Identifying long-term cost-effective approaches to stoat control

A review of sixteen sites in 2002

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ABSTRACT

The control of stoats *(Mustela ermina)* at 16 sites around New Zealand was surveyed on behalf of Science & Research Unit, Department of Conservation (DOC) to help identify long-term cost-effective approaches to stoat control. The stoat control methods used and the results obtained at the sites between July 1999 and March 2002 were summarised. Conclusions were based on a combination of practitioners' and experts' opinion, practical experience, and the results of formally tested experiments. This report identifies approaches which have had, or could provide, more cost-effective stoat control. A similar exercise will be repeated after June 2004 to determine long-term, cost-effective stoat control approaches that have been identified since July 1999.

Keywords: stoat, *Mustela ermina*, control, trapping, toxins, cost-effectiveness, mainland islands, kiwi sanctuaries, New Zealand

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1. Introduction

Stoats *(Mustela ermina)* are an important predator of native wildlife and without effective control species such as kiwi, kaka, mohua and kakariki may disappear from mainland New Zealand. Consequently, the New Zealand Government set aside $6.6 million in July 1999 (to be spent over five years), to identify long-term cost-effective approaches to controlling stoats. The Stoat Technical Advisory Group (STAG) was established to advise on the administration of these funds.

Stoat control programmes currently rely on trapping which is labour-intensive and, therefore, expensive. New tools and practices are needed so that control effort can be directed at more and larger areas, and is affordable in the long-term. Intensive stoat control on the mainland is carried out at 'mainland islands', 'kiwi sanctuaries' and at various other sites to protect mohua, whio and other native bird populations. Stoat eradications have also been trialed on several inshore islands.

The purpose of this report is to provide a summary of the stoat control methods employed and the results obtained at 16 sites between July 1999 and March 2002, and to identify improvements in stoat control, which have been made. A similar exercise will be carried out after June 2004 to determine what long-term cost-effective stoat control approaches have been identified since July 1999.

2. Brief

The Science & Research Unit, Department of Conservation (DOC) contracted Kerry Brown to summarise stoat control methods and results at 16 sites between July 1999 and March 2002. The purpose of the contract was to provide a baseline for a repeat survey of the same sites in June 2004 to identify improvements in stoat control tools and practices and increases in cost-effectiveness and areas being protected.

3. Methods

DOC staff at the 16 sites provided written and verbal information on their stoat control programmes. The sites chosen included five of the six Mainland Islands (no stoat control is carried out at Paengaroa), all of the five current Kiwi Sanctuaries, four sites where the prime objective was to protect mohua, one site where whio were protected and Te Kakahu Island where the intention was to eradicate stoats and prevent reinvasion. A data sheet (Table 1) was used to standardise the questions asked and type of information received on each site (see Appendix 1).

TABLE 1. DATA SHEET USED TO RECORD INFORMATION ON STOAT CONTROL PRACTICES AT THE 16 SITES.

SITE	DETAILS
Site description	Area (in hectares), vegetation type, administered by
Objectives	(e.g. maintain kiwi chick survival >30%)
Methods	Trapping maintained since?
	Trap type, spacing, layout and number
	Tunnel type
	Bait type
	Changes in above through time
	Frequency and timing of checks
Confounding treatments	(e.g. cat control using leg-hold traps, other predators caught in stoat traps and secondary poisoning from rat and possum control) Give timing and methods of operations
Result monitoring (trap catch)	(e.g. trap catch, tracking tunnels, chalk boards and trained dogs). Give timing and methods
Costs ($ and person effort)	Set up cost ($ and effort), trapping, result monitoring, outcome monitoring and Programme Manager effort/annum
Performance measures	(e.g. kiwi chick survival)
Outcome monitoring results	(e.g. 1996/97 and 1997/98—kiwi chick survival <30%; 1998/99, 1999/2000 and 2000/01—kiwi chick survival >30%)
Research/monitoring/trials	Stoat home range, beech seed monitoring, comparing tunnel designs—by whom?
CHANGES SINCE JULY 1999	
Improved tools?	
Improved methods?	Stoat dog, trapping focused on landscape features resulted in increased kiwi chick survival.
Increased area protected?	
Increased cost-effectiveness?	
Lessons learnt?	
Lessons learnt exported?	(e.g. Bream Head and Mimiwhangata)
Opinions	Increase in forest bird abundance
Reference	(Jo Bloggs pers. comm.)

Current practices, changes since July 1999 and opinions of the practitioners were identified. The opinions of practitioners may be incorrect, as opinions were often not formally tested. It was not possible to make direct comparisons between sites due to a multitude of confounding factors but a broad picture of the state of stoat control nationally has been obtained. Comment on different issues was also sought from: Elaine Murphy, Ian Flux, Craig Gillies, Darren Peters, Ian McFadden, Peter Dilks, and Phil Bradfield (DOC); John McClennan and Eric Spurr (Landcare Research); and Ray Henderson (Pest Solutions).

4. Results

4.1 SITE DESCRIPTION

The sites, which were spread throughout the country from Northland to Southland, were dominated by beech (9 sites) or podocarp/hardwood forests (7 sites), but also contained shrublands and grasslands and varied in size from 300 ha to 16 000 ha. Six sites were less than 1000 ha, four were between 1000 and 5000 ha and six were between 5000 and 16 000 ha. All sites were administered by DOC.

4.2 OBJECTIVES

Effective stoat control is likely to result in a wide range of ecosystem benefits and this was widely recognised but most objectives were framed in terms of measurable protection for particular species. Typical objectives included maintaining greater than 30% kiwi chick survival (to 1 kg) per annum, sustainable kaka fledgling and female survival rates, and maintaining viable mohua, orange fronted parakeet and whio populations.

4.3 STOAT CONTROL METHODS

Stoat control commenced at nine sites prior to July 1999 and seven sites after July 1999. Most sites have modified their stoat control regime through time.

Fenn traps were the main stoat control tool used. Mark 6 Fenn traps only were used at eight sites, Mark 4 traps only at six sites, both trap types at one site, and one site used no traps. Trap spacing varied from 25 m to 300 m apart with 200 m being the most commonly used spacing. The number of trap sites varied from 63 at Bream Head (452 ha) to 1500 at Okarito (10 000 ha). A variety of different trap layouts were also used: a 40 km line down the Eglinton Valley, lines of traps along ridges, waterways, and forest edges at Rotoiti, and grid trapping (200 × 500 m) at Okarito.

An aerial 1080 operation was trialed as a stoat control tool at Tongariro where no trapping occurred. Hen eggs injected with 1080 were used and subsequently replaced by trapping at Hurunui, and diphacinone injected into hen eggs was trialed at Hawdon in one year (part of a two year study).

Wood was the most common material used for tunnels but at least two different designs were used (blind tunnel and run through). Wire mesh, Philproof-plastic, corflute, and aluminium tunnels were also used. Tunnels were modified (different entrances, baffles within, and latches) to exclude different non-target species at different sites: weka at Rotoiti, kea at Haast, and kiwi at Trounson.

Hen eggs were the most common bait type used and at some sites beef baits were also placed in tunnels and at other sites eggs were supplemented with meat baits for several months over summer. Freeze dried rats and mice, plastic eggs, salted rabbit, dead day old chickens and fish (trialed and found to be ineffective) were also used as baits/lures at some sites.

The frequency of checking traps varied from twice a week to twice yearly in the case of the eradication attempt at Te Kakahu Island, Fiordland. Traps were mostly checked weekly or fortnightly over summer or in stoat plague years, and monthly or bimonthly over winter.

