Appendix F: Monitoring Effects on Target and Non-Target Species Following 1080 Operations

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Key points

- Relatively high mortalities of individual birds have occurred in the past, in particular with poorly prepared carrot bait at high sowing rates. The significant improvements in carrot bait preparation and application technology (eg, uptake of use of global positioning systems (GPSs) and improved bucket design) and lower sowing rates for control of possums have reduced the numbers of birds killed. There may still be issues with preparation to achieve consistent toxic loadings (eg, on carrot bait).
- Ongoing investigations into improving pest control strategies over time, (eg, Morgan et al 2006) may assist in reducing the frequency of applications, but may also result in 'double-sowing' in the initial 'knockdown' phase.
- There is no evidence of significant adverse effects on populations of any non-target species as a direct result of exposure to 1080, with the exception of some historical cases where unscreened carrot was used at very high sowing rates.
- There are clearly benefits to many native fauna from the use of 1080 over large areas of forest in reducing predation pressure, and in reducing competition for food, particularly at times of high vulnerability (eg, nesting, raising young).

- The indirect effects of the reduction in pest numbers (possum, rodents, and mustelids) on predation and the various interactions between the populations of these species may present a direct short-term risk to some threatened species depending on the timing and level of control operations. This is an area of active research (Tompkins and Veltman 2006). A Foundation for Research Science and Technology–funded research programme is under way to provide greater understanding of multiple pest dynamics (Ruscoe et al 2006).
- There are benefits to ecosystems from removing browsing pressure by using 1080 over large areas that would otherwise be inaccessible.
- Practices on land managed by DoC may differ from those used by other agencies for pest management elsewhere, for example, the use of oats and screening of carrot. Use of unscreened carrot, in rabbit control operations appears to disregard effects on non-native birds and other species.
- Lack of a central data collection agency for information on the poisoning of livestock and companion animals means the summary information presented in this appendix is tentative in terms of scope and number of animals affected. Notwithstanding the limited information available, it appears that the deaths of these animals are largely avoidable.
- No alternative to 1080 as an acute toxicant is available for the control of rodent and stoat irruptions. 1080, as a broad-spectrum acute toxicant, appears to be an effective tool for multiple species pest control, achieving significant reductions through primary and secondary poisoning.
- The availability of cat pellets is listed on Animal Control Products's website as being restricted to DoC only. There is no HSNO control to this effect.

F1 Overview

The applicants provided very brief results from the monitoring of effects on non-target native species in Section 4.1D of the application and in the context case studies (pp 63–68 of the application). The Agency has reviewed the primary source documents cited in the application, and has accessed some additional information to clarify the context for the results reported in the application (eg, the type of bait used and sowing rates).

The summary monitoring information presented below includes potential adverse effects on non-target species; operational monitoring with respect to pest indices, and outcome monitoring for species being protected. Given the volume of material available, it has not been possible to comprehensively review every monitoring report. Furthermore, much of the monitoring data presumably exists within various contractual operational reports and is not available to the Agency. The extent of that information is unknown. The Agency assumes the information reviewed below is likely to be representative of current investigations, and in some cases demonstrates an improvement in practice over time.

1 The applicant did not specifically discuss effects on non-native species (other than target species) in the environmental effects register. Only a small number of reports note effects on introduced birds. The Agency has attempted to source some additional information, which is summarised in the sections below.

The implications of the monitoring information reviewed below in terms of overall risks from substances containing 1080 to populations of non-target species are addressed in Appendix N. In some cases, the focus of the monitoring is on assessing the benefits from removing browsing or predation pressure by the use of 1080 to control pests and will be drawn on in section 7.5.

F1.1 Methods for monitoring pests and non-target species

A very brief overview of the various methods of monitoring target and non-target species is presented below to provide additional background to information noted in the remainder of the monitoring section.

