Cost-effectiveness of Different Possum Control Methods

SCIENCE FOR CONSERVATION: 4

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Published by
Department of Conservation
P.O. Box 10-420
Wellington, New Zealand

Science for Conservation presents the results of investigations contracted to science providers outside the Department of Conservation. Reports are subject to peer review within the Department and, in some instances, to a review from outside both the Department and the science providers.

ISSN 1173–2946
ISBN 0–478–01677–8

This publication originated from work done under Department of Conservation contract No. 1397, carried out by: R Warburton, Weeds and Pests Division, Manaaki Whenua-Landcare Research, P.O. Box 31-011, Christchurch, New Zealand; and R. Cullen, Economics and Marketing Department, Lincoln University, P.O. Box 84, Lincoln, New Zealand. It was approved for publication by the Director, Science and Research Division, Department of Conservation, Wellington.

Cataloguing-in-Publication data

Warburton, Bruce, 1952–
Cost-effectiveness of different possum control methods / B. Warburton and R. Cullen. Wellington, N.Z. : Dept. of Conservation, 1995.
1 v. ; 30 cm. (Science for conservation, 1173–2946 ; 4.)
Includes bibliographical references.
ISBN 0478016778

1. Trichosurus vulpecula––Control––New Zealand. I. Cullen, Ross. II. Title. III. Series: Science for conservation ; 4.
632.6920993 20
zbn95–017176

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1. Introduction

Although possums have been controlled by government agencies for more than 4 decades, there is little quantitative information available on the costs of controlling possums or the extent to which costs vary. A number of aerial and ground-based possum control operations were examined to ascertain which factors most influence control costs. As control funds are limited, it is imperative that the most cost-effective options are identified and considered along with other factors such as environmental concerns. This work was carried out in 1993 by Manaaki Whenua-Landcare Research and the Department of Economics and Marketing, Lincoln University, and was funded by the Department of Conservation (DOC).

2. Background

Australian brushtail possums are a major pest on New Zealand's conservation estate. Their control relies on obtaining initial population reductions in excess of 70%, with subsequent maintenance control at varying time-intervals. Control is largely dependent on the use of aerial-sown 1080 baits. However, increasing public opposition to the aerial sowing of 1080 baits, along with the promotion of hunters as a cost-effective and environmentally acceptable alternative, has led to an increasing use of hunters for controlling possum populations throughout New Zealand (Warburton *et al*. unpubl. FRI contract report 1992).

The acceptance of hunters by some DOC managers as an effective alternative to aerial poisoning has resulted in an in-house debate on which method is the most cost-effective. It is unlikely that in all situations one or other method will always be more cost-effective than the other, but it is important that they are both used as cost-effectively as possible. The selection of one or other of these control options has often been based on personal views of the likely acceptance of the methods by society or on the logistical ease with which they may be implemented, rather than on an evaluation of costs and likely environmental benefits.

A variety of factors affect operational costs. For example, in aerial operations, bait type (carrot, cereal), sowing rates (which have varied from 2 to 40 kg, New Zealand Forest Service 1978), and aircraft type, can significantly influence costs. For ground-based hunters, various contract-based arrangements have been tried, as has the use of unskilled "Task Force Green" personnel, in an attempt to provide low-cost possum control.

Up until now, no attempt has been made to evaluate how the choice of one or other option may influence total control costs. As DOC's funding for possum control is limited ($3.1M in 1992/93; 6.1 M in 1993/94), it is important that the costs of alternative control options are recorded and the factors most likely to affect operational costs are understood.

3. Objectives

- To compare costs of achieving similar outcomes with different control methods.
- To identify which factors significantly affect control costs.
- To recommend the most cost-effective control option for specific control requirements.

4. Methods

Individual DOC Conservancies were requested to itemise costs for each possum control operation undertaken between 1991/92 and 1992/93. The form provided divided the operational costs into five sections (poison and baits, monitoring, planning, staff (contractors), and miscellaneous), and also requested information on the size of the control area and the percent kill achieved. All information obtained was for "knock down" possum operations. No costings were available for maintenance control of possums. For analysis, all operations were grouped into either aerial or ground operations.

Aerial operations were then further subdivided as:

- Operations conducted by DOC against possum populations that were 1080 naive (those not previously exposed to 1080) (10).
- Operations that targeted possum survivors, their progeny, and possum immigrants in areas previously controlled (2).
- Operations undertaken for DOC by a contractor - two using cereal and one using carrot bait.

