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# Uptake of the Vertebrate Pesticide 1080 (Sodium Fluoroacetate) by Watercress, a Culturally Important Food Plant

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**ABSTRACT:** A field-based experiment was carried out to determine if watercress, commonly harvested by Māori, the indigenous people of New Zealand, could take up the vertebrate pesticide sodium fluoroacetate (Compound 1080), often applied aerially in New Zealand for the control of introduced vertebrate pests. Single toxic baits were placed within seven watercress stands, while three stands received non-toxic controls. Water and plant tissue samples were taken out to 17 days after bait placement, and samples analysed for 1080 content. 1080 was recorded from treatment watercress samples, with a maximum concentration of 63 ppb recorded on Day 7. Subsequent sampling did not show any 1080 in watercress tissue. It is concluded that there is a negligible secondary poisoning risk to humans via consumption of watercress after exposure to 1080.

**KEY WORDS:** Compound 1080, Māori, *Nasturtium microphyllum/officinale*, New Zealand, secondary poisoning risk, sodium fluoroacetate, vertebrate pesticide, watercress

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## INTRODUCTION

In New Zealand, the most extensively used vertebrate pesticide is sodium fluoroacetate (compound 1080) (Livingstone 1994; Morgan 1994a,b; Thomas 1994; Gillies and Pierce 1999; Powlesland et al. 1999; Sherley et al. 1999; Styche and Speed 2002), where it is most commonly utilised against possums (*Trichosurus vulpecula*) and rabbits (*Oryctolagus cuniculus*) (Livingstone 1994). Both species are invasive in New Zealand and cause considerable damage to native flora and fauna. Of further concern is that possums are also vectors for bovine TB, which is a threat to New Zealand's meat export industry (Hickling 1994, Morgan 1994a, Morgan and Milne 2002). To control these pests and keep bovine TB in check, aerial application of carrot or cereal baits containing 1080 is the most frequent method of deploying this pesticide (Eason et al. 2000), resulting in >90% reductions in possum population numbers (Eason et al. 1994, Veltman and Pinder 2001).

While aerial 1080 application is highly efficient at reducing possum population numbers, support amongst the general public of New Zealand varies widely, from being seen as a necessary tool, to strongly emotive opposition (Hansford 2009). Most resistance to the use of 1080 continues to be due to its apparent indiscriminate fate via aerial application (Ogilvie et al. 2010). In particular, the concerns of Māori, the indigenous people of New Zealand, regarding the fate of 1080 in wild harvested kai (food) species has been documented (Para 1999), with the risk of secondary poisoning to humans consuming kai resources from areas after aerial 1080 operations are carried out being identified as a key research area.

Atzert (1971) and Rammel and Fleming (1978) note that there is a possibility that after aerial control operations, 1080 leaching from baits may be taken up by nearby plants. Providing a further scientific base for these concerns, laboratory experiments have shown that 1080 can be taken up by aquatic plants, including the native New Zealand plant *Myriophyllum triphyllum* (Ogilvie et al. 1995), and *Elodea canadensis*, a species introduced to New Zealand (Ogilvie et al. 1996). Field-based manipulative experiments have also shown low concentrations of 1080 recorded from terrestrial plants, including karamuramu (*Coprosma robusta*), a native species used as medicine by Māori. However, no 1080 was recorded from pikopiko (*Asplenium bulbiferum*), a native species commonly consumed by Māori (Ogilvie et al. 2006).

Māori harvest a number of wild-growing plant species, both for kai and medicinal purposes. Watercress (*Nasturtium microphyllum/officinale*), is a kai resource of particular cultural significance. In some areas where watercress is harvested, the prevalence of bovine TB is thought to be increasing. To protect native flora and fauna, and New Zealand's meat export industry, the use of aerially applied 1080 to control possum numbers and thus TB is necessary. The aims of the following research were to investigate the uptake and persistence of 1080 leaching from cereal baits used for vertebrate pest control in watercress under natural field conditions, and to assess the toxicity risk to humans via consumption of watercress after exposure to 1080.

## METHODS

This field study was undertaken in a spring-fed stream

that feeds into the Kahutara River, inland Kaikoura, in the eastern coastal region of the South Island of New Zealand (E2550610, N5867300). The experiment was conducted in December 2008 in a spring-fed stream, overhung by exotic vegetation, primarily willows (*Salix* sp.). A 100-m section of the stream was selected for use, based on presence and abundance of watercress. Long grass and other plant species not identified were present at varying points and densities along the stream. The stream was not straight and contained boggy sections, with variable width and depth. The 100 m was divided into 10 even sections of 10-m length and numbered, with Section 1 corresponding to the first upstream section, and Section 10 the most downstream section.

