

Cost Effectiveness and Efficacy of Ground-Control Techniques for Pest-Control in New Zealand

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ABSTRACT: The brushtail possum, introduced to New Zealand in 1858, is a significant conservation pest and a major vector of bovine tuberculosis. Previous control-simulation studies have suggested that aerial delivery of bait containing sodium fluoroacetate (1080) is the most cost effective (large scale) possum control strategy. Over the past decade, considerable improvements in ground-control techniques have been developed by private contractors and bait manufacturers. These techniques are not reliant on 1080, and there have been major cost reductions as the new baits and delivery mechanisms have been optimized. In addition to this, our research team (in collaboration with Connovation Research Ltd.) have recently developed a new bait station design that has the potential to be left out in the field for up to 5 years without the need for servicing. These devices are self setting and have the ability to deliver gel or liquid spray, and 'target-specific' toxicants. Preliminary cost analysis suggests that this new bait station design has the potential to save NZ\$21 million per annum from the amount currently spent on possum ground control.

KEY WORDS: 1080, aerial control, bait stations, cost effectiveness, ground control, New Zealand, possum control, *Trichosurus vulpecula*

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INTRODUCTION

Since their introduction from Australia in 1858 (Pracy 1974), brushtail possums (*Trichosurus vulpecula*) have spread and now occupy more than 90% of New Zealand's land area, with an estimated population of 50 to 70 million (Clout and Ericksen 2000). Possums are a significant conservation pest, killing indigenous plants, suppressing regeneration through intensive browsing (Cowan 1991, Payton 2000), and impacting on indigenous animals through predation, disturbance, and competition for resources (Innes 1994, Brown et al. 1996, Sadleir 2000). They are also considered the most important wildlife reservoir of bovine tuberculosis (*Mycobacterium bovis*; Tb), which they spread to cattle and farmed deer (Coleman and Caley 2000). Increased levels of Tb infection in cattle and deer herds could restrict our NZ\$5 billion export market for beef, venison, and dairy products. It has been estimated that such restrictions on access for meat and dairy products could cost New Zealand up to NZ\$500 million annually (Coleman and Livingstone 2000).

Consequently, central and local government agencies spend millions of dollars every year on possum management activities. As an example of the magnitude of these expenditures, it has been estimated that approximately NZ\$80 million was spent on possum control throughout New Zealand in the 2008/09 financial year with a further NZ\$12 million spent on research activities. Unfortunately, this level of funding remains insufficient to control possums in all Department of Conservation and Animal Health Board Inc. priority areas (PCE 1994), and difficult decisions must be made regarding the location of each year's control operations. Regardless of the criteria used to determine which areas receive possum control, field managers must then make decisions concerning the most appropriate control technique. As there is only a limited amount of money

available for pest control, it is important that the most cost-effective techniques are used (Cullen and Bicknell 2000).

Previous research investigating cost-effective control of possums has favored the use of aerially-delivered sodium fluoroacetate (1080) bait over ground-based techniques (Barlow 1991, Barlow 1993, Hickling 1994, Ross and Bicknell 2006). Since the last cost analysis (field trials conducted in 2002), new baits and delivery techniques have recently been developed for ground control (Thomas et al. 2003, Ross and Henderson 2006) and a reliance on 1080 for sustained control (i.e. 1080) is considered unwise, as bait shyness (Ross et al. 1997) can quickly develop in possum population frequently exposed to 1080 bait (Ross et al. 2000). Accordingly, possum control strategies need to incorporate other control techniques such as ground control using encapsulated cyanide, leg-hold traps and chronic-acting toxins (5 other possum toxins are currently registered in New Zealand). This paper extends previous possum modeling work undertaken by Ross and Bicknell (2006 – see Background section) and incorporates recent ground control costs obtained from a contractor in the central North Island and aerial costs from the Hawkes Bay Regional Council.

BACKGROUND

Efficacy of Possum Control – Hatepe Trial

The data collected from a large-scale field trial conducted in 2004 indicated that control methods using 1080 had the highest efficacy (Table 1). Control using Feratox[®] (containing cyanide) with leg-hold trapping was next, followed by control using Feracol[®] (containing cholecalciferol). Pairwise comparisons of the kill estimates indicated no significant difference between 1080 and cyanide; however, 1080-aerial control had significantly higher efficacy than Feracol[®] ($Z=2.01$, $P = 0.02$) (Ross and Bicknell 2006).

Table 1. Percentage kill (\pm SEM) for the 5 different control techniques.

