Appendix N: Exposure and Risk Assessment (1080): Non-Target Species

Contents

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Key points

1 Evaluation of literature on the effects of 180 usage are complicated due to
2 the variable reporting of the 1080 formulation used. It is recommended that all reports and papers relating to research and monitoring should include the trade name of the product being evaluated to allow for correct cross-referencing in the future.

Birds

Birds are at risk from exposure to 1080 baits. The nature of the risk varies depending on the bait used, the species' food and foraging habits.

3 Monitoring has indicated deaths of individual birds and modelling of exposure indicates that exposure both to fragments of bait and to residues in bird's food could be sufficient to cause effects.

4 Risks to bird populations will be depepndent on species' dispersal abilities, which affect their colonisation of treated areas, breeding strategies which affect their potential to replace individuals and local abundance which affects both potential for immigration and population recovery by breeding.

1 Key bird species have been subject to increased monitoring and no direct
population level impacts attributable to 1080 poisoning have been
2 identified. However, there have been instances where the use of 1080 has
not been successful in adequately managing the risks of predation.
Effective, well-timed (coincident with bird breeding periods), and
widespread pest control is required in most cases to protect vulnerable
species from on-going predation pressure. Considerable work is in
progress to improve the efficiency of pest control, and potentially reduce
the frequency of control under some circumstances. Research is also in
progress to further address the complexities of multiple-pest species
management.

3 Deaths of tomtits and robins have frequently been reported after aerial
1080 operations, but these species, while clearly vulnerable to poisoning,
are both capable of wide dispersal and have a high reproductive capacity.
In the absence of other significant impacts such as severe weather during
key stages of their breeding cycles or high rates of on-going predation,
4 impacts are likely to be short-term. Improvements in bait
quality/preparation and reduced sowing rates have contributed to fewer
5 deaths of individual birds, as indicated by monitoring results.

While there is less certainty around the impact of competition by pest species for available food resources, there is sufficient evidence to suggest that such competition can occur for some species, and that widespread pest control can contribute to improved food availability and potentially to improved breeding success.

Risks are related to a series of recommendations that require further investigation.

- **Peanut-based pastes**
  One currently registered paste is peanut-based (Pestoff Exterminator 0.15% registered by ACVM 2003). Testing has shown that of a number of baits tested, peanut is more attractive to native bats than some of the other types of bait. This product is applied in bait stations only (clarified in additional information from applicants 13 February 2007). However, the HSNO control currently for 'paste containing 1.5 g/kg 1080', which also covers a fruit-based paste, states 'ground-based application' which is less restrictive than 'contained ground-based application'. Consideration is needed to either:
  - split the current approval to contained and non-contained uses
  - make the entire substance for use in contained applications.

- **Apple-based pastes**
  There have been calls to restrict the use of these pastes. Morgan et al (1997) recommends use of Pest-off Professional off the ground/in bait stations when weka, robins and pukeko likely to be present and Morgan 2000 recommends not using apple paste when the weather is likely to be hot and windy, or on very absorbent, dry, sandy soils due to bait dehydrating.

- **Soluble concentrate containing 20% 1080**
  Consideration needs to be given to restricting the use of soluble concentrate containing 20% 1080 perhaps to bait stations only.

- **Carrots**
  1 Consideration needs to be given to ways to restrict fines in carrot bait.

- **Oats**
  2 Treated oats are not allowed on Department of Conservation (DoC) land due to high risk to non-target organisms. Consideration needs to be given to remove grain/oats as an acceptable bait material or to require greater evaluation of risks to non-targets before use

3 The Agency considers that further trials with bird repellent may be warranted given the problems with trials performed to date, that include lack of replication, issues with monitoring possum indices after the trials and less-than-target toxic loading on the carrot.

Bats

4 Monitoring data do not indicate a high likelihood of direct poisoning from
5 feeding on baits or mortalities from secondary poisoning. However, given the low reproductive rate of <1 young/adult female per year there is little scope for the populations to sustain the loss of many individuals (Lloyd 1994).