F1.1.1 Possums

A standard trap-catch protocol for assessing possum population densities both before and after 1080 operations or any other form of control (eg, trapping and cyanide) has been developed and updated by the National Possum Control Agency (NPCA 2005). The data obtained from the application of the trapping protocol is used to calculate the residual trap catch index (RTCI). The protocol is used to assess the number of possums caught over a given number of trap nights. The ratio between the pre- and post-operational indices gives an estimate of the percent kill or percent survival. The RTCI has been in wide use since 1997 (Green 2003a, 2003b) and is not directly comparable with earlier possum density
2 monitoring methods. The Agency notes that the older monitoring reports did not always make explicit mention of the actual technique used and acknowledges that there may be some uncertainty in the way the information has been reflected in the summarised information presented. Older methods are not directly comparable with the current RTCI.

3 Observations have been made that the RTCI may not be accurate at low possum densities. Further investigation was undertaken by Forsyth et al
4 (2005) on farmland and in forest. The authors concluded that the RTCI is non-linear at high possum densities, with a decreased probability of capture and can vary seasonally. The probability of capture on farmland was lower in spring compared with winter and summer on farmland and with forest during summer. There was no evidence of seasonal variation within forest habitat. As the index is approximately linear at low abundance, and the seasonal bias small, the authors concluded that the RTCI is currently the best tool available for monitoring management actions. Whenever possible, use of the RTCI for comparative purposes should be conducted in the same season.

Target RTCI for improvements in vegetation condition and reductions in predation are discussed in the relevant monitoring sections (see sections F2.1.3 and F2.5.1).

F1.1.2 Rodents and mustelids

Tracking tunnels are used to monitor the relative abundance of rodents and mustelids before and after a pest control operation (Hasler et al undated; Blackwell et al 2002). The animal walks through a small tunnel and over an inked surface leaving footprints on removable card or paper for later analysis. Tracking rates are expressed as the proportion of tunnels with tracks. A standard tracking method has been developed for use by DoC (Gillies and Williams 2003).

Kill trapping is an alternative method of monitoring.

F1.1.3 Rabbits

Night-counts can be used to estimate percent kill after a control operation, to provide population trend data and to establish whether a control threshold has been reached. The Modified Maclean Scale is used to establish whether a control threshold has been reached, and can be used for trend monitoring, but is not suitable for assessing percent kill shortly after an operation due to the residual rabbit sign (NPCA 2006). The Modified Maclean Scale is based on faecal pellet heap density and fresh rabbit sign, with a rating (1–8) assigned on the basis of number of heaps in a given area, with 1 being no rabbits or sign of rabbits and 8 being the greatest density of rabbits or signs.

F1.1.4 Birds

A variety of methods is used for monitoring bird populations before and after pest control operations including: five-minute bird counts; marking and re-locating individuals; and roll-calls of individual birds.

- Five-minute counts have been identified as not reliable for assessing population impacts after 1080 operations unless high mortality occurs (Atkinson et al 1995) and not reliable for rarer species (Warren 1984). A species' conspicuousness can vary significantly during the year and from month to month (Powlesland et al 1998). Marking of individual birds and subsequent re-location after an operation has been identified as being more reliable. An investigation of transect based methods as alternatives to banding tomtits (Westbrooke et al 2003) concluded that counting of territorial males along a transect provided relatively high precision for monitoring short-term impacts. Distance sampling techniques were identified for further consideration for monitoring longer term effects. Both techniques were considerably less resource intensive than banding individuals. Distance sampling involves measuring the distance a bird is from a defined transect or point, and is suitable for species that are

relatively common and not affected by the presence of observers such as bellbird, grey warbler and tomtits (Hamilton 2004).

1 Specific monitoring protocols have been developed for robins (*Petroica australis*) to assess individual mortality, nesting success, and the time taken for a population to recover from impact (Powlesland 1997).

F1.1.5 Terrestrial invertebrates

A variety of monitoring methods have been used to assess effects of 1080 operations on invertebrates including: the occupation of artificial refuges; the mark and recapture of larger bodied invertebrates; the use of pitfall traps and manual observations of invertebrates on and under baits.

2 Artificial refuges may be occupied by a wide range of invertebrate species, including weta. However, immature weta are less likely to be found (Spurr
3 and Berben 2004). Mark–recapture techniques allow the monitoring of the fate of individual invertebrates, and overall responses of populations (Spurr and Berben 2004) but are applicable only to larger bodied invertebrates.

