Appendix E: Monitoring of Environmental Media Following 1080 Operations

Note: This section includes largely field data collected during operations. Studies conducted under controlled conditions are included in Appendix C of the report.

Contents

List of tables

Key points

- The timing of sampling relative to an operation and the storage of samples before analysis is critical to interpretation of the results of monitoring.
- Deposition in streams occurs despite best practice. The significance of this is discussed in Appendix N.
- Several reports provide highly summarised results of water quality monitoring, for example, Booth et al (1997) provide collated results from 26 operations from 1990 to 1996. From those operations a total of 742 water samples were analysed, with 94.2% below the detection limit, and residues found in 5.8% of samples, mostly <1 µg/L, with a maximum concentration of 3.4 µg/L.
- Of the studies that provide more detailed information about type of bait, sowing rate, timing of water sampling relative to 1080 application, the highest concentration in water (0.6 µg/L) occurred within 3 hours of a rabbit control operation in winter and then declined to the limit of detection (0.3 µg/L) one day later (Hamilton and Eason 1994).
- Limited information is available on dust drift and it is not known how representative this information is. Bait specifications may need to be modified to reflect current best practice.

E1 Water-quality monitoring

A summary of water-quality monitoring data from the published literature and reviewed by the Agency is provided in Table E1. Only studies that provide some detail of the type of bait, sowing rate, and timing of water sampling relative to the 1080 application have been included.

Several reports provide highly summarised results, but these are less useful due to the lack of contextual information. For example, Booth et al (1997) provide collated results from 26 operations from 1990 to 1996. From those operations a total of 742 water samples were analysed, with 94.2% below the detection limit, and residues found in 5.8% of samples, mostly <1 µg/L, with a maximum concentration of 3.4 µg/L.

A value of 3.5 µg 1080/litre was reported from the Manganuiateao in 1996 (Eason et al, 1999).

Of the studies summarised in Table E1, the highest concentration in water (0.6 µg/L) occurred within three hours of a rabbit-control operation in winter and then declined to the limit of detection (0.3 µg/L) one day later (Hamilton and Eason 1994).

Requirements relating to water-quality monitoring are specified in conditions applied to permissions by the Ministry of Health (Appendix L).

Table E1: Results of water-quality monitoring following aerial 1080 operations

Location/date	Target species	Bait type, size; sowing rate; area treated	Number of sites and number of samples taken	Cumulative rainfall during sample collection period	Time between completion of operation and initial water sampling; duration of sampling period	Test results	Reference
Waipoua Forest Sanctuary Sept–Dec 1990	Possum	0.08% cereal (size not stated) 5–6 kg/ha ~17,000 ha	Six sites; 36 stream/river	348 mm over 4 months (92 mm in first month)	Immediately after operation; after first major rainfall and twice more over six weeks; then monthly for four months	<LOD (0.001 mg/L)	Eason et al 1992
Rangitoto Island Oct 1990 – April 1991	Possum Wallaby	0.08% cereal (size not stated) 14 kg/ha ~2,300 ha	Four sites; 24 surface and groundwater	459 mm over 6 months (110 mm in first month)	Not stated; twice in the first month, then monthly for six months	<LOD (0.001 mg/L)	Eason et al 1992
Mt Taranaki/Egmont Stage 1 May – July 1993 Stages 2 & 3 April – May 1994	Possum	0.15% cereal (size not stated) 5 kg/ha Stage 1: 17,190 ha Stages 2 & 3: 40,500 ha	Fifteen surface and groundwater, and 10 treated water supplies	Stage 1: ~2,100 mm over 3 months (~1,000mm in first month) Stage 2: ~1,250 mm over 3 months (~450 mm in first month)	Fifteen-minute samples on first day of drop, continuing for eight days at 'intensive monitoring' sites; samples composited daily into six-hour samples—analysis for 1080 and fluoride Sampling after significant rainfall events over a three-month period for each stage	All 1080 samples (n=162) <LOD, (LOD 0.0003 mg/L in stage 1; 0.0001 mg/L in stages 2&3) Eighteen samples (three from the control site outside the operational area) showed traces of 1080 <<0.0003 mg/L that were confirmed as contamination of sample containers No significant fluctuations observed in natural background fluoride concentrations (<0.5–0.2 mg/L) Water temperatures during sampling 4.9–13ºC stage 1 5.5–9.8ºC stage 2	Fowles and Williams 1997 TRC 1993, 1994

