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WATER SAMPLING FOR SODIUM FLUOROACETATE

(1080) – HOW MUCH IS ENOUGH?

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National Possum Control Agencies

ABOUT NPCA

The National Possum Control Agencies was established in the early 1990s to help co-ordinate possum control. In November 2001 a constitution was approved that reaffirmed NPCA's aims and objects and the importance of co-ordination in possum control and vertebrate pest control in general.

OVERALL AIM

To provide a co-ordinating forum that will contribute to the effectiveness of all the agencies involved with the possum and vertebrate pest problem in New Zealand and to assist agencies with:

- protecting the farming industry from the effects of bovine Tb, and
- achieving conservation benefits and positive environmental outcomes.

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WATER SAMPLING FOR SODIUM FLUOROACETATE

(1080) – HOW MUCH IS ENOUGH?

A report prepared for the National Possum Control Agencies
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Beasley (1996) pointed out that theoretical routes of human exposure to 1080 might be through drinking contaminated water, ingestion of toxic baits, consumption of food contaminated by contact with bait, inhalation of bait dust or contact with 1080 solution by pest control operators and bait manufacturers. Of these the perceived most significant source of general public exposure is still considered, particularly by community groups, to be contamination of surface water in public water-supply catchments by aerially sown 1080 baits.

In the Drinking-Water Standards for New Zealand, issued in 2000 by the Ministry of Health (MoH), the provisional maximum acceptable value (PMAV) for 1080 in water is 3.5 parts per billion (ppb, μg/L). As a precautionary measure, the Ministry of Health also recommends that water taken from catchments sown with 1080 baits should not be used for human supply until tests show that the concentration of 1080 is below 2 ppb. It is apparent that the Model Permit Conditions (1995) are driving the monitoring practice as well as a requirement to ensure levels approaching the PMAV are not reached (DWS NZ 2005). Sampling protocols have then been influenced by research. In this short article we review the research on the fate of 1080 after aerial application of 1080 bait with a focus on water. There is a very extensive literature on 1080 and key aspects are summarised below prior to our analysis and conclusions. This provides the basis for considering appropriate approaches to future monitoring for 1080 residues in water after aerial application of 1080 for vertebrate pest control.

1080 is highly water-soluble (Parfitt et al. 1995) and may be leached from toxic baits into the soil. Some bait will fall into streams following aerial application, even when major water courses are avoided. Laboratory studies have shown that 1080 is biodegraded by aquatic plants and micro-organisms. Parfitt et al (1994) showed that 1080 was degraded in biologically active water in 2-6 days while Eason et al (1993) showed that 1080 declined by approximately 70% in 1 day and to below detectable limits in 4 days in aquaria containing plants and invertebrates. Research also shows that residues of 1080 do not persist in aquatic plants. Ogilvie et al (1996 and 1998) showed that warmer temperatures significantly enhanced the rate of 1080 degradation and that this was further enhanced in the presence of aquatic plants and microorganism. These laboratory studies have also shown that concentrations of 1080 in aquatic plants declined in parallel to the decline in concentration of 1080 in water (Ogilvie et al. 1995; Ogilvie et al. 1996; Booth et al. 1999), indicating degradation of 1080 within the plants. Some of these studies of 1080 breakdown in water and aquatic plants (Ogilvie et al. 1996; Booth et al. 1999) deliberately used solutions containing much higher concentrations of 1080 (0.12 to 5 ppm) than those that have been detected in streams during field monitoring (0.1 to 9 ppb) to simulate worst case scenarios.

Water monitoring of streams and waterways after aerial application of 1080 baits was initiated by research teams studying the fate of 1080 in soil, invertebrates and water (Eason et al. 1992 and 1993); it was continued in order to provide community re-assurance and evolved into routine practice by the mid-1990’s (MoH 1995). The results of the initial research and subsequent monitoring demonstrate that there has been no evidence of 1080 presence in reticulated water and no evidence of significant or prolonged 1080 contamination in surface waters (Parfitt et al. 1994; Eason et al. 1992; Eason et al. 1993; Hamilton & Eason 1994; Meenken & Eason 1995; Booth et al. 1997; Eason et al. 1999; Eason and Wright 2001; Wright et al. 2002). As summarised by Booth et al. (2007), 3.6% (76) of the water samples contained detectable 1080 residues and in most of them (69) the 1080 concentration measured was less than 1 ng/mL.

Of these 1973 samples analysed by Landcare Research, 136 were taken from reticulated town water supplies for household consumption and all these samples were free of detectable 1080 (Booth et al 2007). When 1080 was found in samples in monitoring programmes it was at very low concentrations in small streams in remote locations, and often baits were seen near where the samples were taken. The contamination was transient and not picked up in repeat samples. There is no evidence of 1080 being washed into streams after heavy rainfall. This is probably not surprising given the massive dilution effects which would occur after heavy rain.