4.4 CONFOUNDING TREATMENTS

Stoat trapping caught non-target predators at most sites (Tongariro and Te Kakahu excluded) but the species and abundance (spatially and through time: for example, rat plagues in beech forest) of predators caught varied significantly. Rats were caught as bycatch at 14 of the 16 sites, (rats were absent from Te Kakahu Island, and no trapping occurred at Tongariro). Cats were caught as bycatch at 10 sites, possums (9), and weasels (9) at most, hedgehogs (7) at many, and ferrets (4) at a few. Cats and rats were targeted independently using different traps (Conibear and snap traps) at some sites. Secondary poisoning of stoats from various poisoning operations targeting rats and possums was likely at 12 of the 14 sites and 1080 (applied aerially) was trialed as a secondary poisoning stoat control tool at Tongariro.

4.5 RESULT MONITORING

Trap catch was used to index stoat abundance or data was available to be used from all trapping sites. Tracking tunnels were used to measure gross changes in stoat abundance at 11 sites. A trained stoat dog was used to confirm the absence of stoats from Te Kakahu and search for stoat dens at two other sites. On Te Kakahu stoat prints in sand, rabbit bait take and day old chicken bait take, and trap catch (no longer catching) were used in addition to the trained dogs to confirm the absence of stoats. Egg take was used as an index of stoat abundance at two sites.

4.6 COSTS

The person effort per annum for trapping, result monitoring, outcome monitoring and management (including report writing) were quantified at most sites, but estimated costs of establishing control and monitoring regimes were mostly not available. Establishment costs can be significant. For example, at Okarito it cost $160 000 to cut tracks and install tunnels and $10 000 to set up traps. Trapper effort per site varied dramatically from 0.03 persons/annum to 1.8 persons/annum in a beech mast year and about 1 person/annum at the same site (Hawdon) in a non-beech mast year.

Estimates of result monitoring effort were sometimes included with control effort but when separated could be twice the effort spent on control (e.g. Haast and Dart). Outcome monitoring effort varied dramatically between sites depending on the type and number of native species that were monitored but outcome monitoring effort was often significantly more than control effort (more than twice as much in some cases). Science and Research sometimes carried out outcome monitoring independently. Programme manager input varied greatly between sites from nearly non-existent to 0.3 persons/annum.

4.7 PERFORMANCE MEASURES

A wide range of performance measures were used. Kiwi chick survival to 1 kg was used as a performance measure at nine sites, and kiwi call counts were used at two sites. Five-minute bird counts were used at seven sites and kereru counts at two sites. Adult female kaka survival and nest productivity were used at two sites, orange-fronted parakeet counts at two sites, mohua counts using two separate methods at four sites, adult female whio survival and nest productivity at two sites, and/or robin, fantail and tomtit nesting success at four sites.

4.8 OUTCOME MONITORING RESULTS

Trapping increased kiwi chick survival rates at most if not all sites. Greater than 30% of kiwi chicks survived in most years, but not all. Likewise forest bird numbers increased in many sites in response to intensive pest management (including stoat trapping) but small forest birds are vulnerable to rats and populations declined in response to rat plagues. Mohua and orange-fronted parakeet numbers declined in the Hurunui and mohua almost disappeared from the Eglinton. Forest bird numbers increased dramatically in the absence of rats on Te Kakahu once stoats were removed. Increased breeding success, survivorship and/or numbers of kukupa, kaka, robin, tomtit, and fantail were recorded in response to intensive pest control, which included stoat trapping. Whio may also benefit from stoat trapping, but sample sizes were to small too be conclusive.

4.9 RESEARCH/TRIALS/MONITORING

Research was carried out at various sites on stoat home range size, habitat use, and the vulnerability of tagged stoats to trapping. Kaka, kiwi, whio, and mohua causes of decline (video cameras have proven a useful tool) and population ecology were also researched. Trials were carried out to compare: bait types, various lures, different trap tunnel designs, test poison baits and long-life baits and test pre-feeding. Different bird monitoring methods were also compared. The ability of a trained dog to find stoat dens and thereby remove trap-shy stoats was tested and confirmed. Beech seed, rat, mice and stoat abundance were also monitored to identify plague years.

4.10 IMPROVED TOOLS AND METHODS

(Since July 1999)

4.10.1 Trap covers

Trap cover designs were improved to exclude kiwi (Trounson), weka (Rotoiti) and kea (Haast). Wooden tunnels were shown to be more effective than wire tunnels at Rotoiti (Craig Gillies pers. comm.). Wooden tunnels replaced corflute tunnels at Hurunui because of kea damage.

4.10.2 Baits and lures

White hen eggs were marginally preferred when compared with brown eggs at Rotoiti but this was not statistically significant (Craig Gillies pers. comm.). Various baits and lures are presently being tested (Elaine Murphy pers. comm.).

4.10.3 Trapping method

Double Fenn sets replaced single Fenn sets at Bream Head to increase efficiency but this has not been formally tested and opinions vary between operators on what option is best. A single line of traps on the valley floor replaced perimeter trapping in the Dart and similar catch rates were obtained for less person effort (Barry Lawrence pers. comm.). Likewise a single line of traps was effective at protecting kaka and mohua from stoats, but not rats (Murray Willans pers. comm.).

Focusing trapping effort along forest margins, ridges, toe slopes and streams where most stoats had been caught historically increased the effectiveness of trapping (Steve Cranwell pers. comm.). Pre-feeding and pulse trapping was more cost-effective when traps needed to be checked daily and pre-feeding may have reduced the risk of trap shyness (Stephen Phillipson pers. comm.). Kiwi chick survival increased when trapping effort was increased at Trounson, but this result is confounded by the use of pulse baiting with 1080, other toxins and variable kiwi survivorship between years (Craig Gillies pers. comm.).

4.10.4 Trapping versus poison eggs

One advantage of trapping over poison eggs is that the animal killed is identified (Andrew Grant pers. comm.). Diphacinone eggs were believed to be very effective against stoats following work in the Hawdon and Dart (Stephen Phillipson pers. comm.). However, traps replaced diphacinone eggs at Boundary Stream because of the effort required to use poison eggs and because many stoats that were caught contained sub-lethal doses of diphacinone (Steve Canwell pers. comm.).

4.10.5 Locating stoat dens with a trained dog and confirming the absence of stoats

A trained dog was effective at locating stoat dens, and female stoats that may have avoided traps were killed in their dens at Trounson (Craig Gillies pers. comm.). A trained dog was used to confirm the absence of stoats on Te Kakahu Island following an eradication attempt (Murray Willans pers. comm.).

4.10.6 Operational improvements

Operations were improved through more consistent checking of traps, better spreadsheet design, improved study design, and the use of statistical analysis (Rhys Burns pers. comm.).

4.10.7 Monitoring methods

Tracking tunnels provided a more accurate tool for measuring mouse abundance than snap traps, though they were time-consuming to run (Barry Lawrence pers. comm.). A stoat-tracking regime was designed that gave gross measures of stoat activity (Craig Gillies pers. comm.). Mohua transect counts were found to be more accurate than five-minute bird counts at measuring mohua abundance in the Dart Valley (Barry Lawrence pers. comm.).

4.11 INCREASED AREA PROTECTED AND INCREASED COST EFFECTIVENESS

(Since July 1999)

The area protected in the Urewera was increased from 1300 ha to 4500 ha. Contracting out work rather than depending on over committed staff and the financing of one person by Environment Bay of Plenty enabled an increased area to be protected (Rhys Burns pers. comm.).

At Rotoiti the area to be protected will increase this year (2002) from 1000 ha to 5000 ha in response to a kaka modelling exercise that identified the need for a larger area to protect dispersing juvenile kaka. A different trapping regime using fewer traps will be trialed to achieve this control. Less frequent checking of traps in off peak times was used to increase cost-effectiveness (David Butler pers. comm.).