Ground operations were further subdivided as:

- Operations on less than 1000 ha (10).
- Operations on more than 1000 ha (3).
- Operations using conservation volunteers (6).

The costs reported here do not include overheads. DOC Head Office retained 31% of the national budget allocated for possum control, to cover both their and Conservancy overheads (G. Adams, pers. comm.). It is presumed that this retained funding was allocated to the Conservancies pro-rata, on the basis of the possum-control funds spent.

5. Results

5.1 AERIAL 1080 OPERATIONS

Information from 15 aerial 1080 operations, undertaken over areas which ranged from 101 to 18 000 ha, indicated that control costs/ha varied from $8 to $54 (Appendix 10.1 and 11.2). The main factors influencing costs were the bait material used (cereal vs carrot), the bait sowing rate, the extent to which monitoring was undertaken (i.e., the percent kill, bait quality assurance and environmental parameters), and the type of aircraft used.

Information from only one operation which used carrot bait was available, nevertheless it appears the cost of carrot bait ($90/tonne) is significantly less than cereal bait ($1690/tonne; mean from 11 operations). Cereal bait costs/tonne ranged from $1448-1876.

Sowing rates significantly affected bait cost/ha with cereal bait operations ranging from $5.80 (sown at 4 kg/ha) to $21.30 (sown at 11 kg/ha) (Appendix 10.1). There was no significant relationship, however, between the sowing rate and percent kill achieved. The one operation that used screened carrot bait, which cost considerably less than cereal bait/ha, still achieved a percent kill (85%) similar to the mean kill achieved by the seven DOC operations using cereal baits (83%) for which percent kill data were available.

The percentage of the control budget spent on monitoring (primarily percent kill) ranged from 5 to 34%, or $2-3/ha. One operation, however, (Rangitoto Is) spent $19/ha on monitoring, because the high public interest in this operation justified a considerable effort in monitoring environmental impacts, bait quality assurance, and the percent kill achieved. It appears that about 10-12% ($2-3/ha) of control budgets is most often allocated to monitoring.

The type of aircraft used for bait application also affected total operational costs, with aeroplanes being cheaper than helicopters, e.g., $1.90/ha for sowing by fixed-wing and $5-11/ha for sowing by helicopter. Larger operations often used both types of aircraft and had aircraft costs of about $2-3/ha. Three operations that relied solely on helicopters had aircraft costs of $9, $10, and $11/ha, but in two of these operations, the higher costs resulted from high bait sowing rates (11.4 and 12 kg/ha). In the third operation, the helicopter cost ($11/ha) was influenced less by sowing rate (5 kg/ha) than by the large amount of flying time used for ferrying staff about the operational area. Generally, for similar sowing rates, fixed-wing and fixed-wing/helicopter operations were 50-80% cheaper than using helicopters alone. One conservancy (Waikato) cited helicopter costs considerably less than other conservancies for similar sowing rates but the reasons for this were unclear. Waikato Conservancy did however, use Squirrel helicopters, which require less flying time between loads, and may partly account for the lower overall costs. Helicopters were generally chosen for sowing bait over areas of less than 2500 ha, with a combination of helicopter and fixed-wing being used for larger areas. One operation of only 957 ha was completed using fixed-wing aircraft only at a cost of $1.90/ha.

Planning costs varied markedly as a percent of the total costs (1-20%, Appendices 11.1, 11.2), but were more consistent when considered on a per hectare basis ($1-$3/ha). One operation cited very low planning costs ($0.2/ha), but as this operation had been run jointly with a Regional Council bovine Tb operation, most of the planning was covered by Local Government funding.

Contracting out the field operation to other organisations reduced the time commitment of DOC staff to control operations, but did not appear, at least with the limited information available, to reduce control costs ($25 & $26/ha using cereal baits, Appendix 11.2).

Two operations attempted to further reduce possum numbers after earlier aerial 1080 operations (Appendix 10.2). Although these operations used bait-sowing rates of 8 and 9 kg/ha and had similar total costs/ha to the other aerial operations using cereal baits, they failed to achieve acceptable kills (32% and 0% kills). Their failure was not a result of poor bait quality or weather (K. Broome, pers comm) but presumably was the result of either poison aversion or of the remaining possums having access to sufficient food not to accept cereal baits.

