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Consequences of slow 1080 breakdown in water in cold conditions.

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Executive Summary

In relation to the use of sodium fluoroacetate (1080) as a pesticide its environmental fate and persistence have been extensively studied in New Zealand and Australia. In this short report we review the fate and breakdown characteristics of 1080 in water and assess the relative contribution that the metabolism and dilution of 1080 makes to the environmental safety of 1080 use. The influence of temperature on the fate of 1080 and the potential risks that may be linked to colder conditions are addressed

Between 1990 and 2003, water monitoring programmes were undertaken after numerous large-scale possum control operations. The analyses of water samples from these surveys show that 1080 does not occur in reticulated water and no significant or prolonged 1080 contamination in surface waters occurs after 1080 use. In complementary field trials when possum baits were deliberately added to small streams < 3 metres wide, 1080 was only detected in the water for a short period (<24 hours). Concentrations were low and below the Ministry of Health's guidelines of 2 µg/L 1080 concentrations 10 metres downstream from the area where baits were added were higher than those 100 metres downstream illustrating the considerable influence of simple dilution. A series of laboratory studies have shown that 1080 can also be biodegraded by aquatic plants and micro-organisms. The rate of breakdown is temperature-dependent. The biological breakdown of 1080 occurs more rapidly at higher temperatures, and slowly at lower temperatures.

It is apparent that there are two means by which any 1080 present in water will be reduced to undetectable and toxicologically insignificant amounts:-

i) dilution.
ii) biodegradation

In practical terms even in small streams and in warm conditions dilution of 1080 will as important, if not more important than biodegradation since the effect is immediate. In most situations dilution to undetectable concentrations is likely to occur before significant biodegradation Hence, potential public risk from such exposure is very low or nonexistent.

In summary 1080 in the amounts and concentrations used in aerially sown baits does not persist in the environment. Water monitoring since 1990 has shown that significant water contamination is unlikely when safety procedures and directions for use are adhered to. In the amounts used either in ground or aerial application in New Zealand, exposure of humans living near possum control areas is most unlikely to occur if adequate safety procedures are adhered to Cold weather conditions will not significantly influence the risk of human exposure to 1080 via drinking water as dilution of 1080 residues in waterways will still occur, and is considerable.

Introduction

Sodium fluoroacetate (1080) has been used in New Zealand for pest control since the 1950s. Literature relating to the fate and breakdown characteristics of 1080 in water has been reviewed by Dr Charles Eason, Dr Laurie Twigg and Dr Wayne

Temple in response to a request from the Animal Health Board. The review was completed in May 2007. 1080 is highly water-soluble (Parfitt et al. 1995) and may be leached from toxic baits into the environment, and baits will fall into streams following aerial application Beasley (1996) pointed out that theoretical routes of human exposure to 1080 might be from drinking contaminated water, ingestion of toxic baits, consumption of food contaminated by contact with bait, or by inhalation of bait dust or contact with 1080 solution by pest control operators and bait manufacturers Bait consumption is theoretically possible but would constitute an exceptional event, and 1080 does not persist for long in sub-lethally exposed livestock so ingestion in food is unlikely (Rammell 1993; Eason et al 1994). Contamination of meat and milk with 1080 are considered to be rare incidents. Furthermore environmental contamination from dust following aerial possum control has been shown to be minimal and short lived with minimal residues detected after 5 days after an aerial application (Wright et al 2002). Hence the perceived most significant source of general public exposure is considered to be contamination of surface water in public-water-supply catchments by aerially sown 1080 baits.

Communities throughout New Zealand have expressed concern with regard to their potential exposure to the toxin through drinking water. 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, MoH 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. In this report we review the fate of 1080 after possum control with a focus on water. There is a very extensive literature on 1080 and key aspects are summarized below prior to our analyses and conclusions.

Objectives

To define i) the fate of 1080 and its breakdown characteristics relative to environmental and human safety ii) the relative contribution of dilution and biodegradation to the fate of 1080 in the environment iii) potential additional risks that may be linked to colder conditions.

Monitoring of 1080 in Waterways

Since 1990, in response to community concerns with regard to potential exposure to 1080, water monitoring programmes have been undertaken after numerous possum control operations and one large-scale rabbit control operation using aerially sown 1080 baits (Green 2003). 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; Hamilton & Eason 1994; Meenken & Eason 1995; Booth et al. 1997; Eason et al 1999; Wright et al. 2002). Concentrations of 1080 close to the limit of detection (0.1 µg/L) have been found in approximately 3.5% of over 1649 water samples (Green 2003) These occurrences have been transient and have usually been associated with the visible presence of baits in small streams. Of the 1649 samples analysed, 107 were taken from reticulated town water supplies and all these samples were free of detectable 1080.

