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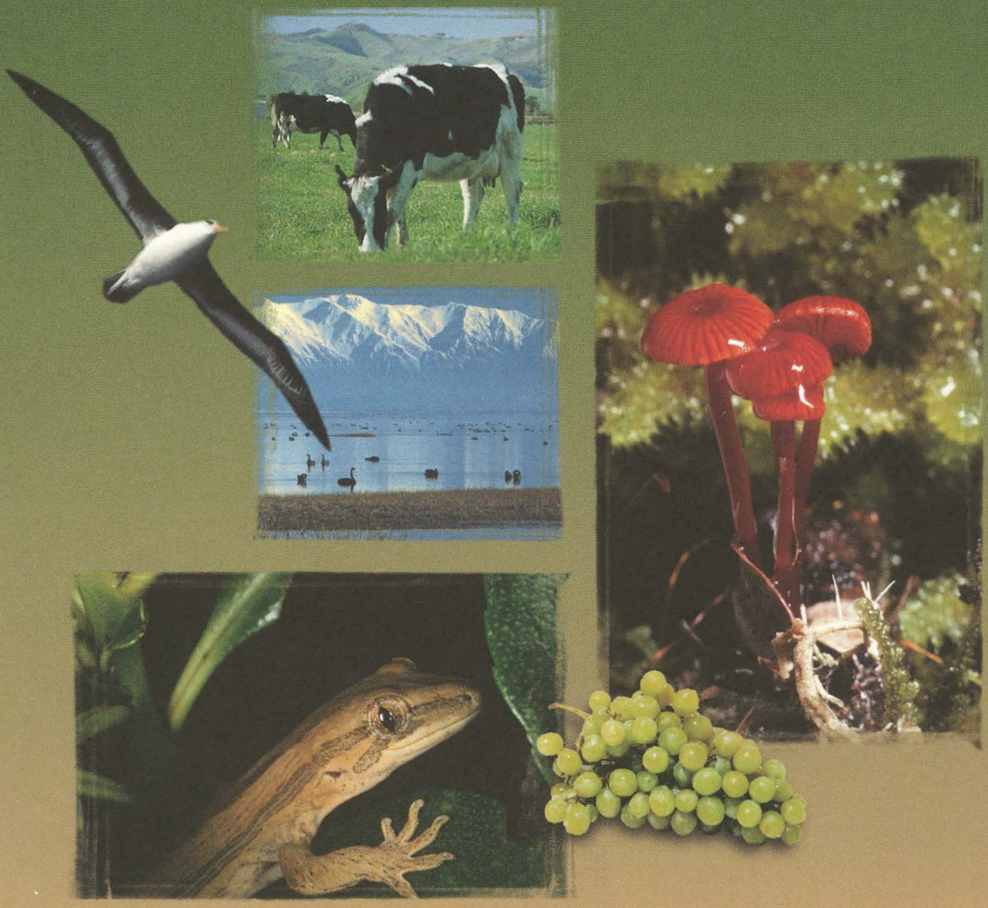

Uptake and persistence of 1080 in Plants of Cultural Importance

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Wildlife Management Report No. 32

Uptake and persistence of 1080 in Plants of Cultural Importance

Final Report

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PREPARED FOR:
Animal Health Board, PO Box 3412, Wellington

DATE: 30 June 2004

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Executive Summary

1.1 Project and client

Research was undertaken for the Animal Health Board under Contract R-80620 "Iwi research on 1080 in plants of cultural importance" to Lincoln University, to determine the field uptake and persistence of 1080 in plants of cultural importance to Maori. The research reported here was carried out between August 2003 and June 2004.

1.2 Objectives

- To identify two culturally-important plant species that may be effected by aerial 1080 bait application
- To measure the uptake and elimination of 1080 in these selected plant species of cultural importance at field sites using application of 1080 baits
- To report findings and engage members of the Lake Waikaremoana Hapu Restoration Trust (Ngai Tuhoe), and Tuawhenua Trust (Ngai Tuhoe) in a dialogue process regarding the fate of 1080 in plants

1.3 Methods

- Consultation was undertaken with Ngai Tuhoe. Pikopiko (*Asplenium bulbiferum*, a plant used for food) and karamuramu (*Coprosma robusta*, a medicinal plant) were identified as suitable species for this study
- A field site within a planned 1080 aerial control operation area was identified, to the south of Lake Waikaremoana (E2861485, N6252803)
- Instrumentation was deployed to monitor temperature, rainfall, and soil moisture during the field experiment
- Ten individual plants of each species were randomly selected, and the chosen pikopiko plants were caged to exclude herbivore browsing
- A single Wanganui No. 7 bait (0.14% 1080) was placed in a small cage at the base of 7 of the plants of each species (the other 3 plants being experimental controls)
- Five-gram samples of shoots (pikopiko) or leaves (karamuramu) were taken from each plant at 0, 3, 7, 14, 28 and 56 days after bait placement, bait samples were taken at 0 and 56 days
- The 1080 concentration of a randomly-selected subset of the samples was measured using gas chromatography
- The results were reported to Lake Waikaremoana Hapu Restoration Trust (Ngai Tuhoe), and Tuawhenua Trust (Ngai Tuhoe), Ngai Tahu, the Department of Conservation, Animal Health Board, and Raukawa Trust Board representatives
- This research has been drafted into a manuscript that will be submitted to a scientific journal such as Ecotoxicology or the New Zealand Journal of Ecology.