Control Technique	Mean _{pre} (%)	Mean _{post} (%)	Kill (%) ¹	n
1080 aerial	17.5	0.2	99.05 \pm 1.36	4
1080 bait stations	21.0	1.3	93.66 \pm 2.93	4
Contractor's choice	18.0	1.3	92.56 \pm 3.61	4
Feratox® & trapping	15.4	1.8	88.04 \pm 5.12	4
Feracol®	17.2	3.6	79.29 \pm 7.96	4

¹ Trap catch and percentage kill estimates calculated using the NPCA residual trap-catch (RTC) monitoring protocol (NPCA 2008)

Mean Operational Cost of Control - Hatepe Trial

The field data indicated that the mean cost of 1080 aerial was substantially cheaper than the other ground-based control techniques (Table 2). There was little difference in the mean cost of the ground-based control techniques; however, there was considerable cost variation for control operations using Feratox®, ranging from a low of NZ\$19.57 to a high of \$70.53/ha. The high costs occurred where contractors failed to meet post-control monitoring targets of less than 2% residual trap-catch (RTC), and additional control work was required for payment. The cost of control for the aerial and ground-laid 1080 remained consistent because there was no additional control required (Ross 2004). The cost of Feracol® was fixed, because the contract was for service only with no requirement for additional control if targets weren't met (C. Speedy, pers. comm., Epro Ltd., 2004).

Table 2. Cost in NZ\$/ha for the 5 different control techniques.

Control Technique	Mean Cost
1080 aerial	\$20.25
Contractor's choice	\$36.23
Feracol®	\$36.46
1080 bait stations	\$43.45
Feratox® & trapping	\$43.82

METHODS

Efficacy and Cost of Ground Control – North Island Contractor Data 2007-09

To obtain new data for the cost of ground-based possum control, we approached a large contractor located in the central North Island. He had kept extensive records of 137 control operations conducted by his company over the past 3 years (2007-09). This information included operation size (ha), cost charged for the contract, and complete RTC information.

Efficacy and Cost of Aerial Control – Hawkes Bay Regional Council 2009

To obtain cost data for aerial control, we approached the Hawkes Bay Regional Council (Owen Harris). They supplied information on 28 aerial control operations and 5 ground control operations that they had been tendered out in 2009.

All data was entered into a Microsoft® Excel worksheet (version 2003). The Analysis-ToolPak add-in was used to calculate the descriptive statistics including a 95% confidence interval estimate.

RESULTS

Efficacy and Cost of Ground Control – North Island Contractor Data 2005-08

Data obtained from the North Island contractor indicated substantially higher control efficacy than had been achieved in the 2004 Hatepe trial (Table 3). At Hatepe, the ground control operators had RTC values ranging from 1.3 - 3.6% (Table 1). Over a period of 3 years, the North Island contractor had a mean RTC value of 0.61% for 137 ground control operations (this average includes failed operations). This RTC estimate has low variability with a 95% confidence interval ranging from 0.47 - 0.74%. In fact, over the 137 operations, the RTC estimate exceeded 2% only on 5 occasions. As detailed in Table 3, only 12 lines failed the RTC criteria (i.e., they had more than 1 possum trapped on an individual monitoring line of 10 traps). Accordingly, 99.5% of monitoring lines passed inspection. This control work was also achieved at an average cost of NZ\$9.16/ha. This value is less than a third of the cost of ground control costs reported at the Hatepe trail and even half the cost of aerial control.

Table 3. Summary statistics of ground control operations conducted by a central North Island contractor over the period 2005-2008.

Total Area Controlled (ha)	586,923
No. operations	137
Average size (ha)	4,446
Average RTC (%)	0.61
No. of monitoring lines	2,578
No. of monitoring lines that failed	12
Average cost/ha	NZ\$9.16

In the Hatepe trial, we were able to estimate the percentage population reduction as we had both pre-and-post estimates of the RTC. Unfortunately, we only had post-control RTC values available from the contractor; however, using the values in Table 1, there appears to be a strong linear relationship between the post-control RTC values and the percentage kill estimates (Figure 1). Based on this relationship, we estimate an average percentage kill for the ground-control contractor of 96.84%, which is very close to the value obtained using aerially-distributed 1080 at Hatepe (Table 2).

Efficacy and Cost of Aerial Control – Hawkes Bay Regional Council 2009

Data obtained from the Hawkes Bay Regional

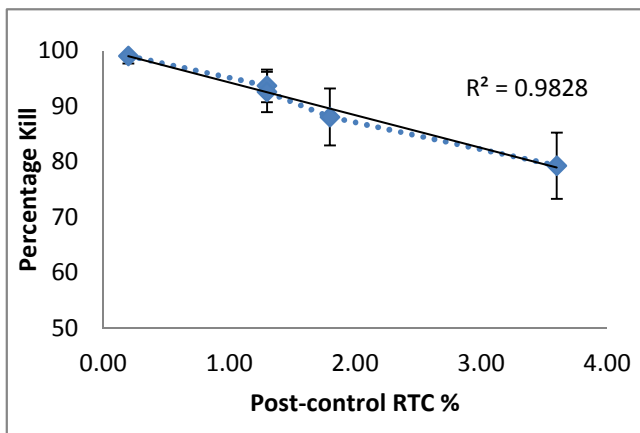


Figure 1. The relationship between post-control RTC and the percentage kill. Data obtained from ground and aerial control operations undertaken at Hatepe in the central North Island, 2004.

