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Part B

MANAGEMENT ACTIVITIES, RESULTS AND PRELIMINARY OUTCOMES

In this section information provided by project and Conservancy office staff — either in project plans and reports, or in questionnaire responses—is presented. Additional comments are made at the end of each sub-section.

It should be noted that this review does not necessarily include the most comprehensive and current information available relating to each of these projects. Rather, it is a compilation of information provided by project managers. In addition to depicting activities and results, this review should be valuable in identifying information needs for future evaluations.

A number of figures, tables and graphs have been included with the purpose of showing how information has been presented and interpreted. No attempt was made during this review to critically examine these interpretations. It is anticipated that a detailed assessment of activities, results and outcomes will be undertaken once all projects have been comprehensively and consistently reported.

4. Long-term project goals, or visions

Five of the six projects have strategic plans which include a long-term project goal, or vision.

4.1 TROUNSON

'Intensive management at Trounson will restore the park's kauri forest ecosystem to a much healthier condition and approaching that of pre-European times. Ecological processes will be enhanced, whilst threatened species of wildlife will recover in the impoverished environment. It will be a site where management techniques will be improved following precise experimental designs and the results closely monitored. While supporting research and monitoring programmes of individual species and the biota generally, we will be able to determine the responses to particular levels of management, and compare these with responses at localities with different management regimes, thereby finding the most effective techniques for specific responses. In this way Trounson will provide a model for the expanding mainland island programmes in Northland, both departmental and private, and will become a showcase for the local community and visitors to the park.' *(Draft strategic plan,* Anon. 1997d*).*

Seven aims listed under this goal for the Trounson project cover ecosystem recovery, threatened species recovery, re-introductions, community interest, ecosystem monitoring, sharing knowledge and research.

4.2 NORTHERN TE UREWERA

'To acknowledge and nurture the mauri of the northern Te Urewera ecosystem.' *(Northern Te Urewera Ecosystem Restoration Strategy, Shaw* et al. *1996.)*

'The strategic approach to fulfilling this vision involves: initially focusing management on a small study area (Otamatuna); developing management techniques at this site for broader application in conjunction with field trials at other sites; assessing such techniques through monitoring the results and outcomes of treatment relative to a non-treatment (control) site at Okopeka; then systematically expanding the application of these techniques into "core breeding areas".' (*1997/98/99 annual report, Beaven* et al. *1999.)*

A management philosophy underpinning the vision is declared in the strategic plan which emphasises a vision to sequentially develop capacity to restore a 50,000 ha area. Management trials are proposed to develop and refine techniques based on reliable data, to identify separate management areas within the greater complex, to use non-treatment 'controls', and the need for an integrated management approach is emphasized.

4.3 BOUNDARY STREAM

'Boundary Stream Scenic Reserve will be restored, by careful nurturing and enhancement, to the vibrant indigenous ecosystem it once was. The reserve will be a place where the public can visit and enjoy a flourishing fauna and flora reminiscent of a typical Hawke's Bay forest of the past. It will be a showcase for the Conservancy, providing a centre for community involvement and demonstrating what can be achieved in protecting and enhancing biodiversity given sufficient resources, enthusiasm, commitment and public support.' (*Boundary Stream Strategic Plan, Anon. 1995a*).

Nine management objectives are given that support the vision: establishing a project infrastructure, monitoring environmental changes, ecosystem recovery through intensive control of animal pests, threatened species recovery, re-introductions, research, community interest, sharing knowledge and staff development.

4.4 PAENGAROA

'To restore and enhance the outstanding biodiversity of Paengaroa Scenic Reserve. To utilise the reserve's outstanding values to promote public awareness of the composition and functioning of a unique ecosystem with many rare elements.' (*Mainland Island Strategy 1996–2001, Barkla 1996.*)

Three specific objectives underpinning the goal are identified; manage weed and animal threats, develop interpretation facilities, introduce plants and animals.

4.5 ROTOITI

'Restoration of a beech forest community with emphasis on the honeydew cycle. A restoration goal such as this has been expressed evocatively as 'restoring the mauri (health and life force) of the forest ecosystem (Shaw et al. 1996).' (*Rotoiti Nature Recovery Project Strategic Plan, Butler 1998.*)

Objectives listed in support of the vision include: to control selected pests to allow recovery of ecosystem components (species) and processes (especially the honeydew cycle), to re-introduce recently-depleted species, to advocate for species conservation and pest control by providing an accessible example of a functioning ecosystem. In addition, the following objectives are listed to 'widen the scope' of the project; to provide an asset for St Arnaud and the Nelson/Marlborough region, to participate in a national restoration experiment, to become a centre of learning, to provide staff development opportunities, to act as a catalyst for pest control elsewhere, and to act as a departmental showcase.

4.6 HURUNUI

'To protect the beech forest ecosystems of the North and South Branches of the Hurunui River and restore them, as much as possible, to their original states and secure their species assemblages and unique habitat character.' 'To develop effective and efficient predator and pest control programmes for large valley based forest habitats, and to ensure these developments are tested in a robust and scientific manner.' (*1997/98 annual report, Grant* et al. *1998*.)

4.7 LONG-TERM PROJECT GOALS, OR VISION—DISCUSSION

It is not clear how useful these statements have been in guiding management to date. Some are 'visions' which may evoke recognition and support from stakeholders (e.g. '… restore the 'mauri', or life force'…), although such statements may be of little value as a basis for management objectives or performance measures. Others are management objectives, describing specific actions (e.g.'… to develop effective and efficient management programmes…'), but lacking a longer-term vision.

All statements include the word 'ecosystem' and refer to, or imply, restoration although only one specifies a previous period at which management is aimed, e.g. Trounson: '… a much healthier condition and approaching that of pre-European times.' Several allude to ecosystem components (species) and functions (processes). One project goal (Rotoiti) focuses on a specific natural process '… with emphasis on the honeydew cycle.'

Most project goals and supporting statements promote wider (off-site) benefits through the acquisition of new information, developing management capacity and advancing awareness. An integrated approach to management is implied, and the need for a sound scientific basis for management identified in several statements. All but the Hurunui project have goals which emphasise community involvement.

No strategic plan for the Hurunui project was available at the time of this review. Declared goals for this project have changed since its initiation in 1995/96. They are now broader, with greater emphasis on ecosystem processes and on developing pest control capacity than the earlier statements. The intention to employ a science-based approach has been retained.

4.8 LONG-TERM PROJECT GOALS, OR VISION—KEY POINTS

Long-term goals, or visions have been declared for all six projects. It is unclear how useful goal statements have been in guiding management. There are few obvious links between declared departmental goals and management objectives at these projects. This is due, in part, to inconsistent use of planning terms.

All goal statements include the word 'ecosystem' and refer to, or imply, restoration. Only one specifies a previous period to which restoration is aimed (Trounson).

One project goal (Rotoiti) includes reference to ecosystem processes (the honeydew cycle). Most emphasize species.

Most projects have objectives promoting wider (off-site) benefits through acquiring new information, developing management capacity and advancing awareness.

Most objectives reflect an intention to apply an experimental approach. All were chosen and are managed primarily as operational, rather than experimental, projects.

5. Controlling pests

Pest control activities, results and outcomes are reviewed in the following sections. Reported objectives, techniques, results and outcomes are either cited verbatim from questionnaire responses or annual reports, or briefly summarised. No attempt was made during this review to critically evaluate sampling procedures or data interpretations. Examples of tables and graphs are presented to illustrate the type of information collected and how it has been interpreted.

All of these projects involve intensive pest control as a key element. The largest number of animal pests being controlled is 10, at the Boundary Stream project (Table 2). A feature is the range of pests targeted for control, the low pest indices sought and the intensity of control regimes.

“Targeting’ involves management according to declared control objectives. Control is being considered for additional pests. A number of pest animals are present in project areas and are not currently targeted either because their control is not considered a priority, or because further information is required (Table 3).

Weeds are targeted for control at two projects; at Paengaroa 14 weeds are actively managed, and at Boundary Stream two are targeted. Informal weed control is also being undertaken at three of the other projects (Table 4). No weeds are targeted for control at Hurunui.

TABLE 2. ANIMAL PESTS TARGETED FOR CONTROL (X DENOTES ‘TARGETING’).

	TROUNSON	NORTHERN TE UREWERA	BOUNDARY STREAM	PAENGAROA	ROTOITI	HURUNUI
Possum	X	X	X	X	X	X
Mustelids	X Stoat Ferret Weasel	X Stoat Weasel	X Stoat Ferret Weasel		X Stoat Ferret	X Stoat
Rodents	X Rats Mouse	X Ship rat Mouse	X Ship rat Norway rat		X Ship rat Mouse	
Cat	X		X			X
Feral Ungulates		X Red deer Pig	X Goat Red deer		X Red deer	
Stock	X		X	X		
Wasps					X	

TABLE 3. ANIMAL PESTS NOT TARGETED FOR CONTROL.

	TROUNSON	NORTHERN TE UREWERA	BOUNDARY STREAM	PAENGAROA	ROTOITI	HURUNUI
Hedgehog	PINF	NP	PRES	PRES	PINF	PNW
Rabbit	PINF	NP	PNW	PNW	PNW	NP
Red deer	NP	X	X	PNW	X	PNW
Chamois	NP	NP	NP	NP	PINF	PNW
Myna	PRES	NIA	NP	NP	NP	NP
Magpie	PRES	NIA	PNW	PNW	NIA	PINF
Hare	PNW	NP	NIA	PNW	PRES	PRES
Cat	X	PNW	X	PRES	X	PNW
Rats	X	X	X	PINF	X	PNW
Mouse	X	X	PRES	PINF	X	PNW
Wasps	NIA	PNW	PNW	PNW	X	PNW

Key:
PNW – identified as a potential pest but control not warranted because of low numbers or low impacts.
PRES – being considered (monitoring, research) for control.
PINF – informal/low intensity control undertaken—no specific control objectives. Includes by-catch.
NP – not present.
X – present and targeted for control
NIA – no information available

TABLE 4. WEEDS OF INTEREST.

	TARGETED FOR CONTROL	INFORMAL CONTROL (PINF) OR CONTROL NOT WARRANTED (PNW)
Trounson		Ginger, Pampas PINF, Wandering Jew, African clubmoss, Mexican devil weed, Mistflower PNW
Northern Te Urewera		Pampas, Buddleia PNW
Boundary Stream	Monbretia, Buddleia, Cotoneaster	Blackberry PINF
Paengaroa	Common ivy, Cherry laurel, Spindle Tree, Rowan, Elderberry, Gooseberry, Barbery, Common privet, Sycamore, Crack willow, Cotoneaster (2 spp.), Blackberry, Plum	Chilean flame creeper PINF
Rotoiti		Rowan, Ragwort, Douglas fir, Sweet Briar PINF

Abbreviations as in Table 3 key.

5.1 POSSUM CONTROL

Possums are targeted for control at all six projects.

5.1.1 Planned possum control objectives

Trounson

- 'Reduce possum (and rodent) populations to very low levels and maintain at less than 2% trap/catch rates.'

Northern Te Urewera

- 'To control possums to a level where the ecosystem shows a positive response.'
- 'To compare changes in possum numbers between treatment and non-treatment areas.'
- 'To compare kokako, rata and mistletoe population characteristics between areas of treatment and non-treatment.'

Boundary Stream

- 'Return forest structure, indigenous biota and ecosystem processes compromised by possum damage to a high state of health.'
- 'Provide a safe environment for proposed re-introductions.'
- 'Possum numbers maintained below a 5% trap catch'

Paengaroa

- 'To maintain possum density at less than four possums per 100 trap nights.'

Rotoiti

- 'To reduce possum numbers and hold them continuously at a low level (less than 5% residual trap catch index initially, and less than 2% after first year) such that: '... preferred browse species show increased growth/productivity and further plants re-establish (greater than 90% monitored plants exhibiting scale 1 browse or less as per FBI (Payton) … and impacts on invertebrates, birds and other forest biodiversity are reduced to insignificant levels compared with other mortality factors.'

Hurunui

- 'To reduce possum populations below 0.3 possums per hectare.'

5.1.2 Reported possum control techniques and management regimes.

Trounson

- Application of toxin using (initially) 500 'Philproof' bait stations at 100 m x 100 m intervals along transect lines, giving an average of 1 station per 0.9 ha.
- Initial 'knockdown' using 1080 (Sodium monoflouroacetate) in June 1996 after 4 pre-feeds in 3 weeks, followed by:

