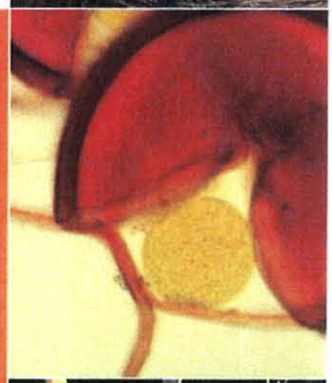
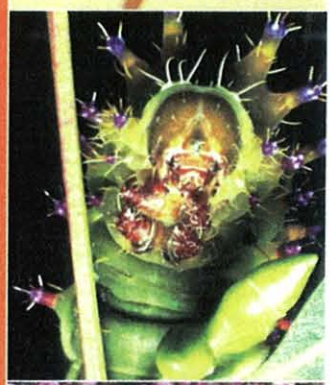
Bio-Protection & Ecology Division

Sodium Fluoroacetate (Compound 1080) Uptake by Puha, a Culturally-Important Food Plant





by

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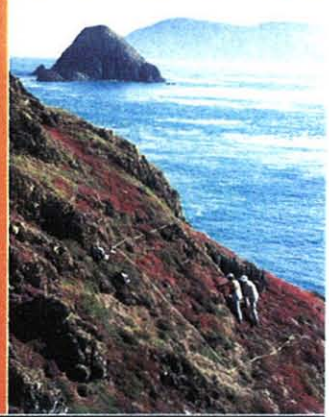

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Prepared For:

Animal Health Board, PO Box 3412, Wellington
Contract R-80694

January 2009

Executive Summary

1.1 Project and client

Research was undertaken for the Animal Health Board Inc. (AHB) under Contract R-80694 "Uptake of 1080 by Watercress and Puha" by Lincoln University. Here we report on the puha component of the research. The watercress component of this contract will be supplied in a later report.

This research was aimed at examining the uptake and persistence of 1080 in a plant of cultural importance, puha, (*Sonchus* spp.). The work was carried out between September 2007 and November 2008.

1.2 Objectives

- Undertake appropriate consultation with local Māori at the potential study site to obtain the necessary consent to carry out the research that involves the addition of 1080 to a food source site
- Complete an application to the Medical Officer of Health and receive approval for field use of 1080
- Undertake fieldwork to measure the uptake and elimination of 1080 in puha using simulated aerial application of 1080 cereal baits
- Complete 1080 laboratory sample analyses
- Add the findings of this work to the 1080 database (R-80667-01)
- Report the research findings on 1080 in puha to members of the collaborative Māori community, and nationally through established networks and interested individuals
- Publish findings in a peer-reviewed journal.
- Complete a report on the findings of this research (the present report is the first component of the final report).

1.3 Methods

- Consultation was undertaken with Ngai Tuhoe at Tuai. It was agreed that puha (*Sonchus* spp., used for food) was an appropriate plant for this study.
- A field site on the shores of Lake Waikaremoana was identified (E28693.29 N62572.25).
- Instrumentation was deployed to monitor rainfall, air and litter temperature, and soil moisture during the field experiment.
- Ten individual puha plants were randomly selected, and caged to prevent herbivore grazing.
- A single Wanganui No. 7 bait (0.15% 1080) was placed in a small cage at the base of eight plants. Two non-toxic baits were placed at the base of two plants (control plants).
- Five gram tissue samples were collected from each of these plants at Day 0, 3, 7, 14, 28 and 38 days after the baits were deployed, and snap-frozen on dry ice.
- The 1080 concentration in each of these samples was measured using gas chromatography.
- Results were reported to the Lake Waikaremoana Hapu Restoration Trust (Ngai Tuhoe), Tuhoe Tuawhenua Trust (Ngai Tuhoe), and Department of Conservation representatives on November 14th 2008; and were presented at the NPCA conference, November 26-27th 2008.

- These findings will be drafted into a manuscript for submission to a scientific article once data from the watercress component of this work has been collated.

