NIWA
Taihoro Nukurangi

30 January 2009

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Dear Glen

STREAM MONITORING, LAKE MCRAE 1080 POSSUM CONTROL OPERATION

Please find the results of the recent 1080 monitoring we conducted for Alpine Pest Control as part of their resource consent application (U080124) for a 1080 possum control operation in the Molesworth - Lake McRae region. As you are aware, condition 5 of the original consent application required sampling of water, instream invertebrates, aquatic vegetation and leaf litter, with sampling to be undertaken within 24 hours of the operation being completed, and immediately following the next significant rainfall event. However, after consultation between you, Steffan Browning, Alpine Pest Control and myself, it was agreed to modify the original condition so that samples were collected within 4 – 8 hours after the helicopter had overflown a particular stream, and not to collect samples at a later date. This modification was in lieu of my recent research (Suren 2006) showing that 1080 leaches rapidly from submerged baits, and which recommended sampling 4 – 8 hours following application of bait within a catchment. These recommendations have also been echoed in a recent review article (Eason and Temple 2008). It was agreed to still collect samples of invertebrates and aquatic plants from each stream to determine whether any 1080 contamination had occurred in these organisms.

Methods

Water samples (250 ml) were collected at each site in sterile polypropylene plastic sample bottles. Each bottle was rinsed three times with stream water prior to collection of the final sample. Invertebrates were sampled in each stream using a kick net: a small triangular net into which invertebrates were collected following disturbance of the streambed. All material collected in the net was placed in white trays with water, and all invertebrates found were placed into small polypropylene containers. A wide range of invertebrates were collected from each stream, representing a range of different feeding modes:

- Shredders, which consume large organic matter particles such as leaf litter, and twigs;
- Filter feeders, which filter out small organic particles from the water column;
- Grazers, which consume thin algal layers on rocks;
- Predators, which consume other small invertebrates

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These different feeding modes are important to consider, as they represent different ways that invertebrates may become contaminated by 1080. For instance, shredders may consume particles of baits directly, while grazers may potentially become contaminated by 1080 if it was absorbed into algae or decaying vegetation. Predators may be exposed to 1080 by consuming other animals which have been contaminated. Care was taken to ensure that we selected both large and small invertebrates, and from representatives of all the different types found in each stream.

Plants were collected by scraping material off rocks with a sterile scalpel blade. The original consent condition stipulated collection of "aquatic vegetation and leaf litter", so this included aquatic mosses, algae, or decomposing leaf litter that was found in the stream margins. The only aquatic macrophyte found during the survey was *Glyceria,* at the outlet of Lake McRae. All plant material was placed in small polypropylene containers.

All samples were placed in a chilli bin and kept cool until frozen, within six hours following collection. All samples were kept frozen and sent to Landcare research for analysis of 1080. Copies of their lab reports have been appended.

At each site, stream discharge was estimated using methodology as outlined by Biggs et al. (1998). Stream width was also measured at five random locations. The presence of 1080 baits in each stream was also quantified by walking up 100 m length and scanning the streambed and banks for baits (see Suren 2006 for methods).

Results

A total of five streams were examined: three on the first day of operation, and two on the second. All streams were small (width < 6m) and had low discharges (mean = 0.75 m^3s^{-1}, ranges from 0.015 to 1.12 m^3 s^{-1}: Table 1). 1080 baits were found in all but one stream, with the most number of baits (8) in both Elliott stream, and the Lake McRae outlet (Table 1). Analysis of 1080 concentration showed that 1080 was detected in three of the five samples. However, in all cases the concentrations of 1080 detected were extremely low (0.001 µg / ml or less). Current Ministry of Health (MoH) guidelines set a 1080 concentration in drinking water of 0.002 µg ml^{-1}. The highest concentration detected in this monitoring program was half the current MoH guidelines for drinking water.

Table 1: Summary of stream conditions showing discharge, width, the number of baits found in 100 m sections, and the observed 1080 concentration. MDL = method detection limit (0.0001 µg ml^{-1}).