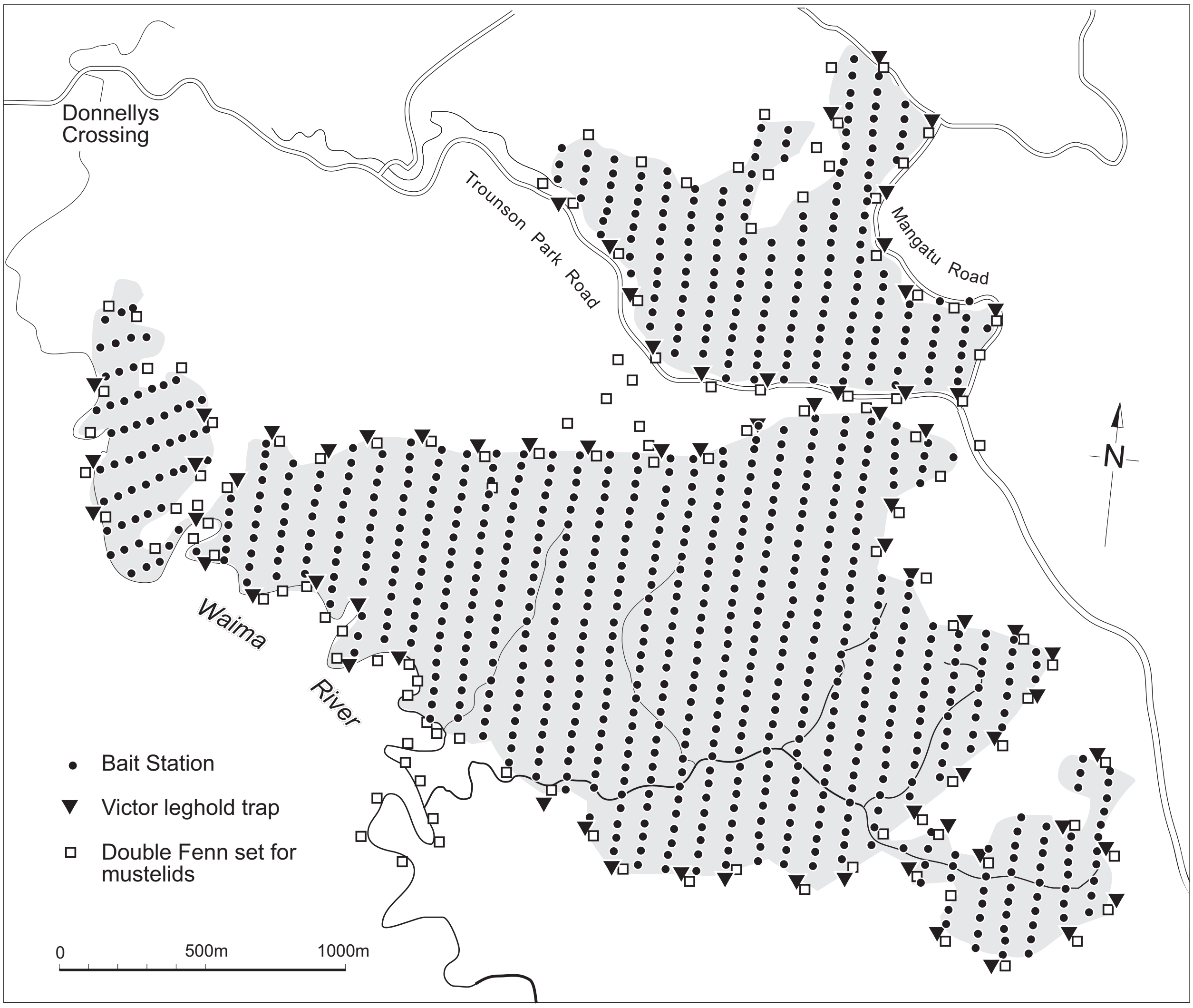
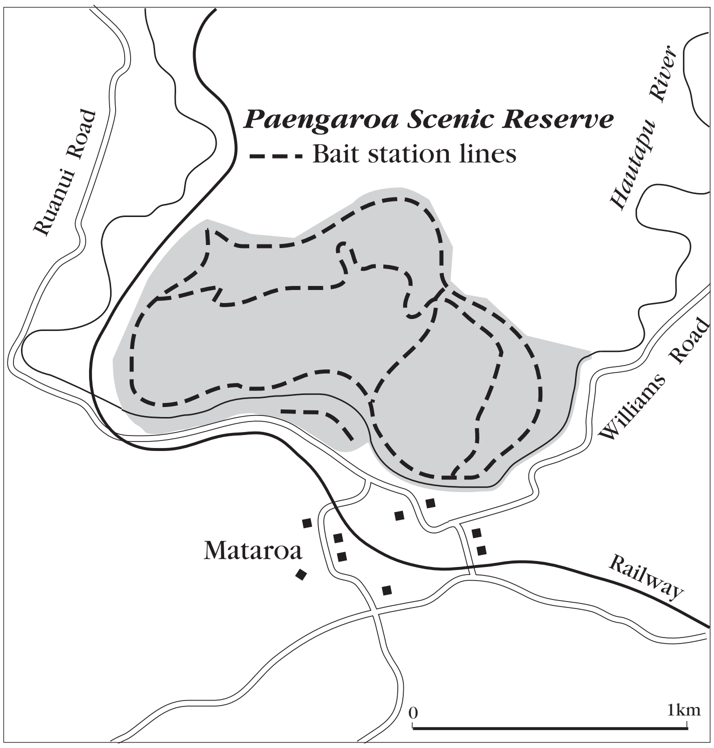


Figure 14. Trounson bait station grid and trap network.

- 'Talon' baits containing the second-generation anticoagulant brodifacoum (600 g/station) in July 1996.
- 'Pest Off' 6 g No.7 baits containing 20 ppm brodifacoum, 350/700 g per station. An additional c. 450 bait stations were added which allowed only mouse access, increasing the density of bait stations to a 100 m x 50 m grid in October/November 1998 (Fig. 14), and used thereafter.
- Concerns over intensive application of brodifacoum led to its use in Trounson being restricted to a portion of the reserve as a study area. All poison was removed from bait stations in August 1998.
- A further pulse of 1080 was carried out in November 1998 following two pre-feeds.
- In the third year of control (1999) alternative, less persistent toxins and a pulsed poisoning regime where baits are removed from stations between pulses were investigated. 1080 is proposed to be used intermittently to reduce risks of resistance.

Figure 15. Paengaroa reserve showing approximate location of possum bait station lines.



- June 1999—combined use of 'Warfarin' (a first generation anti-coagulant) for rodent control—500 g in rat stations, 250 g in mouse stations, and 'Feratox' (encapsulated cyanide) pellets for possums (one toxic pellet every100 m).
- In addition to toxins, 'Victor' leg-hold traps were set on the forest perimeter for possums during February and March 1999.

Northern Te Urewera

- A combination of leg-hold traps and cyanide paste was used by contract possum hunters in an 8-year period over 47,000 ha, including the restoration project area.
- In the Otamatuna area 'Talon' 20P baits were applied in 1996/97 in c. 900 'Philproof' bait stations at 100 m intervals on contours 150 m apart.
- All major spurs and ridges also had bait stations at 100 m intervals. 'Feratox' baits were also used in conjunction with 'Talon' in the Otamatuna area. 'Feratox' was used in conjunction with 'Pindone' (a first-generation anticoagulant) in the Otamatuna and Mangaone study areas in the 1998/99 season.

Boundary Stream

- An aerial 1080 drop was undertaken by the Hawke's Bay Regional Council in May 1996.
- A 150 m x 150 m bait station grid was established in the forest interior, and at 100 m intervals on the perimeter. Internal stations were filled with 500 g (initially) of brodifacoum cereal pellets and subsequent 2-monthly 250 g refills (from February 1997 to April 1999). Perimeter bait stations were refilled monthly from July 1996 to April 1999.

- ‘Feratox’ pellets were used once in September 1997, and then maintained as monthly re-fills from April 1999. ‘Feratox’ has also been used in areas of persistent possum re-invasion.

Paengaroa

- An aerial 1080 drop was undertaken in 1992.
- 106 bait stations were then established on a loose grid at a density of 1–2 per hectare (Fig. 15). 250 g of brodifacoum bait is placed in each station monthly.

Rotoiti

- Possum control is based on a grid of 736 ‘Philproof’ bait stations spaced from 100 m x 100 m in lower parts of the block, to 150 m x 150 m at higher altitudes (see Fig. 17). Initial ‘knockdown’ was achieved in November 1997 using 1080 pellets in ‘Philproof’ bait stations.
- Brodifacoum 20WP pellets were used subsequently, and re-loaded every 4–6 weeks; December 1997 until the present (June 1999).
- ‘Feratox’ pellets were used in 54 ‘Feratox’ stations on the northern boundary from November 1998 until the present. Two toxic capsules are placed in each station in peanut butter balls.

Hurunui

- 1080 in pollard pellets (Waimate, cinnamon-enhanced RS5 @ 0.15%) were delivered in (initially) 149 ‘Killamore’ and ‘Philproof’ bait stations at 100 m spacings for 20 km along bush edge on either side of valley floor (1995/96, 1996/97). An additional 73 stations (T=222) were placed in the upper valley for the 1997/98 season (Fig. 16). Baits were only presented from March to April for the first three seasons, and from March until May (inclusive) in 1998/99. ‘Philproof’ bait stations were abandoned after 1997/98.

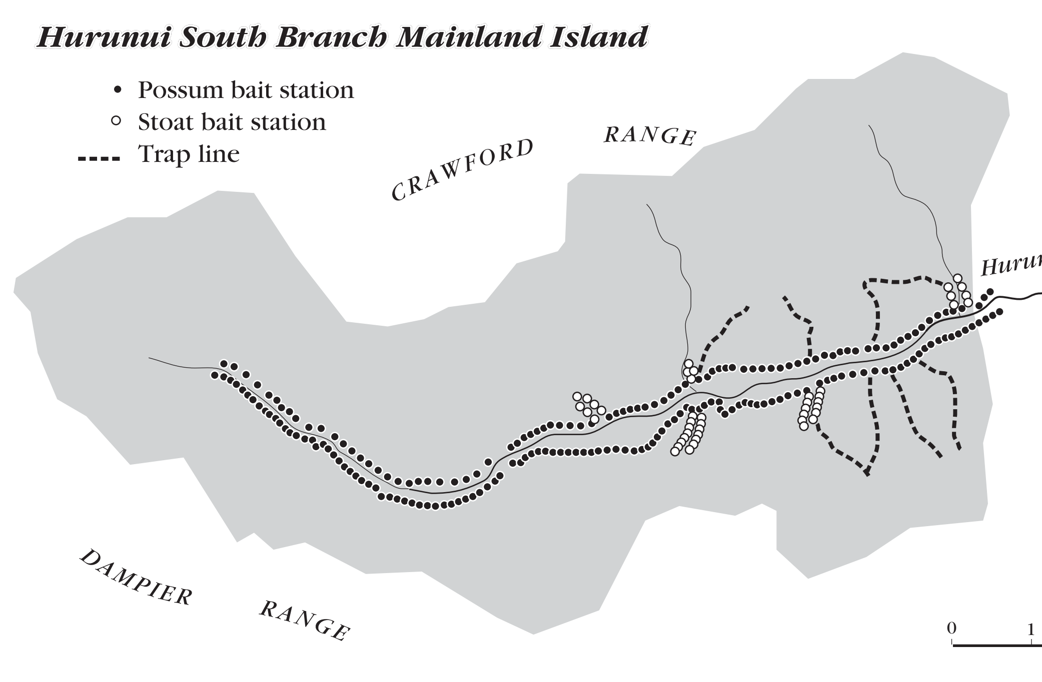


Figure 16. Possum bait stations and poisoned egg station (stoats) locations, Hurunui River South Branch.

5.1.3 Reported possum control monitoring

Trounson

- Five lines of 20 traps set at 20 m intervals are run on 3 consecutive fine nights (standard trap-catch protocol). Two sets of lines have been set up and are surveyed alternately.
- Wax blocks were also used in 1999 to monitor possums, and records of possums caught in 'Victor' traps have also been kept.

Northern Te Urewera

- Since August 1996 the National Possum Monitoring Protocol has been used, involving randomly selected start points for a pre-determined number of trap lines (depending on the size of the area). Three lines with traps spaced at 20m intervals are run for 3 fine nights.

Boundary Stream

- NPCA (1997) protocols applied annually. Same protocol in non-treatment (reference) areas.

Paengaroa

- Possum trap-catch surveys following the NPCA protocol were conducted in the summer of 1997/98.

Rotoiti

- Standard leg-hold trap catch method (Warburton 1997) using 10 lines in the treatment area and 5 lines in the non-treatment (reference) area. From April 1999 the method was altered to use 'Victor' No.1 (from 1.5) traps, and trapped animals are now released.

Hurunui

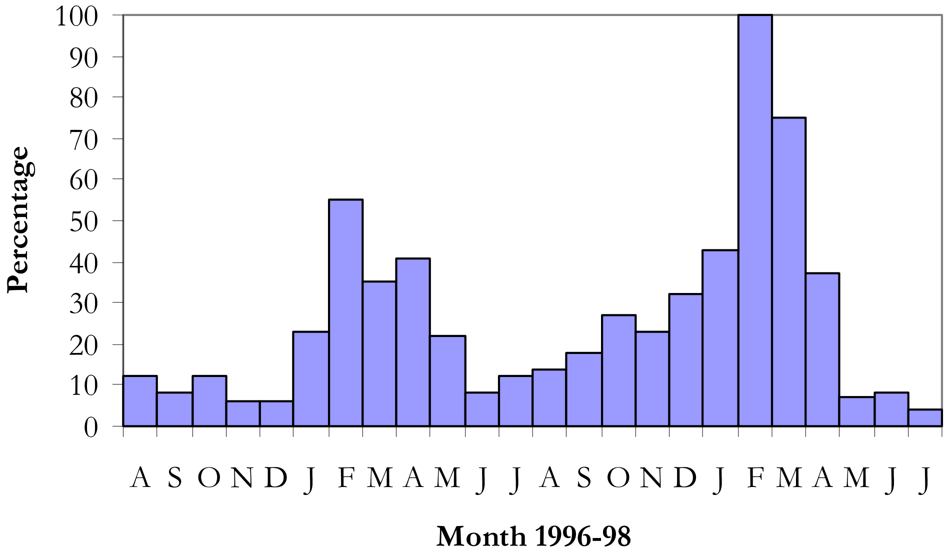
- Trap lines were not selected randomly due to logistical and terrain constraints. Fifteen permanent trap lines were established—each with 25 ramps at 25 vertical metre intervals. Ten lines are run prior to summer poisoning (5 in North Branch, 5 in South Branch), and 5 (South Branch) immediately after the poisoning is completed. Trapping is done over 4 consecutive nights.
- In addition bait take is measured as an indicator of possum distribution and kills.
- Possum scats are also measured along transects in the treatment and non-treatment (reference) areas as a trial.

5.1.4 Reported possum control result summaries

Trounson

- Residual trap catch figures show that possum indices have remained below the 1% target from May 1997 until April 1999 (Fig. 17).

Figure 17. Modified 'Victor' trap captures for possums as an indicator of possum abundance. Possums were trapped as a 'by-catch' in traps set for cats and mustelids. Possum numbers are seen to peak in February in both years. Higher numbers were caught in the second year of trapping (Trounson 1997/98 Annual Report).



Northern Te Urewera

- A 2% target was achieved for the last 3 years in the Otamatuna core breeding area An average index of 2.97% was achieved in 1997/98 across 33,700 ha using performance-based contract hunters, aerial 1080 and 'Talon' in bait stations.

Boundary Stream

- Pre-treatment indices as well as from non-treatment areas (separately and combined) indicate that less than a 2% index has been maintained since June 1997, and that these indices are significantly lower than non-treatment (reference) areas and prior to treatment.

Paengaroa

- 7.7 possums recorded per 95 trap nights following aerial 1080 drop (July 1992). No monitoring was carried out between 1992 and 1997. A 2.3% index was recorded in December 1997, and 1% in December 1998.

Rotoiti

- Indices prior to control (6.5% in treatment area), and following initial 1080 application (0.2% treatment, 8% non-treatment/reference) and annually following 'Talon' (1% treatment, 4.7-8% non-treatment) suggest significant reductions in treatment area after control, and between the treatment and non-treatment (reference) areas.

Hurunui

- Trap-catch indices indicate a progressive decline in possum numbers in the treatment area over the four seasons of control (Table 5, Fig. 18). Indices suggest increasing numbers in the non-treatment (reference) area (Table 6).
- Bait take data also suggest a decline.
- Scat transect data also indicate a downward trend in the treatment area, and an increase in the untreated area.