1.4 Results

- Average litter temperature (where baits were positioned) ranged from 11 – 19 ºC, while average air temperature ranged from 9 – 23 ºC over the 38 days of the study.
- Soil moisture fluctuated during the study from 0.382 - 0.717 m^3/m^3, but after Day 7 remained greater than 0.5 m^3/m^3
- There were three major rain events, with a maximum of 16.7 mm of rain recorded in one day; a total rainfall of 72.9 mm recorded over the duration of the study; and a mean daily rainfall of 1.66 mm.
- Measurable levels of 1080 were detected in 9 of the 10 puha plants sampled.
- The one plant that never showed measurable 1080 was not a control plant.
- The highest 1080 concentration was seen on Day 3, at 15 ppb, from a single sample.
- By Day 38, 1080 had decreased below the Method Detection Level (MDL) for all plants.
- When the MDL was removed, very low concentrations of 1080 were observed in 59 of the 60 plant tissue samples taken, including samples taken on Day 0, prior to the addition of toxic baits.

1.5 Conclusions

- Based on the data collected here, it cannot be ruled out that 1080 occurs naturally in puha.
- The highest 1080 concentration measured was 15 ppb in leaf material 3 Days after bait placement; therefore all concentrations detected were very low.
- 1080 did not persist at levels above the MDL.
- 1080 had decreased to levels close to the MDL by Day 28, and had reduced to levels below this limit by Day 38.
- At the highest measured 1080 concentration of 15 ppb, a 70 kg person would have to eat 9.3 tonnes of affected plant material to receive an LD_{50}
- There is a negligible risk to humans being poisoned by consuming plants that have taken up 1080 from baits.

1.6 Recommendations

- The poisoning of humans via consumption of puha after an aerial 1080 operation should not be considered a significant risk.
- However a withholding period of greater than 38 days could be observed after any aerial 1080 operation in an area where puha might be affected.
- Consideration should be given to conduct further research to confirm whether 1080 occurs naturally in puha, and if so, at what levels over time and under differing conditions i.e. weather/season/grazing pressure.

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Introduction

Sodium fluoroacetate (Compound 1080) is a key tool in the control of possums, and the most extensively used vertebrate pesticide in New Zealand (Livingstone 1994; Morgan 1994a, b; Thomas 1994; Gillies and Pierce 1999; Powlesland et al. 1999; Sherley et al. 1999; Styche and Speed 2002). The most common method of control using this pesticide is via aerial application of cereal or carrot baits containing 1080 (Eason et al. 2000). This is a cost-effective means of reducing possum populations by more than 90% (Eason et al. 1994, Veltman and Pinder 2001).

Despite the efficiency of aerial 1080 application for reducing possum population numbers, support amongst Māori is mixed. In general, Māori oppose the use of toxins in the environment, despite the benefits to be had through the control of pests. In particular, there is much opposition around the aerial use of 1080 (Ogilvie et al. *in press*). Para (1999) documented concerns of Māori regarding the fate of 1080 in wild harvested kai (food) species. The risk of secondary poisoning of people using kai resources has previously been identified as key research by the Animal Health Board (AHB), Environmental Risk Management Authority (ERMA) and Māori.

During aerial application of 1080 baits, there is the possibility that 1080 may leach from baits and be taken up by nearby plants (Atzert 1971; Rammel and Fleming 1978). More recent laboratory research has shown that 1080 can be taken up by terrestrial and aquatic plants, including *Myriophyllum triphyllum*, a native aquatic New Zealand plant (Ogilvie et al. 1995); *Elodea canadensis*, an introduced aquatic species (Ogilvie et al. 1996); and broadleaf and ryegrass, both terrestrial species (Ogilvie et al. 1998). In a field setting where a simulated aerial 1080 operation has been conducted, low concentrations of 1080 were found in *Coprosma robusta,* or karamuramu, a native species used as medicine by Māori; however no 1080 was found in *Asplenium bulbiferum*, or pikopiko, a native species commonly consumed by Māori (Ogilvie et al. 2006).