1.4 Results

- Temperature measurements made at the soil surface (the position of baits) ranged from 2-11 °C over the 56 days of the study
- Soil moisture generally decreased during the study, there were 5 major rain events, and there was a mean total rainfall of about 120 mm
- A 99% reduction in bait 1080 concentration after 56 days in the field.
- No 1080 was detected in any of the pikopiko samples
- 1080 was detected in karamuramu at 7 and 14 days, the highest concentration of 5 ppb was measured at 7 days
- By 28 days no measurable 1080 was present in the karamuramu

1.5 Conclusions

- 1080 can move out of Wanganui No. 7 baits when the baits are applied in the field
- There is no evidence that either pikopiko or karamuramu contain endogenous 1080
- There was no evidence of pikopiko plants taking up 1080 that has leached out of baits
- Karamuramu plants will take up 1080, however based on this experiment only a very small proportion (0.0004%) of the original 1080 present in baits is likely to be seen in the leaves and shoots
- The highest 1080 concentration measured in the karamuramu was 5 ppb, in leaf material 7 days after bait placement
- 1080 did not persist, plants containing 1080 reduced levels to zero after 25 days
- At the highest measured 1080 concentration of 5 ppb, a 70 kg person would need to consume 28 tonnes of this material to receive an LD_{50}
- There is negligible risk of humans being poisoned by consuming plants that have taken up 1080 from baits during an aerial control operation

1.6 Recommendations

- The poisoning of humans by consuming pikopiko or karamuramu plants after aerial application of 1080 should not be considered as a significant risk
- Consideration should be made for Maori groups to adopt a withholding period of 30 days after aerial application of 1080, during which plants from within 1080 application areas are not used for rongoa (medicinal) purposes
- Support should be given to further collaborative research projects involving Maori groups, as this allows these groups to play an informed role in considering the acceptability of 1080 as a vertebrate pest control technique, thus potentially strengthening efforts to reduce Tb vector numbers

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Introduction

Sodium monofluoroacetate (Compound 1080) is used in New Zealand for the control of introduced pests, including possums and rabbits. Methods of deployment include aerial application of 1080 cereal or carrot baits. This is a cost-effective means of reducing vertebrate pest populations particularly in rugged terrain where these pests are compromising agricultural and/or conservation values (Livingstone 1994, Eason, 2002).

During aerial application of 1080 baits, it is possible that 1080 which has leached into soil may be absorbed by plants (Atzert 1971; Rammel & Fleming 1978). Cabbage has been shown to systemically accumulate 1080 through its roots, and subsequently become toxic to aphids (David 1959, Negherbon 1959). Depending on the period of time that 1080 persists in plant tissues, plants could remain toxic after the risk of primary poisoning had gone, i.e. after baits have degraded and become non-toxic. Ogilvie et al. (1998) showed that 1080 can be taken up by broadleaf and ryegrass, and persist for at least 38 days.

Para (1999) documented that Maori have concerns regarding the fate of 1080 in mahinga kai (food and resource gathering areas). The risk of secondary poisoning to Maori who utilise plants for kai (food) or rongoa (medicinal) purposes has been identified as a key research issue by Maori and by the Animal Health Board.

This is the final report of a research programme aimed at investigating the potential risks of 1080 poisoning and contamination through plant species that are of particular cultural significance to Maori, and to Ngai Tuhoe in particular. Ngai Tuhoe are of the eastern central North Island, an area that has been identified as particularly important in terms of 1080 use, because Tb incidence is thought to be increasing in the Urewera National Park. The research reported here was undertaken between August 2003 and June 2004.

Objectives

- To identify two culturally-important plants that may be effected by aerial 1080 bait application
- To measure the uptake and elimination of 1080 in these selected plant species of cultural importance at field sites using application of 1080 baits
- To report findings and engage members of the Lake Waikaremoana Hapu Restoration Trust (Ngai Tuhoe), and Tuawhenua Trust (Ngai Tuhoe) in a dialogue process regarding the fate of 1080 in plants

Methods

Objective 1: Identification of culturally-important plant species

Culturally-important plant species were identified using the process of hui kanohi ki te kanohi (meeting face to face) with key tangata whenua representatives, and other people important in possum control and conservation management in the area. A hui was undertaken at Tuai (South side of Lake Waikaremoana) on 13-15 August 2003. Fourteen people participated, including representatives from Lake Waikaremoana Hapu Restoration Trust (Ngai Tuhoe, southern region), Tuawhenua Trust (Ngai Tuhoe, northern region), Te Whare Wananga o

Awanuiarangi, Landcare Research, The Department of Conservation, and Lincoln University. To initiate the discussion Shaun Ogilvie presented a review of published research on 1080.

A number of potential species that could be impacted by aerial 1080 operations were identified. Plant species included kauka, watercress, kawakawa, horopito, kowhai and larger trees such as tawa. There were also concerns about harore, which are edible fungal species. After in-depth discussion, it was agreed that the work should be done with pikopiko (*Asplenium bulbiferum*) and karamuramu (*Coprosma robusta*). Pikopiko shoots are used as a food source, shoots emerge from August, around the time that 1080 operations are often undertaken. Karamuramu is used throughout the year as rongoa (medicine), applied both externally and internally, and is common within the planned 1080 aerial application area.

Objective 2. 1080 uptake and elimination in the selected plant species

Potential field sites were assessed during the August 13-15 hui. A suitable site was chosen, in State Forest Block 100, grid reference E 2861485, N 6252803 (Fig. 1). The site was within the area planned for aerial 1080 application by the Hawke's Bay Regional Council in September 2003, was reasonably accessible, and contained both pikopiko and karamuramu.