Pitfall traps can be used to monitor abundance and activity of
4 invertebrates, but the taxa found on baits may not be caught in pitfall traps in sufficient numbers for an assessment of impacts at a species level (Spurr et al 2002; Sherley et al 1999).

5 Investigations into video-monitoring invertebrates on baits indicate that the method records lower numbers and diversity of invertebrates as it cannot detect the presence of invertebrates, which may be under the baits, but may be useful for observations of large-bodied species (Wakelin 2000).

F1.1.6 Vegetation

6 A standardised Foliar Browse Index (FBI) developed by Landcare (Payton et al 1999) and used by DoC since the late 1990s (Green 2003a, 2003b) is based on the assessment and reassessment of permanently marked individual plants to determine trends in foliage cover, dieback, possum browsed leaves, possum stem use and flowering and fruiting. While useful for most species, the FBI has proven to be inadequate for monitoring northern (*Metrosideros robusta*) and southern rata (*M. umbellata*), as has an alternative method called 'Rata View' (Green 2003a, 2003b).

F1.1.7 Aquatic invertebrates

Kick-sampling is used to dislodge invertebrates from the bottom of stream riffles, which are then captured in nets and identified and counted (TRC 1993, 1994). Standard protocols for sampling macro-invertebrates have been developed that allow for comparison across agencies (Stark 2001) and were used in sampling streams at Haupiri Forest (Suren and Lambert 2002).

F2 Monitoring for effects of 1080 on non-target species

F2.1 Birds

Deaths of individual birds have been reported frequently after pest control operations, but generally do not give any indication of potential effects at a population level (eg, Powlesland et al 2000). Systematic searches for dead birds are not common practice, with other monitoring methods used to assess potential impacts at a population level. Results of recent monitoring of bird populations during aerial 1080 operations available to the Agency are summarised in Table F1. The level of detail in the reports is highly variable, with more recent studies generally using more refined monitoring techniques for birds at higher risk (see Appendix N for further discussion on the risks to birds), for example, radio-tracking and mark and recapture. Impacts of predation or removal of predation pressure have been noted where this information was included in the study report. In many cases, the conclusions that can be drawn from the monitoring are limited by lack of replication and/or a lack of suitable control (untreated) blocks.

A discussion on the ability of a population to recover from an impact such as may occur as a result of a 1080 operation is included in Appendix N.

One carrot operation in particular was reported to have had a significant impact on tomtits in Cone State Forest in 1977, with the population taking three years to recover and the brown creeper one year to recover (Spurr 1981, cited in Powlesland et al 2000). The carrot bait used was unscreened and sown at 30 kg/ha. Several carrot drops in the central North Island in 1976–77 resulted in a large number of dead birds (large areas systematically searched), primarily introduced birds (Harrison 1978). In one case, where the carrot was unscreened and undyed, 222 dead birds were found (30 native); in a series of three trials to evaluate the utility of screening the bait, all at a sowing rate of 40 kg/ha, 177 dead birds were found (143 native). No analyses for 1080 residues were undertaken on any of the birds found.

Reductions in sowing rates from the very high levels used in the early 1970s and 1980s for possum control and improvements in bait quality (eg, the screening of carrot bait to remove chaff and use of green dye) along with adoption of improved sowing technologies and use of global positioning systems have assisted in reducing impacts on birds.

The adequate screening of carrot removes small pieces that carry a much higher toxic loading than the larger baits based on surface coating (ie, a high surface to volume ratio) and may be more attractive to small birds.

However, it is evident from the information reviewed by the Agency that carrot bait may not always be prepared reliably; for example, inaccurate toxic loading (Clapperton et al 2005; Spurr et al 2002; Sweetapple and Fraser 1997), poor dye coverage (Green 1998), and poor screening to remove chaff (Powlesland et al 1999; Green 1998). The Agency does not have sufficient information to determine how frequently these problems

may occur and what impacts they may have in terms of achieving pest control or on non-target species.