TABLE 5. POSSUMS CAUGHT PER 100 TRAPNIGHTS AND POSSUMS PER HECTARE FOR POSSUM TRAP-CATCH MONITORING LINES (HURUNUI 1997/98 ANNUAL REPORT).

	STATUS		1995/96		1996/97		1997/98	
TRAP LINE	TREAT	PRE/POST	POSSUMS PER 100TN	POSSUMS PER HECTARE	POSSUMS PER 100TN	POSSUMS PER HECTARE	POSSUMS PER 100TN	POSSUMS PER HECTARE
A	T	Pre	4.16	0.85	3.01	0.64	1.01	0.21
B	T	Pre	2.83	0.43	0	0	0	0
C	T	Pre	6.21	1.28	3.19	0.64	1.03	0.21
D	T	Pre	2.03	0.43	2.09	0.43	3.06	0.6
E	U	Pre	4.17	0.85	13.26	2.56	10.70	2.34
G	T	Post	4.12	0.85	3.06	0.64	2.04	0.43
H	T	Post	0	0	1.01	0.21	0	0
I	T	Post	2.18	0.43	1.01	0.21	3.16	0.64
J	T	Post	0	0	0	0	1.04	0.21
K	U	Post	1.01	0.213	5.21	1.07	4.17	0.85
Mean pre-poisoning (treatment + non-treatment)			3.88 (1.59)	0.77 (0.35)	4.31 (5.16)	0.85 (0.99)	3.16 (4.36)	0.67 (0.96)
Mean post-poisoning (treatment + non-treatment)			1.46 (1.74)	0.30 (0.36)	2.06 (2.08)	0.43 (0.43)	2.08 (1.65)	0.43 (0.34)
Mean pre-poisoning (treatment only)			3.81 (1.83)	0.75 (0.41)	2.07 (1.46)	0.43 (0.30)	1.28 (1.28)	0.26 (0.25)
Mean post-poisoning (treatment only)			1.58 (1.98)	0.32 (0.41)	1.26 (1.28)	0.27 (0.27)	1.56 (1.35)	0.32 (0.28)

Figure in brackets = standard deviation of mean. T = treatment area, U = non-treatment area. Possums per hectare is an approximation based on 25 traps at 25 vertical m spacing with influence of 60m either side of trap and with 1.6 correction factor.

TABLE 6. TRAP-CATCH LINE RESULTS (HURUNUI).

LINE	TREATED OR NON-TREATMENT	PRE OR POST TREATMENT	1995/96	1996/97	1997/98	1997/98	1997/98, NORTH BRANCH
A	T	Pre	6.06	4.04	1.01	3.02	8.16
B	T	Pre	8.00	2.00	1.00	1.01	8.04
C	T	Pre	7.07	12.00	2.04	4.12	12.36
D	T	Pre	2.01	8.04	3.02	6.03	12.31
E	NT	Pre	6.06	15.31	12.06	16.49	7.04
G	T	Post	6.00	3.08	4.00	2.00	
H	T	Post	1.00	1.01	0.0	2.04	
I	T	Post	16.08	2.02	5.13	1.01	
J	T	Post	6.00	0.00	2.04	8.04	
K	NT	Post	2.19	8.00	7.04	13.07	

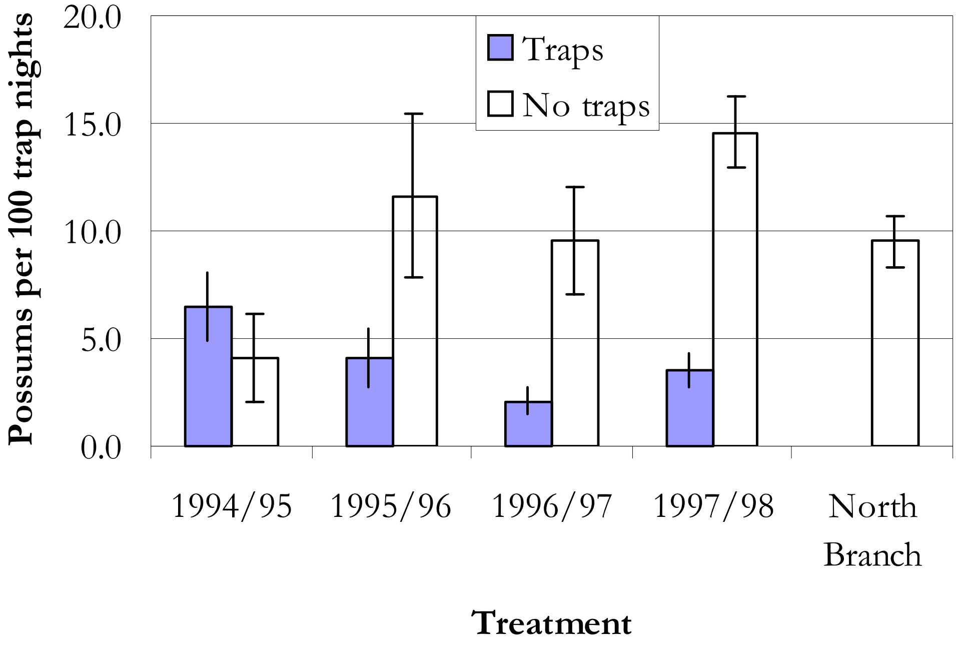


Figure 18. Possum trap-catch ranges for all lines each season (Hurunui).

5.1.5 Reported outcomes attributed to possum control

Trounson

Canopy defoliation

7 years of baseline data have already been collected. Early results have been published. In 1997 a reverse in recorded declines was noted, with more foliage being observed on monitored palatable trees. Levels of canopy defoliation continue to decline, whilst in the Katui reference area an upward trend continues.

Foliar browse

Following a comparison of both, Canopy Density and Foliar Browse methods, the more sensitive Foliar Browse monitoring technique is now used. Almost no browse is now being recorded—a dramatic change from prior to this project being initiated.

Seedling establishment

Annual seedling plot surveys since 1996 suggest there has been no significant seedling growth as a result of possum control. It has been suggested that the monitoring technique used may be inappropriate to detect any seedling establishment responses to possum control.

Phenology

Flowering and fruiting in up to 20 specimens of 9 palatable trees has been monitored since May 1996. Monitoring has been increased from 4-monthly to 2-monthly. No detailed analyses have yet been undertaken to link phenological changes to possum control.

Northern Te Urewera

Vegetation monitoring

Reductions in possum numbers have been correlated with a statistically significant improvement in forest canopy health and directly linked to increased numbers of flowering mistletoes detected in the Otamatuna study area. A 99% mistletoe pollination rate has been taken as indicating a response to possum control. Premature hinau and tawa fruit fall has been linked directly to stress on trees through possum browse. Photographs of monitored northern rata trees have not shown any significant increases in foliage cover as a result of possum control. It has been suggested that any improvement in rata may be a longer-term process.

Bird monitoring

Reductions in possum and rat predation on forest birds generally (as a result of control) has been used to explain the higher peaks in bird conspicuousness in the Otamatuna area compared to the Okopeka reference area. The reduction in pests (primarily possums and rats) to target levels during the breeding season has been used to explain the increase in average total density for all species recorded. A review of kokako recovery in the Northern Te Urewera (1991–98) attributed significant increases in the number of pairs and nesting success to pest control (possums, rodents, mustelids).

Boundary Stream

Vegetation monitoring

Foliar Browse Index monitoring and incidental observations of vulnerable species, and monitoring of known mistletoe plants has shown high canopy density scores, an absence of detectable possum browse, and an increase in the number and size of mistletoes.

Vegetation plots

Data from initial and subsequent re-measurements of 20 m x 20 m vegetation plots are being entered into Landcare Research databases (e.g. PCRECCE, PCUNDERSTORY), although analyses have yet to be undertaken.

Photopoints

Repetition of earlier photographs at fixed points illustrate graphic recovery of palatable seedlings and thickening of the forest canopy.

Phenology and foliar browse

Analyses of phenology and foliar browse have yet to be presented. Anecdotal observations indicate the absence of any detectable browse and exceptionally heavy flowering and fruiting of monitored trees.

Threatened plants

Analyses of mistletoe monitoring data indicate high fruit abundance in 3 of the 5 monitored plants. The discovery of new plants and the absence of any detectable possum browse suggests that possum control is leading to the recovery of mistletoes in the reserve.

Bird encounter rates

Anecdotal observations suggest marked increases in the number of some birds (e.g. kereru, tui) in the reserve. These increases have been attributed as being 'likely to be closely associated with a sustained reduction in possums.'

Paengaroa

'Vigorous regeneration was noted of *Tupeia* (mistletoe) plants previously unknown here prior to possum control. *Tupeia* can now be found throughout the reserve. It is not known if it is spreading or was always there but undetected, as no detailed monitoring was done beforehand. There was a general observation that 'possum preferred species within the reserve have a better canopy cover and are flowering and fruiting more prolifically than those in neighbouring unprotected remnants..' (Wayne Beggs pers. comm.) The level of control '…was considered effective enough to proceed with the transfer of North Island robin to the reserve in March 1999.' (Questionnaire response).

Rotoiti

Few conclusions have been drawn about the outcomes of possum control at this project, due mainly to post-treatment monitoring having not yet covered 2 seasons, although a huge pool of data exists (both historical, and from this project). Preliminary observations indicate little or no possum browse on monitored plants, improved seedling survival of *Fuchsia excorticata*, and an unusual amount of unbrowsed new growth on the palatable *Pittosporum patulum*.

Hurunui

Most monitored mistletoes have maintained or improved their condition in areas where possum control has been undertaken compared with reference areas (Table 7). A larger proportion of plants have deteriorated in condition at sites with no possum control compared with treated sites.

TABLE 7. SUMMARY OF MISTLETOE MONITORING (HURUNUI).

	SOUTH BRANCH				NORTH BRANCH	
	BETWEEN MARCH '97 AND MARCH '98		BETWEEN MARCH '98 AND MARCH '99		BETWEEN MARCH '98 AND MARCH '99	
	NO. OF SITES	% OF SITES	NO. OF SITES	% OF SITES	NO. OF SITES	% OF SITES
TREATMENT AREA						
IMPROVED in condition	10	40	2	7.6		
REMAINED THE SAME	12	48	22	84.6		
DETERIORATED in condition	2	12	2	7.6		
NON-TREATMENT AREA						
IMPROVED in condition	3	12.5	12	35.3	8	23.5
REMAINED THE SAME	7	29.2	13	38.2	13	38.2
DETERIORATED in condition	14	58.3	9	26.5	13	38.2

5.1.6 Possum control—comment

Most possum control objectives include reference to residual trap-catch indices. The availability of a standard national monitoring protocol has been a major advantage in setting objectives and evaluating performance in these projects, although there is some variation in the way these procedures have been applied at different sites.

In addition to target density indices, several projects have possum control objectives which include outcome-focused statements (e.g.'To control possums to a level where the ecosystem shows a positive response', Northern Te Urewera). In one case (Rotoiti) ecosystem responses are itemised, including reductions in possum impacts on invertebrates, birds and other forest biodiversity. The inclusion of outcome-focused statements represents an important step towards achieving broader ecosystem management goals, rather than continuing to focus solely on the pest populations themselves.

There are indications that major changes in forest vegetation have been induced as a result of intensive possum control. Significant declines in foliar browse indices and increases in flowering and fruiting in some palatable plant species have been recorded. It has also been suggested that possum control has led to increased bird pollination of mistletoes, and that pest control (including of possums) has resulted in increases in the number of birds counted. It has even been suggested that pest control (including of possums) may have led to a significant increase in numbers of large invertebrates at Boundary Stream. In all cases where ecological outcomes have been related to possum control, qualifying statements have been added such as that detailed analyses have yet to be completed, some observations are anecdotal, and insufficient time has elapsed to be confident of the associations between possum control and observed changes. To these provisos could be added inadequate non-treatment (reference) area comparisons (at some projects), a lack of replication and limited statistical testing (at all projects).

Possum control undertaken at these restoration projects is more intensive, and has resulted in very low possum indices being maintained for longer periods than for most other projects. There is no question that these results are significant nationally as well as locally. That results and a range of ecological parameters are being regularly monitored and (in most cases) compared with reference areas adds a further dimension to the value of these projects. A recognition that there are major constraints on our ability to predict outcomes of possum control is evidenced by the declaration of objectives at several projects to undertake investigations and trials to improve control techniques, and to reduce the risks associated with sustaining important conservation outcomes. At the heart of these objectives is a need for a better understanding of possum behaviour and impacts, and of conservation outcomes which may be predicted from particular control regimes. While an important start has been made at these and some other projects in addressing such questions at a local scale, a more strategic approach would be more productive.

Despite attempts to justify possum control efforts in relation to desired outcomes in some project objectives, it can be assumed that the 1–3% range of residual trap-catch index targets set at most projects are more a reflection of what is achievable, than an understanding of what is needed to achieve desired outcomes.

The value of the residual trap-catch index in gauging changes in possum densities, distribution and impacts when they are at low densities may also be problematic. There may be little difference, for example, between possum densities at a particular location and possum impacts between 1% and a 5% residual trap-catch indices. More sensitive measurements focused on ecosystem parameters rather than on possums themselves may be required in order to better assess changes when possums are at low densities.

After 3 or 4 years of management it could be suggested that these projects are moving out of the 'establishment' phase where the main objective is to demonstrate that possums can be controlled and responses measured, to subsequent experimental or management phases. Key questions to be addressed include the cost-effectiveness of pest control and the impacts of particular pests. The latter question is particularly important if critical pests are to be identified, and optimal control regimes developed. Rather than targeting multiple-pests, a single pest focus would be most appropriate if this question is to be answered. To date no initiatives have been taken to identify such strategic questions in relation to intensive pest control at these projects.

Emphasis is now being placed at several of these projects to reduce the environmental risks and on-going costs of possum control. For example, at Trounson and Northern Te Urewera brodifacoum use has been curtailed in favour of less persistent toxins. At Trounson it is proposed that poison applications be scheduled according to possum trap-catch indices reaching declared thresholds.

5.2 RODENT CONTROL

Rodents are targeted for control at four projects: Trounson, Northern Te Urewera, Boundary Stream and Rotoiti. Rodents are monitored as part of an evaluation of the success of a North Island robin translocation project at Paengaroa, and mice are also monitored at Rotoiti as part of a coordinated programme involving South Island beech forests.