Invertebrates

6 Due to the level of uncertainty in the toxicity data for invertebrates, and the lack of information on amounts of bait likely to be eaten, the Agency
7 has not attempted to assess direct exposure to invertebrates. Available monitoring data indicate that invertebrates which feed on baits are not
8 adversely affected at a population level, and the extent of any impact is very localized to within a short distance of a toxic bait. While
11 invertebrates feeding on poisoned animal carcasses may be exposed to 1080 residues, the Agency has not assessed exposure from this source. Any effects are likely to be minimal.

Overall, the Agency considers the risks to invertebrate populations from direct and indirect exposure to 1080 to be very low to medium.

Reptiles and amphibians

9 The Agency has insufficient information to evaluate the attractiveness of currently used baits to skinks and has made no quantitative assessment of
10 the risks of 1080 to skinks. The Agency has made no assessment of risks to frogs, but notes that several monitoring trials have been performed and have shown no evidence of effects on frogs.

Dogs and deer

Deaths of dogs from both primary and secondary poisoning have been reported.

Deer are killed by 1080. Addition of deer repellents has been trialled, but monitoring of its effectiveness has been patchy and frequently inconclusive. There is also an issue in that repellent applied to cereal bait changes its colour such that it is not HSNO Act compliant. Given the complexity of the issues, and the very site-specific nature of deer management, the Agency does not consider that at this stage it is feasible to add a control to any substances containing 1080 that would require the use of a deer repellent.

Aquatic biota

No effects are likely based on the number of baits that have been recorded falling into streams. Monitoring of effects on aquatic biota has been confounded by flooding, but no effects have been recorded.

N1 Background

The detailed ecotoxicity hazard assessment of substances containing 1080 is included in Appendix C, detailed monitoring of target and non-target species is in Appendix F, and environmental media in Appendix E.

The overall approach taken to estimating the exposure of non-target species to 1080 in this appendix is to evaluate potential attractiveness and palatability of various bait formulations, residues in food which may be consumed, and how much of each may be consumed by the species of interest.

In order to assess the risk to an individual, the toxicity (hazard) of 1080 is also considered and incorporating the amount of contaminated food ingested, assimilation efficiency and metabolic activity of the species of interest.

The underlying concern from an ecological perspective is survival of self-sustaining populations. The monitoring data reviewed in Appendix F is drawn on in reaching conclusions on risks to populations of non-target species from the use of substances containing 1080. The Agency has made no attempt to model changes in non-target populations over time given differing levels of pest control with or without 1080.

N1.1 Residues of 1080 in biota

A summary of the 1080 residues which have been reported in various biota is in Table N1. More details on the sources of these values can be found elsewhere in the Evaluation and Review (E&R) Report as noted. The biota residue data will be used in different sections of this appendix for estimating the secondary exposure of consumers to 1080.

Table N1: Residues of 1080 measured in New Zealand biota

Species	Tissue sampled	1080 residues (mg/kg[b]) Min	Max	Mean	Field (F) or lab (L) data	Reference
Aquatic species						
Long-fin eel, *Anguilla dieffenbachia*	muscle	0.003	0.32	0.0174 ± 0.0104	L	Lyver et al 2004[a]
Koura/freshwater crayfish, *Paranephrops planifrons*	Tail muscle	-	5	~ 1.2 at Day 1 ~ 0.2 at Day 8	L	Suren and Bonnett 2004[a]
	Viscera	-	3.3	~1.5 at Day 1 ~0.25 at Day 8	L	
	Viscera + muscle	-	7.7		L	
Aquatic plant (assemblage of species)	-	-	0.051 after 1 hour 0.027 after 24 hours 0.005 after 100 hours		L	Eason et al 1993 [a]
Terrestrial Invertebrates						
Striated ant, *Huberia striata*	Whole			5.51 (fed sugar water containing 0.03% 1080 – sub-lethal) 4.78 mg/kg (fed cereal bait containing 0.15%)	L	Booth and Wickstrom 1999[a]
Garden snail, *Helix aspersa*	Whole		1.9 mg/kg after exposure at 500 mg/kg dw soil 23 mg/kg after exposure at 1000 mg/kg dw soil 61 mg/kg after exposure at 1500 mg/kg dw soil		L	O'Halloran and Jones, 2003[a]
Earthworms, *Aporectodea calliginosa*; *Eisenia fetida*	Whole	-	<LOD	-	L	O'Halloran and Jones, 2003[a]
Pooled sample of invertebrates collected from cereal baits containing 0.15% 1080	Whole	12	130	57 ± 25.6 (n=68)	F	Lloyd and McQueen 2000