In each section, a large stand of watercress with plenty of tissue growth for sampling was selected. A cylindrical wire-mesh cage, approximately 1 m high, constructed of "Weldfab" (1-mm-diameter wire, 10-mm<sup>2</sup> mesh) was inserted into these pre-selected stands of watercress to prevent bait floating away. A thin bamboo pole, 1.2 m high, with pink ribbon tied to the end for high visibility, was inserted in the centre of each cage. In the three upstream sections, a single non-toxic RS5 cereal bait was submerged below the water line in each cage; in the seven downstream sections, a single toxic RS5 cereal bait (0.15% 1080 by weight, Animal Control Products Ltd., Wanganui, NZ) weighing approximately 10 - 12 g, was placed below the water line in each cage.

Water temperature and pH were measured every half hour at the site using a YSI sonde field logger (YSI Inc., Yellow Spring, OH), deployed in the stream, at approximately 50 m along the 100-m section. Water velocity was measured in each section of the stream on each sampling day (1, 3, 7, 10, and 17), using a water velocity meter. Air temperature was measured every half hour for the study duration using a HOBO (Onset Computer Corp., Bourne, MA) set up next to a stand of bulrushes positioned approximately 4 m away from the stream, beside Section 1.

Both water and watercress plant tissue samples were taken at various time points. Water samples were taken at time 0, 15, and 30 minutes, and 1, 2, 7, and 14 hours after bait deployment, using plastic 250-ml bottles. In each section, the bottle was rinsed three times prior to sample collection. Water samples were collected from approximately 10 - 20 cm beneath the water surface, depending upon stream depth at the collection point. Bottles were filled to 2/3 of capacity. The water samples were collected immediately downstream from where the bait had been deployed. Control sections were sampled first, followed by treatment sections. Each bottle was labelled corresponding to section, and frozen on dry ice for delivery to the laboratory for 1080 analysis. Samples from the control sections (both water and watercress plant tissue samples) were placed in a separate cooler bin from that used for treatment samples.

Watercress tissue samples were taken at time 0 and 30 minutes, 1 hour, and 1, 3, 7, 10, and 17 days after bait deployment. At each of these times, 5 g of harvest quality leaf and stem from above the water line was removed from a plant within the selected watercress stand immediately downstream of the bait. Control sections

were sampled first, followed by treatment sections. Tissue samples were triple bagged in waterproof plastic ziplock bags, labelled corresponding to section, snap frozen on dry ice, and stored in the appropriate cooler bin for delivery to the laboratory, where all samples were stored at -20°C until analysed.

### 1080 Analysis

The 1080 concentration contained in all samples (both water samples and plant tissue) was quantified by gas chromatography, using methods modified from those developed by Ozawa and Tsukioka (1987). Each sample was homogenised in an alcohol/water mixture, deproteinised, centrifuged, filtered, and passed through an ion-exchange column. The eluent was acidified with hydrochloric acid and converted to the dichloraniline derivative, using dicyclohexylcarbodiimide and 2,4-dichloraniline. The derivative was extracted with ethyl acetate, cleaned with a silica column, and quantified by gas chromatography using electron capture detection. The limit of detection of this method in plant material is 3 ppb, and for water samples 0.1 ppb.

### RESULTS

Quality assurance analysis of baits showed a starting 1080 concentration of 0.17% (95% C.I.  $\pm$  9%), slightly higher than the 0.15% normally expected in baits of this kind. This was deemed to be within acceptable limits and therefore suitable for these study objectives. As this research was carried out in running stream water, cereal baits deteriorated rapidly and were not visible after 24 hours.

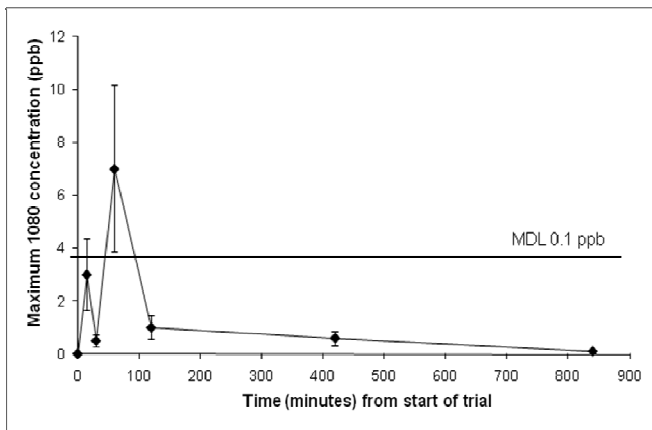
Over the 17-day duration of the experiment, mean daily air temperature ranged from 11 - 20°C; mean water temperature ranged from 13.8 - 14.9°C; and mean daily pH 7.3 - 8.2. Rainfall occurred on three occasions – Day 1 (11 mm), Day 4 (1 mm), and Day 9 (9 mm).