5.2.1 Planned rodent control objectives

Trounson

Rats: the objective for the first two years of control was 'To reduce the rat population to very low levels and maintain at less than 1% tracking index.' From 1998/99 the target was set at 'less than 2% from late winter to mid summer, to provide maximum benefit for bird species.' Indices are allowed to be 'slightly higher' at other times (mid summer to late winter).

Mice: no target index has (yet) been set.

Northern Te Urewera

'To control ship rats to a level where the ecosystem shows a positive response'. A 5% tracking index target was set during the key period of bird breeding.

No mouse control objective has been set, although mouse indices have been recorded.

Boundary Stream

'To maintain rat indices below a 4% tracking rate.' No distinction is made between Norway and Ship rat control.

Mice are not targeted.

Rotoiti

'To reduce ship rat numbers to levels (less than 5% tracking tunnel index, corrected per 100 trap nights) at which predation'… of birds and invertebrates, and inhibition of plant regeneration are insignificant alongside other mortality factors.

'To reduce mouse numbers to consistently low levels to reduce their impact on invertebrates and native plants (seed predation).'

'To reduce the dramatic increases in mouse numbers associated with beech mast years.'

5.2.2 Reported rodent control techniques and management regimes

Trounson

Poisoning regime (both rodents and possums as part of same programme). Initially 500 'Philproof' bait stations on a 100 m x 100 m grid throughout the reserve (i.e. an average of 1 station per 0.9 ha). Initial 'knockdown' using 1080 pellets (June 1996) followed by brodifacoum baits. In response to high mouse tracking rates c. 450 extra bait stations allowing only mouse access were put in (October/November 1998) and used thereafter, increasing the overall grid to 100 m x 50 m (see Fig. 14).

As a result of concerns about the intensive use of brodifacoum, use of this toxin is now restricted to a small research area within the reserve.

1080 was used in a second pulse on October/November 1998, and in operations thereafter. In the third year of management (1998/99) the use of less persistent toxins and a pulsed poisoning regime was being investigated.

In June 1999 'Warfarin' was applied for rodent control, in conjunction with 'Feratox' for possums.

Northern Te Urewera

Rodent control techniques, results and outcomes presented here are summarised from a recently drafted report (Shaw unpubl.).

In the Otamatuna area various techniques have been trialed to control rodents. In 1996/97 and 1997/98 seasons 'Talon' 20p and 'Pest off' baits were applied in 'Philproof' bait stations.

In response to growing concerns about its persistence in the environment, brodifacoum use was stopped in 1998, and replaced with the first generation anti-coagulant 'Pindone' (and 'Feratox' for possums).

In the 1998/99 summer different rat control techniques were trialed including the use of 'Pindone' in bait stations on three (A, B and C) lines at 150 m intervals below ridge crests in a 'pulsed' regime. A second trial involved 'Pindone' in bait stations along a ridge crest, and another investigated the effectiveness of rat control using 'Pindone' in bait stations on 'A' lines 150 m either side of ridge crests. Rat trapping regimes were also investigated on a ridge crest and on 'A' lines.

Boundary Stream

A 1080 aerial drop was undertaken in May 1996, followed by brodifacoum cereal pellets in bait stations (initially 500 g, and 250 g refills thereafter) on a 150 m x 150 m internal grid, and 100 m station spacings on the perimeter.

Internal bait stations were re-filled every 2 months from February 1997 until April 1999.

Invasion areas (internal) were re-filled monthly from August 1996 until April 1999. Perimeter bait stations were re-filled monthly from July 1996 until April 1999.

'Warfarin' in 'Wanganui No. 7' baits was trialed in an isolated 250 ha area in the reserve (perimeter and interior stations) in April 1999.

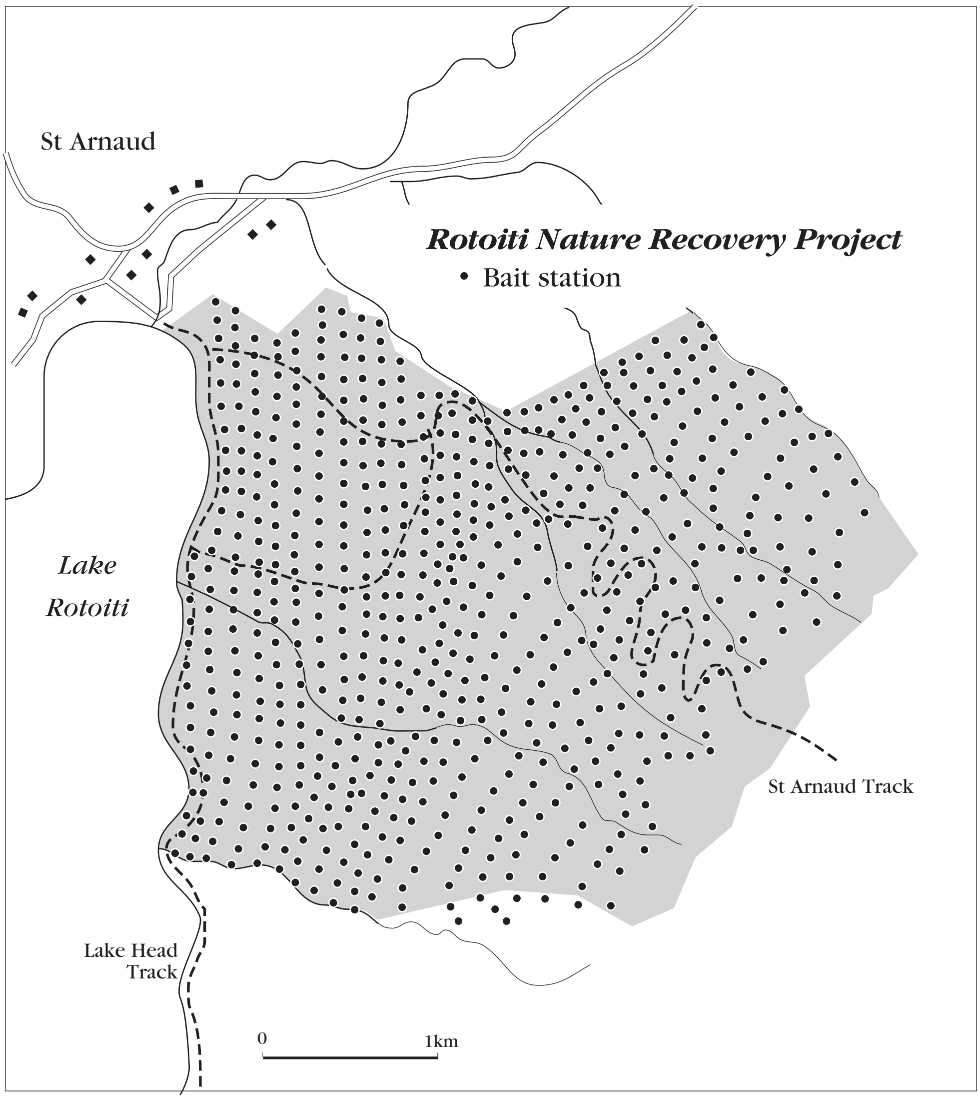


Figure 19. Bait station grid, Rotoiti operational area.

Rotoiti

Initial 'knockdown' of ship rats and mice with 1080 (November 1997) was followed by brodifacoum ('Talon' 20WP) in bait stations at 100 m x 100 m spacings at lower altitudes, and 100 m x 150 m spacings at higher altitudes (Fig. 19) from December 1997, and is on-going. Bait was applied in response to rodent tracking indices, and replaced on assessment of bait take and quality of remaining bait. Replacement quantities varied between 500 g (boundary only), 250 g and 125 g in response to the assessment of amount of bait take from the previous fill.

From July to November 1998 bait was applied in a 200 m wide strip along the northern farm boundary, and around the two northern-most tracking tunnel lines every 4–6 weeks. Poison was available over the whole block from 1998 until August 1998.

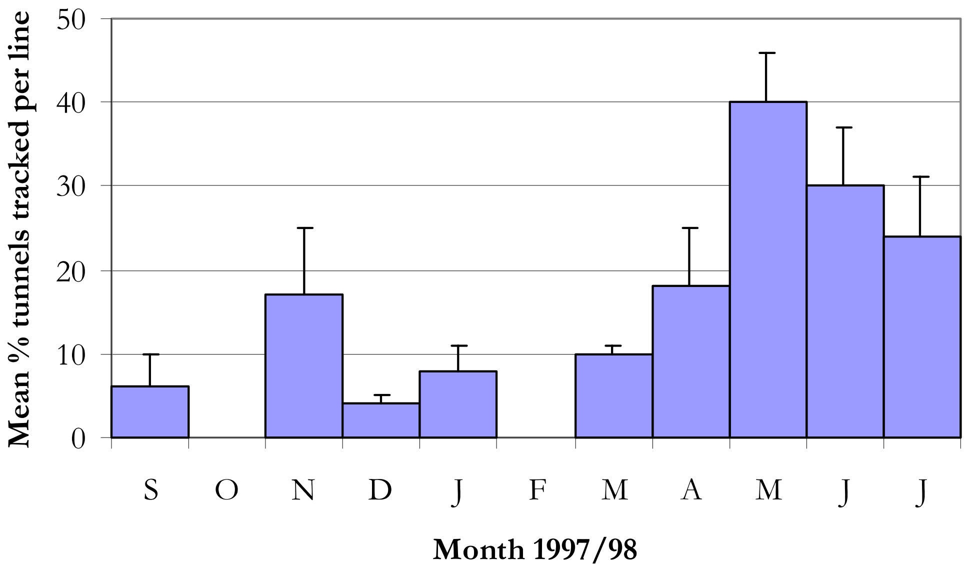
Since December 1998 the whole block has been poisoned every 4–6 weeks in response to rising rodent tracking indices associated with beech seeding. Smaller quantities (250 g/125 g) have been used since May 1998 targeting rats and mice as possum numbers declined. Each bait station has a stick attached to aid mouse access.

5.2.3 Reported rodent control monitoring

Trounson

Rodent numbers are monitored monthly in Trounson, and simultaneously in the Katui reserve non-treatment area (Fig. 20). 100 tracking tunnels spaced at 50 m intervals in each block. Tunnels in Trounson are distributed along compass lines proportionately sampling vegetation types present. Food colouring is used on tracking papers, and tunnels are baited with peanut butter on both ends of wooden bases. Snap-trap and wax block techniques were used initially, but discontinued. Rats are caught as by-catch in Fenn traps set for mustelids on the forest perimeter.

Figure 20. Rates of rat use in tracking tunnels, Katui.



Northern Te Urewera

Four objectives are listed by Shaw (unpubl.) relating to rat control and measuring the effectiveness of rodent control:

- 'To control rats to less than 5% tracking index from November 1998 to February 1999 in the Otamatuna, Mangaone and Ogilvies study areas.'
- 'To measure the effectiveness of 'Pindone' poison at reduced quantities and period in bait stations.'
- 'To measure the effectiveness of an 'A- Line' bait station field trial using 'Pindone' with the outcome determined by kokako breeding success.'
- 'To measure the effectiveness of an 'A-Line' trapping regime.'

Monitoring was conducted over 1 night using lines of run-through tunnels, apart from the 'A-Line' trapping trial.

Different monitoring techniques and regimes have been applied within the Northern Te Urewera as part of trials of different rodent control programmes. In the Otamatuna study area the method used was 5 lines of 10 tunnels spaced at 50 m intervals along the lines, with randomly selected start points for each line. No information is currently available concerning methods and results of trials elsewhere in the area, although a report is currently being prepared (Peter Shaw pers.comm.).

Boundary Stream

300 'Philproof' tracking tunnels; 200 in the Boundary Stream reserve and 50 in each of the two non-treatment areas, run seasonally. The objective is to create a seasonal index of rat activity, and to gauge the presence of residual populations of rats living between bait stations.

Paengaroa

8-weekly rodent tracking is being undertaken (1999/00) as part of an evaluation of the outcome of a North Island robin transfer.

Rotoiti

1997/98: 2 snap-trapping transects of 20 tunnels each. Each tunnel houses one trap for mice and one for rats (40 traps of each type). 5 tracking tunnel transects in treatment area of 20 tunnels each (100 total), used in conjunction with stoat monitoring until June 1998.

1998/99: tracking tunnel transects (only) used. New transects established:

- 2 lines of 10 tunnels in tussock area within project area
- 5 lines of 20 tunnels in Rotoroa non-treatment (reference) area
- 2 lines of 20 tunnels in Rotoiti non-treatment (reference) area.

NB. Rodents are monitored in the tussock area when resources allow, to augment understanding of the part this area plays in the project area as a whole. However, no rodent control is undertaken in tussock area. Rodents are not monitored in the tussock areas in reference areas, so no comparisons are available.

Hurunui

Trapping is carried out to monitor mouse populations. No rodent control is being undertaken. Twenty-five mouse trapping stations 25 m apart are located on a line. Each station has two snap traps which are baited with a mixture of rolled oats and peanut butter.

5.2.4 Reported rodent control results

Trounson

Rats were maintained at or less than 1% tracking index until May 1999 when indices increased from 2% to 6% in April, through to 25% in May—a period of 2 months. The rat index returned to zero following the June 'Warfarin' pulse.

Mouse numbers have fluctuated throughout the poisoning regime. Mice were not being effectively controlled by the 100 m x 100 m grid using wax-coated 'Pest Off' baits. The use of a 50 m x 100 m grid, and the application of 1080 in November 1998 saw mouse tracking rates drop from 77% in October 1998, to 2% in December 1998. Mouse numbers again soared up to 89% by May 1999, and dropped following the June 'Warfarin' pulse to 23% in July 1999.

'Warfarin' has been effective against rats and has temporarily reduced mouse numbers. Warfarin will continue to be used in future pulses. Its effectiveness in controlling mice will continue to be assessed.

Northern Te Urewera

In the Otamatuna area where 'Pindone' was applied in an 'A, B and C-Line' bait station regime, rat numbers were reduced below the 5% trap-catch index target, but increased again relatively quickly following both pulses. In the Mangaone area 'Pindone' was applied on 'A-Lines' 150 m below ridge crests. Although significant reductions in rat numbers were recorded, this regime was not successful in achieving the target 5% trap-catch index. This was attributed to too little bait being applied in the first 'fill' (Shaw unpubl.). The Ogilvies Ridge field trials using bait stations along a ridge crest and 50 m and 100 m below the ridge crest also failed to meet target trap-catch indices. Monitoring at the Okopeka non-treatment (reference) area showed a steady increase in rat numbers over the same period as the above trials were undertaken.