Table 4. Summary statistics of aerial and ground control operations contracted by the Hawkes Bay Regional Council during 2009 (costs in New Zealand dollars).

Control Type	Avg. Size (ha)	Avg. Cost/ha	Low	High	n
Aerial Control	9,692	\$25.75	\$17.84	\$32.76	22
Aerial + Repellent	17,009	\$34.85	\$31.96	\$38.25	6
Ground control	2,235	\$40.52	\$20.34	\$65.00	5

Council indicates that average aerial costs have increased since the Hatepe trial to approximately NZ\$25/ha (Table 4). Also, included was the cost for aerial control using deer-repellent-coated 1080 bait. The inclusion of deer repellent increased the average cost of control by approximately NZ\$10/ha. The average cost of the ground control for the 5 operations was similar to that reported in the Hatepe trial at approximately NZ\$40/ha. We were unable to obtain efficacy values for these operations; however, all had passed post-control monitoring with RTC values of less than 2%.

DISCUSSION

Analysis of the new cost data indicates some conflicting results, with the values obtained from the contractor markedly lower than those supplied by the Hawkes Bay Regional Council. There are many possible reasons for this. First, the control operations were conducted at different sites, and it is likely that there were major differences in terrain and access around the site although all operations were conducted in the Hawkes Bay region. Accordingly, it is difficult to make direct comparisons, as the costs were not obtained from a designed experiment like the Hatepe trial. Second, it is likely that there are major differences in the way that the data was recorded. Accordingly, any direct comparisons between recent possum control cost figures and Hatepe are unlikely to be robust.

Given these issues, there are still two key observations that can be derived from the new cost data. First, in some areas ground-based possum control can be extremely cost-effective with a average cost of less than NZ\$10/ha.

This cost reduction has been driven by the market, due to the competitive nature of the contract tendering process administered by the Animal Health Board Inc. and the Regional Councils. Unfortunately, this means that 'best-practice' knowledge for ground-based possum control is held by a few key contractors and is not public knowledge. Second, aerial control costs appear to have increased since 2004, particularly when deer-repellent bait is utilised. These increases are most likely due to increased fuel costs and the extra labour costs associated with spraying the repellent on carrot and/or cereal bait.

In consideration of the difficulty in obtaining comparative costs, we question whether continuing to compare aerial versus ground-based control is worthwhile. Certainly, when one conducts a research trial like Hatepe, you can derive robust comparative cost estimates; however, there will always be issues relating to the difficulty of ground access, and some sites will always be more suitable for aerial control. Each control technique has its strengths and weaknesses, and advocating one as being superior over the other is not informative for managers. Accordingly, we suggest that research effort should focus on continuing to improve current best-practice for both techniques. For example, ground-based control is not restricted to cereal or carrot bait containing 1080. Accordingly, self-dispensing gel or liquid bait appears to be an exciting new prospect. This could enable bait stations to be left 'in situ' for 3-5 years without the need for annual re-servicing. Station designs could be modified to be 'species-specific' restricting access and/or interference by non-target species. Using a realistic cost of NZ\$15/ha to put out such devices, in areas considered suitable for ground control, we estimate that there are potential savings of NZ\$21 million should the devices have a 3-year field life (Table 5).

Table 5. Potential cost savings from implementing new self-dispensing bait stations (New Zealand dollars).

Realistic cost/ha	\$15.00
Cost using new bait station/ha	\$5.00
Hectares under control	5,423,119 ¹
Total cost using current technology	\$48,808,071
Total cost using new technology	\$27,115,595
Potential savings by 2015 ²	\$21,692,476 ³

¹ Assuming a 10% reduction in control effort per annum.

² Assuming it takes 6 years to convert over to the new bait stations.

³ Using a 10% discount rate.

In conclusion, our research indicates that ground-based possum control (in certain areas) has become more cost-effective and efficacious since the Hatepe trial conducted in 2004. However, this knowledge is held by the industry, and there is a danger that this knowledge could be lost if key contractors go out of business or retire. We suggest that effort should go into publishing best-practice techniques for ground control using current technology. We also suggest that research is required for the development of self-dispensing bait stations. Our preliminary cost assessment suggests that substantial savings could be derived by employing delivery systems that have the ability to continuously deliver toxic bait.

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