Species	Tissue sampled	1080 residues (mg/kg[b])			Field (F) or lab (L) data	Reference
		Min	Max	Mean		
Spiders	Whole	14 (n=4)			F	
Cave weta, *Gymnoplectron tuarti*	Whole		130 (n=2)		F	
Tree weta, species unknown	Whole	-	5.8 mg/kg at 4 and 12 hours 5.0 mg/kg at 24 hours 2.8 mg/kg at 48 hours 4.5 mg/kg at 96 hours 0.2 mg/kg at 144 hours 0.033 mg/kg at 240 hours	-	L	Eason et al 1993[a]
Plants						
Rye grass, *Lolium perenne*	shoots			0.08 at Day 3 LOD at Day 7	L	Ogilvie et al 1998[a]
Broadleaf, *Griselinia littoralis*	Whole seedling			0.06 at Day 10 LOD at Day 38	L	Ogilvie et al 1998[a]
Pikopiko, *Asplenium bulbiferum*	Frond			<LOD (0.002)	F	Ogilvie et al 2006[a]
Karamuramu, *Coprosma robusta*	Leaves			0.005 at Day 7 0.0025 at Day 14 <LOD (0.002) at Day 28	F	Ogilvie et al 2006[a]
Vertebrates						
Birds						
tomtits	muscle	1.3	1.9	1.6 (n=3)	F	Powlesland et al 2000[a]
robins	muscle	0.37	3.8	1.7 (n=3)	F	Powlesland et al 1999[a]
blackbirds	muscle	7.2	32		F	Morriss et al 2005[c]
Possum	Stomach contents			30.6 at Day 25 4.9 at Day 75	F	Meenken and Booth 1997[a]

Notes

a For further details, see Appendix C.

b Fresh weight basis unless otherwise specified.

c This appendix – cereal bait deer repellent trial.

N2 Terrestrial biota

N2.1 Birds

N2.1.1 Attractiveness and palatability of baits

Cereal and carrot

In circumstances where threatened species are perceived as being at risk of exposure to 1080 baits, palatability trials using non-toxic and toxic baits may be undertaken in advance of an aerial 1080 operation to determine the most suitable bait type. A couple of examples are summarised below.

At Waipoua Forest, brown kiwis (*Apteryx australis*) were exposed to non-toxic, brown, cinnamon-lured Wanganui cereal bait containing Rhodamine B, a fluorescent marker dye (Pierce and Montgomery 1992). Scats were collected for three weeks and examined for residues of the marker dye. Of the 17 scats collected, two contained dye. Observations were also made of several kiwi probing for food near baits without them actually contacting
1 the baits. In a parallel trial with toxic baits (0.08% cereal, dyed green, cinnamon-lured) five kiwi with radio-transmitters were monitored after baits were hand-sown into their home ranges at approximately 1 bait/10 m^2. All birds survived the trial, and also survived the full-scale aerial operation.

The acceptance of carrot bait by kaka (*Nestor meridionalis*) was assessed on Kapiti Island in May 1993 by aerial sowing non-toxic bait, dyed green over ~170 ha of forest at a target rate of 10 kg/ha (Lloyd and Hackwell 1993). The baits were also coated with 0.3% v/w pyranine as a fluorescent
2 marker and 0.1% v/w cinnamon oil. The baits were screened, but not very
3 well, with a high proportion of baits (31% by weight) < 5mm long. Caged kaka at the Wellington Zoo were given carrot treated with pyranine with no signs of any aversion to the treatment. Baits were regularly inspected
4 for signs of feeding within eight 100 m^2 plots. Kaka were captured in the drop zone and at feeders by the ranger's house and examined for traces of marker dye; droppings from the feeders were also examined. Of the 'many hundreds' of baits examined only three baits over a kilometer apart showed
5 beak marks by kaka but no sign of actual consumption. Twenty kaka were captured and caught in the 11 days after bait application, with five
6 recaptures. Only one showed signs of the tracer dye. Of the droppings examined, those from a number of different species showed fluorescence, including: 10/87 weka droppings; one kereru, one small passerine; one weta. Of five kiwi (*Apteryx oweni*) droppings examined, none fluoresced. A large number of kaka droppings were examined from the feeders, with none showing any fluorescence. The authors concluded that kaka may be at risk from consuming carrot bait, with juveniles more likely to consume bait than adults, with the risk influenced by the abundance of natural food at the time of aerial application.