Location/date	Target species	Bait type, size; sowing rate; area treated	Number of sites and number of samples taken	Cumulative rainfall during sample collection period	Time between completion of operation and initial water sampling; duration of sampling period	Test results	Reference
Tararua Forest Park, June–Oct 1993	Possum	0.08% Wanganui No 7 cereal (5 g) 5.7 kg/ha ~1,050 ha	Eight sites ; 66 samples stream, groundwater and water supply holding tanks	739 mm over 6 months	2–6 hours for initial sampling in each catchment Sampling continued over a 120-day period	<LOD (0.0003 mg/L)	Meenken and Eason 1995
Blackstone Hill, central Otago July 2002	Rabbit	0.023% carrot (4 g) 16–60 kg/ha Sowing rate varied with rabbit density 3,970 ha total over five different sites	Four sites; 29 creek and watercourse; Some baits observed watercourses	30 mm; with snow lying in shaded areas at time of water sampling, melting shortly after the operation	One hour; sampling continued for 1 month	16 of 29 samples <LOD (0.0003 mg/L) Nine samples—trace Two samples from one stream 0.0006 mg/L one hour after treatment 0.0003 mg/L one day later Water temp 0ºC at time of sample collection; trace levels probably due to some carrot dropped into stream; samples frozen within five hours of collection	Hamilton and Eason 1994
Haupiri Forest near Kopara, West Coast April 2002	Possum	0.15% Wanganui No 7 (6 g) cereal 3 kg/ha	Four streams; water and sediment samples	Not stated; flood events reported between the operation and sampling at day 14	One day and 14 days after operation	All samples <LOD (0.0001 mg/L) Baits observed in streams but not counted Water temperature 9–11ºC on day of sampling	Suren and Lambert 2002

Location/date	Target species	Bait type, size; sowing rate; area treated	Number of sites and number of samples taken	Cumulative rainfall during sample collection period	Time between completion of operation and initial water sampling; duration of sampling period	Test results	Reference
Taranaki/Mt Egmont winter 2002	Possum	0.15% Wanganui No 7 cereal (6 g); green, cinnamon 5 kg/ha Lower Egmont (17,562 ha) 3 kg/ha Upper Egmont (15,928 ha) Streams used for water supply were not overflown below 600 m altitude.	Twelve water supply streams monitored above the intakes	Not stated	Day of operation and after first rainfall at each site, with timing chosen to maximise the chance of measuring contamination based on estimates of flow time from the upper catchment to the intake	All samples <LOD (0.0001 mg/L)	Ovenden and Merrifield 2003
Hutt water supply catchment July 2003	Possum	0.15% Wanganui No 7 (11 g) cereal 2 kg/ha 8,600 ha	Control site Weir Creek picnic area Kaitoki Intake Weir	Cumulative rainfall at two sites: 4 and 11 mm day 7 27 and 59 mm day 26 30 and 70 mm day 29 156 and 298 mm day 52 367 and 718 mm day 88	Day of operation and at days 7, 20, 30, 60 and 120	All samples <LOD (not specified)	Wright 2004

E1.1 Timing of water sampling

A recent sampling protocol (Wright 2001) prepared for the Department of Conservation (DoC), regional councils and medical officers of health sets out matters to be taken into consideration when sampling water bodies for 1080 after a pest control operation. These include the choice of sampling location and timing of sample collection, "Samples should be taken immediately after poisoning and continue daily until after the first significant rainfall reaches the site", along with the recommendation that the "sample timing should be decided by the local regional council hydrologist". Few of the monitoring programmes summarised below reported such frequent initial sampling, possibly because there was no regulatory requirement to do so (resource consent or Ministry of Health permission) or because of the cost of sample analysis (indicative costs: $238 per sample for 1–3 samples; 4–6 samples $181 per sample; more than 6 samples $161 per sample; with higher prices for urgent 24-hour turnaround (Wright 2001)). Bulking of samples, while expedient, may mask samples that do contain measurable amounts of 1080.