A total of 70 water samples were taken. No 1080 was detected from any of the 21 water samples taken from the three control sections. Measurable levels of 1080 were detected in 18 of the 49 treatment water samples. 1080 was first detected 15 minutes after bait deployment (3 ppb). 1080 concentration peaked at 7 ppb at 1 hour. The minimum 1080 concentration detected was 0.1 ppb at 14 hours, equivalent to the Method Detection Limit (MDL) for water (95% C.I.  $\pm$  45%) (Figure 1).

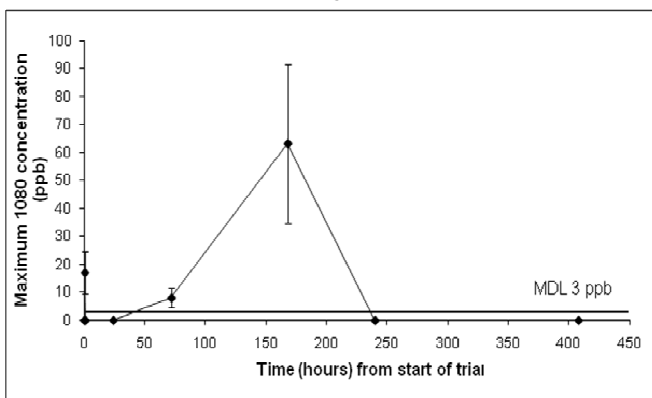
A total of 80 watercress plant tissue samples were taken. 1080 was not detected in any of the 24 tissue samples taken from the three control sections. 1080 was detected three times from the 56 treatment samples – at 30 minutes after bait deployment (17 ppb) in Section 9; on Day 3 (8 ppb) in Section 10; and maximum 1080 concentration (63 ppb) was detected on Day 7 in Section 8 (95% C.I.  $\pm$  45%). All readings after this were below the MDL, indicating 1080 had been eliminated (Figure 2).

### DISCUSSION

Visual inspections of the baits, while not quantifiable, gave an indication of the rate of deterioration in flowing stream water. As expected, rapid deterioration occurred, as 1080 is known to be highly water soluble (Booth et al. 1999, Eason et al. 1992, Meenken and Eason 1995).



**Figure 1. Maximum 1080 concentration (ppb) seen from water samples over the study duration (95% C.I. ± 45%).**



**Figure 2. Maximum 1080 concentration (ppb) seen from watercress tissue samples over the study duration (95% C.I. ± 45%).**

Mean daily water temperature recorded from the stream did not vary greatly. The stream is spring-fed with much overhanging vegetation providing shade; therefore, external environmental conditions would have had little effect on water temperature. No change in water temperature was associated with the three rainfall events recorded.

1080 was first detected in water samples 15 minutes after the addition of toxic baits, and peaked 1 hour later, in Section 8. Levels of 1080 decreased rapidly from water after 1 hour, and by 2 hours were below the Ministry of Health's (MoH) Maximum Acceptable Value (MAV) of 3.5 ppb, indicating the water was safe to consume. At 14 hours, 1080 was detected at a low level equivalent to the MDL (0.1 ppb), in a single water sample. The 1080 was most likely diluted to low concentrations through mixing with the stream water or was possibly degraded by microorganisms and bacteria present in the water and stream bed (Booth et al. 1999, Eason et al. 1992, Meenken and Eason 1995, Ogilvie et al. 1995, 1996). These findings correspond well with previous research where small streams <3 m wide were deliberately spiked with 1080. 1080 was detected in the water for <24 hours, and concentrations 10 m downstream from the site where baits were added were higher than those 100 metres downstream, illustrating the influence of dilution (Suren and Lambert 2004, 2006, Suren and Bonnett 2006, Suren 2006).

This is the first time that watercress tissue has been analysed for 1080 content. 1080 did not occur in any of the control samples, indicating it does not occur naturally in watercress. Of the watercress plant tissue samples from the treatment sections, only three showed 1080 at detectable levels (above 3 ppb). Of these, the maximum 1080 concentration was detected in Section 8, the same place where 1080 concentration peaked in the water samples. It is possible that fragments of baits from upstream sections may have accumulated here, exposing watercress in this section to greater levels of 1080 than plants in other sections. 1080 was not detected in any watercress treatment samples after Day 7. Concentrations of 1080 detected here were comparable to that seen in experiments investigating 1080 uptake in the native New Zealand aquatic plant *Myriophyllum triphyllum*, (25 ppb) (Ogilvie et al. 1995), and the non-native aquatic plant *Elodea canadensis* (80 ppb) (Ogilvie et al. 1996).