7 A summary of birds known to consume either carrot or cereal bait used in 1080 operations is in Table N2, adapted from Spurr and Powlesland

(1997). Introduced species have been included by the Agency based on monitoring data from Appendix F.

1 A number of bird species are known to have consumed cereal-based baits containing brodifacoum used during aerial rat eradication operations and subsequently died, these include; little spotted kiwi, brown teal, spotless crake, kakariki, and pukeko (Spurr and Powlesland 1997) indicating potential for these species to also consume cereal baits containing 1080.

Table N2: Birds known to consume cereal or carrot baits used in aerial 1080 operations: Summary

Species	Bait type eaten		Found dead after 1080 operation		Possible risk of secondary poisoning	1080 residues found in body tissues
	Cereal	Carrot	Cereal	Carrot		
Native species						
Kereru	?	yes	no	yes	?	yes
Kaka	yes	yes	no	yes	?	yes
Robin	yes	yes	no	yes	?	yes
Tomtit	yes	yes	?	yes	?	yes
Rifleman	?yes	?yes	?	yes	?	yes
Kea	yes	yes	no	yes	?	yes
Morepork	no	no	yes	yes	yes	yes
Weka	yes	yes	yes	?	yes	yes
Kiwi	?	yes	no	no	?	no
Whitehead	yes	yes	?	yes	?	yes
Fernbird	?yes	?yes	no	no	?	no
Yellowhead	?no	?no	no	no	?	yes
Falcon	no	no	no	no	yes	no
Pukeko	yes	yes	no	?	?	?
Kakariki	yes	yes	no	no	no	no
Brown creeper	?	?	no	no	?	no
Yellowhead	?	?	no	no	?	no
Grey warbler	?	?	?	yes	?	?
Fantail	?	?	?	yes	?	?
Silvereye	yes	yes	?	yes	?	?
Bellbird	?	?	no	no	?	no
Tui	?	?	no	yes	?	?
Kokako	yes	yes	yes	no	no	yes
Saddleback	yes	yes	no	no	no	no
Black-back gull	?	?	no	yes	yes	yes
Introduced species						
Blackbird	yes	yes	yes	yes	?	yes
Chaffinch	yes	yes	yes	yes	?	yes
song thrush	?	yes	?	yes	?	?
Dunnock	?	yes	?	yes	?	?
Redpoll	yes	yes	yes	yes	?	?
goldfinch	?	yes	?	yes	?	?
yellowhammer	?	yes	?	yes	?	?

Note: ? = uncertain or not assessed.

Other bait types

Cut apple

The attractiveness to native birds of prepared non-toxic apple baits has been evaluated in cage trials (Thomas et al 2003). Caged kaka, kea, kakariki, silvereye, weka, and kereru were presented with non-toxic carrot and apples baits (size 10–12 g), both of which were dyed green. The carrot bait was coated with 0.3% cinnamon oil and the apple bait with 0.3% orange oil (cinnamon oil turns apple brown, orange oil does not affect the green dye). Kereru ate neither bait type, while kaka, kea, kakariki and silvereye spent more time feeding on apple than carrot. Weka spent equal time feeding on the two bait types.

Carrot and apple were usual components of the birds' diets in captivity with the exception of weka (meat-based diet) and kereru (fruit only), which may bias the results of the study as the birds were already familiar with the bait materials. Given the uncertainty in the extrapolating to the field, the authors recommended that apple bait should only be used in bait stations.