E1.2 Collection and storage of samples

In relation to environmental monitoring, the Agency notes the concerns about storage information discussed in Appendix C. For example, Eason et al (1994) (cited in Table E1) refer to water samples being frozen "within 5 hours" of collection, which seems a relatively long period before appropriate storage is carried out. Samples taken from a water intake might be expected to be analysed relatively quickly to allow water to be extracted again, which would reduce degradation before analysis.

E1.3 Deposition of baits in water bodies

Four 1080 operations were monitored for accidental deposition of baits into small streams within the treatment areas (Suren and Lambert 2004; Suren 2006). The streams were randomly selected and 100 m transects were surveyed in each stream. Observations of baits in streams were undertaken visually and location of baits recorded to the nearest metre. An underwater viewing tube was used to search the bottom of pools and turbulent areas. Counting included baits in the 'active' streambed. Canopy cover was also recorded but not presented in the report. Results from the sampling are summarised in Table E2. The initial assumption being tested was that baits would be evenly distributed along streams where baits were applied. Assessment of the data indicated that distribution of the baits was not uniform. The authors concluded that the expected number of baits deposited in a stream cannot be assessed from stream size or bait application rate. Nineteen streams had a similar number to those predicted. Sixteen streams had significantly more baits present than was predicted and 13 significantly less. The number of baits located was not related to either stream width or application rate. However, there was not a large difference in the sowing rates amongst the four operations. The greatest number of baits was found in the Awatere operation (2 g baits) and the least at Lewis Pass (12 g baits), which is not unexpected

given the greater number of small baits distributed per hectare (see Table E3) relative to the larger ones.

Suren (2006) suggested that the reason for so many non-detects in water monitoring programmes may be partly due to an absence of baits in the water body, but also a result of the rapid dilution or loss of 1080 from, and disintegration of, baits within the first 12 hours of deposition relative to the time of first sampling. The author recommends sampling within 4–8 hours of potential water contamination. Frequently resource consents require monitoring one day or more after completion of the operation (Southland and Taranaki Regional Council consent conditions, cited in Suren 2006).

Table E2: Deposition of baits in streams during aerial operations

Bait type, size (mean); sowing rate	Location Application rate	Number of streams surveyed; stream width	Number of baits found per 100 m			Reference
			Mean	Min	Max	
0.15% ('DoC' type unspecified); 12 g	Lewis Pass 2.5 kg/ha	20 0.5–5 m	4.8	0	15	Suren and Lambert 2004; Suren 2006
0.15% RS5 cereal 7.6 g	Mt Grey, Canterbury 2.6 kg/ha	8 2–6 m	12.7	2	21	
0.15% (type unspecified); 2 g	Awatere, Marlborough 2.5 kg/ha	9 1.2–6.5 m	23	7	38	
0.15% Wanganui No 7 cereal 6.4 g	Moana-Ruru, Grey Valley 3.0 kg/ha	11 1–5.5 m	7	0	19	
Not stated	Ashley Forest, Canterbury (not stated)	2 (not stated)	Kowhai River—21 baits found—nearby water sample 1 µg 1080/L Tributary of Bushy Creek—19 baits—nearby water sample 0.8 µg 1080/L			J Todd personal communication Suren 2006

Table E3: Sowing rates and bait distribution

Bait sowing rate	Size of bait (g) nominal weight	Number of baits	
		per hectare	per 10 m^2
2 kg/ha	2	1,000	1.00
	6	333	0.33
	9	222	0.22
	11	182	0.18
3 kg/ha	2	1,500	1.50
	6	500	0.50
	9	333	0.33
	11	273	0.27
30 kg/ha	2	15,000	15.00
	6	5,000	5.00
	9	3,330	3.30
	11	2,730	2.70

E1.4 Effect of 1080 ground-baiting on water quality

The Ministry of Health commissioned a study on the potential for ground-baiting with 1080 to impact on water quality (Meenken et al 2000).