Boundary Stream

Brodifacoum filled bait stations have been effective in maintaining rat numbers consistently below a 4% tracking rate.

Rotoiti

Snap trapping and tracking tunnel indices for rats and mice suggest that rat control has been successful in maintaining numbers below the 5% target level for almost the whole period, while numbers were increasing in the reference area in response to beech seed.

Rats caught in Fenn traps set for mustelids on the perimeter, but not within the block were also interpreted as a further indication of successful control.

While mouse numbers were kept low (less than 5%) until February 1999, they have climbed since then in response to beech seeding, with the poisoning regime unable to 'turn this around'.

The increasing populations of both rats and mice in reference areas, and the interactions between them, make assessing the impact of poison on mice very difficult.

5.2.5 Reported outcomes attributed to rodent control

Trounson

No outcomes have been attributed specifically to rodent control.

Northern Te Urewera

A recorded increase in monitored robin numbers within the Otamatuna study area over the 1997/98 season has been attributed to rat control. Increases in the number of kokako pairs and nesting success, and the ratio of pairs to singles have also been attributed to reductions in possum, rat and mustelid populations (Table 8).

Boundary Stream

No conservation outcomes have been attributed specifically to rodent control, although various observed and anecdotal changes have been suggested as responses to pest control generally. The abundance, size and diversity of invertebrates has been monitored using pitfall traps. A significant difference between the average number of invertebrates caught in the reserve compared with the reference areas indicates that there has been an increase in their abundance as a result of pest control. Caution has been expressed, however, in relating these differences to management, and further research and monitoring is proposed to investigate any relationships between invertebrate communities and pest control. Weta occupancy of artificial 'houses' established in the reserve is also being monitored as a potential indicator of invertebrate responses to pest control. Insufficient data have been collected to justify analyses to date.

TABLE 8. OTAMATUNA BI-ANNUAL KOKAKO CENSUS RESULTS. CENSUS FIGURES BETWEEN JUNE 1992 AND JUNE 1997 SHOW A DECLINE IN KOKAKO NUMBERS THROUGH TO JUNE 1994. PAIR NUMBERS REDUCED FROM 16 DOWN TO 8 PAIRS, BUT THEN INCREASED TO 14. THIS INCREASE IN PAIR NUMBERS COINCIDES WITH THE COMMENCEMENT OF POSSUM CONTROL IN THE OTAMATUNA AREA (NORTHERN TE UREWERA 1996/97 ANNUAL REPORT).

DATE	PAIRS	SINGLES	JUVENILES	TOTAL NO. OF BIRDS
June 1992	16	8	10	50
November 1992	15	8	9	47
June 1993	12	11	9	44
November 1993	11	9	7	38
June 1994	8	10	8	34
November 1994	10	10	5	35
June 1995	13	11	10	47
November 1995	13	10	3	39
June 1996	12	6	5	35
November 1996	12	7	3	34
June 1997	14	4	12	44

Rotoiti

Robins are monitored as a measure of the success of rat control. High nesting success has been related to low numbers of rats.

5.2.6 Rodent control—comment

Different combinations of rodents are targeted for control at each project. Some objectives do not make it clear why some rodents are targeted, and not others, although the impacts of ship rats on nesting birds—especially North Island robins and invertebrates—is a focus for several objectives and performance measures. Justifications are given for controlling mice at Rotoiti, but the reasons for their recent targeting at Trounson are not clear.

Rodents, particularly rats, were initially targeted using the same management regime (brodifacoum in bait stations) as possums. In effect, they were managed jointly. A single control objective and linked target indices have been used at Trounson. At Paengaroa, while rodents have not been deliberately targeted, a level of rodent control from a management regime focused on possums is anticipated.

Two projects (Trounson, Northern Te Urewera) have discarded brodifacoum as a possum and rodent toxin. 1080, followed by 'Warfarin' have been used at Trounson, 'Pindone' and trapping is now being used at Northern Te Urewera, and 'Warfarin' is being trialed at Boundary Stream. At Rotoiti smaller quantities of brodifacoum bait are being applied now that possum bait take is low. In addition to reducing risks associated with the environmental persistence of brodifacoum, the application of smaller quantities of less toxic anticoagulants and 'Feratox'—the baits of which rodents will not take—perhaps herald a move towards more specific pest targeting. Bait stations which make it easier for mice to enter have been used at Rotoiti and, more recently, a mouse-only station has been developed at Trounson.

While most people would agree that more specific control techniques are preferable to multi-species approaches, these recent moves towards separate rodent and possum baits are the result of efforts to reduce environmental risks, rather than a deliberate attempt to improve the specificity of control. A departmental task group has recently been established to better evaluate the risks and benefits of brodifacoum use, and to recommend alternative approaches and toxins. It may be that recommendations from this group will lead to further developments in relation to better targeting of particular pests.

An experimental approach to improving rodent control has been applied at several projects. A pulsed poisoning regime has been proposed at Trounson, with rodent indices being used as a basis for determining the frequency of toxic bait application. At Northern Te Urewera different baits and bait stations have been trialed in different blocks and compared with a reference area. A rodent trapping regime has also been trialed in one block. A rodent management regime based on bait station lines on and near the top of leading ridges and spurs is also being investigated. Results of these trials have yet to be reported. At Rotoiti objectives have been declared to monitor interactions between rodents and their predators, and to contribute to (proposed) research to investigate the role of rats in secondary poisoning. The Rotoiti and Hurunui projects both contribute to a South Island beech forest mouse monitoring programme coordinated as part of the mohua recovery programme. An important objective of this programme is to improve the confidence in predicting increased stoat predation of mohua, and other forest birds following beech masts and subsequent mouse population irruptions. This is a rare example of a coordinated approach to information gathering from multiple sites for conservation benefit. Given the effort and risks associated with intensive rodent control at mainland restoration sites, a more proactive and coordinated approach to improving rodent control programmes would be valuable.

Problems in setting appropriate mouse target indices were mentioned in several questionnaire responses. These difficulties are due, in part, to the major population fluctuations which typify mouse populations, and the absence of a standardised monitoring approach. Different approaches are being used to monitor rodents at each project. A standard national protocol for monitoring rodents and other small mammals is currently being prepared (C.Gillies pers. comm.).

Apart from recorded increases in robin and kokako numbers, breeding success in the Northern Te Urewera, and high robin nesting success at Rotoiti being attributed to pest control (including rodents), no conservation outcomes have, as yet, been attributed to rodent control specifically. It can be expected that the need for investigations to better understand rodent impacts, the implications of control, and the development of appropriate rodent control regimes will increase. It can be observed that an important challenge for improving the effectiveness and efficiency of pest control is centred on the need to identify the particular disturbance effects of specific pests, and to employ pest-specific control programmes. Experience to date suggests it is extremely difficult to separate the effects of some pests, such as possums and rodents.

In most cases it is not clear why rodent control is being undertaken at these projects and interpretations of outcomes are not definitive. To determine the need for and value of rodent control, for example, the problems will need to be identified and hypotheses declared and tested through management.

5.3 MUSTELID CONTROL

Mustelids are targeted for control at five projects: Trounson, Northern Te Urewera, Boundary Stream, Rotoiti and Hurunui. Monitoring for mustelids also takes place at Paengaroa.

5.3.1 Planned mustelid control objectives

Trounson

Specific mustelid control objectives are not reported, but are included under general pest management objectives.

Northern Te Urewera

- ‘To reduce mustelids in the Otamatuna study area.’
- ‘To trial and refine mustelid trapping methods.’

Boundary Stream

- 'Return indigenous biota and ecosystem processes compromised by mustelid predation to high state of health.'
- 'Provide a safe environment for proposed re-introductions.'
- 'Reduce and maintain mustelid numbers to a level where they present minimal/no threat to indigenous wildlife.'

Rotoiti

- 'To reduce mustelid numbers to a sufficiently low level that they have minimal negative impacts on the breeding success of resident birds (particularly kaka) and on bats, and that they would allow the re-introduction of other species vulnerable to mustelid predation (e.g. mohua, kiwi).'

Hurunui

- 'The stoat population will be maintained at a level which allows vulnerable bird species to recover.'

5.3.2 Reported mustelid control techniques and management regimes

Trounson

150 double Fenn trap sets placed at 100–200 m spacings, under wooden covers. These are set around the forest boundaries, along access ways to the park and in one internal line within the main block of the reserve (see Fig. 14). Traps are open continuously and baited with eggs or rabbit meat.

Northern Te Urewera

174 double Fenn trap sets are placed at 150 m spacings, under wire mesh covers. These are set on ridgelines, riverbeds, tracks and roads. Traps are open continuously and baited with eggs.

Boundary Stream

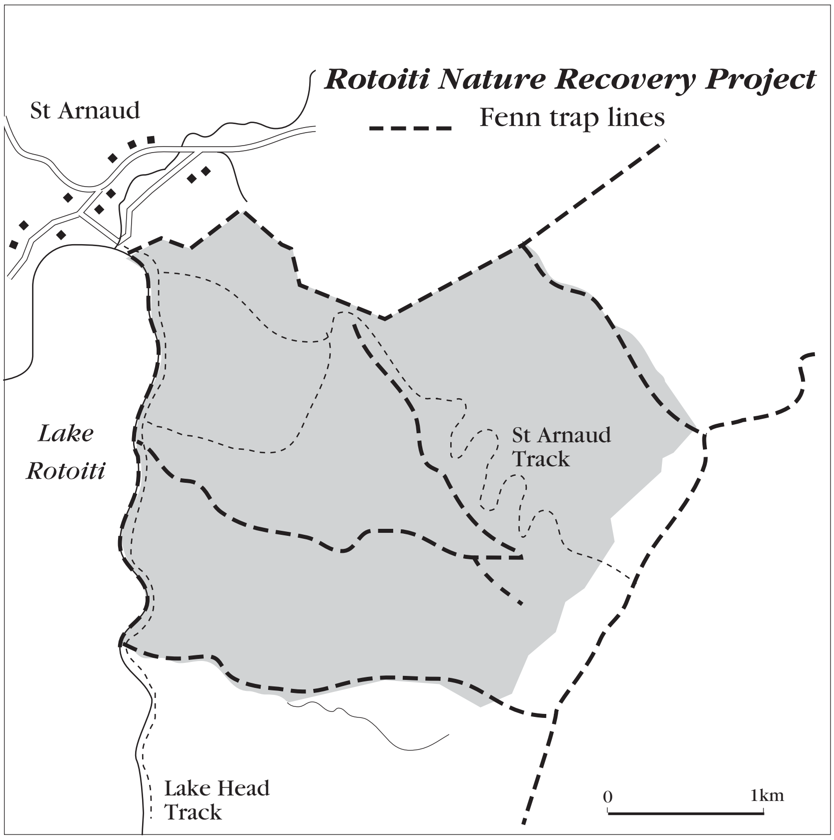
Double Fenn trap sets (number not reported) placed at 100 m spacings, under 'Philproof' plastic covers. These are set around accessible areas of the forest boundary and areas where mustelids have been repeatedly caught in the past. An additional line of Fenn traps (number and spacing not reported) under wire mesh covers is run through the interior of the reserve. Traps are open continuously and baited with eggs or rabbit meat.

Diphacinone (a first-generation anti-coagulant) injected into hen eggs were placed in 'Philproof' bait stations (number not reported) at 100 m intervals around the reserve perimeter for the first 2 years of the project.

Rotoiti

In November 1997 to January 1998, 25 Fenn traps (cover type not reported) were placed around each of four kaka nests, combined with aluminium bands placed around the trees for nest protection.

Figure 21. Rotoiti mustelid trapping lines.



In June 1998 to present, 304 Fenn traps were placed at various spacings (exact distances not reported) under alternate wooden and wire mesh covers. These are set in strategic lines in and outside the block (Fig. 21).

Hurunui

1080 injected hens eggs placed in 272 'coreflute' bait stations set every 100 m along the bush edge and extending 200–300 m up every major creek. Toxic eggs are replaced regularly between October and March of each year.

5.3.3 Reported mustelid control monitoring

Trounson

Kiwi chick survival is the primary indication of the success of 'predator' (cat and mustelid) control operations.

Mustelid control operations are monitored as part of SRU Investigation No. 2343. Techniques include radio telemetry, records of any mustelids sighted by staff during the course of normal duties, tracking plates and tracking tunnel surveys.

Northern Te Urewera

The effectiveness of trapping has been assessed by evaluating trapping results.

Kiwi chick survival is used an additional measure of the success of the mustelid control operations.

Boundary Stream

Comparison of mustelid captures on interior trap line versus capture rates on the perimeter.

Estimates of mustelid activity within the reserve are being compared with those at the non-treatment sites using tracking tunnels as part of SRU Investigation No. 3275.

Paengaroa

The presence of mustelids is monitored every 8 weeks as part of a study evaluating the success of the robin transfer. Tracking tunnels are used in two lines of 13 tunnels spaced at 100 m. Tunnels are set for 2 nights and baited with rabbit meat.

Rotoiti

Monitoring kaka nesting success is a key monitoring measure for stoat control.

Telemetry and ear tagging of live-captured mustelids is used to assess territories, movements and re-capture rates.

The effectiveness of trapping has been assessed by evaluating trapping results.

Hurunui

Predictive monitoring; to determine if a stoat population change will occur based upon snap trap indices of mouse abundance and counts of beech seedfall.

Recording toxic egg take from bait stations. This is related to results from Fenn trapping sessions (and radio telemetry of stoats in the 1996/97 year).

Monitoring of native species known to be vulnerable to stoat predation.

Estimates of mustelid activity within the reserve are being compared to those at the non-treatment sites using tracking tunnels as part of SRU Investigation No.3275. The first survey will be undertaken in August 1999.

5.3.4 Reported mustelid control results

Trounson

99 stoats, 43 weasels and 8 ferrets were trapped during the period August 1996 to May 1999.

Northern Te Urewera

Initially high mustelid capture rates reduced significantly and remained low as the bait station and trapping operations progressed, suggesting control was successful.