Recent research by NIWA involved deliberately spiking small streams with 1080 baits. 1080 could only be detected in streams deliberately spiked with 1080 baits for a short duration (<24 hours). The concentrations were below the Ministry of Health guidelines of 2 µg/L and were consistent with earlier findings in that the concentrations were lower 100 metres below the test site than they were 10m below where the baits were added (Suren and Lambert 2004)

It is noteworthy that the conclusions of those research groups involved in over a decade of monitoring of actual control operations and the conclusions of the NIWA research team conducting a simulated exposure are very similar. 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

Effects of Temperature on Breakdown

Baits on the ground will eventually breakdown and a number of studies in New Zealand and overseas (e.g. Australia) have showed that a number soil bacteria and fungi are very capable of degrading 1080 into harmless products. The ubiquitous fungus, Fusarium oxysporum, is the most prolific detoxifier identified to date (Bong et al. 1979; Walker 1994; Wong *et al* 1992; Twigg and Socha 1996). However, the activity of these degrading microorganisms can depend upon adequate moisture and temperature levels in the soil (Parfitt *et. al* 1994; Twigg and Socha 2001).This further adds to the environmental safety of using 1080 products

A series of laboratory studies have shown that 1080 could also be 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. Ogilvie et al (1996 and 1998) showed that temperature significantly enhanced the rate of 1080 degradation and that this was further enhanced in the presence of aquatic plants and microorganism. The biological breakdown of 1080 occurs more rapidly at higher temperatures. 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. 1996; Booth et al 1999), indicating degradation of 1080 within the plants. These laboratory studies suggest that 1080 could be degraded by aquatic plants and micro-organisms when small amounts enter waterways, and that the rate of degradation would be temperature-dependent, occurring more rapidly at higher temperatures, but still occurring within 1–2 weeks at 11°C (Ogilvie et al. 1996).

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 water during field monitoring (0.1 to 9 ppb) to simulate worst case scenarios. In a laboratory study reported by ~~Fisher~~ Wright et al 2003 the effects of an aquatic plant on the degradation of 1080 were determined in solutions containing lower 1080 concentrations In this study concentrations declined quickly within 24 hours both in water and in plant material but uptake by plants was slower below 15°C.

In summary, these studies indicate that biodegradation could play an important role in the elimination of 1080 derived from baits from waterways However as indicated above biodegradation is likely to be overshadowed by dilution even when conditions for biodegradation are favourable. Some concerns have been expressed that 1080 might accumulate in aquatic plants and these could be a source of persistent contamination The research shows that residues of 1080 do not persist in aquatic plants.

The amount of 1080 used during pest control programmes in New Zealand is less than 5 g per hectare. This is much less than the natural levels of fluoroacetate (1080) which occur in areas of Western Australia which contain fluoroacetate-producing plants (estimated amounts range from 200 to > 550 g per ha). Thus to examine a worst case scenario, New Zealand researchers undertook a collaborative study with the Western Australians to further demonstrate the environmental fate and safety of 1080. 1080 content was determined in the 1080-containing plants, soil underneath these plants, nearby streams and reservoirs for four main catchment dams with considerable fluoroacetate-bearing vegetation present. No 1080 was detected in any water sample, and it was only found at very low levels in 1 of 9 soil samples even though these were collected directly underneath the toxic plants. The plants, however, were shown to contain considerable amounts of fluoroacetate (1080 – Twigg et al 1996). This extreme example, relative to baiting campaigns in New Zealand, demonstrates that 1080 does not accumulate in the environment.

Conclusions

It conclusion there are two means by which any 1080 present in water will be reduced to undetectable and toxicologically insignificant amount:-

iii) dilution.
iv) biodegradation

One of the processes is temperature dependent and the other is not. In streams rapid dilution of 1080 will be more important than biodegradation, particularly in cold conditions. 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 signicant 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. Cold weather conditions will not significantly influence the risk of human exposure to 1080 via drinking water since dilution of 1080 residues to undetectable concentrations in waterways will occur with or without biodegradation processes playing a role.

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