This report is part of a research programme conducted to investigate the uptake and persistence of 1080 in watercress and puha. This report focuses only on data generated from the puha component of this work. The watercress component will be reported at a later date.

Puha is a plant species of particular cultural significance to Māori as a kai (food) resource, and to Ngai Tuhoe. Ngai Tuhoe are a Māori tribe of the eastern central North Island. The Urewera National Park lies within this area, and here, the incidence of Tb is thought to be increasing. Consequently, the use of 1080 in this area to control possum numbers and therefore Tb is important, especially as food is often harvested in this area from wild growing kai species, such as puha. The research reported here was undertaken between September 2007 and November 2008.

Objectives

1. Undertake appropriate consultation with local Māori at the study site to obtain consent to carry out the research that involves the addition of 1080 to a food source site.
2. Complete an application to the Medical Officer of Health and receive approval for field use of 1080.
3. To measure the uptake and elimination of 1080 in puha using simulated aerial application of 1080 cereal baits.

4. Add the findings of this work to the 1080 database (R-80667-01).
5. Report the research findings on 1080 in puha to members of the collaborative Māori community, and nationally through established networks and interested individuals.
6. Publish findings in a peer-reviewed journal.
7. Complete a report on the findings of this research (that document will combine this preliminary report and the watercress component of the contract in a final report in keeping with the re-aligned milestones for watercress).

Methods

Consultation with local Māori

A strong working relationship with Lake Waikaremoana Hapu Restoration Trust (LWHRT – Ngai Tuhoe) and Tuhoe Tuawhenua Trust (TTT – Ngai Tuhoe) has been established during previous research carried out by this research team. An initial hui at Tuai, on the south side of Lake Waikaremoana, was held during September 2007 to discuss any issues surrounding this work, and the use of 1080 in a food source, with members of LWHRT, TTT and local Department of Conservation (DoC) representatives present. Puha (*Sonchus* spp.) was selected as a plant of particular cultural significance in this area, due to the regular harvesting of this species for human consumption. It was also discussed a number of times in submissions during the ERMA 1080 reassessment process recently conducted.

Following this, site visits were conducted on September 13th – 14th 2007 with members of LWHRT, TTT, DoC and the research team, to determine whether suitable sites were available. A number of potential sites were present. Due to the use of 1080 in this research, sites were then narrowed down by selecting areas with low or no public access, or a means of blocking public access; little or no access by stock, dogs or other non-target species; somewhere accessible for the research team carrying the required equipment; an area with large puha plants present; and a site that was not currently being used by local people for puha harvesting. A site on the shore of Lake Waikaremoana was eventually chosen for use (Fig. 1. E28693.29 N62572.25). This site was on DoC administered land. Public access was able to be restricted, and highly visible signage was erected.