Different types of carrot cutter produce different qualities of bait, that is, a greater or lesser proportion of fine pieces (Batcheler 1996). The Agency notes that there does not appear to be a consistent industry standard, although the Agency does not have sufficient information to fully assess the matter, having only been provided with the standard operating procedure for one contractor used by the Animal Health Board (AHB) (further information from the applicants, 22 December 2006). DoC best practice for carrot operations has specific requirements for cutting and screening (chaff, pieces less than 0.5 g to be less than 1.5% by weight); bait size (6 g or larger to ensure a single bait is lethal to a possum); toxic loading 0.15% 1080 (0.08% loading acceptable only when sowing at more than 5 kg/ha); green dye; double lure (cinnamon or orange at 0.3% rather than 0.15%).

The Agency notes that birds that feed on invertebrates may be affected by secondary poisoning (from consuming invertebrates containing 1080 residues) or primary poisoning (from direct ingestion of bait) or both. This is discussed further in Appendix N.

F2.1.1 Effects on game birds: rabbit control operations

The Agency is unaware of information on the effects of 1080 operations on game birds, particularly after rabbit control. The applicants provided further information on the use of carrot bait from the Otago Regional Council (further information from applicants, 22 December 2006) that indicates that this council does not screen carrot bait used for rabbit control. The sowing rates for rabbit control (10 to more than 40 kg/ha at 0.02% 1080) are much greater than that used for possum control, resulting in a significantly larger number of baits being available for ingestion by target and non-target species. The rationale given for not screening the bait is two-fold. Firstly, a large population of rabbits needs to be exposed to a large number of baits, and secondly, "native birds which could be deemed at risk, are not usually present in the type of country where rabbit control takes place". *Pest Rabbits: Monitoring and Control* (NPCA 2006, p 19) also has a similar statement.

Treated oats are also used for rabbit control and their use on land under DoC management is not allowed due to the high risks to non-target native species (further information from applicants, 22 December 2006).

F2.1.2 Birds vulnerable to secondary poisoning from feeding on animal carcasses

Moreporks, *Ninox novaeseelandiae*, are not known to eat vegetation, so the poisoning of these birds is most likely to be secondary from the consumption of poisoned rodents (Spurr and Powlesland 1997) and invertebrates (Lloyd and McQueen 2000). Dead birds have been reported following 1080 operations and the morepork has been flagged as a high

priority for further research to determine longer term impacts, including from indirect effects due to loss of prey (Spurr and Powlesland 1997; Greene 1998).

- Harrier hawks have been observed feeding on carcasses of poisoned possums (Spurr and Anderson 2004) and weka, while kea have been known to feed on poisoned thar (Douglas 1967).

Table F1: Monitoring for effects on birds from possum control operations using 1080 in New Zealand

Primary non-target species being monitored	Target species and 1080 application method, bait type, sowing rate	Location (area treated) date of application	Monitoring method	Monitoring results	Reference
Kereru/kukupa, *Hemiphaga novaeseelandiae*	Possum/ship rat Ground-based Three pre-feeds cereal bait 0.15% 1080 1 kg/bait station for one week, then replaced with brodifacoum for the next two years and cyanide Feratox in cholecalciferol paste for two years (Trapping for mustelids)	Motatau Forest, Northland (350 ha) October 1997–2001 3 Control (untreated 300 ha) Okaroro, Northland	**Birds** 1 Five-minute bird counts and 30-minute display counts (abundance) 4 Radio-transmitters (nesting success) **Pests** RTCI for possums Tracking tunnels for rats	Ship rat tracking declined to zero after 1080 operation and remained <4% until three months after final bait station fill with brodifacoum in Aug 1999. Rates increased with use of 2 cyanide/cholecalciferol. RTCI dropped from 26% to 12% after the 1080 operation (initial knockdown), and subsequently stayed below 7%. Significant increase in five-minute counts: more than trebled compared with control site. Maximum number of display flights increased from 11 (August before pest control) to 33 in October 2000. 5 All nests (13) failed due to predation before commencement of pest control (Sept 1996 – Oct 1997). Some ongoing predation managed by intensive trapping around nest trees after initial pest control started. In 1998–99 when possum and rat indices both low (<4%), all (seven) nests fledged 6 young. An increase in ship rat numbers (tracking rate 34%) in 2000–01 resulted in rat predation of 11 out of 16 nests. 7 Counts of chaffinches, eastern rosellas, mynas and tui also increased relative to control site. Counts of grey warblers, pheasants and silvereyes increased at the control site relative to the treated site. No significant difference in fantails, kingfisher, shining cuckoo or tomtit between treated and untreated blocks. No poison-related mortalities reported in any non-target species	Innes et al 2004