Apple pastes and gel bait block

The palatability of two non-toxic fruit-based paste formulations (code BB13 = superceded formulation, old 'apple jam bait' known to be highly attractive to bees, native birds and bats, BB16 = an alternative formulation, similar to current) and non-toxic gel bait block to native birds has been assessed using both caged and wild birds (Morgan 1999).

Caged kaka (n=3), brown kiwi (n=2), kereru (n=4) and kakariki (n=5) were presented with the 100 g of gel block for 8 hours on each of two days. On separate days, they were presented with 100 g of two apple paste bait formulations. Samples of BB13 paste and gel bait block were placed on tree mounted platforms and on the ground at two sites on the edge of mixed beech forest at Bullock Creek, Paparoa National Park. At the field sites, bowls were observed for two hours after dawn and two hours before dusk each day for seven days. Baits were removed at night to prevent access by possums and rodents.

Of the captive birds, small amounts of the two pastes were eaten by kereru (mean 0.5 g of BB13 and mean 1.0 g of BB16) and kakariki (mean 1.3 g of BB13 and none of BB16). Caged weka ate larger amounts of BB13 (mean 19.6 g) than BB16 (mean 0.3 g), as did kaka (mean 8.7 g and 2.0 g respectively) as did kea (mean 5.1 g and 2.8 g) Brown kiwi consumed more BB16 (mean 17.9 g) compared with BB13 (mean 7 g).

Caged kaka, kereru and kakariki did not consume any of the gel bait while the weka and brown kiwi both ate small amounts (mean 0.1 and 0.4 g respectively).

At the field site, 16 species were observed near the baits but only five species approached within three metres of the bait bowls, on a total of 17 occasions. None of these five species (bellbird, fantail, tui, silvereye, kereru) actually investigated or ate the bait. A family of three weka was observed interacting and feeding on baits placed on the ground, and three robins were observed interacting with baits on the ground and on the platforms. The amount of bait consumed by these birds was not reported, but the weka spent approximately 15 minutes feeding/investigating each bait types, while the robins spent 30 seconds on the paste and 12 seconds on the gel.

The palatability of non-toxic 'improved BB3 apple paste' (stated as being Pestoff Professional paste, the currently approved paste base) to a range of native birds has been evaluated in the wild on Tiritiri-Matangi Island (Morgan et al 1997). Paste was dyed green and contained cinnamon. Baits (~10 g) were laid on upturned earth 'spits' at four locations on the island and birds observed from dawn to dusk for three consecutive days at each location, with frequency, duration of visit and time spent feeding on paste recorded. Additional study sites were also used to ensure that birds identified from earlier studies as likely paste-feeders were adequately represented, that is, robins on Tiritiri-Matangi Island; kereru at a private bush block in Otorohanga, weka in a semi-natural 50 metre by 50 metre enclosure at Karori Reserve, Wellington, and pukeko on farmland near Levin.

Of the 19 bird species observed near the general trial sites on Tiritiri-Matangi Island, seven species visited the baits, and only robins, saddlebacks and blackbirds were observed to visit more than once. Feeding occurred on 29% of visits by robins, 30% of visits by saddlebacks and 37% of visits by blackbirds.

When paste was deliberately placed within the known territories of 25 robins on the island 15 visited baits and 6 fed on baits, with two individuals making repeated visits. Robins were observed to probe the surface of the baits, with later examination of the baits showing a number of invertebrates trapped on the bait surface. A couple of robins were also seen removing bait from their feet having walked over it while foraging in the surrounding area. During the observation of these robins, tui, saddlebacks, whiteheads, bellbirds, fantails and blackbirds were also seen to visit the baits but did not feed.

As kereru are not usually ground-feeders, baits were placed on platforms but none were observed feeding on the paste.

Weka found the paste highly palatable in the enclosure trial and were observed readily feeding on baits during the trial at Karori. Responses of individuals were variable with one individual eating a whole 10 g bait in <2 minutes to a group of 21 weka taking ~ 30 minutes to eat one bait. Weka also remained interested in residues on paste on turf and soil after baits had been consumed.