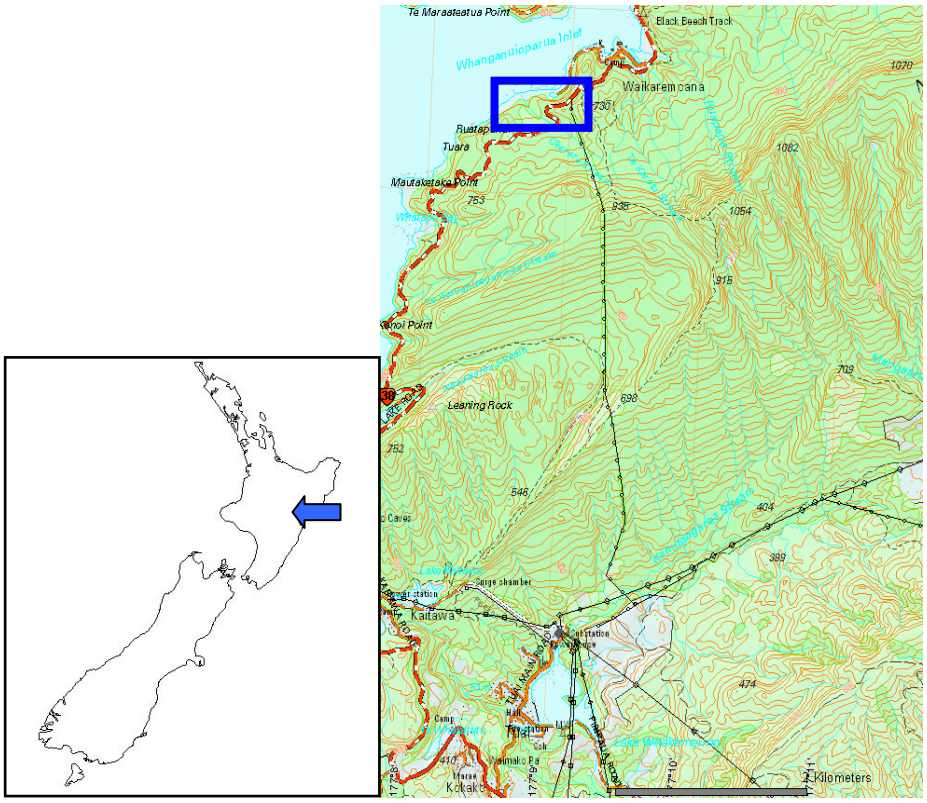

Figure 1. (Inset) New Zealand with blue arrow indicating the general location of Lake Waikaremoana. Large figure showing the edge of Lake Waikaremoana, with a blue rectangle representing puha site location. E28693.29 N62572.25.

Medical Officer of Health Approval

Obtaining the Medical Officer of Health permit required an "Application for Medical Officer of Health Permission for the use of Controlled Pesticide(s)" to be filled out and filed with the Hawkes Bay District Health Board. This involved providing a background to the project; gathering information about the selected site; providing GPS co-ordinates and maps of the site (fig. 1); providing information about the type of toxin to be used and method of use; stating the proximity of the site to schools, camping grounds, public access, roads, water ways, dwellings, and tramping tracks/huts and bivvies; providing copies of the warning notices to be posted; listing all places (i.e. local doctors, veterinary clinics, local DoC office) that would require notification of the research, and providing copies of these letters. The permit was issued approximately two weeks after submission. Permission was also sought, and granted, to carry out this research on DoC administered land.

Measuring the uptake and elimination of 1080 in Puha

This research investigated the uptake of 1080 under a simulated aerial operation in field conditions. In previous research (R-80620), simulated field conditions enabled our team to replicate a 'worst-case' scenario of bait landing at the base of plants – a situation that may not actually occur in an aerial operation. The same approach was used here.

Toxic (1080) and non-toxic cereal baits (Wanganui No. 7) with a nominal 1080 concentration of 0.15% were obtained from Animal Control Products, Wanganui. The concentration of 1080 in the toxic baits was quantitatively analysed at Landcare Research by gas chromatography, as described below.

Ten puha plants were selected at the study site. Each plant was enclosed in a wire-mesh cage, constructed of ''Weldfab'' (Fig. 2) (1 mm diameter wire, with 25 mm mesh size) to prevent grazing by wild animals such as deer, pigs, goats and possums. Each plant was a minimum of 600 mm distance from the neighboring plant. A single toxic bait was placed in a smaller wire cage (10 mm mesh size) at the base of eight of the plants (Fig. 3), while a single non-toxic bait was placed at the base of two plants to act as controls. Five-gram samples of leaf material were harvested from each of the ten plants at Days 0, 3, 7, 14, 28 and 38 after bait deployment. Each plant sample was triple bagged in water-proof ziplock bags. Five toxic baits were enclosed in a wire cage (Fig. 4) and left in the study site area. A single one of these baits was taken on each of the subsequent sampling days (3, 7, 14, 28 and 38 days) to determine the percentage of leached 1080 over the duration of the study. Bait samples were always taken after the plant tissue samples had been handled and bagged. Baits were triple bagged in water-proof ziplock bags. Plant and bait samples were snap frozen in dry ice and stored at -20°C prior to analysis at Landcare Research.