Harvestable watercress refers to plant stem and leaves above the water line. All watercress samples taken here were of harvestable plant tissue. Samples were taken immediately downstream and as close as possible to where bait had been placed. For 1080 to be detected in these tissue samples, it first had to leach from the baits into the water, enter the plant below the water line and move through the plant to the upper harvested tissue, explaining the lag time seen between 1080 appearing in the water samples, and appearing some time later in the watercress tissue samples. The appearance of 1080 in the tissue samples would also depend upon individual plant uptake rates. After Day 7 no 1080 was detectable in tissue samples, showing a rapid uptake and elimination of this compound from watercress.

### Assessment of Toxicity Risk to Humans

The LD<sub>50</sub> of 1080 for humans is 2 mg/kg (Rammell and Fleming 1978). For a 70-kg person, this is equivalent to a dose of 140 mg. The maximum concentration of 1080 measured in the watercress was 63 ppb, or 0.000063 mg/g. The amount of watercress that would contain 140 mg of 1080 is 2,222,220 g (2.2 tonnes). A 70-kg person would therefore have to consume 2.2 tonnes of affected watercress to receive an LD<sub>50</sub>, or a 50% chance of dying from 1080 poisoning. Consuming this amount of watercress is not possible, and added to this fact, watercress is often washed and/or boiled in water before consumption, further decreasing the chances of secondary poisoning risk to humans. The risk of mortality from consuming 1080-affected watercress would therefore have to be considered negligible, based on results presented here.

In summary, this research showed that watercress can take up and eliminate 1080 introduced from an external source. However, the toxicity risk to humans via consumption of watercress that has taken up 1080 is likely to be negligible.