Primary non-target species being monitored	Target species and 1080 application method, bait type, sowing rate	Location (area treated) date of application	Monitoring method	Monitoring results	Reference
Kereru Kaka, *Nestor meridionalis*	Possum (secondary: rats) Aerial 5 kg/ha pre-feed 10 kg/ha screened carrot at 0.08% (6–8 g baits), chaff <0.2%	Whirinaki Forest Park (2250 ha treated Otupaka; 3,000 ha control untreated Oriuwaka) May 2000	**Birds** Re-location of birds Banding before operation and radio-transmitters attached to all kereru, female kaka and some male kaka. Male kaka not radio-tagged were marked with coloured leg-flags **Pests** RTCI for possums Tracking tunnels for rats and mustelids	RCTI dropped from 27–33% pre-operation to 4.4% post operation (June 2000) rising to 9.5% in February 2002. In the non-treatment area, RCTI dropped from 30.8% in February 2001 to 11.5% in February 2002, with no significant differences between treatment and control by Feb 2002. Decline in control block due to possum poisoning and trapping for fur by people not involved in the study. Tunnel tracking for rats declined from 43% to 5% in the treatment area immediately after the operation and remained at ≤11% for the next 21 months then increased to 32% by May 2002 (no significant difference from control area at May 2002) Mustelid indices were low (<10%) for both treatment and control and did not differ significantly during the study. **1080-related mortality of kaka and kereru** None of the radio-tagged kaka died in either the treatment or control area in the two weeks following the operation. All radio-tagged kereru survived in the treatment area, one died in the control area, cause not stated. **Nesting success** Kaka and kereru nesting is linked with mast fruiting in podocarps, which is inherently variable. There was ongoing predation of both kaka and kereru nests (egg, nestlings, fledglings and one incubating female kaka). The RCTI achieved (4.4%) was below that recommended for protection of kokako, and close to that recommended for protection of kereru. The authors commented that the treatment area may have been too small to realise significant gains from the 1080 operation.	Powlesland et al 2003

Primary non-target species being monitored	Target species and 1080 application method, bait type, sowing rate	Location (area treated) date of application	Monitoring method	Monitoring results	Reference
Kaka	Possum Aerial 0.08% carrot at 15 kg/ha	Waihaha, Pureora Forest August 1994	**Birds** 1 21 radio-tagged birds (18♂)	Contact with one bird lost before the 1080 operation; all other birds successfully monitored after the operation 2 Issues with preparation of carrot bait included poor uptake of dye in some batches; and adjustment screen to reduce number of small particles passing through 3 Dead birds noted included four kereru, two blackbirds, four riflemen, one grey warbler and seven tomtits, but no analysis for 1080 residues. Snow fell soon after the poison drop and may have contributed to the deaths of the smaller birds.	Greene 1998
Kea, *Nestor notabilis*	Thar Aerial 0.17% unscreened carrot bait; green dyed	Dobson Valley, Sept/Oct 1964		4 Four dead kea found; two analysed for 1080 residues one positive the other 'doubtful' (also eight dead gulls *Larus dominicanus*, one analysed for 1080 and found positive) One kea observed feeding on toxic carrot; kea may also have fed on poisoned thar carcasses (one thar observed with viscera removed)	Douglas 1967
	0.08% screened carrot at 20 kg/ha (1983) 0.2% screened carrot at 20 kg/ha (1986)	Westland National Park Two operations 1983 and 1986	**Birds** 5 Five-minute call counts	Counts similar before and after both operations	Spurr 1994
Tomtit, *Petroica macrocephala toitoi*	Possum Aerial One pre-feed 12 g cereal baits 0.15% 1080 at 3 kg/ha Nine nights without rain after the drop	Tongariro Forest (~20,000 ha) September 2001	**Birds** 6 Banding of 15 male tomtits in treatment and control areas Distance sampling (population density) Territorial male counts **Pests** RTCI for possums	RTCI 5% pre-operation; 0.1% post-operation Sighting of banded birds 14/15 in treatment area; 15/15 in control area Distance sampling 3% reduction in average density: not significantly different from the control area Territorial male counts, no significant differences	Westbrooke et al 2003