Miscellaneous costs, which included items such as notices, first aid and safety equipment, and mileage, varied from $1-3/ha. The main contributer to this cost was vehicle mileage, which varied greatly between control operations depending on the distance of the control areas from accommodation.

5.2 GROUND-CONTROL OPERATIONS

Information on hunter-based possum control operations was available for 19 operations from four conservancies. The size of the areas controlled varied from 1.5 ha to 14 122 ha (Appendices 10.3, 10.4 & 10.5).

For the 10 areas of less than 1000 ha controlled by hunters under contract, total cost varied from $14 to $62/ha (Appendix 10.3). Percent kill data available from seven of these operations ranged from 72% to 90%. There was no significant relationship, however, between cost/ha and percent kill.

The cost/ha paid to the contractors varied considerably ($9 - $44, Appendix 11.3), but also had no significant relationship with the percent kill achieved. Similarly, there was no relationship between the cost/day of the contractor ($84 - $182) and the hectares covered per day (2.7 - 41.8), or between the cost/day and percent kill achieved. Costs to DOC associated with operational planning varied from $1 to $19/ha, and in two operations planning costs exceeded contractor costs (Appendix 10.3).

Contract hunters were used by East Coast Conservancy to control possums in two areas over 10 000 ha and one of 4000 ha (Appendix 10.4). Total control costs/ha for two of these areas were very low ($8 and $4). However, while the reported percent kills for these operations (based on trap catch) were 63% and 68%, respectively, the wild animal manager involved believes the actual kills achieved were likely to be lower than these. It is likely that kills of 50% can be achieved relatively easily by contract hunters, but kills of 80%+ require a significantly higher input of time and dollars.

Bay of Plenty Conservancy used Conservation volunteers to carry out possum control in several small reserves (Appendix 10.5). In these areas, control costs/ha were higher ($29 - $185) than when contract hunters were used. The higher costs of these operations were partly a result of the small size of the areas controlled (1.5-11.4 ha). Small areas have disproportionately large planning and logistical costs, and may obscure any potential reduction of costs gained from using volunteer hunters. Nonetheless, it appears that a significantly greater effort was expended in planning (supervising) these operations than in planning operations using contract hunters ($p = 0.001$). However, as long as the DOC dollar input (from the National Priority Pool funds) into these operations does not exceed the "normal" costs expected of possum control operations, additional funds required (from employment schemes) can be considered as employment creation costs rather than control costs.

The area covered per day of hunting in all ground operations ranged from 0.1 to 41.8 ha. In the largest blocks where relatively large areas were covered per day it appears that the actual area covered (effective area) may be less than the total management area. Operations with low areas covered per day were all small (<5 ha), and presumably a large portion of a day was spent travelling to and from the control area. For areas greater than 100 ha, about 10-15 ha were covered per day to achieve an 80%+ kill.

6. Conclusions

The information provided by Conservancies on possum control operations indicates that there is a wide range of operational costs, size of management units controlled, and percent kill achieved. For aerial operations, the total costs varied from $8 to 54/ha, with bait contributing the largest proportion of cost. Significant cost savings can be made by reducing all high sowing rates (10+ kg/ha) down to 4-5 kg/ha with no apparent loss in effectiveness. In future, sowing rates may be able to be reduced to as low as 1 kg/ha without compromising effectiveness (D. Morgan pers comm). Further, the lack of relationship between sowing rates and percent kills indicate that DOC should have a policy that limits the sowing rate of cereal pellets to a maximum of 5 kg unless management staff can clearly justify higher sowing rates.

Although costs were available from only one operation that used carrot bait, the significant cost reduction achieved (down to $8/ha) would appear to justify a greater consideration of carrot as the bait of choice. If carrot bait was prepared and used by DOC staff, there would be a greater salary component and therefore overhead component to the operation. This bait material also poses greater logistical problems (e.g., short shelf-life, access to cutting and spraying equipment) than do pre-made cereal baits, and poses possible environmental concerns (e.g., risk to birds), but even so the cost advantages appear significant enough to outweigh some of the potential drawbacks. Carrot bait, if screened, poses no greater risk to common bird species than cereal baits (Spurr 1991). However, if cereal bait sowing rates are further reduced, the competitive cost advantage of carrot baits will diminish.