In order to provide a worst-case estimate, 0.15% Wanganui No 7 bait (5 g) was hand broadcast at 10 kg/ha rather than the 3–5 kg/ha, which would normally be used for aerial application by the Wellington Regional Council at that time. In total, 150 kg of bait was applied to the catchment. The width of the riparian buffer was reduced from 20 m to 2 m, reducing the distance for potential surface runoff. An entire 14 ha steep catchment on stony soil was baited, with source of water from the stream predominantly surface inputs. Any carcasses or baits that entered the stream were left in place. Water sampling was undertaken directly after rainfall and at times when the highest 1080 concentration was anticipated to occur. The timing of the operation was in late spring, when stream water temperatures were likely to have been ~15ºC, rather than in winter with cooler temperatures. The catchment had previously been treated aerially with 1080 in 1995, 1996 and 1998.

One toxic bait was found in the stream 40 m upstream from the sampler on the day of application and is likely to have rolled downslope at the time of application. One possum carcass was also found in the stream on the morning after bait application, with its death attributed to 1080 poisoning, although no tissue samples were taken.

After bait application, water samples were collected by automatic sampler for 72 hours at 15-minute intervals, with the exception of the 12-hour overnight period following bait application, where samples were collected at 30-minute intervals. Rainfall started at 35 hours and continued for the remainder of the sampling period (85 mm cumulative rainfall over 37 hours). The first 40 mm of rain were largely absorbed by the soil, with remainder occurring as runoff. Due to costs of analysis, not all water samples were analysed. Sequential samples were aggregated in groups of three before analysis. Four individual samples collected at 15-minute intervals after the bait was observed in-stream were also analysed.

None of the water samples contained detectable quantities of 1080 at a detection limit of 0.1 µg/L for the individual samples and 0.3 µg/L for the aggregate samples. Two weathered baits collected after 85 mm of rain contained 0.013% and 0.018% 1080.

E2 Terrestrial environment

E2.1 Spillage of bait from bait stations

The spillage by possums feeding on RS5 cereal baits in a Kilmore bait station (300 g bait per station) and on gel bait placed in gel bait stations (300 g gel bait block) has been assessed in cage trials (Morgan 1999). Both bait types were non-toxic for the purposes of the trial. In total four possums ate 1,560 g of cereal pellets and 790 g of gel over eight nights.

On average, a greater amount of cereal bait was spilt than of gel bait (6.6% and 0.4% respectively).

E2.2 Bait capture in forest canopy

There is little, if any, current information on the proportion of baits that may end up lodged in the forest canopy where they may be consumed by birds and other non-target (or target) species.

An estimate of the number of screened baits lodging in a pine (*Pinus nigra*) plantation was 1–2 pieces/m^2 (Batcheler 1982) with all baits that remained in the canopy for at least one day weighing less than 4 g. The sowing rate was not specified but is likely to have been at the high end (eg, 30 kg/ha) given that the operation being monitored occurred in 1978 and high rates were relatively common practice at that time.

In a trial on Kapiti Island to assess the palatability of non-toxic carrot bait to kaka, 15% of bait more than 5 mm in size caught in canopy and dropped to the ground during 10 days after the drop (Lloyd and Hackwell 1993).

E2.3 Fate of dust from baits

Three aerial operations using cereal baits were monitored for dust drift in 1997 and 1998 (Wright et al 2002). The results are summarised in Table E4. Any baits or fragments more than 1 g were removed from the dust samples before analysis. The maximum deposition of 1080 falling in dust was 25.2 µg/m^2 on day 1 at Rangitaua. Residues in dust inside all treatment areas were significantly greater than outside at day 1, but not at day 5.

Water samples were taken from streams inside the treatment areas at Rangitaua and Whitecliffs, with two positive samples from five collected on day 1 at Whitecliffs (0.1 and 0.2 µg/L; LOD 0.1 µg/L). No information was provided on wind speed on the day of operation; whether a global positioning system was used to check flight paths and the accuracy of bait release. The main conclusion that can be drawn from Wright et al (2002) is that dust drift can occur over a considerable distance off-site (at least 1 km), although the concentrations of 1080 in dust are small. The degradation of 1080 in leaf litter under laboratory conditions is summarised in Table C8, Appendix C.

The Agency is not aware of any other studies reporting on dust drift from the aerial application of 1080 and it may be difficult to generalise to other situations. There is insufficient information to know whether other bait types or delivery buckets would create more or less dust. The authors in this study did not report the amount of dust collected after bait application, only the amount of 1080 per square metre of dust collector.