Pukeko at Levin were observed for three days, and encountered baits 144 times with feeding observed on four visits, and baits probed 11 times. Other species which were observed at these baits included a farm dog, a heifer, sparrows and blackbirds. The dog and heifer were seen seeking out and feeding on the baits. On Tiritiri-Matangi Island pukeko made 44 visits to baits over four days but none were observed feeding.

Effect of lures and repellents on attractiveness and palatability

Cinnamon oil has been routinely added to cereal and carrot baits since the early 1980s to act as a deterrent to birds (Udy and Pracy 1981; Pracy et al 1982) and to mask the odour and taste of 1080 to possums (Morgan 1990). Orange oil is also effective at masking 1080 (Morgan 1990) and may be used for subsequent operations where cinnamon has been used previously and there is potential for a learned aversion to have developed in the possum population. Cinnamon oil at 0.15% has been reported to dissipate from baits after six weeks in storage, with 0.3% frequently used in Department of Conservation operations (Brown and Urlich 2005). At <0.1% cinnamon oil, possums can detect and avoid 1080 baits and at greater then 0.5% baits are less palatable to possums (Henderson and Frampton 1999 cited in Brown and Urlich 2005).

Other lures noted as being routinely used in significant quantities include spearmint and cloves (Additional info from applicants 22 December 2006). Raspberry, juniper, banana, rose and wintergreen were amongst a number of different 'flavours' used with 1080 pellets and 'jam baits' during the 1970s (and also cyanide pastes) and these were 'banned' from use after being identified as attractive to kiwi (Udy and Pracy 1981). Raspberry essence was also associated with high mortality of introduced birds in an aerial 1080 operation in 1977 using undyed cereal bait (Harrison 1978).

An investigation with captive rare birds at Mt Bruce National Wildlife Centre tested the effectiveness of 0.1% cinnamon oil as a bird repellent (Spurr 1993). The birds used in the trials were: Antipodes Island parakeet, *Cyanoramphus unicolor*; Reischek's parakeet, *C. novaezelandiae hochstetteri*; red-crowned parakeet, *C. novaezelandiae novaezelandiae*; kokako, *Callaea cinerea wilsonii*; North Island saddleback, *Philesturnus carunculatus rufusater*; North Island weka, *Gallirallus australis greyii*; North Island kaka, *Nestor meridionalis septentrionalis*. Birds were presented with non-toxic cereal or carrot bait, both plain and with cinnamon flavour. The Antipodes Island parakeets preferred carrot to cereal, kokako and saddlebacks preferred cereal to carrot, and the other birds showed no preference. Some individuals of all species ate baits with cinnamon but numbers of each species were small. Cinnamon deterred kaka, kokako and Antipodes Island parakeet for the first day only.

The Agency requested further information from the applicants on the current status of research on bird repellents for incorporation into/onto baits. (Refer to the Confidential Appendix to this report for the identification of the bird repellents trialled—restricted to Authority and Agency only because of the information's potential commercial sensitivity.)

The Animal Health Board (AHB) has funded a number of studies on the identification and use of bird repellents and provided two to the Agency. In the first study, a bird repellent which had previously been tested with caged possums and birds to assess palatability was applied to nominal 0.12% 1080 carrot baits (12 g) and sown across 1400 ha of Wharerino Forest, King Country at a rate of 3 kg/ha and without the bird repellent
1 over an adjacent 1000 ha (Clapperton et al 2005). Analysis of the toxic carrot indicated a lower-than-target concentration of 0.072% 1080 for the no-repellent trial block and 0.094% for the repellent trial block prior to application. Bait collected from the ground in the repellent block immediately after application contained 0.05% 1080, well below the target concentration. All bait used in the trials contained orange flavoured lure
2 and were dyed blue. Bird repellent was added at a nominal 0.2% during the coating of baits with 1080 and dye, measured at ~0.035% after baits had been sown (indicating less-than-adequate application of the repellent).