It appears most managers are selecting helicopters for sowing baits over small areas and a combination of fixed-wing and helicopters for larger areas. Although the use of helicopters results in higher operational costs, their use cannot be avoided where airstrips are not available or where there is a need for accurate sowing to cover small areas. Managers should therefore ensure the most cost-effective machines are used.

Contracting out (tendering) the field operation should also be considered by DOC managers, especially if staff are not familiar with managing aerial operations. Specifications for bait type, quality assurance, and operational performance can be set and compensation rates agreed to where the contractors do not meet the programme requirements. Regional Councils have possum control capabilities, especially in areas where routine operations are being carried out for bovine TB control, and should be considered as a potential alternative to DOC undertaking their own control. In joint work with Regional Councils, facilities can be shared, and potential cost savings made.

On average, the cost and effectiveness of aerial and ground operations appeared similar. Aerial operations, that used cereal baits against 1080-naive possums cost c. $30/ha, and resulted in an average population reductions of 83%. By comparison, the average cost for ground control (excluding those operations using Conservation volunteers and the three large areas that had exceptionally low costs/ha), was $35/ha and also resulted in an average population reduction of 83%. The average size of the control areas was considerably larger (1326 ha, excluding Waipoua at 18 000 ha) for aerial operations than for ground operations (204 ha, excluding the three large areas). Although ground-based operators were used in three large operations, the effectiveness of ground hunting in controlling possums over such large areas is still unclear.

The price paid to contractors to control possums in areas less than 1000 ha (Appendix 10.3) varied from $11 to $31/ha. Because there was no relationship between the cost/ha and percent kill, excessive contractor costs (>$20/ha) cannot be justified. Planning costs/ha, where given, varied even more ($1-19/ha, Appendix 10.3; $13-54/ha, Appendix 10.5), and it appears that excessive planning time was used for some operations. Planning a ground control operation of less than 500 ha should not require more than 2 person days (c. $250). Even for small areas (e.g., 20 ha) the planning cost should not exceed $12.50/ha. Planning is, however, required for all areas, and for smaller areas the cost will be disproportionately large. DOC should be aware of the relatively high costs of attempting to protect small areas, not only because of the initial one-off costs but also because of the need to repeat control more frequently as immigration will be more rapid. Therefore, when choosing priority control areas, the continuing control costs ($/ha/yr) for different sized areas should be considered to ensure that funds available for control are used in the most cost-effective way.

The data available for the operations that used Conservation volunteers suggest this type of employment scheme is an inefficient use of DOC's possum budget. Even though wages were not part of the control costs, high planning costs meant that the costs/ha for operations using "free" labour were generally greater than when a "professional" contractor was used. This was, in part, due to the small areas chosen for control. Nevertheless, providing the cost to DOC in

achieving the required level of possum reduction is not greater when using employment schemes than it would be if aerial operations or contract hunters were used, there is no problem with DOC using these schemes to achieve their goals.

The wide range of costs associated with the employment of hunters suggests there is a need for the development of guidelines on how DOC Conservancies should contract hunters. It appears that in the smaller control areas (<2000 ha), capable hunters can achieve effective control at costs comparable with current aerial operations.

The costs tabled in this report do not include overheads, but ultimately overheads must be applied to at least DOC staff time. Thus, operations that have proportionately more planning, supervision or staff field time per hectare (e.g., operations using Conservation volunteers, or DOC staff carrying out the control or cutting carrot bait) will be more demanding on National Priority Pool (NPP) funds than operations that have a higher component of operating costs.

This report has been restricted to the analysis of costs associated with "knock-down" operations and does not address the costs associated with maintenance control. Before the latter costs can be evaluated, the most effective strategies must first be determined.

7. Recommendations

- Sowing rates for cereal baits should be restricted to a maximum of 5 kg/ha unless the animal control manager can justify a higher sowing rate.
- Fixed-wing aircraft should be used in preference to helicopters wherever possible.
- Carrot bait should be considered as a potential bait more often than it is currently.
- Where experience in carrying out aerial operations is not available within the Conservancy (especially with using carrot bait), contracting the field operation with detailed operational specifications should be considered.
- Repeat 1080 operations may not provide a realistic maintenance strategy for managing possums and should not be attempted until further trials on its effectiveness have been carried out.
- If "professional" contract hunters can be contracted, they should be considered as cost-effective alternatives to aerial 1080 operations for smaller operational areas. However, it is recommended that specific target kills are set and that payments be restricted unless those targets are achieved.
- Employment schemes should not be used by DOC for controlling possums unless all costs additional to those that DOC would normally incur for such an operation are covered by the employment scheme.