All statutory requirements were met to allow the field use of 1080 in this study. A permit to perform this research in a Department of Conservation Estate was obtained from the Department of Conservation. Written permission was obtained from the Medical Officer of Health, Dr Caroline McElnay, of the Hawke's Bay District Health Board. We also verbally informed the neighbouring LandCorp farm manager, Mr Mark Boenders.

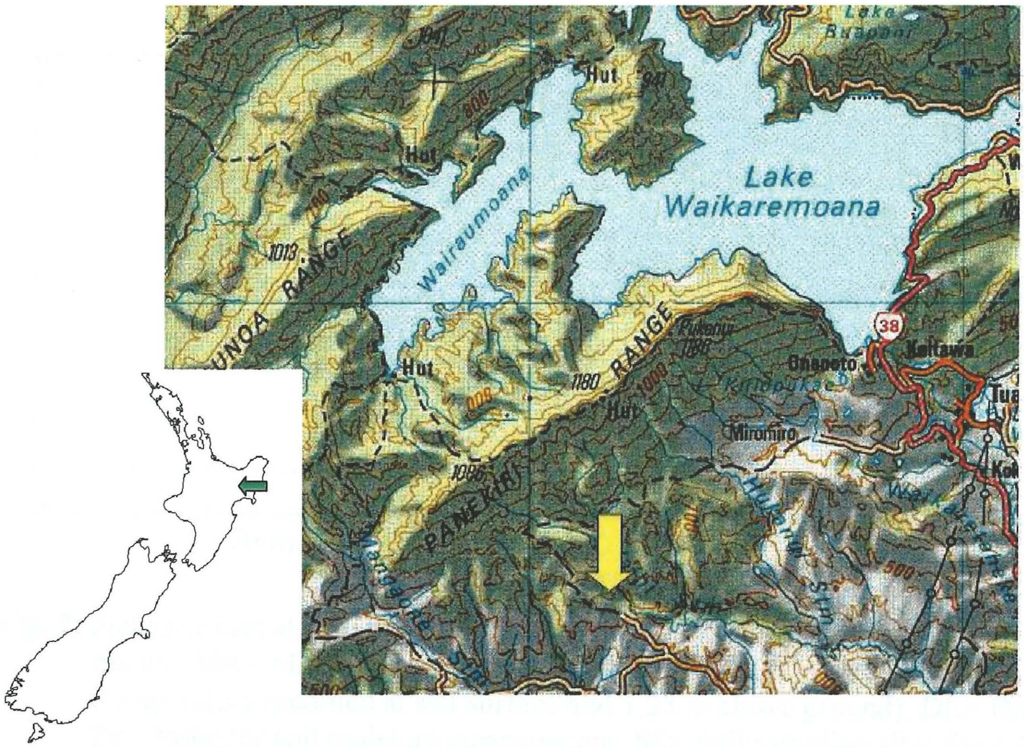

Fig. 1. Study site. Small arrow on inset shows general location of Lake Waikaremoana, larger arrow main picture shows the experimental field site (E 2861485, N 6252803).

Five-gram samples of shoot (pikopiko) or leaves (karamuramu) were taken from each plant at 0, 3, 7, 14, 28 and 56 days after bait placement. The experiment was started on 23rd September 2003, and the final sampling day was 18th November 2003.

In addition to the plant material, bait samples were taken at Day 0 (for Quality Assurance purposes) and at Day 56, to determine if 1080 concentration had changed in the baits over the duration of the study.

Plant and bait samples were stored frozen and transported to Landcare Research, Lincoln. Four of the 10 plants of each species (including one control plant) were randomly chosen, and only the samples from these plants were analysed for 1080 content.

The 1080 concentration of each chosen sample was quantified by gas chromatography, using methods modified from those of Ozawa and Tsukioka (1987). Samples were 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 then 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 was 2 ppb.

Objective 3. Reporting findings

The results of this study were presented to:

Lake Waikaremoana Hapu Restoration Trust and Tuawhenua Trust, at Te Pa Kuha Marae, on 29 March 2004. A summary of that presentation is attached, Appendix 1.

Ngai Tahu, AHB, and Department of Conservation representatives at Tuahiwi Marae, on 6th May 2004. A summary of the data was given to Nick Hancox (AHB) and Wren Green on May 7th 2004, to aid their work in the 1080 re-registration process.

Lincoln University staff and post-graduate students, on May 12th 2004.

Te Roopu Mana Taiao (Environmental Committee) Raukawa Trust Board, Tokoroa on May 17th 2004.

Tuhoe Tuawhenua Trust, Mataatua Marae, Ruatahuna on May 29th 2004.

This research has also been drafted into a manuscript that will be submitted to a peer-reviewed scientific journal, either Ecotoxicology or the New Zealand Journal of Ecology.

Results

Quality Assurance analysis of the baits used in this study showed a starting 1080 concentration of 0.14% (Table 1). This was slightly lower than 0.15% which is normally used for aerial control operations. At the conclusion of the study (56 days), the baits were intact, and reasonably unchanged in physical appearance from the start of the experiment. We were able to lift whole intact baits when we sampled them. More than 99% of the 1080 had gone from the baits by Day 56 (Table 1).

Table 1. 1080 concentration in baits after 0 and 56 days.

	Mean 1080 in bait (% of total weight)		% 1080 gone from bait by Day 56
	Day 0	Day 56	
Pikopiko	0.14	0.00046	99.7
Karamuramu	0.14	0.00113	99.2

During the 56 days of the study, air temperatures varied between –1 and 12 °C (Fig. 5) while ground surface temperatures (where baits were placed)were less variable ranging between 2 and 11 °C (Fig. 5).