Figure 2. Setting up a wire mesh cage around a puha plant.

Fine copper-constantan thermocouples covered by a radiation shield located 1.25 m above the ground logged air temperature every 30 seconds using a data logger (21X, Campbell Scientific, Logan, UT, USA), and averaged every 30 min. An automatic rain tipper gauge monitored rainfall events and volume. Volumetric soil water content at a depth of 50 mm was measured daily (ThetaProbe (Delta-T, UK)), calibrated to moisture measured manually from soil samples.

Figure 3. Caged puha plant with toxic 1080 bait in mesh cage at base of plant. Arrow indicates the toxic bait at the base of the plant

Figure 4. Toxic 1080 baits within mesh cage for sampling over the duration of the study.

The 1080 concentration contained in each sample was quantified by gas chromatography, using methods modified from those developed by Ozawa and Tsukioka (1987). Each plant 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 0.003µg/gm, or 3 ppb.

Results

Quality assurance of the baits used for this field work showed a starting 1080 concentration of 0.15%, the same as that normally found in baits used for aerial operations. This 1080 concentration decreased over time (Fig. 5), until no 1080 was detected above the MDL by Day 38, the final day of sampling. This equates to > 99% of the 1080 leaching from the baits (Table 1). Physical appearance of baits deteriorated; while still intact, they appeared weathered, cracked and the presence of the green dye faded considerably over this period.

Table 1: 1080 Concentration of 1080 in baits after 0 and 38 Days

	1080 Concentration in bait (% of total weight)		
	Day 0	Day 38	% 1080 gone from bait by Day 38
Cereal Bait	0.15	<MDL	> 99%

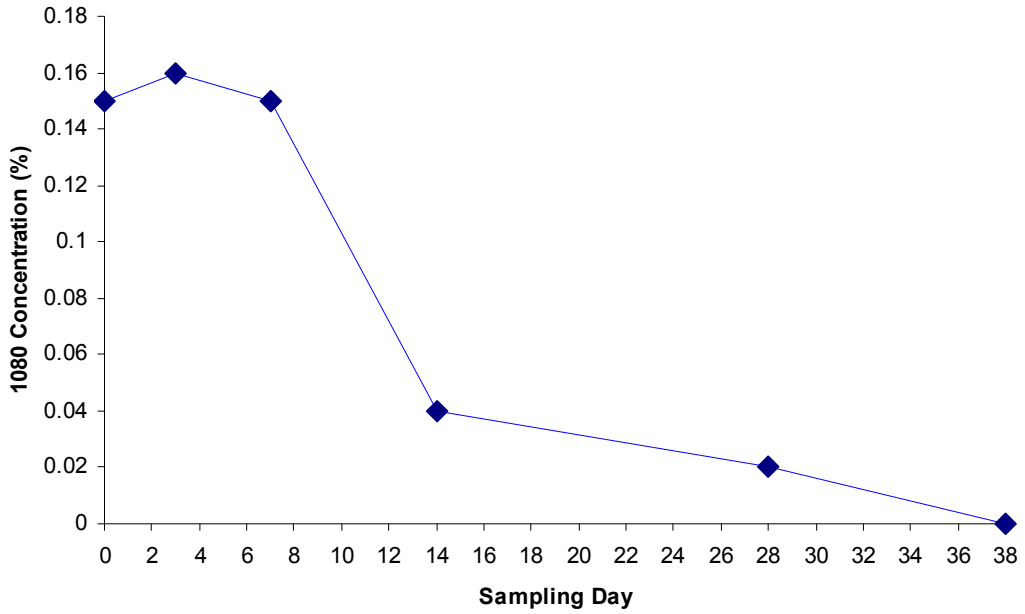

Figure 5. Concentration of 1080 from toxic baits over the duration of the study

Over the 38 day duration of this study, average air temperature ranged from 9 - 23ºC (Fig. 6); average litter temperature from 11 - 19ºC (Fig. 6); rainfall from 0.0 – 16.7 mm/day (Fig. 6); and soil moisture from 0.382 – 0.717m^3/m^3. Maximum rainfall was 16.7 mm/day, and the mean rainfall was 1.66 mm/day. Three major rainfall events occurred. No discernable patterns are apparent from this environmental data; however average air and average litter temperature showed similar fluctuations (Fig. 6).