- Particular scrutiny should be given to the high long-term control costs in small priority possum control areas. The NPP funds would achieve significantly more if control areas were large, because large areas can generally be controlled at lower costs/ha.

8. Acknowledgements

We wish to thank all DOC Conservancy staff who supplied data on their possum control operations and J. Coleman and J. Orwin for commenting on drafts of this report.

9. References

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10. Appendices

10.1 Costs of aerial 1080 operations undertaken by DOC. All operations used cereal baits.

10.2 Costs and effectiveness of aerial 1080 operations carried out on contract, using different bait types, or when the operation has followed a previous 1080 operation.

10.3 Costs and percent kill obtained from contract ground control operations in areas less than 1000 ha.

10.4 Costs and percent kill obtained from contract ground-control operations in areas greater than 1000 ha.

10.5 Costs and percent kills obtained from ground-control operations using Conservation volunteers in Bay of Plenty Conservancy.

10.1 COSTS OF AERIAL 1080 OPERATIONS UNDERTAKEN BY DOC. ALL OPERATIONS USED CEREAL BAITS.

CONTROL AREA & CONSERVANCY	RANGITOTO AUCKLAND	WAIPOUA NTHLAND	ISOLATED HILL NELSON	KAHAROA BOP	WHITECLIFFS WANGANUI	NGAURUKEHU WANGANUI	PAENGAROA WANGANUI	TITIRANGI WANGANUI	ROTOKAHU WANGANUI	TARAMOUKOU WANGANUI
Hectares	2300	18000	3426	440	1500	105	101	311	500	700
Cost/ha ($)	54	17	17	47	21	34	45	24	33	21
Percent kill	93	86	89	66	91	-	-	96	-	-
Bait sowing rate (kg/ha)	12	5	4	11	6	5	5	5	5	5
Bait $ cost/ha (% of total)	19.5 (39)	8.8 (56)	5.8 (40)	21.3 (55)	11.5 (58)	7.9 (23)	9.1 (20)	9.1 (37)	9.3 (28)	8.3 (40)
Aircraft $ cost/ha (% of total)	9 (17)H[+]	3 (16)FH	2 (12)FH	10 (22)H	4 (20)H	6 (18)H	6 (13)H	6 (25)H	11 (33)H	4 (19)H
Monitoring $ cost /ha (% of total)	19 (34)	3 (17)	2 (12)	2 (5)	2 (10)	6 (18)	10 (22)	4 (17)	3 (9)	3 (14)
Planning $ cost /ha (% of total)	2 (3)	-	3 (20)	3 (5)	1 (5)	7 (21)	7 (16)	21 (8)	5 (15)	3 (14)
DOC salaries $ cost/ha (% total)	1.5 (3)	3.1 (18)[*]	0.3 (2)	3 (6)	1 (4)	5 (15)	5 (11)	2 (8)	2 (6)	1 (5)
Misc. $ costs/ha (% of total)	2 (4)	0.2 (1)	1 (7)	3 (5)	1 (4)	1 (3)	1 (2)	0.4 (2)	2 (6)	.4 (2)

[*] *This cost includes planning.* [+] *H = Helicopter; F = Fixed-wing*

10.2 COSTS AND EFFECTIVENESS OF AERIAL 1080 OPERATIONS CARRIED OUT ON CONTRACT, USING DIFFERENT BAIT TYPES, OR WHEN THE OPERATION HAS FOLLOWED A PREVIOUS 1080 OPERATION.

AREA & CONSERVANCY	MAPARA, WAIKATO	MAPARA, WAIKATO	CROYDEN, STHLAND	CRAIG RANKIN, OTAGO	WAIPAPA EA, WAIKATO
Operation type	Successive ops.	Successive ops	Carrot/contract	Cereal/contract	Cereal/contract
Hectares	1500	1500	957	226	5000
Cost/ha ($)	25	24	8	26	25
Percent kill	32	0	85	80	61
Bait sowing rate (kg/ha)	9	8	12	10	10
Bait $ cost/ha (% of total)	15 (64)	14 (58)	1.1 (26)	25* (96)	17.7* (74)
Aircraft $ cost/ha (% of total)	5 (19)H+	3 (13)H	2 (23) F	0	2 (10)FH
Monitoring $ cost/ha (% of total)	2 (9)	4 (17)	0	0	3 (12)
Planning $ cost/ha (% of total)	1 (5)	1 (4)	0	0	0.2 (1)
DOC salaries $ cost/ha (% of total)	0.5 (2)	0.5 (2)	4 (50)**	0	1 (3)
Misc. $ costs/ha (% of total)	0.2 (1)	0.2 (1)	0	1 (4)	0#