At Bream Head the use of salted rabbit bait increased bait life by two weeks (Pete Graham pers. comm.). The effectiveness of freeze-dried versus fresh rabbit bait is presently (2002) being trialed (Craig Gillies pers. comm.).

The use of single line trapping rather than perimeter trapping in the Dart and Eglinton increased the cost-effectiveness (Barry Lawrence and Murray Willans pers. comm.).

Reduced trapping and monitoring effort was used to attempt stoat eradication from Anchor Island because of the experience gained on Te Kakahu Island (Murray Willans pers. comm.).

4.12 LESSONS LEARNED—OBSERVATIONS AND OPINIONS OF PRACTITIONERS

The opinions of practitioners may be incorrect, as many have not been formally tested, but practitioners' opinions have been included here because they are based on practical experience, and once tested could result in improved stoat control. Many lessons learned have been transferred to other projects.

Large areas with stoat control are needed to give protection to kiwi and other vulnerable native species because stoats are highly mobile and reinvade areas quickly. Trap density will likely vary with the species you wish to protect. For example, kiwi may require more protection than kaka and whio. Stoats can be controlled in rugged mixed broadleaf/podocarp forested terrain in some years. Finely set traps catch more rats. Freeze dried rats are a useful tool, but may not work in all years. The cost-effectiveness of freeze-dried rats over other baits (eggs and freeze dried mice) is presently (2002) being tested (Craig Gillies pers. comm.). Trapping should be carried out all year and different lures may be required in different seasons in response to changes in stoat food preferences. Tangata whenua did not support the use of toxins in the Urewera (Rhys Burns pers. comm.).

Stoat control has had a positive effect on common bush bird abundance. Rabbits have increased on surrounding farmland. A good universal means of determining stoat impacts (e.g. kereru survival) could provide a valuable tool for comparing the efficacy of stoat control between sites (Steve Cranwell pers. comm.).

Trapping plus secondary poisoning has protected kaka, but trapping alone has yet to be fully tested. The appearance of weasels was associated with significant beech seed fall or possibly reduced stoat numbers. Ferrets occur within the forest including the sub alpine zone. Stoats use scent more for hunting while rats and hedgehogs use visual cues. The Fenn trapping regime killed stoats quickly after they were live-captured and tagged. Catching hedgehogs may reduce the likelihood of catching stoats [suggested by observations, but not yet tested]. Some individual traps caught hugely more stoats than other traps. The line along the top of the range was the most successful at catching stoats for a while indicating the potential for rapid reinvasion over the range (David Butler pers. comm.).

More stoats were caught in traps next to rat captures. Weasels replaced stoats after a double mast. Stoat control resulted in an increase in hares. Cat numbers are increasing—possibly in response to increased hare abundance. We can effectively manage stoats in the absence of rats. We need to control rats in mast years (Andrew Grant pers. comm.).

Avoid 'T' junctions in trap lines and use loops instead to prevent back tracking by trappers. Stoat control is a good way to build relationships and an understanding of conservation because it is relatively low intensity on the ground, but is ongoing through time (Josh Kemp pers. comm.).

Stoats reinvaded quickly after the 1080 operation and stoats killed kiwi chicks (including those at the centre of the block) within four months of the operation. Five kiwi chick deaths were linked to stoats, but only one set of tracks was recorded in tunnels (Pete Morton pers. comm.).

Fenn traps were electroplated but this process accelerated rusting. Kea accessed wooden tunnels so the latch design was changed to exclude them (Jo Crofton pers. comm.).

Mohua can decline in the presence of stoat control in some years, probably due to high rat numbers. Cats were caught when best practice of 40 × 50 mm wire mesh size at tunnels was abandoned for wire size > 40 × 50 mm. Weka-proof control devices are needed because weka appeared in areas where they were not previously recorded and accessed non-toxic eggs (occurred in north branch of the Hurunui). Craig Gillies tracking regime is only going to be worth the effort of trialling if everyone is prepared to use it so that its worth can be accurately determined and valid comparisons can be made (Barry Lawrence pers. comm.).

Rat plagues may not occur in silver beech forests because silver beech seed may not provide enough food to result in high rat numbers. Rat numbers have remained constantly low in the Landsborough while rat plagues have occurred elsewhere in red beech and mixed species forests (Paul van Klink pers. comm.).

The Eglinton valley is atypical and results from one site should be treated with care. A single line of traps along the valley floor is very cost-effective for protecting kaka and mohua. More stoats were caught at the ends of the line. Stoats are significantly impacting on whio productivity and female survivorship in the Clinton and stoat control results are encouraging, but it is early days. Mainland trapping may be more effective than people appreciate. Reinvasion is a major issue and large areas could potentially be protected using low intensity trapping effort and natural boundaries (Murray Willans pers. comm.).

Mohua disappeared before big increases in rats occurred in the Eglinton and the Dart valleys so something else was going on. Pulse trapping (using pre-feeding) can potentially reduce the risk of trap-shy animals and result in less effort to protect larger areas. A range of different techniques (e.g. diphacinone eggs and trapping) is needed to protect mohua and orange fronted parakeet in mast years (Stephen Phillipson pers. comm.).

5. Conclusions

These conclusions are based on a combination of opinion, practical experience and the results of formally tested experiments. In the author's opinion, avenues of enquiry worth further investigation include measuring the effectiveness of: pre-feeding, trap concealment, secondary poisoning using pulse poisoning regimes, new trap designs, trained dogs to kill trap shy stoats and long-life baits (with and without toxins) to provide more cost-effective stoat control.

- Trapping can be effective. Stoats have been eradicated from islands, and kiwi, mohua and kaka protected in some years by trapping. But protection is not achieved in all years probably because of high rates of reinvasion and the presence of individuals that avoid traps.
- Stoats are probably less trappable when abundant natural foods are available.
- Stoat reinvasion could be minimised by extending the areas controlled and where feasible, making use of natural boundaries like mountain ranges. But as the Rotoiti experience illustrates not all mountain ranges act as barriers.
- Some stoats are either inherently wary or learn to avoid traps (trap-shy).
- Ways of killing trap-shy stoats could greatly increase the efficacy of stoat control. The use of a variety of tools at one site is more likely to put trap-shy

stoats at risk. Dogs have proved to be valuable for locating stoats (which can then be killed) in dens, and for determining the absence of stoats. Traps (of improved design) which will always kill stoats that trigger them, would prevent learned trap-shyness.