Primary non-target species being monitored	Target species and 1080 application method, bait type, sowing rate	Location (area treated) date of application	Monitoring method	Monitoring results	Reference
	Possum/rats Aerial Carrot (1997) one pre-feed 0.08% 1080 at 10 kg/ha (bait checked and contained <0.2% chaff) 9.5 mm rain 3–4 days after drop, 100 mm within a month Cereal (1998) no pre-feed 0.08% Wanganui No 7 cereal bait at 5 kg/ha	Pureora Forest, August 1997 (Waimanoa study area 8577 ha) and 1998 (Long Ridge study area 200 ha) (non-treatment control block – Tahae (100 ha) in both 1997 and 1998 Tahae had been treated in 1996)	Each study area comprised ~300 ha within a larger block, but only ~100 ha of each was regularly searched for tomtits **Birds** Banded after being accustomed to hand-feeding with mealworms. Monitored every day or second day for a fortnight after poison drop Nests visited by following banded males Analysis of dead birds for 1080 residues in muscle **Pests** RTCI for possums Tracking tunnels for rats	**1997 carrot** Banded tomtits seen 14 before, 3 after (3 before and after in control block) RTCI 23.7% before operation; 0.2% after operation Tunnel tracks 44% before; 0% in Sept/Oct 1997, rising to 7% by Feb 1998, late in the nesting season No dead banded tomtits found, three dead un-banded tomtits found. Concentrations of 1080 in muscle tissue of each bird were 1.9, 1.5 and 1.3 mg/kg. No bait fragments found in dead birds, but tomtits known to regurgitate pellets of indigestible food and may do the same with toxic food. Four of five nests in the treatment area were successful (one failed due to predation) compared with four of six nests in the control block (one failed due to predation., the other for unknown reasons); the difference in nesting success between blocks was not significantly different One year after operation: fewer tomtits seen in treatment block compared to before the operation but only a small proportion of the population banded making assessment more difficult. The following season, pairs reared two and sometimes three broods in a season (mean four chicks/brood) indicating a high likelihood of population recovery. **1998 cereal** Banded tomtits seen 14 before and after (16 before and after in control block) RTCI 9.7% before operation; 2.5% after operation Tunnel tracks 46% before; 9% after	Powlesland et al 2000

Primary non-target species being monitored	Target species and 1080 application method, bait type, sowing rate	Location (area treated) date of application	Monitoring method	Monitoring results	Reference
	Possum Aerial 2 kg/ha carrot at 0.15% 1080	Hampden, Otago (6500 ha) July 2002 2 Non-treated control at Moeraki	**Birds** Distance sampling: once pre-operation, and three times post-operation (summer and winter 2003; summer 2004)	1 No adverse effect on population density after the operation; increased tomtit density after first breeding season but declined in the later survey periods to below the pre-operation levels. A severe winter in 2003 followed by a wet and windy summer may have contributed. Significant damage occurred to plantation forest at the treatment site during the storm and was followed by harvesting, which may also have affected the bird surveys by reducing habitat and creating significant noise. At control site, tomtit density decreased after the first monitored season and continued to decline. No dead birds found during monitoring, though apparently deer stalkers in the area had made claims to the contrary.	Hamilton 2004
	Possum Aerial unscreened carrot 0.06% at 30 kg/ha	Cone State Forest, Southland 1977	**Birds** 4 Five-minute counts	3 High mortality, three years for population to recover	Spurr 1981 cited in Powlesland et al 2000
	Possum Aerial 3 kg/ha pre-feed 3 kg/ha carrot at 0.08% 1080	Kokomoka Forest May 2003	**Birds** Counting of territorial males on transects within a month of the operation **Pests** RTCI for possums	Significant differences in tomtit counts between cereal and carrot operations (as also seen in the Tongariro 2001 result above). 5 Decreases in male tomtit numbers after operations with carrot, point estimates were 47% at Kokomoka, 20% at Mohaka, 15% at Waimanoa Small increases in average counts after operations with cereal baits; point estimates were 10% at Pureora (3% Tongariro based on re-analysis of data)	Westbrooke and Powlesland 2005
	Possum Aerial 5 kg/ha pre-feed 5 kg/ha carrot at 0.08% 1080	Mohaka forest May 2003			

