L (p)	Brushgun 1 L in 100 L	• As for glyphosate
Trounce GorseKiller	Knapsack (15 L) 75 g (p)	5–7 kg in 200 L (p)	Brushgun 500 g in 100 L	• Apply any time of year • Use clean water
Velpar DF	Knapsack (p) 450 g other applicator (r) 105 g in 15 L	7–10 g in 200 L (p, r)		• For aerial spraying seedling pampas only • Avoid releasing with Velpar DF on light or sandy soils
Velpar 20G	Weed-a-Metre #2 trigger × 2 or #3 trigger × 1(r)			• Avoid releasing with Velpar 20G on light or sandy soils

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

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

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

Contact Person(s): Henry Dorian

Address: Department of Conservation, Mangaweka Field Centre, Private Bag, Mangaweka

Telephone: (06) 382-5824 **Fax:** (06) 382-5824

Ecosystem/Landscape: Forest

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

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: Moutohora (Whale) Island cliff faces

Scale of operation:	Medium.
Objective(s):	Remove isolated pampas from cliff faces to eliminate seed source.
Herbicide/Application Rate:	Nil—hand pull seedlings.
Additives used:	
Time of operation:	Summer.
% Kill:	100%.
% Regrowth:	Nil.
Non-target impacts:	Minor damage from human impact of abseiling.
Monitoring method and details (e.g. frequency, % sample, etc.)	Surveillance for new infestations.
Objective(s) met?	Yes.

Comments:

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.

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

Scale of operation:	About 40 hours per annum.
Objective(s):	Remove *Pinus contorta* from bluffs, slips etc. where access is limited.
Herbicide/Application Rate:	Nil.
Additives used:	N/A.
Time of operation:	Summer.
% Kill:	-
% Regrowth:	-
Non-target impacts:	None.
Monitoring method and details (e.g. frequency, % sample, etc.)	-
Objective(s) met?	Yes

Comments:

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.

Control method: aerial gunspray

Contact Person(s): Rory Renwick

Address: Department of Conservation, Kaitaia Area Office

Telephone: (09) 408-2100 **Fax:** (09) 403-6019

Ecosystem/Landscape: Dunelands

Scale of operation:	Small scale trial.
Objective(s):	Trial techniques for pampas control.
Herbicide/Application Rate:	Gallant.
Additives used:	Uptake and spray marker dye.
Time of operation:	March 1998.
% Kill:	79%.
% Regrowth:	Not noted.
Non-target impacts:	Some minor damage, probably when operator tried to spray out on an angle and spray drift occurred.
Monitoring method and details (e.g. frequency, % sample, etc.)	Transects.
Objective(s) met?	Yes.

Comments:

More trials are required. Kill rates were good on large pampas, and not so good on small plants which could not be easily seen from the air. Ground spray follow up is required. A 1.5 m handgun was used by an operator sitting behind the pilot. There was little spray drift if the operator waited until the machine was directly over the pampas.

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

Scale of operation:	Small scale trial.
Objective(s):	Evaluate technique to see if it can be used to treat pampas in areas with limited access.
Herbicide/Application Rate:	1% Roundup (glyphosate).
Additives used:	Spray marker dye.
Time of operation:	November 1998.
% Kill:	80–90%.
% Regrowth:	Not assessed yet.
Non-target impacts:	Not assessed yet.
Monitoring method and details (e.g. frequency, % sample, etc.)	Seven sites were sprayed, with varying infestations of pampas. Ten native plants at each site were tagged.
Objective(s) met?	Too early to tell. Sites and non-target impacts will be reassessed in March.

Comments:

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.

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

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

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

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

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: 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

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

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.

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

Contact Person(s): Edward Te Kahika

Address: Puketitiri Field Centre

Telephone: (06) 839-8814 **Fax:** (06) 839-8825

Ecosystem/Landscape: Various

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

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.