- Pre-feeding and concealment of traps are two techniques used elsewhere to increase catch rates and minimize the risk of learned trap-shyness. Eleven stoats were captured (out of a total of 16 stoats captured) on the first night traps were set after two weeks pre-feeding on Te Kakahu. Video photography and monitoring with a dog would provide valuable tools for testing these two approaches.
- Skilful trappers who choose trap sites wisely (e.g. natural runs), conceal traps and 'fine set' traps are a valuable resource and trapping skills should be taught to new trappers. Note: A 'Best Practice Predator Manual' was discontinued, and advice on best practice is now available on the Intranet.
- Reduction in human scent around traps is also thought to be important by some practitioners. Preliminary tests are inconclusive and the increased effort involved in boiling, waxing, storing and handling traps in ways that reduce human scent needs to be compared with reliable measures of benefit (Ian McFadden pers comm.).
- The use of landscape features such as ridges, waterways, toes of slopes and valley bottoms will likely increase stoat captures. Trapping along valley floors alone has proven effective and far less labour intensive than grid trapping in some situations (i.e. Dart and Eglinton).
- Traps that meet animal ethic requirements are needed. The Fenn trap is the current best practice tool and various new trap designs are being developed (Darren Peters pers. comm.).
- Trapping becomes increasingly cost-effective the longer that traps can be left unattended. Present baits (e.g. eggs) have limited life (especially over summer) and are not attractive to all stoats. Attractive long-life bait used with traps would provide a valuable tool.
- Hen eggs containing toxins (e.g. 1080, diphacinone and cholecalciferol) are labour intensive to prepare and appear only partially effective.
- Long-life baits (attractive to all or nearly all stoats) containing an effective toxin, administered from bait stations would provide a very cost-effective stoat control tool.
- Secondary poisoning could provide a valuable stoat control tool. Secondary poisoning (press poisoning using brodifacoum) and trapping combined were effective at protecting kaka at Rotoiti (David Butler pers. comm.) and nesting female kokako at Mapara (Phil Bradfield pers. comm.). However, press poisoning (using brodifacoum) and trapping did not provide protection for all kiwi chicks at Trounson but pulse poisoning (secondary poisoning using 1080) combined with trapping did provide protection for all kiwi chicks in one season (Craig Gillies pers. comm.).
- Ecological damage thresholds cannot be determined because no precise means of determining stoat abundance presently exists.
- Interactions between prey abundance (e.g. rats and mice), predator guild, differing stoat abundance and differences in the vulnerability of native species

will result in different risk. Therefore different intensities of control will likely be required at different sites.

- Trials need to be carried out in a rigorous manner so that reliable information is obtained and valuable resources are not wasted. Trials have sometimes been carried out in an ad hoc fashion and unreliable results transferred to others. Historical trials should be analysed and both reliable and unreliable results identified. A Standard Operating Procedure for running trials is presently being developed (Craig Gillies pers. comm.).
- Effective rat control tools are also needed to protect small forest birds in beech mast years and in diverse forests were rats occur in high densities year round. Pest control targeting rats and possums at Waipapa Ecological Area has been effective at protecting native bird populations (Phil Bradfield pers. comm.).

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Appendix 1

STOAT CONTROL DATA FROM SIXTEEN SITES

1.	Trounson Kauri Park Mainland Island
Site description	445 ha, kauri/broadleaf forest, administered by Northland Conservancy.
Objectives	Maintain kiwi chick survival >30%
Methods	Trapping maintained since August 1996. Two trapping regimes used. 1996/97 and 1997/98—120 Mk 6 double Fenn sets baited with rabbit under wooden tunnels. 1998/99, 1999/2000 and 2000/01—180 Mk 6 Fenn sets (double and single) baited with rabbit and hens eggs. Trap spacing varies from 100 m to 300 m. Perimeter traps are checked twice weekly and internal traps once weekly.
Confounding treatments	Cat control using 1.5 Victor traps replaced with Conibear and chimney box traps in November 2000. Non-target predators caught include: cats, ferrets, harrier, hedgehogs, morepork, mice, possums, rats and weasels. Secondary poisoning likely occurred during 1080 operations (1996, 1998 and 1999), brodifacoum was used 1996–1998. Pulse poisoning (e.g. warfarin) of rats and possums every 2–3 months since 1999.
Result monitoring (trap catch)	Trap catch, tracking tunnels (Craig Gillies method), trained dog used to find stoats dens.
Costs ($ and person effort)	0.7 trapper, 0.7 kiwi monitoring position, 2 weeks/year PM
Performance measures	Kiwi chick survival, kukapa and five-minute bird counts.
Outcome monitoring results	1996/97 and 1997/98—kiwi chick survival <30%; 1998/99, 1999/2000 and 2000/01—kiwi chick survival >30%; significant increases in kukapa and other forest bird abundance since 1996.
Research/monitoring/trials	Home range, migration and efficacy of trapping from radio collared stoats. Trained dog used to fine stoat dens.

Changes since July 1999	
Improved tools?	Trap cover entrance design changed to prevent kiwi captures, stoat den location by dog.
Improved methods?	Increased trapping effort resulted in increased kiwi chick survival.
Increased area protected?	
Increased cost-effectiveness?	Single Fenn traps, spaced between the double set ones on the bush perimeter, were trialed for a year, but removed as not cost-effective to run—no predators were trapped in them.
Lessons learnt?	The extra single set Fenns were not required.Three lines of defence boosted protection: internal, bush-edge, and outer perimeter saw no monitored kiwi chick deaths due to mammalian predators for 2 years. Dens may be an effective method of targeting stoats.
Lessons learnt exported?	Bream Head and Mimiwhangata. Boundary Stream also getting advice and trap cover design stuff from Trounson.Private land owners, private restoration projects.
Opinions	
Reference	(Natasha Coad and Mark Leach pers. comm.)

2.	Otamatuna/Mangaone (Northern Te Urewera Mainland Island)
Site description	4500 ha, tawa/podocarp forest, part of Te Urewera National Park, administered by East Coast/ Hawke's Bay Conservancy.
Objectives	Maximise kiwi chick survival (minimum acceptable of 20% survivorship). Recover whio and other native bird populations.
Methods	Trapping maintained since August 1996. 2001/02—840 Mk 6 double Fenn sets under wire tunnels (3 types) at 150 m spacing along ridges and waterways. Baited with freeze-dried feral rats, hen's eggs and freeze-dried white laboratory mice (trial) replaced approx. every 6 weeks and checked approx. every two weeks. All tunnels have a clear plastic cover over them to protect the freeze-dried baits from rain. 2000/01—3000 ha, using freeze-dried feral rats and hen's eggs baits, (no stoat control carried out over winter).1999/2000—(February/March 2000 and repeated in April/May 2000: trial, freeze dried rats, and plastic eggs in alternate traps). 1300 ha controlled using plastic eggs as bait/lures during rest of season.
Confounding treatments	Rat and possum control using brodifacoum (1996/97, 1997/98) and pindone (1998/99, 1999/2000) killed some stoats through secondary poisoning. Non-target predators caught in stoat traps included: cats, possums, rats, and weasels. Victor professional rat traps used in 2000/01 caught some stoats (approx. 10% of total stoats caught were in rat traps).

Result monitoring (trap catch)	Trap catch.
Costs (person effort)	Stoat trapping: 1.5 people for eight months and 0.5 people for four months over winter. Kiwi monitoring: 0.5 people, whio: 5 weeks, bird counts: 2 weeks, report writing: 2 weeks, project management: 0.3 people per annum.
Performance measures	Kiwi chick survival, five minute bird counts, and whio chick survival.
Outcome monitoring results	Kiwi chick monitoring = 1996/97 two survived and one unknown; 1997/98 two dead and one survived; 1998/99 two survived and one dead; 1999/2000 three survived, 2000/01 three died. Bird counts (May 2000 versus May 1997) = bellbird, kereru, tomtit and tui numbers doubled, robins and kokako increased 3–5 fold, and whitehead and silvereyes increased 7–8 fold. Whio chicks = 1999/2000: 18 chicks fledged; 2000/01: 20 chicks fledged.
Research/monitoring/trials	Series of trials comparing freeze-dried rats and fresh hens eggs as bait (plastic eggs and mouse litter were trialled previously). Trial of different scent lures—Pete Shaw/Rhys Burns. A trial using captive stoats to determine preference to different lures and baits—Lloyd Robins. Gut analysis (rats main food item)—Pete Rudolf. Aging of stoats—Rhys Burns. 'Fisholene' as a lure for catching stoats, on tunnels and between tunnels—Pete Rudolf.