Primary non-target species being monitored	Target species and 1080 application method, bait type, sowing rate	Location (area treated) date of application	Monitoring method	Monitoring results	Reference
	Possum Aerial 3 kg/ha pre-feed 3 kg/ha carrot at 0.08% 1080	Pureora Forest (Waimanoa) 2003			
	Possum Aerial 2 kg/ha pre-feed 2 kg/ha cereal bait at 0.08% 1080	Pureora Forest (Mt Pureora) 2003			
Robin, *Petroica australis longipes*)	Possum Aerial 7 kg/ha pre-feed 15 kg/ha screened carrot at 0.08% 1080 Operation in two stages: first stage wastage from carrot screening was 23% by weight compared to 9.9% by weight for the second stage, suggesting a higher proportion of chaff was not removed but was distributed with the bait	Pureora Forest September 1996 Tahae (control block Waimanoa)	**Birds** Territory mapping of banded and unbanded birds Monitoring of banded birds which would approach for food **Pests** RTCI possums Tunnel tracking rats	Twelve of 28 robins disappeared from the treatment area after the operation (32/32 were observed the control block) based on territory mapping. Of the birds that disappeared, most did so within three days of the operation Three banded birds were found dead and contained 1080 residues 0.37, 0.83, and 3.8 mg/kg muscle. Autopsy of one the most recently dead bird revealed an empty alimentary tract from the beak to the gizzard; invertebrate fragments were found in the gizzard. Robins are known to regurgitate pellets of indigestible food and have been observed to regurgitate mealworms coated in cinnamon oil Twelve of 22 robins disappeared from the treatment area based on monitoring of banded birds seeking food (24/24 were seen in the control area) *Nesting success in the 1996/97 breeding season* Four of 35 nests fledged chicks in the control block (mean 0.4 chicks/pair); four adult females lost to predation; 13/18 nests fledged chicks in the treatment block (mean 3.7 chicks/pair) One year after the operation: Control block: 33 birds compared with 32 pre-treatment	Powlesland et al 1999

Primary non-target species being monitored	Target species and 1080 application method, bait type, sowing rate	Location (area treated) date of application	Monitoring method	Monitoring results	Reference
				Treatment block: 36 birds compared with 16 post-operation and 28 pre-operation indicating recovery from impact **Possums** Treatment block pre-operation October 1995 RTCI 6.2%; none post operation Control block RTCI 8.9% in October 1995; 14% in October 1996 **Rats** Sept 1996 – February 1997 (robin breeding season) 89–95% reduction in treatment area compared with essentially no change in the control block (~60% of tunnels with prints)	
	Possum Aerial 5 kg/ha pre-feed 10 kg/ha screened carrot at 0.08% 1080 (<0.2% chaff)	Pureora Forest October 1997 Waimanoa (Control block – the above Tahae area treated in 1996)		Three of 35 birds disappeared based on territory mapping in the treatment area compared with one in 49 in the control Three of 31 banded birds disappeared in the treatment block based on monitoring of birds seeking food (one in 42 disappeared in the control block) Nesting success in 1997/98 season: Control block: 23 pairs monitored 20/67 nests fledged chicks (mean 1.5/pair); seven adults disappeared Treatment block: 10 pairs monitored 20/30 nests fledged chicks (mean 3.8 /pair) 2 adults lost Numbers in June 1998 Treatment block: 46 birds compared with 32 post-operation and 35 pre-operation Control block: 65 birds compared with 49 Aug 1997, 48 October 1997 **Possums** Treatment block pre-operation RTCI 23.7.%; 0.8 post operation	