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## LITERATURE CITED

- ATZERT, S. P. 1971. A review of sodium monofluoroacetate (Compound 1080), its properties, toxicology, and use in predator and rodent control. Special Scientific Report – Wildlife 146. Bureau of Sport Fisheries and Wildlife, US Fish & Wildlife Service, Dept. of the Interior, Washington DC. 34 pp.
- BOOTH, L. H., S. C. OGILVIE, G. R. WRIGHT, and C. T. EASON. 1999. Degradation of sodium fluoroacetate (1080) and fluorocitrate in water. *Bull. Environ. Contamin. Toxicol.* 62:34-39.
- EASON, C. T., C. M. FRAMPTON, R. HENDERSON, M. D. THOMAS, and D. R. MORGAN. 1994. Sodium monofluoroacetate and alternative toxins for possum control. *NZ J. Zool.* 20:329-334.
- EASON, C. T., B. WARBURTON, and R. HENDERSON. 2000. Toxicants used for possum control. Chapter 14 (Pp. 154-163) *in*: T. L. Montague (Ed), *The Brushtail Possum*. Manaaki Whenua Press, Lincoln, N.Z. 292 pp.
- EASON, C. T., G. R. WRIGHT, and H. FITZGERALD. 1992. Sodium monofluoroacetate (1080) water-residue analysis after large-scale possum control. *NZ J. Ecol.* 16(10):47-49.
- GILLIES, C. A., and R. J. PIERCE. 1999. Secondary poisoning of mammalian predators during possum and rodent control operation at Trounson Kauri Park, Northland, New Zealand. *NZ J. Ecol.* 23:183-192.
- HANSFORD, D. 2009. 1080. *NZ Geographic* 97: 52-63.
- HICKLING, G. J. 1994. Behavioural resistance by vertebrate pests to 1080 toxin: Implications for sustainable pest management in New Zealand. *Proc. Science Workshop on 1080. The Royal Society of NZ Miscell. Series* 28:151-158.
- LIVINGSTONE, P. G. 1994. The use of 1080 in New Zealand. *Proc. Science Workshop on 1080. The Royal Society of NZ Miscell. Series* 28:2-6.
- MEENKAN, D., and C. T. EASON. 1995. Effects on water quality of a possum (*Trichosurus vulpecula*) poisoning operation using toxin 1080 (sodium monofluoroacetate). *NZ J. Marine and Freshwater Res.* 29:25-28.
- MORGAN, D. R. 1994a. Improved cost-effectiveness and safety of sodium monofluoroacetate (1080) possum control operations. *Proc. Science Workshop on 1080. The Royal Society of NZ Miscell. Series* 28:144-150.
- MORGAN, D. R. 1994b. Improving the efficiency of aerial sowing of baits for possum control. *NZ J. Agric. Res.* 37:199-206.
- MORGAN, D. R., and L. MILNE. 2002. Cholecalciferol-induced bait shyness in possums (*Trichosurus vulpecula*). *Int. J. Pest Manage.* 48:113-119.
- OGILVIE, S. C., J. M. ATARIA, J. WAIWAI, J. DOHERTY, M. LAMBERT, N. LAMBERT, and D. KING. 2006. Uptake and persistence of the vertebrate pesticide, sodium monofluoroacetate (Compound 1080), in plants of cultural importance. *Ecotoxicol.* 15:1-7.
- OGILVIE, S. C., L. H. BOWEN, and C. T. EASON. 1995. The effect of the plant *Myriophyllum triphyllum* and temperature on the degradation of sodium monofluoroacetate (1080) in an aquatic ecosystem. Pp. 260-263 *in*: *Proc. 48<sup>th</sup> NZ Plant Protection Conference*.
- OGILVIE, S. C., F. HETZEL, and C. T. EASON. 1996. Effects of temperature on the biodegradation of sodium monofluoroacetate (1080) in water and in *Elodea Canadensis*. *Bull. Environ. Contam. Toxicol.* 56:942-947.
- OGILVIE, S. C., A. MILLER, and J. M. ATARIA. 2010. There's a rumble in the jungle: 1080 – poisoning our forests or a necessary tool? *In*: R. Selby, P. Moore, and M. Mulholland (Eds.), *Maori and the Environment: Kaitiaki*, Huia Publishers, Auckland, N.Z.
- OZAWA, H., and T. TSUKIOKA. 1987. Gas chromatographic determination of sodium monofluoroacetate in water by derivitization with dicyclohexylcarbodiimide. *Analytical Chem.* 59:2914-2917.
- PARA, D. 1999. A Māori perspective of pest control from within DoC. *Proceedings, Manaaki Whenua Conference, Lincoln, New Zealand, 21 March 1999*. Landcare Research, Lincoln, N.Z. pp. 1-7. [www.landcareresearch.co.nz/news/conferences/manaakiwhenua/proceedings.asp](http://www.landcareresearch.co.nz/news/conferences/manaakiwhenua/proceedings.asp).
- POWLESLAND, R. G., J. W. KNEGTMANS, and I. S. J. MARSHALL. 1999. Costs and benefits of aerial 1080 possum control operations using carrot baits to North Island Robins (*Petroica australis longipes*), Pureora Forest Park. *NZ J. Ecol.* 23:149-159.
- RAMMEL, C. G., and P. A. FLEMING. 1978. Compound 1080. Properties and use of sodium monofluoroacetate in New Zealand. *NZ Ministry of Agriculture and Fisheries, Animal Health Division, Wellington, N.Z.* 112 pp.
- SHERLEY, G., M. WAKELIN, and J. MCCARTNEY. 1999. Forest invertebrates found on baits used in pest mammal control and the impact of sodium monofluoroacetate ("1080") on their numbers at Ohakune, North Island, New Zealand. *NZ J. Zool.* 26:279-302.
- STYCHE, A., and H. SPEED. 2002. Rodent bait preferences in non-target birds. *Internal Series 40, Department of Conservation, Wellington, N.Z.* 12 pp.
- SUREN, A. M. 2006. Quantifying contamination of streams by 1080 baits, and their fate in water. *NZ J. Marine and Freshwater Res.* 40:159-167.
- SUREN, A. M., and M. L. BONNETT. 2006. Consumption of baits containing sodium fluoroacetate (1080) by the NZ freshwater crayfish. *NZ J. Marine and Freshwater Res.* 40:169-178.
- SUREN, A. M., and P. LAMBERT. 2004. The effects of 1080 on invertebrate communities and fish in West Coast streams. *National Institute of Water and Atmospheric Research Ltd. (NIWA) Client Report CHC02/38, Unpublished.* 47 pp.
- SUREN, A. M., and P. LAMBERT. 2006. Do toxic baits containing sodium fluoroacetate (1080) affect fish and invertebrate communities when they fall into streams? *NZ J. Marine and Freshwater Res.* 40:531-546.
- THOMAS, M. 1994. Possum control in native forest using sodium monofluoroacetate (1080) in bait stations. *Proc. N.Z. Plant Protect. Conf.* 47:107-111.
- VELTMAN, C. J., and D. N. PINDER. 2001. Brushtail possum mortality and ambient temperatures following aerial poisoning using 1080. *J. Wildl. Manage.* 65:476-481.