Changes since July 1999	
Improved tools?	Freeze dried rats. Double baffle wire tunnel design—direct stoat over plate, minimise non-target impacts and standardise design.
Improved methods?	More consistent checking of traps, spreadsheet design improved and statistics design and analysis improved. No anti-coagulant poison (only cyanide) used since Jan 2000, making trapping the only control method, eliminating risk of any unknown poisoning of native animals and non-target species.
Increased area protected?	1300–4500 ha
Increased cost-effectiveness?	Reduced cost per hectare—contracting out work so effort is focused on single tasks. Environment BOP contributing $ for one person.
Lessons learnt?	Needs a large area controlled to prevent reinvasion of stoats—4500 ha minimal size. Small sample size of kiwi chicks needs to be increased. Tangata whenua didn't want poisoning because poison was detected in deer and pig livers and muscle tissue, sometimes in very high concentrations. Fine-set traps catch more rats. Freeze dried rats are a valuable tool, but may not work in all years (eggs and rats similar result this year).
Lessons learnt exported?	Freeze-dried rats used elsewhere. Shown that it is possible to control stoats in very rugged terrain in mixed broadleaf/podocarp forest (at least in some years), e.g. Coromandel Kiwi Sanctuary attempting similar objective.
Opinions	Trap density varies per site depending on what you want to protect. Kiwi protection may require a higher trap density than kaka or whio. More stoat ecology research is required in mixed broad leaf/podocarp forest. Trained dogs should be used more as an independent test of trapping efficacy. Intensive and extensive trapping may be necessary year-round, not just during spring/summer/autumn, and baits or lures may need to be changed to suit each season as dietary requirements may differ at these times. The 4500 ha currently being trapped in northern Te Urewera may be a minimum size needed to reduce stoat density sufficiently to allow kiwi survival.
Reference	(Rhys Burns pers. comm.)

3. Boundary Stream Mainland Island

Site description	800 ha, podocarp/broadleaf forest, administered by East Coast/Hawke's Bay Conservancy.
Objectives	Recover indigenous animal populations and ecological processes.
Methods	Trapping maintained since 1996, but changed in February 2000. Presently 258 Mk 6 or Mk 4 traps in double or single Fenn sets under single or double Philproof or wooden covers. Historical spacing was three lines at 100 m apart, but some traps have been removed from these lines. Baits used include: rabbit suspended from a hook under tunnels, plastic and fresh eggs. Perimeter traps are checked 4-weekly and other weekly (September/April) and fortnightly for the remainder of year.
Confounding treatments	Cat control using Conibear and cage traps. Pindone rat and possum control using pindone with potential secondary poisoning of stoats. Non-target predators caught in stoat traps include: cats, ferrets, hedgehogs, possums, rats, and weasels.
Result monitoring (trap catch)	Trap catch and tracking tunnels (Craig Gillies)
Costs (person effort)	Trapping: 600 hours, tracking tunnels: 150 hours, programme manager (report writing, auditing, etc.): 200 hours, monitoring kiwi: 700 hours, five-minute counts: 66 hours, robins: 190 hours, kereru: 40 hours.
Performance measures	Kiwi chick survival, robin nesting success, kereru counts and five-minute bird counts.
Outcome monitoring results	No kiwi chicks of 800 gm+ have been lost inside the reserve; 28 robins released, now > 40 robins; increasing forest bird abundance.

Research/monitoring/trials	Diphacinone eggs trialed, but discontinued in favour of trapping because results were unclear and considerable effort required (few eggs were removed, but still caught good numbers of animals with diphacinone in their livers).

Changes since July 1999	
Improved tools?	
Improved methods?	Targeted control on margins (ferrets), ridges, toe slopes, and streams, where animals were mostly caught.
Increased area protected?	
Increased cost-effectiveness?	
Lessons learnt?	Stoat control has had a positive effect on common bush birds. Rabbits have increased on surrounding farmland.
Lessons learnt exported?	
Opinions	A good universal means of determining stoat impacts (e.g. kereru survival) would be valuable.
Reference	(Tamsin Ward-Smith and Steve Cranwell pers. comm.)

4. Rotoiti Mainland Island

Site description	1000 ha, honeydew beech forest, administered by Nelson/Marlborough Conservancy.
Objectives	Manage stoats to low levels (as one of the key pests), as part of an ecosystem restoration project. Kaka are the main indicator species.
Methods	Trapping maintained since 1997/98. Single Mk 6 Fenn sets now baited with fresh white hens eggs under wooden tunnels. Various trap spacing of 100 m, 50 m, and 25 m along ridges, lake and forest edges, and stream margins along seven separate lines. A total of 297 traps checked weekly from Dec to Feb; every second week Mar/Apr and Oct/Nov. Monthly May to Sept (weather permitting: top of the range is sometimes snow covered).
Confounding treatments	Stoats and weasels were also caught in rat Snap traps. Non-target predators caught by Fenn traps (targeting mustelids) include: cats, hedgehogs, possums, and rats. Stoats were likely killed through secondary poisoning using brodifacoum in bait stations (1998–2000) targeting rats and possums. A 1080 bait station operation targeting possums was also carried out initially (November 1997).
Result monitoring (trap catch)	Trap catch, but tracking tunnels for rodents only.
Costs (person effort)	One full-time trapper, including a PM role. Monitoring kaka—S&R two full-time people, and some assistance over summer (one person for three months).
Performance measures	Kaka fledgling and nesting female's survival.
Outcome monitoring results	Kaka breeding success increased dramatically in response to predator management (80% success versus 5–10% outside treatment area and lost no nesting females; previous study lost 5 of 7 nesting females). Dramatic increase in bellbird numbers following control (stoat, wasp and rat control). Kakariki have also increased (probably mainly in response to stoat control).
Research/monitoring/trials	Kaka Research—Ron Moorhouse. Stoat trapping research trialling wire mesh v wooden trap covers. Fresh versus plastic eggs; and white versus brown eggs.

Changes since July 1999	
Improved tools?	Wooden tunnels are significantly better than wire (changed 2001/02) and white fresh eggs are the best bait trialed. Wire tunnels were modified to exclude weka after a weka was caught.
Improved methods?	
Increased area protected?	2002 extended area to 5000 ha in response to kaka-modelling work that identified the need for larger areas to protect dispersing juveniles; trap density 100 m along features on lines surrounding 800 ha blocks. One trap line down the Rainbow valley run by the Friends of Rotoiti Group.
Increased cost-effectiveness?	Now checking traps fortnightly or monthly in 'off-peak' times, a change from weekly.
Lessons learnt?	Trapping network plus secondary poisoning protected kaka. Weasels appeared associated with significant beech seed fall or possibly reduced stoat numbers. Ferrets occur within the forest including the sub alpine zone. Stoats use scent more for hunting, while rats and hedgehogs use visual clues. The Fenn trapping regime killed stoats quickly after they were live captured and tagged. Catching hedgehogs may reduce the likelihood of catching stoats [suggested by observations, but not yet tested]? Some individual traps caught hugely more stoats than other traps.
Lessons learnt exported?	Wooden tunnel/trap set up has been applied elsewhere.
Opinions	Line along the top of the range was, for a while, the most successful at catching stoats, indicating the potential for rapid reinvasion over the range.
Reference	(David Butler pers. comm.)