More recent research by NIWA scientists involved deliberately spiking small streams with 1080 baits. They examined the ecological consequences of 1080 baiting in waterways and found none, and at the same time monitored the fate of 1080 (Suren and Lambert 2004; Suren and Bonnett 2006; Suren 2006; Suren and Lambert 2006). In these recent field experiments quantities of baits were deliberately placed in small streams < 3 meters wide. 1080 was only detected in the water for a short period (<24 hours). 1080 concentrations 10 meters downstream from the site where baits were added were higher than those 100 meters downstream illustrating the influence of dilution. The concentrations were below the Ministry of Health guidelines of 2 µg/L. It is noteworthy that the conclusions of those research groups involved in over a decade of monitoring of actual aerial control operations and the conclusions of the NIWA research team conducting a simulated exposure are very similar. Suren recommends that water samples should be taken within 8 hours after streams are potentially contaminated with bait which suggests that monitoring at subsequent time points after 1080 operations is likely to be of limited value. All the research groups report that when contamination does occur only low concentrations can be detected and these concentrations only occur in water for a short time. Even in small streams and in warm conditions dilution of 1080 will be more important than biodegradation since the dilution effect is immediate.

In practice Medical Officers of Health are faced with a complex array of legislation, guidelines and challenges when exercising their responsibilities in regards to authorisation of 1080 aerial operations and applying conditions for monitoring water quality. At the present time deciding on conditions to impose and an appropriate water monitoring strategy is an additional challenge for these professionals. In this regard the conclusions of the NIWA researchers on the duration of 1080 in water after deliberate spiking of streams are helpful. Suren's recommendation that water samples should be taken within 8 hours after streams are potentially contaminated with bait suggests that monitoring at subsequent time points after 1080 operations is likely to be of limited value. In conclusion there is a case for rationalisation of water monitoring based on the results of the recent NIWA research, limiting samples to the first 24 hours after an operation as a first step.

Sampling recommendation prepared by Landcare Research in the 1990's recommended that "*Because most samples are taken at timed intervals, it is important to ensure that sample times cover the most likely occurrence of 1080 in the stream/s. The data from previous monitoring programmes suggest those most positive samples and certainly the ones that have been above 1ng/mL (part per billion), have occurred in the first 2 days of sampling. Samples should be taken immediately after poisoning and continue daily until after the first significant rainfall water reaches the sampling site. Samples may also be taken before poisoning and from adjacent sites, to provide a check on the sampling process. This may be especially useful to eliminate cases of accidental sample contamination*."

These recommendations are now outdated and in any case reflected the research focus of the period. Updated recommendations have been prepared by Landcare Research which are now more appropriate.

"*Water samples taken within 8 hours of bait application are expected to provide the greatest likelihood of detecting any residual 1080. Ideally, sampling from the same relevant point on a waterway at 8 hours and again at 24 hours after bait application will be useful to confirm whether or not 1080 was present in detectable*".

More information about testing water for 1080 can be found at
www.landcareresearch.co.nz/services/laboratory/toxlab/protocol_water.asp

However, it is important that any move in this direction should not be perceived as an indication that current safety procedures are excessive. There are high performing operators in the industry who meet and exceed all the safety standards associated with 1080 and exercise due diligence and product stewardship not only in regard to handling baits but also in ensuring that the public health is protected. We recommend that any reduction in the extent of water monitoring needs to be accompanied by maintenance of the highest standards across the industry. All the organisations and companies involved in the aerial application of 1080 bait need to operate at the level of current exemplars. We also recommend that hydrological modeling of the fate of 1080 in catchments is undertaken to confirm the conclusions of Suren and co-workers. Recently new Tolerable Daily Intake (TDI) values of 0.03 μg/kg/day for humans have been proposed (Foronda et al 2007 a and b). It will be important to be able to demonstrate through a modeling approach that the TDI will not be exceeded after a standard aerial application amount of 1080, at 5 g per hectare during pest control programmes, and also to determine if there are any realistic circumstances (e.g. an accident with a sowing bucket) that might lead to the TDI being exceeded. The results of this modeling exercise, using real case studies should be used to further define whether there is a need for future water monitoring after aerial operations.

This short article has attempted to clarify the implications of water related research. In summary, research in the 1990s demonstrated that biodegradation could play an important role in the elimination of 1080 derived from baits and residues in waterways. There are two means by which any 1080 present in water will be reduced to undetectable and toxicologically insignificant amount:-

- i) Dilution.
- ii) biodegradation.