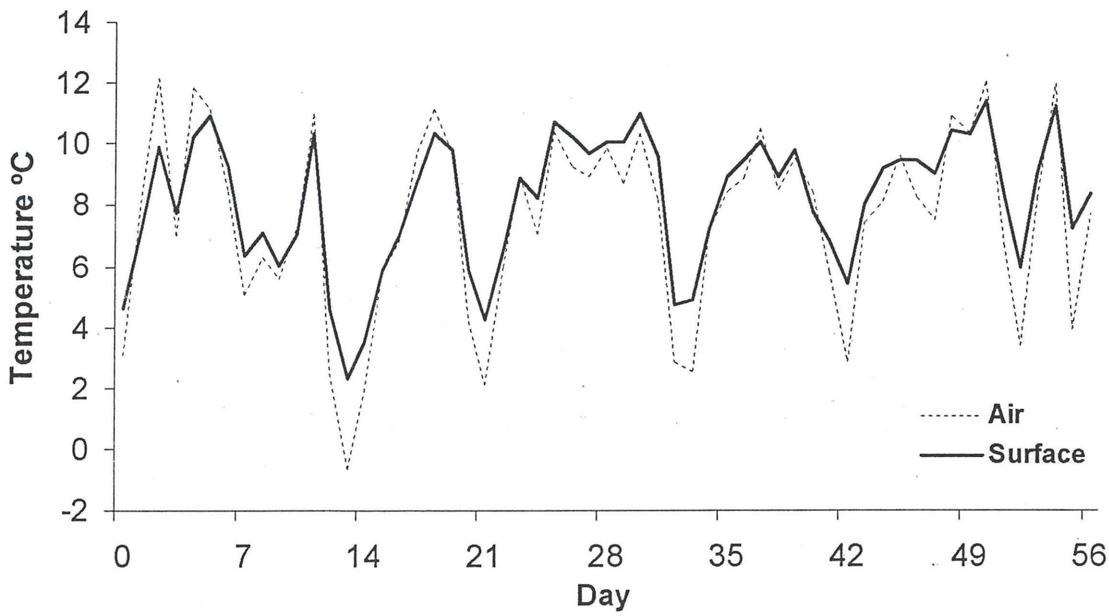

Fig. 5. Ground surface and air temperatures over the 56 days of the study.

Soil moisture generally decreased over the 56 days of the study (Fig. 6). This trend was perhaps to be expected, as the experiment was undertaken between September 23rd and November 18th, when daily solar radiation hours would be increasing. Furthermore, this may reflect the decreasing incidences of major rainfall events (peaks in the soil moisture curve) that were measured at approximately 7, 13, 21, 30 and 55 days after the experiment commenced (Fig. 6).

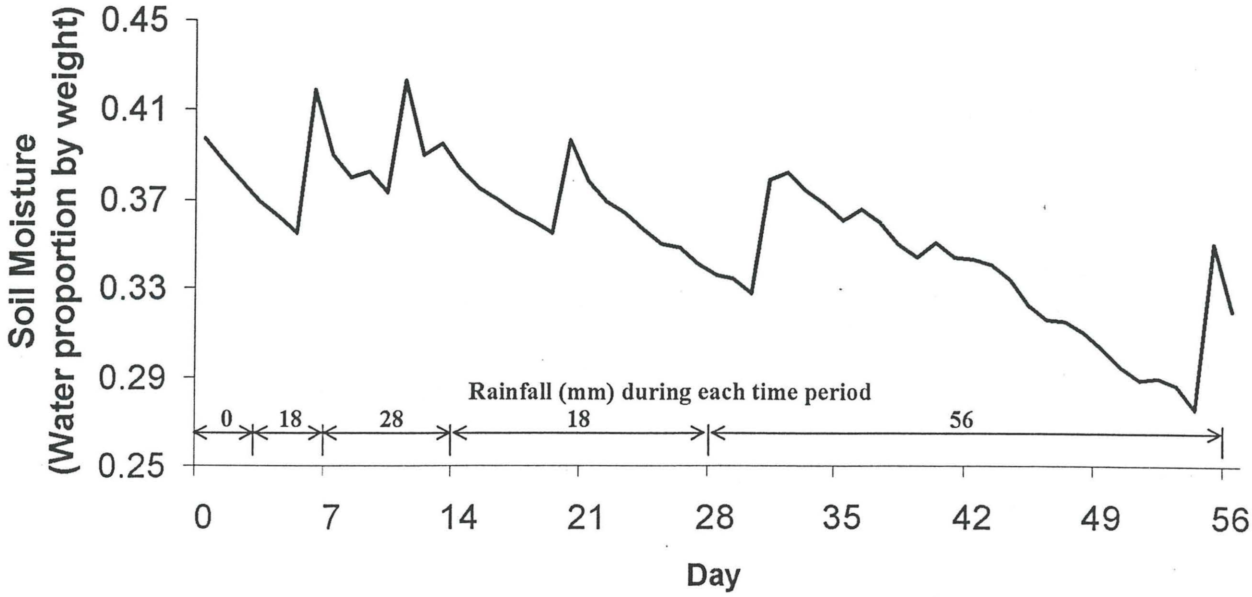

Fig. 6. Soil moisture and rainfall over the 56 days of the study.

No 1080 was detected in any of the control plant samples, confirming that 1080 is not a natural component of the study plant species.