5.	Hurunui (South Branch) Mainland Island
Site description	6000 ha, dry eastern beech forest, administered by Canterbury Conservancy.
Objectives	Maintain viable mohua and orange-fronted parakeet populations.
Methods	Control commenced in October 1995. Poison bait stations containing 1080 eggs (one pricked and one whole) at 100 m spacing along the valley floor (checked at least once every 10 days). 2000/01—272 Mk 4 double set, wooden tunnels, 100 m spacing, checked at least once every 10 days (Sep–May and checked every two months over winter). Positioned along bush edge on the valley floor.
Confounding treatments	Possum control using 1080 pollard baits at 0.15% in bait stations at 100 m spacing. Non-target predators caught include: cats, rats, and weasels.
Result monitoring (trap catch)	Trap catch (animals caught per day per trap). Tracking tunnels (C. Gillies model). Toxic egg-take per station per day and non-toxic egg take.
Costs (person effort)	2 people for six months. Mohua monitoring—1 persons for six months; OFP—2 people for six months; project manager—2–3 months.
Performance measures	Mohua counts and survivorship/productivity monitoring, five-minute bird counts, orange-fronted parakeet counts, kiwi call counts, and hare counts.
Outcome monitoring results	Until 2000—increased mohua, kiwi calls. 2000/01—rats arrived and mohua numbers plummeted. Five-minute counts and OFP counts declined. Kiwi calls increasing trend.
Research/monitoring/trials	Radio tracking stoats—stuck to valley floor and killed most radio tagged stoats.
Changes since July 1999	
Improved tools?	Corflute tunnels replaced with wood because of kea damage, but corflute was easier to use.
Improved methods?	Trapping which also targets rats provides a better indication of what is being killed than poison eggs.
Increased area protected?	
Increased cost-effectiveness?	
Lessons learnt?	More stoats caught in traps next to rat captures. Weasels replaced stoats after a double mast. Stoat control resulted in an increase in hares. Cat numbers are increasing, possibly in response to increased hare abundance.
Lessons learnt exported?	Hawdon
Opinions	Effectively manage stoats in the absence of rats. Need to control rats in mast years.
Reference	(Andrew Grant pers. comm.)

6.	Bream Head Kiwi Sanctuary
Site description	452.5 ha peninsula headland, steep coastal cliffs, coastal hardwood, and 50-year-old kanuka forest, administered by Northland Conservancy.
Objectives	To increase kiwi survivorship by reducing predator numbers.
Methods	Predator trapping in place since Sept 2000—63 single Mk 6 Fenn traps under blind wooden tunnels. Baited fortnightly with salted rabbit, checked weekly.
Confounding treatments	54 Steve Allan Conibear traps on raised sets, baited weekly with rabbit mince. Trap spacing approx. 250 m and traps run all year. Non-target predators caught include: cats, ferrets, harrier, hedgehogs, possums, rats, and weasels. Secondary poisoning may have occurred during various aerial 1080 drops; bait station 1080 and bait station brodifacoum operations since 1993. Cholecalciferol, feratox, and warfarin used in Dec 2001 to target possums and rodents.
Result monitoring (trap catch)	Trap catch and tracking tunnels (Craig Gilles model). Predator dog run annually from April 2002.
Costs (person effort)	Trapping—100 person days/annum. Trap set up—20 person days; tracking tunnels monitoring—32 person days/annum; tracking tunnel set up time—20 person days; project management—87 person days for Bream Head in total.
Performance measures	Kiwi call counts, fantail nest survival, and juvenile kiwi survival.
Outcome monitoring results	10 kiwi chicks released and one mortality (cause natural); fantail nest survival 3 of 4 nests fledged young.
Research/monitoring/trials	Bait trial with freeze-dried rabbit versus fresh rabbit—Nigel Miller.
Changes since July 1999	
Improved tools?	Conibears modified locally to insure that cats died within animal ethics guidelines.
Improved methods?	Double Fenn sets have replaced single Fenn sets to increase efficacy.
Increased area protected?	
Increased cost-effectiveness?	Salting of bait increases bait life to two weeks.
Lessons learnt?	Cats cover large areas and are not evenly distributed, so not as many traps are needed. Stoat sign found outside the trapping area so trap area may need extending during peak stoat season.

Lessons learnt exported?	Modified Conibears being used at the Motu and Trounson.
Opinions	
Reference	(Pete Graham pers. comm.)

7. Moehau Kiwi Sanctuary

Site description	16 500 ha, manuka/kanuka scrubland, podocarp/hardwood forest, sub-alpine scrub, from coast to 892 m, very steep, demarcated by isthmus 4–5 km wide at tip of Coromandel Peninsula, administered by Waikato Conservancy.
Objectives	Maintain kiwi chick survival (>30%)
Methods	Area protected (now 9000 ha, later 16 500 ha). Trapping began in April 2001 across 2400 ha and the area has continued to increase since. Aim to cover all 16 500 ha by September 2002. So far 1350 Mk 6 single Fenn sets (will grow to 2200) baited with fresh pullet eggs (meat in April and November) under wooden tunnels (Rotoiti stoat trap). At 200 m spacing along lines placed on ridges and along streams chosen for ease of access. Lines usually 500–800 m apart. Average density of traps = one per 7 ha. Checked fortnightly in summer and monthly for the rest of the year.
Confounding treatments	Rat trapping (450 ha, hopefully more in future). Possum control (750 ha, April 2002)—brodifacoum in bait stations on private land. Brodifacoum in numerous small blocks. Large-scale possum bait station set up on the mountain, not presently being filled with mustelid-lethal toxins. Non-target predators caught in stoat traps include: cats, hedgehogs, possums, ship rats, and weasels.
Result monitoring (trap catch)	Trap-catch, tracking tunnels (Craig Gillies model)
Costs (person effort)	Trapping currently takes about 600 person days/year, will grow to about 1000. Kiwi monitoring takes about 800 person days/year.
Performance measures	Kiwi chick survival (>1000 g) greater than 30%.
Outcome monitoring results	First season.
Research/monitoring/trials	

Changes since July 1999

Improved tools?	
Improved methods?	
Increased area protected?	
Increased cost-effectiveness?	
Lessons learnt?	Avoid 'T' junctions in trap lines. Use loops instead.
Lessons learnt exported?	
Opinions	Many people issues—stoat control is a good way to build relationships and an understanding of conservation because it is relatively low-intensity on the ground, but is ongoing through time.
Reference	(Josh Kemp pers. comm.)

8. Tongariro Kiwi Sanctuary

Site description	16 000 ha, lowland podocarp/hardwood forest, administered by Tongariro/Taupo Conservancy.
Objectives	Assess the effect of a one off large-scale 1080 operation on kiwi chick survival; grow the kiwi population by 12% by 2004.
Methods	1080—2 kg/ha Wanganui 7 @ 0.15 toxic, September 2001. Target species possums, stoats, and rats.
Confounding treatments	Aerial 1080 in 1995 and 1996; small scale (250 ha) mustelid trapping up until 1999. Non-target predators likely poisoned (primary and secondary) include: cats, ferrets, hedgehogs, mice, and weasels.
Result monitoring (trap catch)	Tracking tunnels (Craig Gillies model) showed stoat tracking stopped after 1080 operation; February one set of tracks only out of 420 tunnel nights.
Costs (person effort)	$450 000 for 1080 operation. Tracking tunnel monitoring: 60 person days/annum (5 people × 3 days × 4 times/annum). Set up tunnels: about 30 person days; kiwi monitoring: 9 months/annum; project management: 120 hours/annum.
Performance measures	Wild hatch kiwi chick (N = 20) survival.
Outcome monitoring results	Kiwi chick survival high initially, declined dramatically within four months of the operation; Tomtit and fantail nesting success very high for the 2000/01 breeding season. No significant impact of the 1080 operation on adult tomtit survival.
Research/monitoring/trials	Comparison of bird monitoring techniques—Ralph Powlesland. Videoed two stoats and rats visiting a nest pre-drop, but no rats and stoats videoed since.

Changes since July 1999	
Improved tools?	
Improved methods?	
Increased area protected?	
Increased cost-effectiveness?	
Lessons learnt?	Stoats reinvaded quickly after the 1080 operation; stoats killed kiwi chicks (including in the centre of the block) within four months of the operation. Five kiwi chick deaths were linked to stoats, but only one set of tracks was recorded in tunnels.
Lessons learnt exported?	
Opinions	
Reference	(Peter Morton pers. comm.)