Boundary Stream

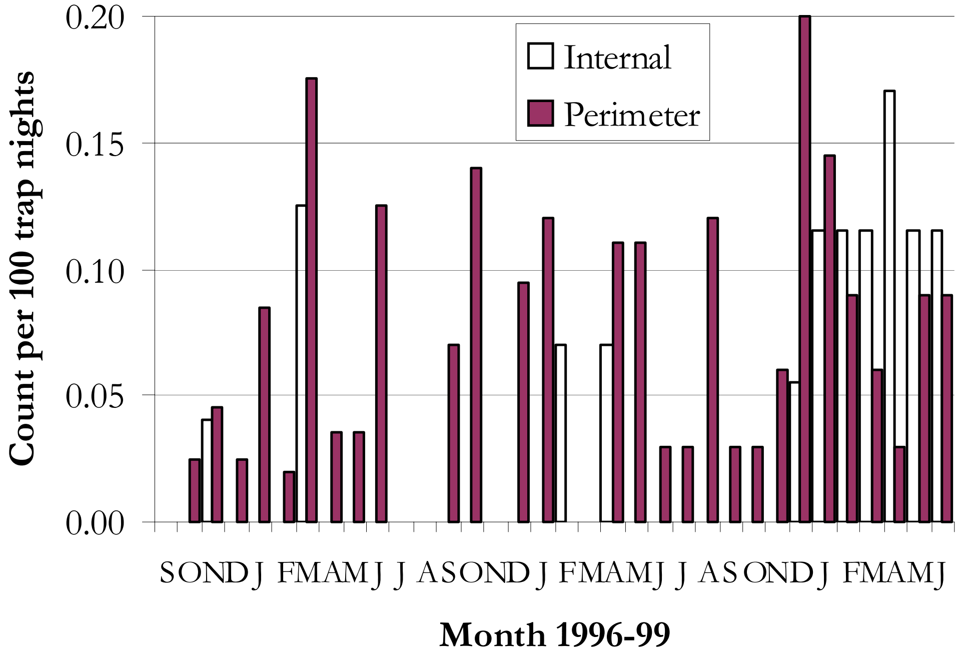
Perimeter traps captured a greater proportion of mustelids than internal ones (Fig. 22).

Rotoiti

Fenn trapping at kaka nests. Seven stoats caught (all at 1 nest).

Fenn trapping for general mustelid control; 52 stoats, 5 ferrets and 1 weasel caught.

Figure 22. Stoat captures, internal and perimeter traps: Boundary Stream.



April-May 1998 live trapping; one stoat ear-tagged, one ferret transmitterised and tracked until kill-trapped.

Hurunui

Toxic egg take has declined from 210 in 1995/96 to 15 in 1998/99, suggesting a decline in stoat numbers.

During 1997/98 5 stoats were transmitterised and their movements monitored.

A Fenn trapping survey in 1998/99 using hare meat instead of eggs indicated that baiting with hen eggs may not kill all stoats in the area.

5.3.5 Reported mustelid control outcomes

Trounson

1996/97 and 1997/98 years' kiwi chick survival was approximately 30%. Mustelids were believed to be responsible for most chick deaths in these years. Approximately 50% of kiwi chicks survived in the 1998/99 year (to date), however no chicks were believed to have been killed by mammalian predators.

Northern Te Urewera

In the years 1996–98 kiwi chick survival was about 24%, and about 50% of kiwi chicks survived in the 1998/99 year (to date).

Boundary Stream

The re-introduction and subsequent breeding of North Island robins in 1998 suggests that mustelid control has been successful.

Rotoiti

1997/98 all 4 protected kaka nests fledged successfully. 11 chicks fledged in 1998/99, with young fledging at 3 out of 4 monitored kaka nests. 1 out of 4 kaka nests was preyed on by a stoat which killed 4 chicks.

TABLE 9. SUMMARY OF RANDOM MOHUA RECORDS FOR EACH SEASON (HURUNUI).

YEAR	NUMBER	RECORDS	SIZE
1995/96	328 mohua	144 records	Mean group size 2.278
1996/97	506 mohua	233 records	Mean group size 2.269
1997/98	422 mohua	166 records	

TABLE 10. MOHUA PRODUCTIVITY (HURUNUI).

	1996/97	1997/98	1998/99
Mean fledging rate	1.66	1.77	2.5

TABLE 11. RANDOM MOHUA ENCOUNTERS – MEAN GROUP SIZE (HURUNUI).

DATE	PREDOMINANT ACTIVITY	1995/96	1996/97	1997/98	1998/99	
– Oct 1	Feeding flocks	4.2				Nth Branch
Oct 1 – Nov 15	Territory set up	2.01	1.8	2.03	2.16	2.4
Nov 16 – Dec 16	Incubation	1.09	1.59	1.84	2.16	2.08
17 Dec – Feb 1	Hatching – fledging	2.8	2.35	3.29	2.9	3
Feb 2 –	flocking	4.56	3.25	3.35	4.3	2.3

Hurunui

Monitoring of the resident mohua population since 1995/96 (Table 9) suggests increasing flock sizes and breeding groups, and productivity (Table 10) has steadily increased in the 3 seasons that banded birds have been monitored. No obvious differences have been detected, however, between the treatment area population and the North Branch (reference) area (Table 11).

Analysis of data from 5-minute bird count transect lines in the South Branch recorded over four seasons, and counts for 1 season in the North Branch, suggest a ‘definite improvement in the situation, and an upward trend for those (bird) populations within the treatment area.

5.3.6 Mustelid control—comment

No mustelid control objectives are result-focused. All are outcome-focused, related to bird or bat numbers and breeding success. While there is good evidence that stoats, in particular, have significant impacts on native bird populations, and increasing numbers of vulnerable species (e.g. kaka, kiwi) suggest stoat control is effective at some of these sites, these outcome-focused objectives do not adequately reflect that other factors may also be contributing to the decline of some species. That mustelids (in some cases, all three) and cats are targeted together further complicates evaluations of conservation outcomes.

An intention to reduce mustelid and other predator numbers through a secondary poisoning effect (Gillies & Pierce 1999) has been declared at several projects. Apart from on-going research at Trounson, and observations of dead stoats in the Northern Te Urewera, there is little discussion of the value of secondary poisoning as a management tool at these projects.

Mustelids epitomise the inherent difficulties in controlling essentially solitary pests with large home ranges. The absence of a reliable monitoring technique makes the application of result-focused objectives difficult. A standard protocol for monitoring mustelids and other small mammals is currently being developed. An advantage in using kill traps is that the number of animals captured can be measured. It is problematic, however, to relate the number of stoats trapped, for example, to the number of stoats present, or to the risk to native species from stoat predation.

5.4 CAT CONTROL

Cats are targeted for control at three projects: Trounson, Boundary Stream and Rotoiti.

5.4.1 Reported cat control objectives

Trounson

Specific cat control objectives not reported, but provision for their control is included under a general pest management objective.

Boundary Stream

Specific cat control objectives are not reported, but provision for their control is included under general pest management objectives

Rotoiti

- 'To reduce feral cat numbers to a sufficiently low level that they have a minimal deleterious effect on the breeding success of resident birds and lizards and that would allow the re-introduction of other species vulnerable to cat predation (e.g. kiwi).'
- 'In the longer term to reduce the population of pet cats at St Arnaud with support of the local community.'

5.4.2 Reported cat control techniques and management regimes

Trounson

100 1.5" Victor' soft-catch leg-hold traps spaced at 200 m, set on ramps around forest boundaries and along access routes to the park. Additional 'chimney' box traps at at key points.

Traps are opened on weekdays, (for first 2 years only half the traps were opened in any one week, alternated between northern boundary traps and southern boundary traps). Traps baited with rabbit meat initially, later changed to commercial tinned tuna cat food.

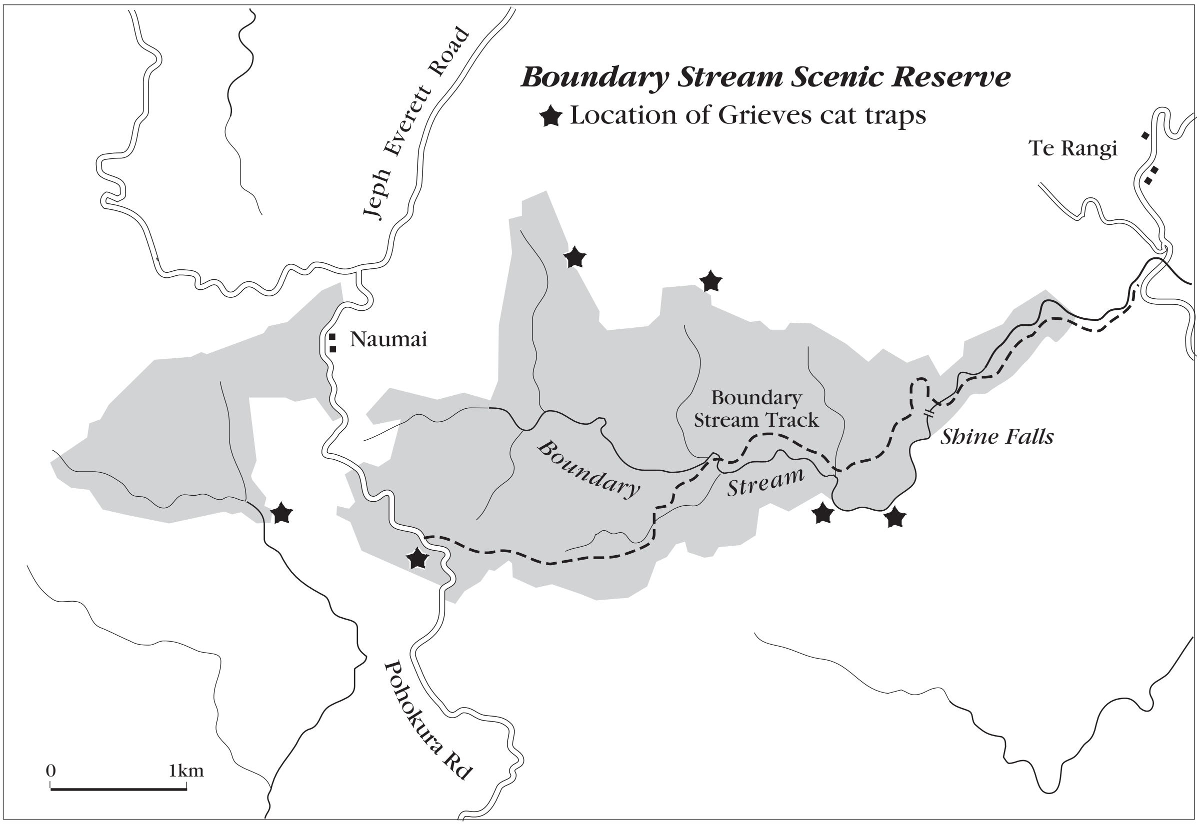


Figure 23. Location of cat traps, Boundary Stream.

As an additional control measure all cats seen during the course of daily duties or periodic night shooting expeditions are shot.

Boundary Stream

1.5" Victor' soft-catch leg-hold traps (number or placement not reported) plus 6 Grieves cage traps set in key locations within the reserve and on forest boundaries (Fig. 23). Soft-catch leg-hold traps maintained daily for varying periods with different bait types. Grieves cage traps set for 48-hour periods at a time different bait types used.

Rotoiti

No programmed cat control was reported as having taken place at the time of the questionnaire, although some shooting of cats at the local dump was noted.

5.4.3 Reported cat control monitoring

Trounson

Kiwi chick survival is the primary indication of the success of predator (cat and mustelid) control operations.

Cat control operations monitored as part of SRU Investigation No. 2343. Techniques include radio telemetry, records of cats sighted and shot by staff during the course of normal duties and tracking plates.

Boundary Stream

Single line of 1.5" Victor' soft-catch leg-hold traps (number not reported) spaced at 100 m intervals through the reserve used as an annual spot check to detect presence of cats.

Cat sign (scats or obvious cat predation upon other species) within the reserve is used as an informal measure of the effectiveness of cat control.

Rotoiti

No formal cat control monitoring reported as having taken place at the time of this review.

5.4.4 Reported cat control results

Trounson

136 cats have been trapped during the period August 1996 to May 1999.

Boundary Stream

15 cats have been trapped during the period May 1996 to June 1998.

Rotoiti

16 cats shot at local dump during the period December 1997 to June 1999.

5.4.5 Reported cat control outcomes

Trounson

Improved kiwi chick survival since predator trapping (cats and mustelids) increased in 1998-99 year.

Boundary Stream

No specific outcomes declared.

Rotoiti

No specific outcomes declared.

5.4.6 Cat control—comment

Problems associated with controlling cats are similar to those with controlling mustelids. Apart from being solitary and quite difficult to trap, cats are very difficult to monitor. Trials aimed at developing cat monitoring techniques are being undertaken, including spotlighting and the use of trained dogs.

As with mustelids, declared cat control objectives are outcome-focused. At Trounson, where over 130 cats have been trapped (and others shot) improved kiwi chick survival is attributed to cat and mustelid control. Given the effort required to maintain trapping regimes, separating cat and mustelid impacts could be expected to result in important improvements to cat (and mustelid) control programmes as a result of better targeting and timing.

At the other two projects where cats are targeted no specific outcomes of cat control have been declared. Cat control at Boundary Stream has been of a relatively low intensity, and reactive. Cat trapping was not initiated at Boundary Stream as a control measure *per se*. Rather, it was intended to determine cat impacts (through analysing gut contents of trapped cats) so that priorities could then be established for future cat control. Consideration is currently being given to increasing the intensity of cat control as part of management associated with the proposed re-introduction of kiwi to the reserve (Steve Cranwell pers. comm.). Apart from some shooting at the local dump it is not clear if any cats have been trapped at Rotoiti.

In summary, a number of comments in questionnaire responses refer to the difficulties in separating cat impacts from those of mustelids, and the problems in monitoring cats. Intensive cat control is only being undertaken at one project (Trounson)—and even here the benefits of cat control are not clear. Intentions to review and investigate cat impacts and control techniques are declared at all three projects.

5.5 FERAL UNGULATE CONTROL

Feral ungulates are targeted for control at three projects; Northern Te Urewera, Boundary Stream and Rotoiti. Domestic ungulate (stock) control is examined separately .

5.5.1 Reported feral ungulate control objectives

Northern Te Urewera

Specific feral ungulate control objectives are not reported, although objectives 'To assess deer abundance in the Northern Te Urewera through the relationship between deer pellets and density' and 'To compare deer abundance between 1980-81 and 1997' are included in the 1996/97 annual report.

Boundary Stream

- 'The maintenance of ungulate numbers at low levels within the reserve boundaries, and the control of a buffer zone in adjoining farmland.'

Rotoiti

- 'To control deer numbers so that they have minimal impact on the forest ecosystem.'

5.5.2 Reported feral ungulate control techniques and management regimes

Northern Te Urewera

A programme of intensive deer and pig control was initiated in the Otamatuna area (including the study area) in 1997. Ground hunting was undertaken by DOC staff and contractors. Emphasis in the first year (1997/98) was to establish infrastructure including hut construction and monitoring systems (pellet lines, vegetation plots and exclosures). In the 1998/99 year a contract hunter was employed.