* *This cost covers the total contract to undertake the operation.*

\+ *H = Helicopter; F = Fixed-wing.*

\# *No costs cited.*

** *Contract cost included carrot bait preparation.*

10.3. COSTS AND PERCENT KILL OBTAINED FROM CONTRACT GROUND CONTROL OPERATIONS IN AREAS LESS THAN 1000 HA.

AREA & CONSERVANCY	TAUTUKU OTAGO	WISP RANGE OTAGO	WAREPA OTAGO	HINA HINA OTAGO	FOREST HILL STHLAND	FOREST HILL STHLAND	KOUTUNUI E. COAST	OROKAWA BOP	HOMANGA BOP	OHINEKOAO BOP
Hectares	520	195	256	120	750	570[@]	357	320	113	17.8
Cost/ha ($)	24	33	29	38	30	6	24	21	62	53
Percent kill	81	85	81	86	90	-	85	-	72	-
Monitoring $ costs/ha (% of total)[#]	0	0	0	0	2 (7)	0	6 (25)	0	0	0
Planning $ costs/ha (% of total)	7 (28)[*]	19 (58)[*]	10 (34)	18 (46)	1 (3)	1 (17)	0	2 (9)	12 (20)	14 (27)
Contractor $ costs/ha[+] (% of total)	16 (67)	12 (36)	18 (63)	16 (42)	26 (87)	4 (67)S	11 (46)	17 (79)	44 (71)S	31 (59)
Misc. $ costs/ha (% of total)	1 (5)	2 (6)	1 (3)	4 (11)	1 (3)	1 (17)	7 (29)	3 (12)	5 (9)	7 (14)
Contractor persondays	49	14	-	14	168	20	41	50	42	4
Hectares/persondays	10.5	14	-	8.5	4.5	28.5	9	6.5	3	4.5

[#] *Monitoring costs are often included either in contract costs or DOC salary.*

[*] *Includes both monitoring and other DOC staff costs*

[@] *Repeat of 750 ha operation.*

[+] *Those contractor costs marked S, were carried out by DOC staff.*

10.4 COSTS AND PERCENT KILL OBTAINED FROM CONTRACT GROUND-CONTROL OPERATIONS IN AREAS GREATER THAN 1000 HA.

AREA & CONSERVANCY	N. UREWERA, EAST COAST	E. RAUKUMARA, EAST COAST	WHAKATANE, EAST COAST
Hectares	14122	11998	4000
Cost/ha ($)	8	4	22
Percent kill	63	68	75
Monitoring $ costs/ha (% of total)#	2 (25)	1 (25)	8 (36)
Planning $ costs/ha (% of total)	0	0	1 (5)
Contractor $ costs/ha (% of total)	5 (63)	2 (50)	13 (59)
Misc. $ costs/ha (% of total)	1 (12)	1 (25)	0.2 (1)
Contractor persondays	791	287	288
Hectares/personday	18	42	14

Monitoring costs are often included either in contract costs or DOC salary.

10.5 COSTS AND PERCENT KILLS OBTAINED FROM GROUND-CONTROL OPERATIONS USING CONSERVATION VOLUNTEERS IN BAY OF PLENTY CONSERVANCY.

Hectares	11.4*	11.4*	4.5+	4.5+	1.5	11.4
Cost/ha ($)	29	46	51	77	185	71
Percent kill	-	-	-	-	-	80
Monitoring $ costs/ha (% of total)	0	0	0	0	0	0
Planning $ costs/ha (% of total)	13 (46)	27 (58)	23 (44)	34 (44)	34 (18)	54 (75)
Contractor $ costs/ha (% of total)	0	0	0	0	0	0
Misc. $ costs/ha (% of total)	16 (54)	20 (42)	29 (56)	43 (56)	151 (82)	17 (25)
Contractor persondays	9	12	5	11	11	7
Hectares/personday	1.3	1	1	0.5	0.1	1.5

*, + *These areas have been controlled twice.*