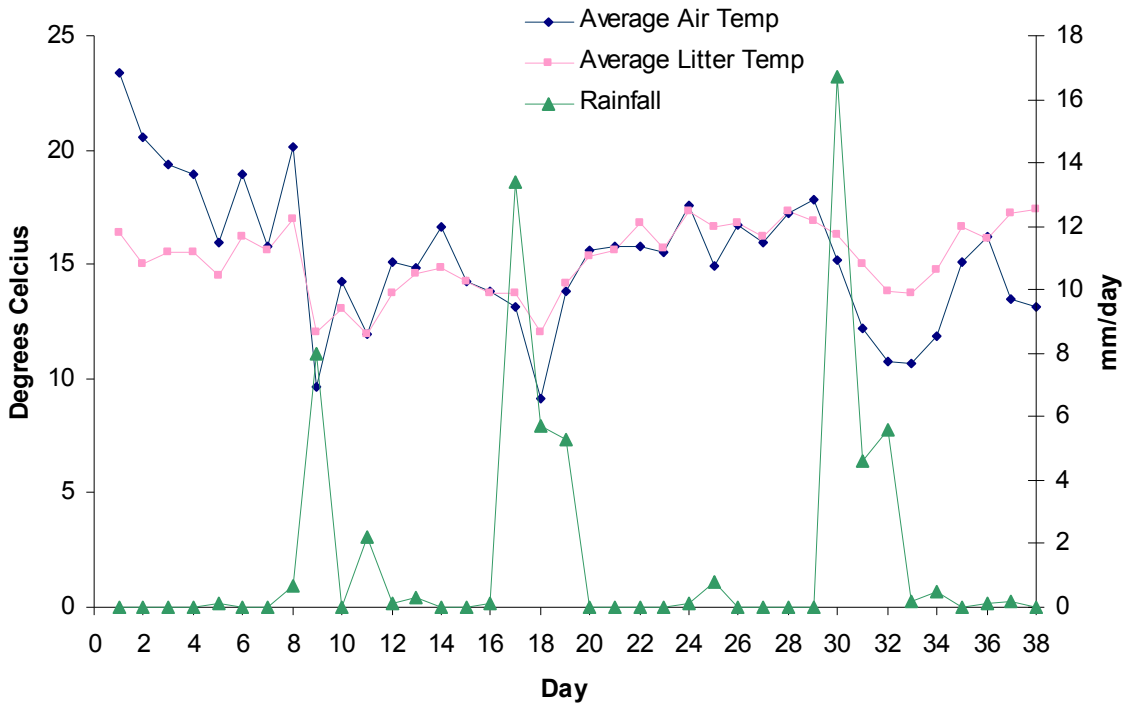

Figure 6. Air temperature, average litter temperature (ºC), and rain fall (mm/day) over the duration of the study

Of the 60 plant tissue samples collected (10 plants x six sampling days), 14 showed measurable concentrations of 1080 i.e. 14 samples were above the Method Detection Level (MDL) of 3 ppb (Table 2). Maximum 1080 concentration recorded in plant tissue was 15 ppb from a single sample on Day 3. One plant (plant 3) never showed 1080 concentrations above the MDL. This was not a control plant. Both control plants showed levels of 1080 above the MDL at varying time points, although this was not consistent across all days, only occurring once in one plant, and twice in the other control plant.

Curiously enough, with the MDL removed, 1080 appeared at very low concentrations (minimum 0.1 ppb) in ***59 of 60*** plant tissue samples, including on Day 0, before the addition of toxic baits (Table 2). This is comparable to levels of 1080 seen in common brands of tea leaves, i.e. Bell Tea, Tiger Tea, PG Tea etc., where the concentration of 1080 detected ranged from 0.2 – 1.2 ppb (Eason et al. 1995). However, as mentioned earlier, accuracy decreases at these low concentrations.