Boundary Stream

Initially project staff time was devoted to goat control, following which control was largely incidental to other activities. From May 1997, two contract hunters made 1-week visits at 3-month intervals over 12 months. Since May 1998 contract hunters have been employed on an 'as required' basis, with incidental hunting by project staff to maintain low numbers.

Rotoiti

The first season was aimed at assessing deer impacts and trialing shooting as a control method here. One hunting session was carried out above the tree line in summer.

5.5.3 Reported feral ungulate control monitoring

Northern Te Urewera

Deer and pig numbers are monitored in the Otamatuna area using four 'presence/absence' pellet lines, and on five representative lines in the greater northern Te Urewera area. Some were existing lines which had not been measured since 1986. In some cases lines had been initially established and measured in 1969. New lines in the Otamatuna area 'were randomly selected using the method described by Braddely (1985)'. Both 'presence/absence' in a 1.26 m radius plot and 'point distance' in 2.5 m radius methods were used. Plots occurred every 10m on a transect which ran from stream to ridge crest and covered a distance of at least 80 plots. 'This method is fully described in Knowlton (1982) and Beadel (1988)'.

In addition two 20 m × 20 m exclosures have been established in the Otamatuna area. Ten 9 m x 9 m vegetation plots have also been established in the Otamatuna area to measure ungulate impacts.

Records of the number of ungulates shot per hunter effort were also kept.

Boundary Stream

Records have been kept showing changes in the number of goats shot relative to hunting effort over time, and changes in the number of ungulates encountered relative to time spent in the reserve.

Sixty photopoint sites were established within Boundary Stream and the reference areas between September 1995 and March 1998 to depict vegetation recovery. Sites were chosen based on their potential to demonstrate change. A range of sites have been sampled from bluff systems, forest understorey, canopy and single species. Locations of all photopoints have been referenced for future visits. Re-photographing is proposed every 3–5 years.

Twenty-seven 20 m × 20 m vegetation plots were established and initially measured between October 1996 and February 1997 to establish a baseline from which the effectiveness of ungulate control could be measured. Of these 19 occur in Boundary Stream, 3 of which are exclosure plots with a paired 'control' plot. Each plot is located in areas representative of the vegetation mosaic, topography and altitude gradient. The remaining 8 plots are 4 paired exclosures with 2 located in each of the reference areas. These are replicates of plots sited in the dominant vegetation categories sampled in Boundary Stream. All plots have been assessed using Allen's standard forest plot assessment technique, and RECCE protocols. All plots were re-measured in the summer of 1998/99. Future re-measurements will occur 5-yearly, or as management needs dictate.

Rotoiti

The time required to monitor the number of deer themselves was not considered justified given the low numbers in the area, but sightings were recorded along with the person-days in the block as a gross measure of activity. One 20 m × 20 m exclosure has been constructed to date (paired with an unfenced 20 m × 20 m plot) to monitor browse on susceptible species.

5.5.4 Reported feral ungulate control results

Northern Te Urewera

41 deer and 3 pigs were shot in the Otamatuna area (including a 1200 ha buffer) during the 1997/98 year. This figure had increased to over 140 deer by April 1999.

Deer monitoring results (faecal pellet density counts) showed a slight (not statistically significant) reduction in deer numbers.

Brodifacoum residues were found in some samples assayed from these animals.

Boundary Stream

Staff encounter rates with goats in and around the reserve boundaries have declined from ‘multiple’ to ‘occasional’ encounters with low numbers of animals.

Support from all neighbouring landowners has enabled the establishment of an effective buffer area, reducing goat re-invasion rates into the reserve.

Few deer and pigs have been shot by staff or contractors to date.

Rotoiti

No results reported.

5.5.5 Feral ungulate control—comment

That feral ungulates are targeted for control at these projects may be taken as an acknowledgement of the ecological impacts that these animals can have on forests, and on ecological restoration goals. The active targeting and effective control of deer and pigs, in particular, is by no means universal at projects where intensive control regimes are in place for other pests. This is probably due to the difficulties in controlling deer and pigs to low densities, problems in measuring specific feral ungulate impacts, and issues associated with the values ascribed by some user groups and project staff to feral ungulates as game animals.

The removal of goats from the Boundary Stream reserve has been a major undertaking. Since goats are widespread and numerous throughout the Hawke’s Bay region it can be anticipated that an increased awareness of their impacts, and of ecological responses to their control as a result of this project will lead to further initiatives by farmers and local groups to control goats elsewhere. The initiation of intensive deer control in the Otamatuna area has also been important in that relatively high numbers of deer continue to be shot despite it being a popular and accessible recreational hunting area.

Feral ungulate control objectives for these projects are general rather than specific, and are either directed at results (e.g. maintenance at low levels) or outcomes (e.g. minimal impacts on forest ecosystems). The Northern Te Urewera project objectives were focused on developing monitoring techniques and comparing past and present deer densities. Problems associated with separating feral ungulate impacts from those of other herbivores, and in targeting control at specific ungulates (e.g. deer rather than pigs) are probable reasons why more specific control objectives have not been used.

The use of contract hunters at the Boundary Stream and Northern Te Urewera projects reflects a need for specialised hunters to focus on specific ungulates if low pest densities are to be achieved. Although the results achieved by contract hunters to date suggest that the use of specialists devoted to ungulate control specifically is justified, it has been observed that, at Boundary Stream at least, incidental goat control has been effective in maintaining goats at very low levels (Steve Cranwell pers. comm.).

It can be anticipated that important improvements to monitoring techniques for assessing feral ungulate densities and impacts will come from the various research and monitoring programmes being undertaken at these projects.

5.6 WASP CONTROL

Wasps are targeted for control at only one project, Rotoiti, although they are also monitored at Hurunui. At Rotoiti the common wasp (*Vespula vulgaris*) and the German wasp (*Vespula germanica*) are collectively targeted.

5.6.1 Reported wasp control objectives

Rotoiti

- 'To reduce wasp numbers so they have minimal impacts on native fauna.

Other general objectives are:

- 'To reduce the take of honeydew'

- 'To reduce predation on native invertebrates and bird nestlings so that the impacts of wasps are insignificant alongside other mortality factors affecting these groups to improve the public's experience visiting the beech forest in late summer'.

Hurunui

No objective to control (monitor only).

5.6.2 Reported control techniques and management regimes

Rotoiti

A 300 ha area was treated on lower slopes below c. 800 m a.s.l. The area was divided into 2 blocks with bait stations placed 100 m × 100 m apart in one, and 100 m × 50 m apart in the other. Equal amounts of poison were applied to the two blocks. Bait stations were attached to tree trunks at eye level.

In the 1997/98 summer 'Finitron' bait was used (active ingredient sulphuramide), manufactured by Elliott Chemicals, with 640 g and 320 g applied to bait stations in the two areas. The poison was available in tubes as a frozen mix of sardine cat food and was placed in the bait stations using a 'Mastic' gun. Bait stations were halved recycled milk cartons.

In the 1998/99 summer 'Extinguish' bait was used (active ingredient 'Fiprinol'), manufactured by Rhone-Poulenc, and available in early February and took six staff 1–2 days to administer the bait to all stations, under an Experimental Users Permit through Landcare Research NZ Ltd. Small plastic 'KK' bait stations were used in 1998/99.

Hurunui

No control undertaken.

5.6.3 Reported wasp control monitoring

Rotoiti

Malaise traps were used to obtain indices of wasp numbers in both the treatment area (20 traps) and the Rotoroa reference area (10 traps).

The number of wasp nests and nest traffic rates were measured on transect lines established within the block, through the boundary, and at the non-treatment site. Wasp densities were measured using protocols developed by Landcare Research NZ Ltd. Once five wasps were on monitored baits after one hour poison application commenced (early February in both years).

Hurunui

The monitoring objective was to 'Determine the nature of the wasp population so that the impact of wasps on various conservation values can be assessed.'

Forty wasp traps were set out immediately downstream of the treatment area. In 1995/96, 20 traps were baited with sardines and 20 with sugar water. These were left set for a 24-hour period. During 1996/97 and 1997/98 traps were set from November until March, checked periodically and re-baited with either sardines and sugar water, or sugar water and fresh meat.

5.6.4 Reported wasp control results

Rotoiti

Results for the 1997/98 season are presented in the draft annual report. Results of the 1998/99 season are still being analysed. In summary;

1997/98

- 74% reduction in wasp activity in treated area. No clear difference between control achieved at 100 m × 100 m or 100 m × 50 m spacings.
- 41% reduction in nest density
- Figures equate approximately to 1.7 million wasps and 2,300 nests destroyed.
- A lot of bait was left in stations.

- Wasp numbers did not recover at Rotoiti after poisoning (ie. includes limited re-invasion),so planned second poisoning did not take place.
- Wasp control maintained honeydew above target levels in treatment area throughout. It dropped below target levels with peak wasp numbers in the reference area.
- Initial analysis of malaise trap samples suggest no detectable impacts of wasp reduction on invertebrate fauna.

1998/99 (preliminary results: Fig. 24)

- Reduction in wasp activity at Rotoiti = 99.87%, and at Rotoroa reference area = 12.74%
- Reduction in wasp nests at Rotoiti—96.72%, and at Rotoroa = 3.85%
- Most of the reduction occurred in the first 12 hours. There was no significant difference in take between the 2 blocks.
- Not all poison was removed from stations—due largely to wasps being at lower densities than the previous year.
- There was a significant difference in numbers at the two sites which proves management had an impact.
- Further analyses of the data have yet to be completed, including malaise trap samples.

Hurunui

Reported monitoring results:

- No wasps were caught in 1995/96—due probably to being set at an inappropriate time.
- In 1996/97 7 wasps were caught (1 in January, 6 in March).
- In 1997/98 36 wasps were caught (in March).

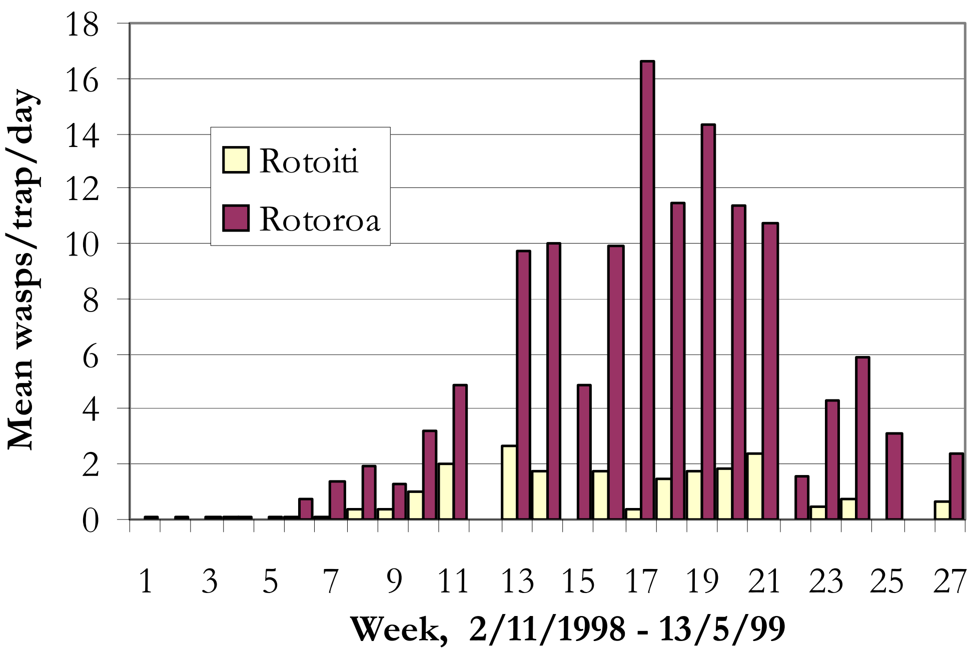


Figure 24. Wasp numbers from malaise traps in the 1998/99 season, Rotoiti.

5.6.5 Reported outcomes attributed to wasp control (Rotoiti)

These results have been interpreted as follows:

'In the first year the wasp control had a significant impact on wasps and enhanced the honeydew supply for native fauna to levels targeted. No direct beneficial impact on native invertebrates was detected. In the second season the poisoning was even more effective, almost 100%, due in part to the greater toxicity of the toxin used. Honeydew and malaise (trap) samples are in the process of being analysed. We can confidently extend the bait station spacing next season which represents a significant advance.' In addition, 'The St Arnaud Community Association, using volunteers and a grant from Trustbank, controlled c. 1000 nests by direct poisoning in the village area in 1997/98. Their 1998/99 results are not yet available' (Rotoiti questionnaire response).

Reported interpretations of monitoring results (Hurunui)

'It would appear that a tiny overall wasp population exists which seems to be transitory, or individuals exploring new territory. There is no evidence of a resident wasp population in the valley, wasps are very rarely encountered, and no indication of nests has been found. Whether this is because the valley is unsuitable for wasps, or it is because wasps have not yet colonised is still to be determined. Only further data collection over the next few years will tell.'

5.6.6 Wasp control—comment

The targeting of wasps for control at Rotoiti is important for several reasons. Firstly, it is the only restoration project where invertebrate pests are targeted for control. It can be anticipated that important lessons will be learned from this project which may lead to more cost-effective wasp control elsewhere. Secondly, previous wasp research undertaken by Landcare Research in this area means there is a useful pool of data for comparison. Advice from ecologists involved in this research is provided on an on-going basis to assist in interpreting results as the control programme proceeds. A further benefit of this earlier research is that techniques have been developed to monitor both, wasp densities and wasp impacts. Relatively comprehensive monitoring and interpretation procedures are in place for the wasp control programme compared to some other targeted pests. Thirdly, wasp control is focused on addressing disturbance to, and measuring changes in, the food web, and requires attention to natural ecological processes such as nutrient cycling and energy flows, rather than on the more usual agents of decline addressed elsewhere. This focus presents opportunities to understand different ecosystem processes.

Health and safety issues, as well as public enjoyment add a further dimension to the Rotoiti wasp control. There is strong interest among local communities, as well as from visitors to these forests in late summer, in the development of more cost-effective wasp control techniques. It is likely that the efforts being taken in this project to control wasps have helped engender support for the project from these groups. A cooperative approach based on shared goals and information sharing is clearly emerging amongst project staff and St Arnaud residents. Recently commissioned social research should allow a better understanding of stakeholder views and aspirations to be obtained, and for changes in these views to be measured.