Site	Estimated discharge (m^3 s^{-1})	Width (m)	Number of baits in 100 m	1080 concentration (µg ml^{-1})
Elliot Stream	1.12	5	8	0.0004
Halfmoon Creek	0.91	4.6	0	<MDL
Rough Creek	1.10	6	4	0.0001
Gloucester Creek	0.63	2.8	3	0.001
Lake McRae Outlet	0.015	3	8	<MDL

The invertebrate fauna of the streams we sampled was typical of flood prone hill-country rivers, and was dominated by mayflies such as *Deleatidium*, filter-feeding caddisflies such as *Aoteapsyche*, stoneflies, and cased caddisflies (Table 2). Such a fauna is typical of relatively low-nutrient streams flowing through undeveloped catchments. Despite the finding of minute concentrations of 1080 in 3 of the streams, and observing baits in 4 of them, no 1080 was detected in any of the plant or invertebrate samples (see attached lab results). This was despite the wide range of invertebrates collected, and their wide range of feeding modes (Table 2), which would have maximised the chance of ingestion of 1080 from either algal layers, plant material, fragments filtered from the water, or other invertebrates.

Discussion

Positive detection of 1080 in 3 of the 5 water samples is not surprising, especially given that baits were observed in the streams, and that samples were collected within a suitable timeframe before all 1080 had leached from them. The majority of water sampling programmes conducted to date have collected samples 24 hours after application - and most of these have returned a negative result. Such negative results are not surprising given the rapid rate that 1080 is leached from baits (Bowen, et al. 1995; Suren 2006). Although 1080 was detected in 3 of the streams, the concentrations were low, with the highest being half the upper recommended limit set by the MoH for drinking water. Such small concentrations reflect the huge dilution that the 1080 would be exposed to. For example, the smallest stream (Lake McRae, with a discharge of 15 liters s^{-1}) would have discharged a total of 432 cubic meters (or 432 000 liters) of water over an eight hour period (the time taken for 1080 to leach from a bait). This would effectively dilute any 1080 to levels below recommended MoH levels, as observed in our results. Furthermore, 1080 is broken down by naturally occurring bacteria in water (Ogilvie et al. 1996), so any 1080 leaching into the streams would be broken down by natural processes. No more 1080 would be found in the water after a 24 h period, given its solubility from the baits, and its metabolism by bacteria. Suren and Lambert (2007) also found no evidence of long-term 1080 residues in stream water following experimental addition of up to 80 baits in a small West Coast stream. They found that 1080 concentrations peaked in the first 2 hours, and decreased to below detection levels within 12 h.

Research by Eason et al. (1999) and Eason and Turck (2002) found that 1080 is teratogenic, a male reproductive toxin and a myocardial toxin in rats. Such findings may fuel the ongoing debate about the potential toxicological effects of the use of 1080 in the environment. To help alleviate these concerns, an upper tolerable daily intake (TDI) of 0.03 $\mu g\ kg^{-1} d^{-1}$ for humans has recently been suggested (Foronda et al., 2007). Thus, a 80-kg adult would exceed this if they drank 10 litres of water with a 1080 concentration of 0.00024 µg ml-1. This concentration was exceeded by 2 of the water samples, so there is a theoretical possibility that an individual may be exposed to 1080 at concentrations exceeding the upper TDI level. However, the short time that 1080 is present in stream water for means that the chances of someone repeatedly drinking from a continually contaminated water source are remote.

There is also concern for potential contamination of ground and stream water by 1080 following aerial applications (see Eason and Temple 2008), even in small quantities, and this is currently being addressed by research at NIWA. This detailed research will involve detailed monitoring of the fate of 1080 in a catchment following aerial application, where multiple water samples at a particular stream catchment where 1080 has been applied will be collected. Such focussed research is outside the scope of standard monitoring conditions, which generally lack the temporal sensitivity or resolution to properly follow the fate of 1080 in a catchment.