No 1080 was detected in any of the experimental pikopiko samples (Fig. 7). There was 1080 detected in the experimental karamuramu, at 7 and 14 days after bait placement (Fig. 8). The maximum concentration measured was 5 ppb, on Day 7, while 2.5 ppb was measured after 14 days. The maximum concentrations was only seen in one of the four karamuramu plants, and that was karamuramu No. 10 (Fig. 2). At and after 28 days there was no 1080 detected in any of the karamuramu plants. The 1080 maximum of 5 ppb measured in the karamuramu represents a very small proportion, about 0.0004%, of the 1080 originally in a single bait.

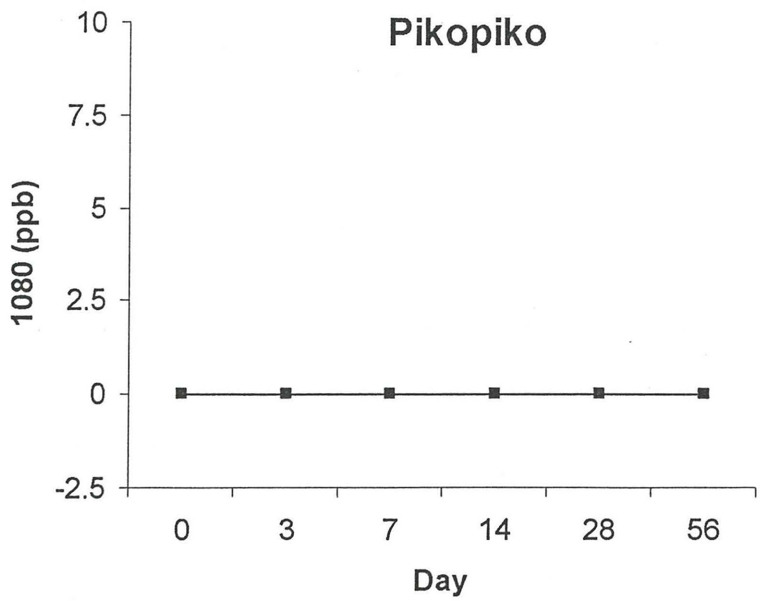

Fig. 7. Uptake and persistence of 1080 in pikopiko over 56 days.

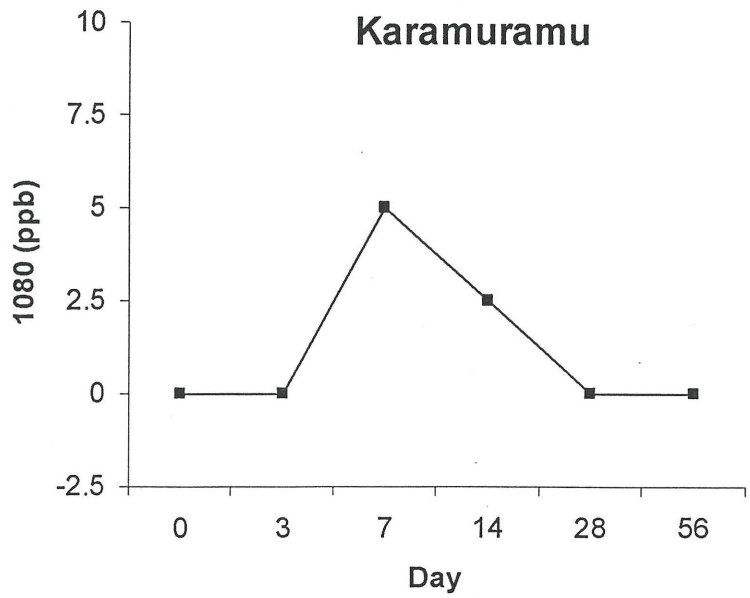

Fig. 8. Uptake and persistence of 1080 in karamuramu. Values are the maximum concentration measured in any plant at each time point.

Discussion

While the starting 1080 concentration in the baits was lower than that normally used for 1080 possum control operations, we considered the difference to be within normal limits of bait manufacture, and therefore the bait used to be appropriate for the objectives of this study.

There was some initial surprise at the durability of the Wanganui No. 7 bait. However previous documented research has shown this type of bait to be particularly durable. Booth *et al.* (1999) showed that No. 7 can remain intact after 250 mm of rainfall, compared to a total of 120 mm of rainfall in the present study. The No. 7 bait is therefore suitable for use in high-rainfall environments, and the results of the this study support the decision of the Hawke's Bay Regional Council to use this type of bait in their planned aerial control operation in the vicinity of the study area.

After 56 days we found a 99% reduction of 1080 in the baits. It is possible that the 1080 moved out of the bait at the point of contact with the ground because the underside of the baits were partially degraded. The measurement of 1080 residues in the karamuramu also supports the movement of 1080 out of the bait and into the soil. It is also possible that some microbial/fungal breakdown of 1080 occurred in the baits themselves, particularly at the point of contact with the soil, where soil microbes/fungi may have been able to penetrate and metabolise the 1080.