9.	Okarito Kiwi Sanctuary
Site description	10 000 ha, coastal podocarp/hardwood forest, administered by West Coast Conservancy.
Objectives	Reduce predation on kiwi chicks so >25% survivorship.
Methods	Commenced trapping April 2001—single Mk 6 Fenn traps in 600 mm (double traps used on the buffer zone and second trap used when a stoat is caught in the core area) wooden tunnels (wire mesh ends) at 200 × 500 m spacing over 10 000 ha of core kiwi area; comprising 1100 tunnels. 400 tunnels set 200 m apart on buffer lines outside core area; checked monthly during winter and fortnightly rest of year; baited with eggs and rabbit meat.
Confounding treatments	Non-target predators trapped: rats and weasels. Aerial 1080 possums operation in 1998.
Result monitoring (trap catch)	Trap catch and tracking tunnels (Craig Gillies model).
Costs (person effort)	$160 000 to cut tracks and install tunnels, $6850/trap visit, $10 000 set up traps. 160 staff hours by programme manager to set up and monitor contracts, 80 staff/IEC hours auditing contractor using tags in tunnels.
Performance measures	Kiwi chick survival, min. 25% chick survival to 1000 g
Outcome monitoring results	8 of 22 chicks alive and most still to reach 1000 g. Five-minute bird counts and tomtit/fantail nest success monitoring.
Research/monitoring/trials	ONE kiwi programme; monitoring rimu seed

Changes since July 1999	
Improved tools?	
Improved methods?	
Increased area protected?	
Increased cost-effectiveness?	
Lessons learnt?	Fenn traps electroplated, but accelerated rust; kea accessed wooden tunnels, so changed the latch design.
Lessons learnt exported?	New latch design used in Haast.
Opinions	
Reference	(Jo Crofton pers. comm.)

10.	Haast Kiwi sanctuary
Site description	12 000 ha, silver beech/podocarp forest, administered by West Coast Conservancy.
Objectives	Maintain kiwi chick survival above 25% per annum.
Methods	Trapping maintained since June 2001—615 Mk 6 double Fenn sets baited with white hens eggs (rabbit bait 2 × per season over summer). Placed on lines along ridges, rivers, and the toes of slopes, approximately 1 km apart. Wooden box tunnels, wire ends and wire baffles, to exclude kiwis placed 200 m apart. Traps are checked once a month, and checked fortnightly Nov–Apr.
Confounding treatments	Non-target predators caught include: rats, possums, cats, and mice. 1080 drop in May 2001 (aerial and hand: approximately 6800 ha in total; within the reserve, hand laid 1080 and victor traps: 2996 ha; and aerial 1080: 3774 ha).
Result monitoring (trap catch)	Trap catch and tracking tunnel (Craig Gillies model).
Costs (person effort)	Tracking tunnels: 60 person days; trapping: 285 person days; kiwi monitoring: 2.5 person years; nest monitoring: 5 months
Performance measures	Kiwi chick survival > 25%, and fantail and tomtit nesting success. Kiwi call count monitoring (5 people for 5 nights).

Outcome monitoring results	33% kiwi chick survival to date
Research/monitoring/trials	Beech seed traps

Changes since July 1999

Improved tools?	
Improved methods?	
Increased area protected?	Aim to extend present protection within the sanctuary.
Increased cost-effectiveness?	
Lessons learnt?	
Lessons learnt exported?	
Opinions	
Reference	(Phil Tisch pers. comm.)

11. Dart Mohua site

Site description	3260 ha, beech forest (dominated by red beech), administered by Otago Conservancy.
Objectives	Maintain viable mohua population
Methods	Trapping maintained since 1998. Two trapping regimes used: 1999/2000—Perimeters enclosing approx. 1 km^2 of 185 Mk 4 double Fenn sets at 100 m spacing, baited with hen eggs under wooden tunnels, checked weekly.1999/2000 and 2000/01—Single line down valley Mk 4 double Fenn sets at 200 m spacing, baited with hen eggs under wooden tunnels, checked monthly (changed to three-monthly check in August 2001, but will return to monthly monitoring in beech seedfall years).
Confounding treatments	Non-target predators caught include: cats (traps subsequently modified to prevent cat captures) and rats. Diphacinone egg trial in 1995/96 with high egg-take and potential secondary poisoning (Peter Dilks).
Result monitoring (trap catch)	Trap catch. Tracking tunnels (Craig Gillies model)
Costs (person effort)	12 person days trapping and 24 person days monitoring tracking tunnels. Project management—24 person days.
Performance measures	Annual mohua transects (10/valley × 4 times). See *Conservation Advisory Note 316*.
Outcome monitoring results	Mohua decline in both valleys, but significantly greater decline in non-treatment valley (Caples Valley).
Research/monitoring/trials	Test long-life baits (alternated with egg baits) 2002—Ray Henderson. Test validity of mohua transects survey method—Barry Lawrence.

Changes since July 1999

Improved tools?	Tracking tunnels far more accurate tool for measuring mouse abundance than snap traps, though time consuming.
Improved methods?	Mohua transect counts are more accurate than five-minute bird counts. Trapping regime changed to long line from perimeter trapping—significant saving in person power, and catch rates similar.
Increased area protected?	
Increased cost-effectiveness?	Trapping regime changed to long line from perimeter trapping.
Lessons learnt?	Mohua can decline in the presence of stoat control in some years, probably due to high rat numbers. Cats were caught when best practice of 40 × 50 mm wire mesh size at tunnels was abandoned for wire size > 40 × 50 mm. Weka-proof control devices are needed because weka appeared in areas where they were not previously recorded and accessed non-toxic eggs (occurred in north branch of the Hurunui River).
Lessons learnt exported?	Caples Valley
Opinions	Craig Gillies tracking regime is only going to be worth the effort if everyone is prepared to use it so valid comparisons can be made (so that its worth can be accurately determined).
Reference	(Barry Lawrence pers. comm.)

12. Landsborough Mohua site

Site description	300 ha, silver beech forest, administered by West Coast Conservancy.
Objectives	Maintain viable mohua population.
Methods	Trapping maintained since November 2000—93 Mk 4 double Fenn sets baited with a hen eggs under wooden tunnels at 200 m spacing; checked monthly to every 2 months.
Confounding treatments	Possum control using aerial 1080 at adjoining site, in 1999/2000. Non-target predators caught include: rats.
Result monitoring (trap catch)	Trap catch?
Costs (person effort)	Ranger hours for predator control—288/year; project management hours—40/year (more when setting up); Mohua monitoring hours—120 /year.

Performance measures	Five-minute bird counts; 1000 yard walking transect (Dilks and O'Donnell).
Outcome monitoring results	Counts inside trapping area higher than out side.
Research/monitoring/trials	Beech seed fall traps, mouse index counting (March/April 2000).
Changes since July 1999	
Improved tools?	
Improved methods?	
Increased area protected?	Area increased in response to more money.
Increased cost-effectiveness?	
Lessons learnt?	
Lessons learnt exported?	
Opinions	Rat plagues may not occur in silver beech because of less abundant seeding or poorer nutritional value of silver beech seed?
Reference	(Paul van Klink pers. comm.)