Numbers of territorial male tomtits were monitored along transects before
3 and after the operation in both blocks. While differences in tomtit disappearances (assumed to be deaths) were not statistically significant between blocks, the authors considered that there was a trend for a lower
4 rate in the repellent block. The RTCI values in the repellent block were 18.6 ± 2.7% pre- and 5.6 ± 1.2% post-operation; and in the no-repellent block 11.8 ± 2.3% pre- and 9.7±1.2%. Post-operative monitoring was delayed until February and may have impacted on the RTCI (the 1080 drop occurred in October 2004). The authors considered that the use of the repellent in this study had a positive impact on tomtit survival and may assist in allaying public concerns regarding deaths of non-target species. Lack of replication limits the conclusions which can be drawn from the study and further field trials were recommended. The AHB indicated that no further trials were undertaken and that the repellent was not to be used in their operations (P. Fairbrother, *in litt.* 19 February 2007).

A trial using the same repellent (P Fairbrother, personal communication, 19 February 2007) on Probait coated apple caused problems with possum palatability (Ross et al 2006). The trial compared 0.15% 1080 Wanganui No 7 cereal bait (12 g) with the treated apple (15–20 g), with both bait types hand-broadcast at 2 kg/ha in native beech forest and in pine plantation in the South Island. Birds feeding on baits were monitored by video.

The authors recommended that Probait coated apple not be used without a more effective bird repellent and that the repellent is not used at 1% w/w due to palatability issues. The reasons for choosing 1% repellent in this trial were not stated, though the authors included data from an earlier possum palatability trial indicating >50% palatability of Probait coated apple with repellent at either 0.04% or 0.20%. The measured 1080 concentrations in the bait was 0.13%, which didn't explain the poor possum kill achieved. If measured, the actual concentration of repellent on the bait was not reported. South Island robins were observed pecking at the apple bait more often than other bird species.

Probait appears to be an additive used with apple to assist with spreading and sticking of the 1080 stock solution and lure (orange flavour) to the apple, and also contains a preservative– the Agency does not know the composition of this additive, but Ross et al 2006 noted that Probait already contains a bird repellent so the use of an additional repellent at a high concentration (at least five times greater than in the carrot trial) may have had an effect on palatability to possums.

1 The AHB indicated that they considered the studies by Clapperton et al (2005) and Ross et al (2006) to have produced RTCI below target and that the repellent did not deter birds as effectively as they considered desirable and therefore are not considering the use of the bird repellent further. They also cited additional costs of the bird repellent not being supported by the benefits but did not provide any information on those costs (P. Fairbrother *in litt.* 19 February2007).

The Agency considers that further trials with the bird repellent may be warranted given the lack of replication and issues with monitoring possum indices noted in the trial on carrot. The less-than-target toxic loading on the carrot may also have had a role in the lower than expected RTCI, but this is speculation only.

N2.1.2 Primary v secondary poisoning of insectivorous birds

Many New Zealand birds feed on invertebrates and several authors (eg, Spurr 1999; Lloyd and McQueen 2000) have discussed the potential for secondary poisoning via ingestion of invertebrates which may contain 1080 residues from feeding on baits. Hegdal et al (1986) report several cases from the US where deaths of individual birds have been attributed to potential ingestion of ants containing 1080 residues although treated grain baits were also accessible to the birds.

Some birds, including tomtits and robins, may regurgitate food which is not digestible and/or toxic (Powlesland et al 2000) making it difficult to determine whether toxic bait or contaminated insects have been ingested. Information for two non-native insectivorous birds indicates short gut retention times of 10 minutes to two hours, with mean ~50 minutes (Levy and Karasov 1989, 1992, 1994, cited in Lloyd and McQueen 2000). The average time to death is generally >1 hour (McIlroy 1984). Analysis of tissues for 1080 residues can confirm poisoning but cannot be used to attribute the source of 1080.

Invertebrates have been recorded as more abundant on toxic baits at night
2 (Lloyd and McQueen 2001), and ingestion of sub-lethal doses may alter invertebrate behaviour resulting in abnormal daytime activity, and increased likelihood of ingestion by birds (McIntyre 1987; Hutcheson 1989). Residues in sub-lethally poisoned invertebrates decrease over time, in tree weta as shown in Table N1 (Eason et al 1993).

Addition of an effective bird repellent to baits may reduce the incidence of primary poisoning, and the use of an effective invertebrate repellent may