The highest observed 1080 concentration of 5 ppb in karamuramu was lower than that seen in previous comparable research on other plant species. After the application of single 1080 baits to ryegrass and broadleaf, Ogilvie *et al.* (1998) observed maximum concentrations of 80 ppb in ryegrass (after 3 days) and 60 ppb in broadleaf (after 10 days). The differences are likely to be attributed to two key factors. Firstly, Ogilvie *et al.* (1998) used RS5 bait which tends to disintegrate quicker than Wanganui No. 7 (Booth *et al.* 1999) and so the 1080 is likely to have been released from the bait at a faster rate. Secondly, the earlier study was done under controlled laboratory conditions, plants were smaller than the present study plants, and were placed in pots with a limited volume of soil, resulting in a smaller plant and microbial/fungal biomass and soil volume per unit 1080. Aside from the differences in magnitude of 1080 measured, the 1080 uptake and elimination kinetics in the present study are comparable to the earlier study. The karamuramu did contain 1080 at measurable levels for around 25 days (similar to 24 days seen for broadleaf) and that after this time the 1080 was eliminated from the plant. It is perhaps worthy of note that in the present study pikopiko did not take up 1080 in measurable concentrations, and to the best of our knowledge this is the first time that 1080 persistence and elimination has been studied in a fern. The existence of a physiological feature unique to ferns could be responsible for this difference in 1080 uptake compared to the other plant types that have been studied. Another consideration is that the preferred environment for ferns is typically more moist than that for karamuramu, perhaps the presence of more water could assist in the breakdown of 1080 in a more rapid manner, before it is taken up by the plants.

An assessment of toxicity risk to humans

Given that in the present study we were unable to show evidence of pikopiko taking up 1080 from baits, it is reasonable to expect that there is negligible risk of humans being poisoned by 1080 through consumption of pikopiko after an aerial 1080 control operation.

For the karamuramu the maximum measured 1080 concentration was 5 ppb or 0.000005 mg/g. The 1080 LD_{50} (dose considered lethal to 50% of individuals of a given population) for humans is 2 mg/kg (Rammell & Fleming, 1978). For a 70 kg person this is a dose of 140 mg. So the amount of this karamuramu that would contain 140 mg of 1080 is:

$$\frac{140 \text{ mg}}{0.000005 \text{ mg/g}} = 28{,}000{,}000 \text{ g}$$

Therefore a 70 kg person would need to consume 28 tonnes (28,000,000 g) of this karamuramu to receive an LD_{50}, and therefore have a 50% chance of dying from 1080. After doing these calculations, we believe there is negligible risk of humans being poisoned by 1080 through consumption of karamuramu after an aerial 1080 control operation. This risk is even further reduced when it is considered that karamuramu is not consumed directly, but is boiled in water and the tea consumed –any 1080 present in the karamuramu will be diluted by the addition of the water. The potential sub-lethal effects of exposure to these low levels of 1080 would be minimal given the very low levels of 1080 and the transient nature of this chemical due the body's ability to metabolise 1080. As a point of comparison it is interesting to note that 1080 has been measured in tea leaves at a concentration of 1.2 ppb (Twigg *et al.* 1996), certainly within the ballpark of measurements made in the present study.

Other issues that were considered and discussed

In an holistic sense, there were concerns about what aerial 1080 application could be doing to the wairua (spiritual energies) of the forest. Every living thing has its own particular type of energy, and the potential influence toxins could have on these energies was a topic that was passionately discussed. There was a general opposition to the presence of any 'introduced' poisons into the forest because of the impact that this has on the meta-physical dimensions, an impact that cannot be measured by Western Science methodologies. In a genealogical sense Maori regard the earth (Papatuanuku) as the ancestral mother and the flora and fauna as tuakana (senior to humans) so to 'pollute' this environment with poison is unacceptable.

However, as commented by one of the kaumatua (respected elders): "I support the discussion regarding the wairua aspects. However, as kaitiaki (stewards) we have a responsibility to look after our forest using what methods or technologies are available to us. What we do not have at the present time are answers to many of our concerns about 1080. This is why this project is a step forward. Providing us with information so that we can make an informed decision about the benefits and acceptability of 1080."

After talking it through, a pragmatic viewpoint was raised, where it is a balancing act between the negative impacts of the possum and the negative impacts of 1080, with 1080 perhaps the lesser of the two concerns.

There was also concern whether the rongoa (medicinal) properties of karamuramu could be altered in some way when 1080 was present in the tissues of these plants. The point was raised, that while 1080 was only present in minute quantities, if somebody was to utilise karamuramu after 1080 control, in traditional ways such as for a urinary complaint, is it possible that the effectiveness might be significantly altered? While it was not possible to conclusively answer this question, one approach might be to undertake clinical trials to assess the effectiveness of karamuramu with and without 1080 present. The team also noted that the 1080 did not persist in the plant tissues for longer than about 25 days, and there was suggestion that concerns about effectiveness of rongoa could be overcome by having a withholding period of say a month after 1080 aerial control, during which time plants are not used for rongoa.

There were also concerns about whether other medicinal or food plant species, not addressed in this study, could also take up 1080. There is much scope for future research in this area. However, making the assumption that these other plant species will be effected by 1080 in the same manner as seen for pikopiko and karamuramu in the present study, and ryegrass and broadleaf in an earlier study (Ogilvie *et al.* 1998), we can be reasonably assured that there is negligible risk of humans being poisoned by 1080 through consumption of other plant species after an aerial 1080 control operation. In terms of the potential influence on medicinal properties, again having a withholding period of a month after 1080 aerial control could be a prudent approach to minimising the issue.