E2.3.1 Concentrations of 1080 in soil, leaf litter and small plants

Soil (the top 5 cm), leaf litter and small plants (under 30 cm high) were collected from the same locations as those from which dust was collected before (control) and 1, 5, 15 and 30 days after the operation. No 1080 was measured in any of the control samples. Full results of the soil sampling were not reported, other than to note that of 118 samples taken, six had 1080 residues, with trace levels at Whitecliffs inside the treatment area at day 1 and at Titirangi at day 5. Trace levels were found in 11 plant samples at Titirangi and Whitecliffs with mean values at or below the limit of analytical detection (LOD) (0.005 mg/kg). The maximum measured concentration was 0.014 mg/kg in a single sample on day 1 at Whitecliffs. It is unknown whether the residues in plants resulted from dust deposition or uptake from the soil, the authors attributed them to dust. Summary details are included in Table E4.

E2.4 Bait manufacturing to minimise dust and fines

A crush test is used as part of the standard quality control procedures to ensure cereal pellets are resistant to significant breakage when mechanically distributed. A protocol established between the Animal Health Board and DoC limits the amount of fines to less than 5% of the total weight of any bag. There are no manufacturing specifications for dust and fines in cereal baits (eg, screening of bait at the factory). Unless baits are mishandled during storage and transport after leaving the factory, the baits should remain as manufactured. New equipment and manufacturing processes indicate that occurrence of more than 1% fines (pieces less than 1 g) is rare (B Simmons, written communication, 14 January 2007).

Table E4: Concentrations of 1080 in dust and leaf litter from aerial application of 0.15% cereal baits

Application rate	Location and date of 1080 operation	Vegetation type	Bait quality measured prior to application	Location of dust collectors	Rainfall	Mean 1080 concentration	
						Dust (µg/m^2)*	Leaf litter (mg/kg)
5 kg/ha native forest 2 kg/ha young plantation helicopter MHL auger bucket	Rangataua Forest Park, southeast corner Tongariro National Park (2,000 ha) adjacent to young plantation forest August 1997	Mixed beech (*Nothofagus* spp.) semi-open canopy 10–15 m high Five-year-old *Pinus radiata* with tussock/sedge understorey	1.01% fines 0.18% 1080	Located in plantation outside treatment area	None on day of application with 6.9 mm over five-day period during dust collection	Inside treatment area Day 1: 3.81 Day 5: 0.1 Outside treatment area (day 1): 0.2 at 200 m, 0.06 at 1 km <LOD (not stated) at day 5	<LOD (0.005 mg/kg) in all locations, inside (n=24) and outside treatment (n=20) areas on all sampling dates (up to 30 DAT)
5 kg/ha Helicopter Wanganui Aeroworks own design (no further information)	Titirangi Reserve, (300 ha) near Mangaweka October 1997	Mixed podocarp, tight canopy to 10 m	1.16% fines 1080 content not assessed	On open spurs within treatment area and open hill pasture outside treatment area	5.5 mm on day of application; none in five days after	Inside treatment area Day 1 0.29 Day 5 0.1 Outside treatment area Day 1 none at 200 m–1 km Day 5, 0.11 at 200 m, 0.05 at 400 m, none at 600 m, 0.03 at 800 m, 0.13 at 1 km	0.023 at day 5 inside the treatment area (n=10) <LOD on all other sampling occasions.(n=34)
	Whitecliffs Forest, coastal, near New Plymouth (1,800 ha)	"Continuous forest" nikau and gorse, tight canopy <3 m	1.37% fines 0.16% 1080	In canopy and on semi-developed farmland outside treatment area	None for duration of study	Inside treatment area 2.22 (Day 1) 0.05 (Day 5) Outside treatment area Day 1 0.03 at 200 m 0.09 at 1 km Day 5 0 at 200–600 m 0.09 at 1 km	<LOD inside treatment area on all occasions (n=24); Day 1 0.0057 at 200 m Day 5 0.0058 at 200 m 0.0062 at 400 m 0.0053 at 600 m

Note

* Units as reported in text; amount of dust collected was not reported.

E3 Residues in biota

Residues in game are discussed in Appendix H.

The monitoring of residues in eels, aquatic plants and terrestrial plants is discussed in Appendix C.