5.7 WEED CONTROL

In total 16 plant species are targeted for control at two of the six projects; Boundary Stream and Paengaroa. Weed control objectives have not been declared at other projects, although some informal/low intensity control has been undertaken.

5.7.1 Reported weed control objectives

Boundary Stream

'Exotic plants that have the capacity to spread widely or destructively will be eliminated from Boundary Stream and the surrounding area.' Three weeds are targeted for control: *Monbretia, Buddleja* and *Cotoneaster.*

Paengaroa

Control objectives are divided into '[Common] Ivy and other vines', 'Woody weeds of forest understorey' and '[Crack] Willows along Hautapu Riverbank'.

Woody weeds include: cherry laurel, spindle tree, rowan, elderberry, gooseberry, red currant, *Cotoneaster franchetii, C. simonsii*, plum, Himalayan honeysuckle, barbery, common privet and sycamore.

Ivy and other vines—objectives:

- 'to remove all ivy from the reserve.
- 'to remove ivy from properties adjoining the reserve.
- 'to remove all other exotic vines with actual or potential undesirable impacts.'

Woody weeds of forest understorey—objectives:

- 'to remove all exotic shrubs and trees from the forest understorey'.
- 'to advocate for and/or assist in removal of known problem woody weeds from neighbouring properties'.

Willows along Hautapu Riverbank—objectives:

- 'to remove all willow trees from riverbanks adjoining the reserve.'
- 'to permit natural regeneration of indigenous riparian vegetation.'

5.7.2 Reported control techniques and management regimes

Boundary Stream

Monbretia is controlled using a herbicide ('Roundup') spray during periods of active growth and immediately prior to dormancy.

Buddleja is hand-pulled in mid-summer during flowering.

Key *Cotoneaster* plants are hand-pulled in early autumn and large stumps painted with herbicide to precent re-growth. In most cases *Cotoneaster* plants are not actively controlled, but are monitored. It is not shade tolerant and is not expected to be a major problem as forest regrows.

Blackberry has made a notable resurgence along margins, tracks and light wells. Although it is unlikely to be a major problem inside the forest, control will be undertaken where it is a problem for neighbours or visitors.

All weed infestations are recorded and mapped, control is documented and control sites re-visited to ensure success.

Paengaroa

Ivy and other vines: The infested area was divided into blocks and systematically searched. Large vines were cut with a chainsaw. Smaller vines were pulled by hand, piled into heaps and sprayed with glyphosate. A concerted effort to control common ivy has been in place since 1990 involving volunteers initially, and contractors and departmental staff. Some 20% of the reserve may have been infested. Large ivy plants on adjacent properties have also been treated.

Woody weeds of forest understorey: Infested areas were divided into grids which were systematically searched. Large trees and shrubs were drilled and poisoned with a herbicide. Seedlings and saplings were hand-pulled and/or sprayed with herbicide. An annual programme of control has been undertaken since 1995. Control work is generally undertaken between November and February. The 1998/99 summer was the first year that woody weeds were targeted on nearby private lands as part of the annual control programme. This work was generally well recieved in the local community.

Willows along the Hautapu Riverbank: Shallow holes were drilled into tree trunks at approximately 10 cm spacings and filled with herbicide (‘Escort’). Control work began in November 1998 at the lower end of the reserve on the true right bank. By February 1999 all of the willows on the true right and half of those on the true left had been treated.

5.7.3 Reported weed control monitoring

Boundary Stream

- ‘All weed infestations are recorded and mapped, control is documented and control sites re-visited to ensure success.’
- Annual surveillance of C*otoneaster* continues.
- No pre-control weed monitoring was undertaken. Detailed operational monitoring has been employed. Post-control monitoring is planned for November 1999.

5.7.4 Reported weed control results

Boundary Stream

Monbretia has been contained to an area of about half a hectare within the reserve.

Buddleja has been eliminated from the infected area within the reserve. As it is common in gardens in the vicinity of the reserve, however, there is a possibility of re-invasion. Because it is not shade-tolerant the chances of it becoming a major problem within the forest is considered low.

Paengaroa

Ivy and other vines: Most ivy has been removed, but isolated untreated patches are still being found and seedlings and small rooted pieces are sometimes encountered in areas where control has been done in the past. All known large plants have been removed from nearby properties.

Woody weeds of forest understorey: Most species of woody weeds have been greatly reduced from their original densities and ranges. It has taken about 3 years to treat the whole reserve with the resources available.

Willows along the Hautapu Riverbank: Treated trees began to lose their leaves a month after treatment. Eradication of the mature trees should be achieved over the next 2 years. Some re-infestation of willows, by vegetative regeneration of willow material washed down the river is likely to require on-going maintenance.

5.7.5 Reported outcomes attributed to weed control

No conservation outcomes have been reported from either of the above projects although 'massive regeneration' has been observed at Paengaroa following weed control. Because no baseline study was done however, and due to the difficulties in separating responses to weed and possum control, it has been difficult to attribute outcomes to weed control (Wayne Beggs pers. comm.).

5.7.6 Weed control at other projects

While Boundary Stream and Paengaroa are the only projects for which weed control objectives have been declared, informal weed control has been undertaken at two other projects: Trounson and Rotoiti, and consideration to weed control given at Northern Te Urewera. No weed control objectives have been declared and no control activities described for the Hurunui project.

Trounson

A weed inventory was undertaken of the reserve in 1997. This survey showed that a wide variety of weeds were present, particularly along the banks of the Waima River. The interior of the forest, apart from the fringes, is largely weed-free.

Weeds identified as posing the most significant threats to Trounson were ginger, African clubmoss and wandering jew, and to a lesser degree Mexican devil weed and mist flower.

Although no control objectives have been identified, pampas and ginger control work was undertaken by volunteers during 1997/98 on the perimeter of the forest, and in nearby pasture and riparian areas.

Northern Te Urewera

Pampas and *Buddleja* have been identified as potential weeds but no control work was initiated as they were not considered a priority for funding.

Rotoiti

No specific weed control objectives have been declared. Weeds known to be present in the project area are ragwort, rowan seedlings, Douglas fir and sweet briar. Informal control (opportunistic hand-pulling) and possible removal of seed sources is proposed. More comprehensive control is planned following the recruitment of a staff member with relevant expertise.

5.7.7 Weed control—comment

Weeds are recognised as a pest management issue at all but the Hurunui project. Different priorities are assigned to weed control at these projects. Weed control has a relatively low priority at the Northern Te Urewera project, with no control being undertaken. Informal control has been undertaken at Trounson, although a weed inventory may lead to surveillance monitoring of potential problem species and, perhaps, targeted control. Informal control is also being undertaken at Rotoiti, although this too may change with the appointment of a weed specialist. Notable progress has been made in relation to weed control objectives at Boundary Stream with Monbretia and *Buddleja* eliminated from the reserve, and a surveillance monitoring programme set in place for *Cotoneaster*, the other targeted species.

An important difference between Paengaroa and the other projects is the priority given to weed control, and the intensity of effort over a number of years involving volunteers, departmental staff and the local community. Objectives for weed control at Paengaroa are also more specific than at the other projects, although even here they lack time frames to assist in performance measurement. Unlike all the others weed control was the first intensive management programme to be initiated at Paengaroa. Prior to approval for the transfer of North Island robins to the reserve, pest animal control was secondary.

While it was beyond the scope of this review to compare this project with weed control being undertaken elsewhere, the results achieved to date in significantly reducing the density and range of most targeted weeds within the Paengaroa reserve are undoubtedly significant in a national context. It has been concluded by project staff that 'Local eradication of many of the species is feasible, but it will take a concerted effort over a medium to long-term period.' Reference is made in the questionnaire response to support from the local community and adjacent landowners. The crucial importance of such support in achieving and maintaining weed control objectives is emphasized in the questionnaire response thus; 'The long-term success of the programme will depend on our ability to remove problem species from properties surrounding the reserve. This, in turn, depends upon gaining the support of local people for the mainland island concept, and for the reserve in particular.'

Apart from the Trounson and Paengaroa projects where detailed weed surveys have been undertaken, the basis for assigning priorities to weed control is not clear. There is a need to identify desired conservation outcomes in goal and objective statements relating to weed control so that progress may be measured. It may be an indication of the 'newness' of intensive weed control as part of conservation management projects that outcomes have yet to be identified, and progress towards outcome-focused goals declared. Given the intensity of monitoring undertaken at Paengaroa, and relevant research, it may be that an important benefit of the Paengaroa project could be the identification of conservation outcomes of intensive weed control.

5.8 STOCK EXCLUSION

Farm stock were not listed as a targeted pest in any of the questionnaire responses, although reference was made to the exclusion of stock from the Hurunui area. Objectives to maintain perimeter fences and to exclude farm stock have been declared in plans, however, for all projects which lie adjacent to farm land. For example, at Trounson reference is made to '… good fences around the perimeter of the forest prevent neighbouring livestock from causing damage within the reserve.' Provision is also made for the exclusion of domestic farm animals in strategic plans for the Boundary Stream and Paengaroa projects.

The 1997/98 annual report for the Hurunui project includes an objective 'to exclude stock from the upper valley and monitor other ungulate populations to determine their impacts on forest health, grassland community and palatable species'. Cattle and sheep have been excluded from the South Branch operational area since 1995. Prior to this they had access to the upper valley for about 125 years. Stock have also been excluded from the North Branch reference area since 1998.

Six 50 m × 25 m vegetation plots have been established in the North Branch in order to assess the impact of cattle in these upper valleys. The initiation of this monitoring programme seems to have been in response to 'pressure to return to some limited grazing regime.' In addition to assessing the impacts of stock, measures have also been taken to gauge impacts of hares and deer. One of these plots has been fenced to exclude hares, and one fenced to exclude deer only. No monitoring of the outcomes of stock exclusion has been carried out in the South Branch. It has been observed, however, that 'obvious benefits of stock exclusion have been the recovery of marsh areas and their vegetation within the (South Branch) study area' (1997/98 annual report).

Forest margins of reserves often feature stock-resistant post and batten fences which can be used as a starting point for 'border control' operations. The exclusion of ungulates, both domestic and feral, is a prerequisite to conservation management achievements at virtually any habitat fragment. The exclusion of sheep and cattle may be all that is required to allow forest understorey plants or swamp vegetation to re-establish. The construction of a fence across the South Branch of the Upper Hurunui River, for example, has allowed cattle to be excluded from the forested river flats for the first time in 125 years. Important changes have already been detected as a result. High-quality stock fences maintained around the perimeter of forest reserves have permanently excluded grazing and trampling stock, and led to dense understorey vegetation being protected.

5.8.1 Boundary fences

Boundary fences are continually being developed and refined to more effectively limit the immigration, or exclude a growing number of pest mammals. For example, several variations of a 'possum fence' using electrified outriggers based on a standard post and batten stock fence are being used to limit the immigration of possums to forest fragments. More recently a fence has been developed which is intended to prevent most climbing and jumping animals from entering managed areas. An extreme example of a perimeter fence is the one recently constructed at the Karori Sanctuary in Wellington City. In this case a 2.3 m high fence based on a 6 mm high tensile mesh skirt and wall with a metal 'top hat' encircles the 9.2 km perimeter of the 250 ha reserve. This fence has been designed to exclude all digging, climbing and jumping pest mammals known to be in the area. Reserve fences are used on the (often undeclared) premise that the costs of constructing and maintaining a fence are offset by the benefits in pests being excluded, and that such costs are less than those associated with on-going pest control within the reserve in the absence of a fence. The costs of designing, building and maintaining fences can be a significant component of reserve management. Design and construction of the Karori Sanctuary fence, for example, cost approximately $2.1 million. Maintenance costs can also be high—especially where electrics are involved. Furthermore, all fences will be breached by pest animals at some stage and pest management programmes based on perimeter fences must include contingency plans to deal with unwanted immigrants. As further fence designs are developed and employed, detailed evaluations of their costs and benefits would allow for better choices to be made concerning the type of barrier to be used at management area borders.

5.8.2 Stock exclusion—comment

Given the destructive potential of stock in native forests it is surprising that the importance of stock exclusion was not better reflected in questionnaire responses, and in specific management objectives.

This lack of specific objectives probably does not reflect the priority actually given to fence construction and maintenance at fenced sites. Any stock invasions are likely to be immediately responded to, and fence maintenance programmes will probably be given an increasingly high priority as these projects evolve, and habitat values improve. Reference was made to the preparation of a fencing plan in relation to the Boundary Stream project. It is assumed detailed fence surveillance and maintenance programmes are set out in such plans, and contingency measures identified in operational plans to be applied when stock do gain access to restoration areas. In some plans farm stock are 'lumped' with feral ungulate control discussions. While some measure of boundary protection from feral ungulate encroachments may be afforded by standard post-and-batten stock fences, this would not generally the case. It would be unusual for feral deer, pigs and goats to be excluded more than momentarily from attractive food sources by standard stock fences. Given the fundamental importance of excluding stock from these project areas there is a need for more precise objectives and performance measures to be declared in operational plans.

The exclusion of cattle from the Hurunui operational and reference areas is likely to result in important conservation benefits. Anecdotal observations of ecological responses have already been recorded. If, as suggested, there is pressure from runholders to allow stock access once again to these areas, detailed information showing the impacts of stock based on comparisons between areas where stock do and do not have access will be valuable. It is not clear from the information provided if monitoring currently in place will allow strong inferences of stock impacts to be drawn upon which decisions regarding the renewed grazing of these areas could be based.

5.9 CONTROLLING PESTS—KEY POINTS

- Intensive, multi-pest control is a key element of all these projects.
- Up to 10 animal pests and 14 weeds are targeted for control at individual sites. Other pests are also being considered for control. It is not always clear why some pests are targeted and not others. In some cases pests are jointly targeted (e.g. possums and rats).
- Detailed result and outcome monitoring programmes are in place to detect expected changes. 'Non-treatment' reference areas have also been monitored for comparison at most sites, and pre-treatment data have also been collected at some.
- Lower pest indices have been achieved and maintained for longer periods at these projects than is normal in pest control operations.
- Reported outcomes are significant in that they indicate, virtually for the first time, that populations of a range of native species can be enhanced, and ecological processes may be re-vitalised at mainland sites as a result of intensive pest control.
- While it is clear that reported results and preliminary outcomes from these projects are very important, critical assessments of experimental design, sampling and analysis techniques and interpretations were not undertaken as part of this review. It is likely that some observations and reported conclusions may change following scientific review.
- Different approaches have been taken in response to growing concerns about the environmental risks associated with intensive, on-going use of brodifacoum. It is not clear why alternative toxins were chosen.
- Trials are being undertaken at most projects to improve pest control techniques.

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