Conclusions

- 1080 can move out of Wanganui No. 7 baits when the baits are applied in the field
- There is no evidence that either pikopiko or karamuramu naturally contain 1080
- There is no evidence of pikopiko plants taking up 1080 that has moved out of baits
- Karamuramu plants will take up 1080, however only a very small proportion (0.0004%) of the original 1080 present in baits is likely to be seen in the plants
- The highest 1080 concentration measured in the karamuramu was 5 ppb, in leaf material 7 days after a single bait was placed at the base of the plant
- 1080 did not persist, plants containing 1080 eliminated it in around 25 days

- There is negligible risk of humans being poisoned by consuming plants that have taken up 1080 from baits during an aerial control operation

Recommendations

- The poisoning of humans by consuming plants after aerial 1080 control should not be considered as a significant risk
- Consideration could be made for Maori groups to adopt a withholding period of 30 days after aerial application of 1080, during which plants from within the 1080 application area are not used for rongoa (medicinal) purposes
- Support should be given to further collaborative research projects involving Maori groups, as this allows these groups to play an informed role in considering the acceptability of 1080 as a vertebrate pest control technique, thus potentially strengthening efforts to reduce Tb vector numbers

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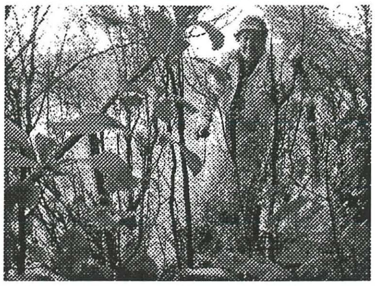
Appendix 1.

Presentation given to Lake Waikaremoana Hapu Restoration Trust and Tuawhenua Trust on 29th March 2004.

1080 and Plants



A report on the AHB-funded project
"1080 in Plants of Cultural Importance"

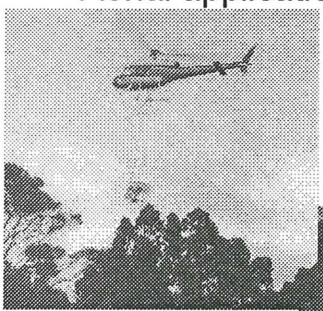
• S, J

Acknowledgements

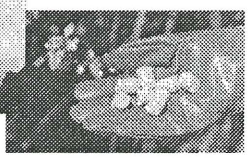
• Lake Waikaremoana Hapu Restoration Trust
• Tuhoe Tuawhenua Trust
• Te Whare Wananga o Awanuiarangi
• Department of Conservation
• Landcare Research
• Lincoln University
• Animal Health Board

• Very much a collaborative effort

Aerial application of 1080



- Helicopter and bait bucket
- 1080 in cereal or carrot
- Used for both possum and rabbit control



1080 uptake in plants

- 1080 is water soluble, and will leach from uneaten baits
- Previous 'laboratory' work has shown uptake by ryegrass and broadleaf

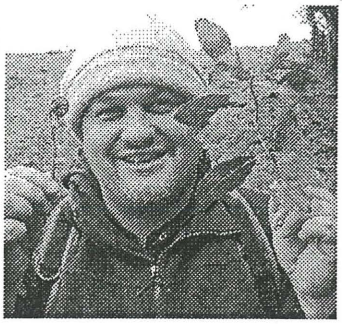
Objectives of this research

- To identify two culturally-important plant species that may be effected by aerial 1080 bait application
- To measure the uptake and elimination of 1080 in these species in the field

• Utilised parts of plants

Obj 1: Identifying the plants

Chosen plant species



- **Pikopiko**
  Asplenium bulbiferum
  - Kai
- **Karamuramu**
  Coprosma robusta
  - Rongoa

Objective 2

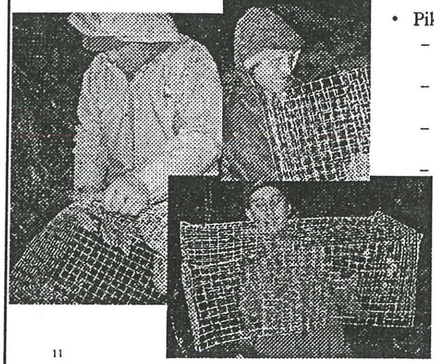
- Measuring the uptake and elimination of 1080 in these two plant species in the field
- Steps:
  - Find suitable study area
  - Setting up field experiment
  - Sampling plants
  - Laboratory analysis
  - Presentation of results
  - Assessment of risk

Finding study area

Study area

- End of Panekiri Rd
- Planned site for aerial 1080 application
- Both plant species present
- Reasonable access
- Thanks to Neuton!!

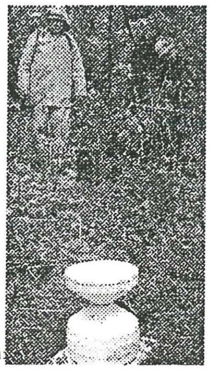
Setting up field experiment



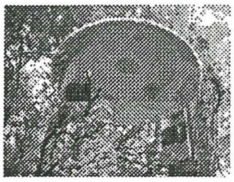
- Pikopiko in cages
  - To avoid grazing by possums and deer
  - Stopped baits from being eaten too
  - Plants still open to natural conditions
  - Equipment, cages removed at end of experiment

- Ten individual plants of each species
- Simulated aerial 1080 application (worse-case scenario)
  - 1080 bait placed at base of each plant

Environmental parameters



- Used equipment to monitor factors that can influence 1080 breakdown and leaching
  - Temperature
  - Rainfall
  - Soil moisture



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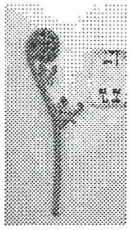
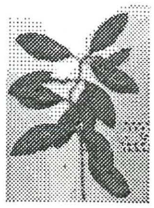
Sampling





- 5 grams of sample taken from each plant
  - 0, 3, 7, 14, 28, 56 days after bait placement
- Samples stored frozen
- Sent to Landcare Lincoln for 1080 analysis