13. Eglinton Mohua site

Site description	4,000 ha, grassland/beech forest, administered by Southland Conservancy.
Objectives	Test 40 km trap line to protect mohua from stoats
Methods	400 Mk 6 double Fenn sets at 200 m spacing along a 40 km line, baited with hen eggs and beef, under wooden tunnels. Checked monthly and fortnightly in (Dec or Jan) in stoat plague years, and run all year.
Confounding treatments	Non-target predators caught include: cats, ferrets, hedgehogs, possums, rats, and weasels. Ground-based 1080 and Feratox work for possums.
Result monitoring (trap catch)	Trap catch and tracking tunnels (Craig Gillies model?) relate the numbers of stoats caught to beech seeding years.
Costs ($ and person effort)	Trapper: 2 person days/month; project management: 1 day/year; report writing: 2 days/year; monitoring by S&R (Colin O'Donnell).
Performance measures	Mohua population size and kaka productivity.
Outcome monitoring results	Intensity trapping effort protects mohua and kaka from stoats. Ship rats important predator of mohua in some seasons.
Research/monitoring/trials	(Colin O'Donnell and Peter Dilks, S&R). Trapping used to indicate rat plagues.
Changes since July 1999	
Improved tools?	
Improved methods?	Single line of traps along the valley floor is very cost-effective for protecting kaka and mohua.
Increased area protected?	
Increased cost-effectiveness?	Reduce traps checks from 12 to 6 or less per year.
Lessons learnt?	Eglinton is atypical, and results from one site should be treated with care. Single line of traps along the valley floor is very cost effective for protecting kaka and mohua. More stoats caught at ends of line.
Lessons learnt exported?	Dart, Clinton, Iris Burn, and Murchison Mountains
Opinions	
Reference	(Murray Willans pers. comm.)

14. Hawdon Mohua site

Site description	2500 ha, mountain and red beech forest and river flat, mixed species shrubland and short tussock grassland, administered by Canterbury Conservancy.
Objectives	Maintain mohua and orange-fronted parakeet populations.
Methods	1999/2000 and 2000/01—220 Mk 4 double Fenn sets baited with hen eggs under wooden and corflute tunnels, 100 m spacing and checked weekly in summer and every 1–2 months in winter. Pulse trapping—pre-fed with eggs and take monitored to trigger trapping, used for 2–3 years.
Confounding treatments	Trials with diphacinone for one year (in the Hawdon). Non-target predators caught in traps include: hedgehogs, possums, rats, and weasels.
Result monitoring (trap catch)	Trap-catch and egg take (used previously).
Costs (person effort)	Trapping: 650 person hours in mast year and 400 in non-mast year; zero mohua monitoring because no funding; orange-fronted parakeet monitoring: 220 hours.
Performance measures	Orange-fronted parakeet counts and nesting success.

Outcome monitoring results	Methods being developed at present.
Research/monitoring/trials	1989—(covered versus uncovered traps) covered were better; (bait preference between possum, fish cat food and hens eggs) clear preference for hens eggs.1990—(blind tunnels versus run through) run through preferred.1991—(same experiment/blind tunnels v run through) no preference; (mustelid anal sac (hormones × 2) versus hens eggs) hens eggs preferred (working with Kay Clapperton).1993—(bait trial, frozen mice versus hens eggs) frozen mice preferred, just.1994—repeated and no preference detected.1998/99—(diphacinone in hens eggs) was effective against stoats; (pulse trapping, pre fed eggs) steady take, trap for three nights. Egg monitor and then trap accordingly.1999/2000—(wood versus corflute tunnels) no significant difference.
Changes since July 1999	
Improved tools?	
Improved methods?	Pre-feeding/pulse trapping; diphacinone eggs.
Increased area protected?	
Increased cost-effectiveness?	Pulse trapping reduced labour when needed to check traps daily.
Lessons learnt?	Pulse trapping is very effective. Diphacanoe in hens eggs: effective, chronic poison, safe (antidote), breaks down quickly, stoats running round for 10 days as predators so adjust timing to reduce risk of predation of good guys.
Lessons learnt exported?	
Opinions	Mohua disappeared before big increases in rats in the Eglinton and the Dart so something else going on? Pulse trapping can potentially reduce the risk of trap-shy animals and result in less effort to protect larger areas. A range of different techniques (diphacenone eggs and trapping) are needed to protect mohua and OFP in mast years.
Reference	(Stephen Phillipson pers. comm.)

15. Clinton Whio site

Site description	6000 ha, beech forest, administered by Southland Conservancy.
Objectives	Determine cause of zero whio productivity and reason for sex bias (more males) in the Arthur River. Determine if trapping intensity could protect whio from stoats in Clinton. Developed to include kiwi—determine if trapping intensity could protect kiwi from stoats in Clinton and measure stoat impact on kiwi in the Arthur. Protect kaka and mohua.
Methods	Trapping commenced in October 2000—180 Mk 4 double Fenn sets baited with hen eggs and beef under wooden tunnels, place 200 m apart, checked monthly except in December when checked fortnightly, all year.
Confounding treatments	Non-target predators caught include: low numbers of rats.
Result monitoring (trap catch)	Trap catch and tracking tunnels (3 lines each of 25 tunnels, three times a year) showed similar rodent densities in both valleys (Clinton and Arthur), but lower stoat numbers in the Clinton Valley.
Costs ($ and person effort)	Trapper: 1 person 28 days/year; kiwi and whio monitoring: 3 people × 4 months, 1 person × 3 months; project management: 4 days/annum.
Performance measures	Five-minute bird counts, whio and kiwi breeding success and survivorship.
Outcome monitoring results	Stoats are significantly impacting whio productivity and female survivorship. Stoat control results are encouraging, but its 'early days'.
Research/monitoring/trials	Video cameras on nests and transmitters on adult whio to measure productivity and female survivorship.
Changes since July 1999	
Improved tools?	
Improved methods?	Eglinton model
Increased area protected?	
Increased cost-effectiveness?	
Lessons learnt?	Stoats are significantly impacting whio productivity and female survivorship. Stoat control results are encouraging, but it's early days.
Lessons learnt exported?	
Opinions	
Reference	(Murray Willans pers. comm.)

16.	Te Kakahu Island
Site description	514 ha, mixed beech/podocarp forest, administered by Southland Conservancy.
Objectives	Eradicate stoats
Methods	Trapping commenced in June 1999—Tracks cut first,140 Mk 4 double Fenn sets baited with day-old chicks and hen eggs under wooden tunnels, aluminium and wire at 100 m spacing and 50 m on accessible beaches, pre-baited with eggs and fish (not taken) for two weeks. Trapped for 10 days in July 1999 and returned approximately every two months. Now check (Te Kakahu, mainland and steeping-stone islands) twice yearly in November and February. Double sets on mainland and single sets on Te Kakahu (60) and steeping-stone islands.
Confounding treatments	N/A
Result monitoring (trap catch)	Trap catch and rabbit and day-old chicken bait take. Four visits by a trained stoat dog. Stoat prints on beaches. No more stoats caught since October 1999.
Costs ($ and person effort)	Trapper: 30 days; 4 person days/return visit.
Performance measures	No young stoats caught, therefore, no adult female stoats present. Didn't reach the island despite two stoat plague years.
Outcome monitoring results	Five-minute bird counts; bird abundance increased dramatically.
Research/monitoring/trials	NIL
Changes since July 1999	
Improved tools?	NIL
Improved methods?	Reduced trapping and monitoring effort.
Increased area protected?	N/A
Increased cost-effectiveness?	Reduced trapping and monitoring effort.
Lessons learnt?	Reduced the track intensity to 1.25 km apart for Anchor island. Reduced trap abundance—not around coastline and 150 m spacing for Anchor. Reduced follow up effort—twice-yearly checks for Anchor.
Lessons learnt exported?	Anchor Island, Fiordland.
Opinions	Mainland trapping may be more effective than people appreciate, and reinvasion is a major issue. Large areas could be protected using low intensity trapping effort and natural boundaries.
Reference	(Murray Willans pers. comm.)