Table 2. **List of invertebrate taxa found in each of the 5 streams, showing their feeding group and common names. Representative samples of these taxa were collected and analysed for residual 1080 following collection.**

Feeding Group	Taxa	Common name	Elliot Stream	Halfmoon Creek	Rough Creek	Gloucester Creek	Lake McRae Outlet
Grazer	*Deleatidium*	Mayfly	✓	✓	✓	✓	✓
	Helicospyche	Spiral caddisfly			✓		
Filter Feeder	*Coloburiscus*	Spiny gilled mayfly	✓				
	Aoteapsyche	Net-spinning caddisfly	✓	✓	✓	✓	✓
	Austrosimulium	Blackfly				✓	✓
	Pisidium	Pea clam					✓
Shredders	*Megaleptoperla*	Stonefly	✓		✓		
	Zelandoperla	Stonefly			✓		
	Zelandobius	Stonefly					✓
	Olinga	Horn-case caddisfly	✓				
	Pycnocentria	Stony-cased caddisfly	✓		✓		
	Tipulidae	Cranefly					
	Aphrophilia	Cranefly				✓	
Predator	*Archichaulioides*	Toe-biters		✓		✓	
	Psilochorema	Predatory caddisfly			✓	✓	
	Ceratopogonidae	Biting midge					✓
Browser	Oligochaeta	Worms					✓

Absence of 1080 in any of the stream invertebrate samples is not surprising, most likely reflecting a combination of the low number of baits in streams, and the inability of small invertebrates to consume either intact baits, or fragments. The possibility of invertebrates consuming 1080 baits has been discussed by Suren and Bonnett (2004), who concluded that this was extremely unlikely. The results of this monitoring support this conclusion. They did however suggest that the native crayfish, *Parenephrops* would be the only invertebrate capable of consuming the large 1080 baits. Although this animal did consumed 1080, which was found in its tail muscle (Suren and Bonnett 2004), they were highly resistant to 1080, as are other cold-blooded animals (McIlroy 1994). Suren and Lambert (2007) also examined the effect of 1080 on fish and invertebrate communities in four West Coast streams, and found no evidence of adverse effects, despite placing up to 10 times the amount of 1080 baits in a small area of stream that would occur following an aerial operation. They concluded that no long-term effects of 1080 would be possible to fish or invertebrate communities as a result of minute quantities of 1080 leaching from submerged baits as the chemical would not be present in the environment for long enough.

Recommendations

The results of this monitoring programme were not unexpected in that small traces of 1080 were detected in the stream water at three of the sites. However, concentrations were all very low, ranging from half to one twentieth the recommended MoH guidelines. No 1080 was detected in any of the stream invertebrates or plant material collected, highlighting the low degree by which it is taken up by these aquatic organisms. Given the recent research directed at the fate of 1080 in aquatic ecosystems (e.g., Suren 2006, Suren and Bonnett 2007, Suren and Lambert 2007, Ogilvie et al 1996, Lyver, Ataria et al. 2005) which generally show no demonstrable adverse effects on aquatic ecosystems, and even little chance of secondary poisoning if humans consumed 1080 contaminated eels or crayfish, it is suggested that the MDC not require on-going monitoring of 1080 in stream water or aquatic life following 1080 operations, as long as the operators applying it follow the current rules and regulations guiding its application. Suren and Lambert (2007) further suggested that councils dispense with placing buffer strips around water bodies, as this may reduce the cost-effectiveness of aerial 1080 operations, as areas of catchments would become no-drop zones, increasing the operational difficulty. Additionally, buffer zones around waterways may create refuge zones for the target species. Creation of such refuge zones may diminish the overall effectiveness of 1080 operations in specific areas. The only exception to this recommendation is that buffers should be maintained around huts, or around waters used for stock or human drinking water – not for any specific health requirements, but more from a public perception point of view.

I trust that you find these results satisfactory, and that you consider the relevance of future routine water quality monitoring programmes in lieu of recent research and of these latest findings. Any questions please get back to me.

Regards

A Suren

Alastair Suren

cc. Phil Packen
Steffan Browning

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