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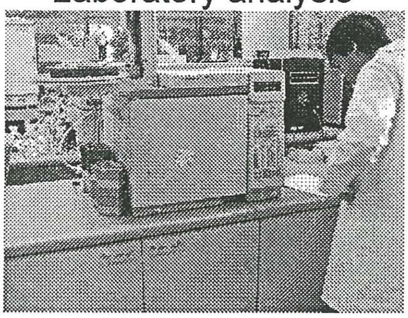
Laboratory analysis



- 1080 content measured with Gas Chromatography

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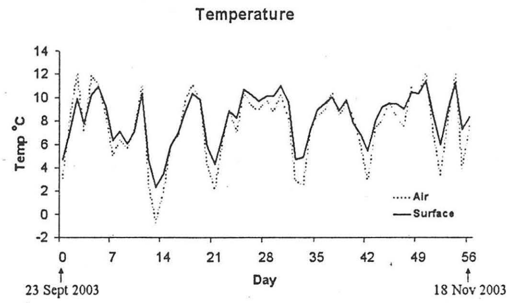
Results



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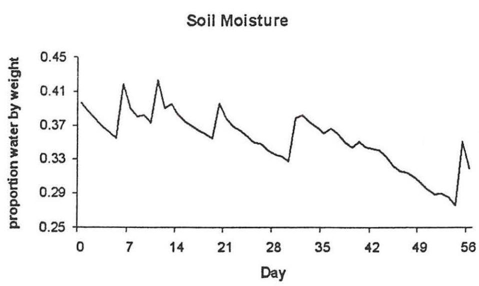

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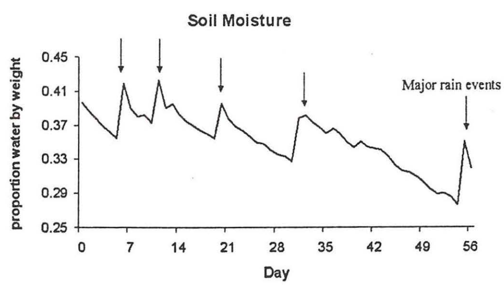

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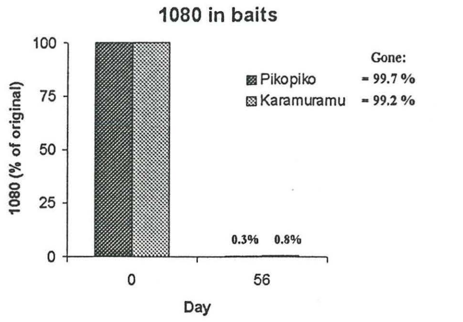
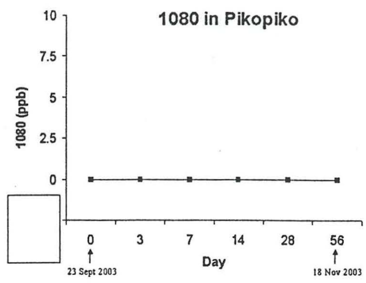
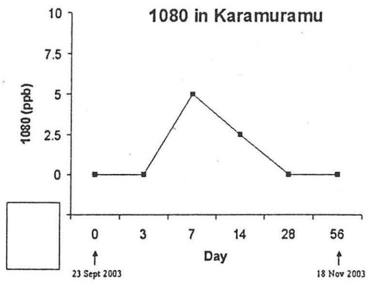


• Original: 0.14%





Values show the maximum concentration measured in any plant at each time point

Results summary

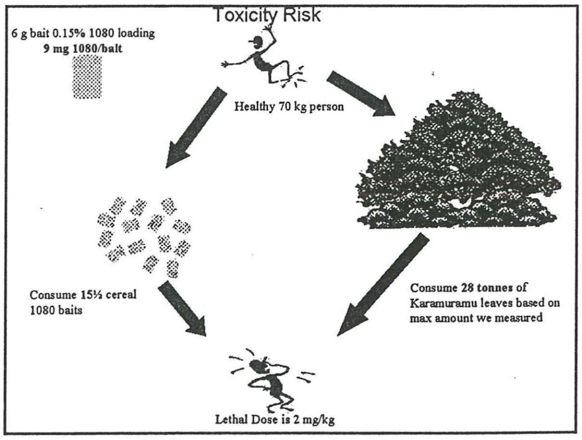
- Temperature range at baits 2-11 °C
- Soil moisture generally decreased during the study, and showed 5 major rain events
- A minimum of 99.2% of the 1080 had gone from the baits by Day 56
- No 1080 was detected in pikopiko
- 1080 detected in karamuramu at 7 and 14 days
  - Highest concentration 5 ppb

Toxicity risk

- Lethal Dose of 1080 for humans is 2 mg/kg
- 70 kg person would need 140 mg dose to die
- Karamuramu max 5 ppb = 0.000005 mg/g

$$\frac{140 \text{ mg}}{0.000005 \text{ mg/g}} = 28{,}000{,}000 \text{ g}$$

- Would need to eat 28,000 kg of karamuramu



Conclusions

- Most of the 1080 had gone from the baits at Day 56
  - A number of options: breakdown in baits, leach into soil, breakdown in soil, taken up by plants
- No evidence of pikopiko taking up 1080
- 1080 was taken up by karamuramu
- Maximum seen in karamuramu was 0.0004% of the original 1080 in the bait
- Low concentrations persisted in karamuramu for up to 28 days
- There is negligible risk of people being poisoned by consumption of plant material that has taken up 1080

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1080 and Plants

Next steps

- Report for AHB
- Scientific paper in Journal
  - Key players as co-authors
- Discussion....

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1080 and Plants