Even though substantial biodegradation can occur over the first 24 hours of 1080 entering water the effect of dilution will be immediate. In many situations dilution to undetectable concentrations is likely to occur before significant biodegradation. Water monitoring since 1990 has shown that significant water contamination is unlikely when safety procedures are adhered to. In the amounts used either in ground or aerial application exposure of individuals living near possum control areas is most unlikely to occur. When 1080 was found in samples in monitoring programmes it was at very low concentrations in small streams in remote locations, and often baits were seen near where the samples were taken. Research teams involved in water monitoring in the 1990s initially looked for 1080 in streams sometimes for several days, after rainfall and on occasion for some weeks after the application of baits. None of the monitoring work has picked up 1080 washed into streams after heavy rainfall. This is probably not surprising given the massive dilution effects which would occur after heavy rain. The contamination was transient. Research on bait degradation and the effects of soil micro-organisms indicate that 1080 from baits that are not eaten by pests is unlikely to migrate to streams in measurable quantities, particularly when dilution is combined with biodegradation. As indicated above if or when small amounts of 1080 enter streams then biodegradation is likely to be overshadowed by dilution even when conditions for biodegradation are favourable. If 1080 monitoring of small streams is to be undertaken then water samples should be taken within 8 hours after the streams are potentially contaminated. However when testing public water supply source water analyses need to demonstrate absence of 1080; hence sampling within and at 24 hours will be important.

Bibliography

Beasley, M. 1996: 1080 - overview of toxicology issues. In: Improving conventional control of possums: Proceedings of a workshop organised by the Possum and Bovine Tuberculosis Control National Science Strategy Committee, 25-26 October 1995, Wellington. (Royal Society of New Zealand: Wellington.) Pp. 15-17.Booth, L. H.; Ogilvie, S. C.; Wright, G. R.; Eason, C. T. 1997: Water quality monitoring after 1080 pest control operations. Water and Wastes in New Zealand 96: 22.

Bong, C. L., Cole, A. L., Walker, J. R., and Peters, J. A. (1979). Effect of sodium fluoroacetate (Compound 1080) on the soil microflora. *Soil Biology and Biochemistry* 11, 13-18.

Booth, L.H.; Ogilvie, S.C.; Wright, G.R.; Eason, C.T. 1997: Water quality monitoring after 1080 pest control operations. *Water and Wastes* 96: 22.

Booth, L.H.; Ogilvie, S.C.; Wright, G.R.; Eason, C.T. 1999: Degradation of sodium monofluoroacetate (1080) and fluorocitrate in water. *Bulletin of Environmental Contamination and Toxicology* 62: 34–39.

Eason, C. T., Wright, G. R., and Fitzgerald, H. 1992:. Sodium monofluoroacetate (1080) water-residue analysis after large-scale possum control. *New Zealand Journal of Ecology* 16, 47-49.

Eason, C.T., Gooneratne, R., Wright, G., Pierce, R., Framptom, C.M. (1993). The fate of sodium monofluoroacetate (1080) in water, mammals, and invertebrates. *Proceedings of 46th New Zealand Plant Protection Society Conference*: 297-301.

Eason, C.T.; Gooneratne, R.; Rammell, C.G. 1994: A review of the toxicokinetics and toxicodynamics of sodium monofluoroacetate in animals. Pp. 82–89 in Seawright, A.A.; Eason, C.T. (Eds): Proceedings of the science workshop on 1080. *The Royal Society of New Zealand Miscellaneous Series* 28.

Eason, C. T.; Wickstrom, M.; Turck, P.; Wright, G. R. G. 1999: A review of recent regulatory and environmental toxicology studies on 1080: results and implications. *New Zealand Journal of Ecology* 23: 129–137.

Eason, C.T., Wickstrom, M., Gregory, N. (1997). Product stewardship, animal welfare, and regulatory toxicology constraints on vertebrate pesticides. *Proceedings of 50th New Zealand Plant Protection Conference*: 206–213.

Eason, C.T., Wright, G. (2001). Water monitoring for contamination after aerial 1080 pest control operations: an update. *He Korero Paihama: Possum Research News* 16: 10–11.

Faronda, N., Fowles, J., Smith, N., Taylor, M., Temple.W and Darlington. C. (2007a) the use of myocardial and testicular end –points as a basis for estimating tolerable daily intake for sodium monfluoroacetate (1080). Regulatory Pharmacology and Toxicology 47: 29-36

Faronda, N., Fowles, J., Smith, N., Taylor, M., and Temple.W (2007b) A benchmark dose analyses for sodium monfluoroacetate (1080) using dichotomous toxicity data. Regulatory Pharmacology and Toxicology 47: 84-89

Hamilton, D. J.; Eason, C. T. 1994: Monitoring for 1080 residues in waterways after a rabbit-poisoning operation in Central Otago. *New Zealand Journal of Agricultural Research* 37: 195–198.

Meenken, D; Eason, C.T. 1995: Effects on water quality of a possum poisoning operation using toxin 1080 (sodium monofluoroacetate). *New Zealand Journal of Marine and Freshwater Research* 29: 25–28.

MoH 1995: Model Permit Conditions for the use of Sodium Monfluoroacetate (1080). Ministry of Health p.12

Ogilvie, S., Bowen, L., Eason, C.T. (1995). The effect of plant *Myriophyllum triphyllum* and temperature on the degradation of sodium monofluoroacetate (1080) in an aquatic ecosystem. *Proceedings of the 48th New Zealand Plant Protection Conference*: 260-263.

Ogilvie, S.C.; Hetzel, F.; Eason, C.T. 1996: Effect of temperature on the biodegradation of sodium monofluoroacetate (1080) in water and in *Elodea canadensis*. *Bulletin of Environmental Contamination and Toxicology 56*: 942–947.

Ogilvie, S.C.; Booth, L.H.; Eason, C.T. 1998: Uptake and persistence of sodium monofluoroacetate (1080) in plants. *Bulletin of Environmental Contamination and Toxicology 60*: 745–749.

Parfitt, R. L.; Eason, C. T.; Morgan, A. J.; Wright, G. R.; Burke, C. M. 1994: The fate of sodium monofluoroacetate (1080) in soil and water. *In*: Seawright, A. A.; Eason, C. T. *eds* Proceedings of the Science Workshop on 1080. *The Royal Society of New Zealand Miscellaneous Series 28*: 59–66.

Parfitt, R.L.; Eason, C.T.; Hoff, H.; Heng, L.K. 1995: Sodium monofluroacetate leaching through soil. *Bulletin of Environmental Contamination and Toxicology 55*: 162–169.

Rammell, C.G. 1993: Persistence of compound 1080 in sheep muscle and liver. *Surveillance 20(1*): 20–21.

Suren, A.; Lambert,P. 2004: the effects of 1080 on invertebrate communities and fish in West Coast streams. Unpublished NIWA report p.47.

Suren AM, Bonnett.T ML 2006. Consumption of baits containing sodium fluoroacetate (1080) by the NZ freshwater crayfish. *NZ Journal of Marine and Freshwater Research*, 2006, vol.40: 169-178

Suren AM, 2006. Quantifying contamination of streams by 1080 baits, and their fate in water. *NZ Journal of Marine and Freshwater Research*, 2006, vol 40: 159-167

Suren AM, Lambert P, 2006. Do toxic baits containing sodium fluoroacetate (1080) affect fish and invertebrate communities when they fall into streams? *NZ Journal of Marine and Freshwater Research*, 2006, vol. 40: 531-546

Twigg, L. E., and Socha, L.V. (2001). Defluorination of sodium monofluoroacetate by soil microorganisms from Central Australia. *Soil Biology and Biochemistry 33*, 227-234.

Twigg, L.E., King, D.R., Wright, G.E., Eason, C.T., and Bowen, L.H. (1996a). Fluoroacetate content of the toxic Australian plant genera, *Gastrolobium*, and its environmental persistence. *Natural Toxins 4*, 122-127.

Walker, J.R. (1994). Degradation of sodium monofluoroacetate by soil micro-organisms. In '*Proceedings of the science workshop on 1080'*. The Royal Society of New Zealand, *Miscellaneous Series 28*. (Eds A.A. Seawrigh, and C.T. Eason.) pp. 50-53. (SIR Publishing, Wellington, New Zealand.)

Wright, G. R.; Booth, L. H.; Morriss, G. A.; Potts, M. D.; Brown, L.; Eason, C. T. 2002: Assessing potential environmental contamination from compound 1080 (sodium monofluoroacetate) in bait dust during possum control operations. *New Zealand Journal of Agricultural Research 45*: 57–65.

Wright, G. R.; Manning L.M.; Fisher P.M 2003 Effects of aquatic palnts on the concentration of 1080 in water. Landcare Research Contract Report: LC0203/177 16 p.

Wong, D.H., Kirkpatrick, W.E., King, D.R., Kinnear, J.E. (1992). Defluorination of sodium monofuoroacetate (1080) by microorganisms isolated from Western Australian soils. *Soil Biology and Biochemistry 24*, 833-838.

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