Table 2: Raw data showing all concentrations of 1080 (ppb) detected in plant tissue samples. Method Detection Limit (MDL) has been removed. Numbers in RED indicate 1080 concentrations that are above the MDL of 3 ppb.

Day	Plant 1 Control	Plant2	Plant 3	Plant 4	Plant5	Plant 6 Control	Plant 7	Plant 8	Plant 9	Plant 10
0	0.7	0.2	0.2	0.2	0.1	0.2	0	0.4	1.6	0.2
3	**11.2**	1.8	0.5	0.8	0.6	0.5	**8.9**	1.2	**15.4**	0.8
7	1.5	1.5	2	0.9	0.6	0.6	1.1	0.8	0.5	0.4
14	0.5	**9.2**	0.3	0.5	**5.8**	0.4	1.3	0.8	**3.9**	1
28	**3.5**	**4.9**	2.5	**4.7**	2.9	**3.3**	**5.1**	**3.2**	**4.3**	**3.1**
38	0.3	0.6	0.3	0.3	0.3	0.3	0.2	0.2	0.4	0.3

A standard uptake and decay curve was not seen (Fig. 7). With the MDL in place, no 1080 appeared on Day 7 or Day 38; with the MDL removed, 1080 was detected on both of these days at very low concentrations (Table 2). All levels of 1080 detected, regardless of plant or sample day, were at very low concentrations.

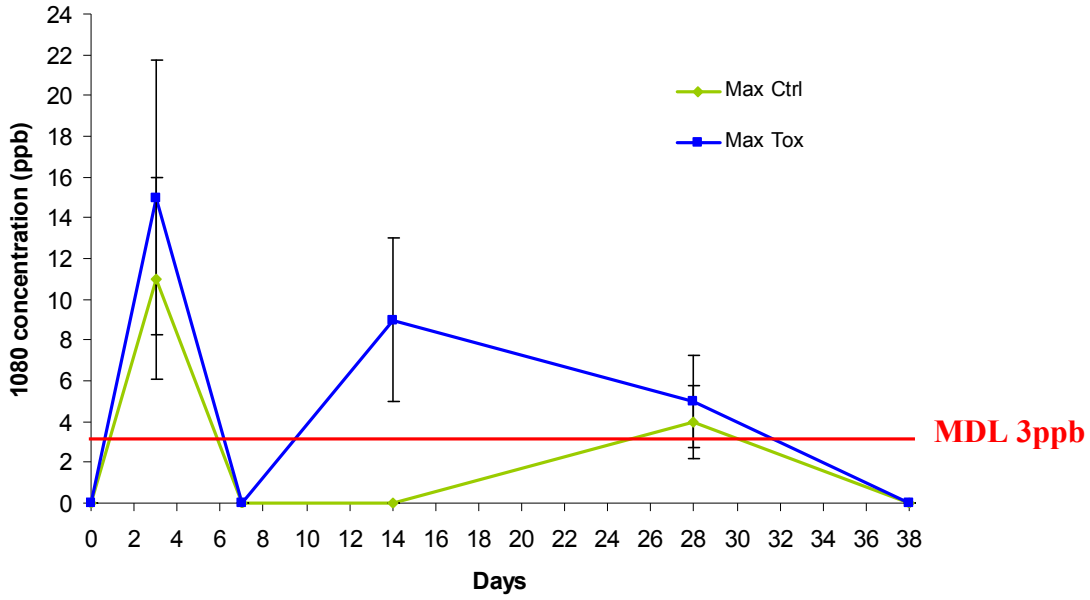

Figure 7. Maximum 1080 concentrations (ppb) seen from puha tissue samples over duration of the study

When graphed with rainfall (Fig. 8) (mm/day) no pattern occurred between rainfall and 1080 concentrations seen from puha, as the rainfall events occurred after sampling. However, plant tissue samples were not collected every day, and had daily sampling occurred a pattern may have been observed.

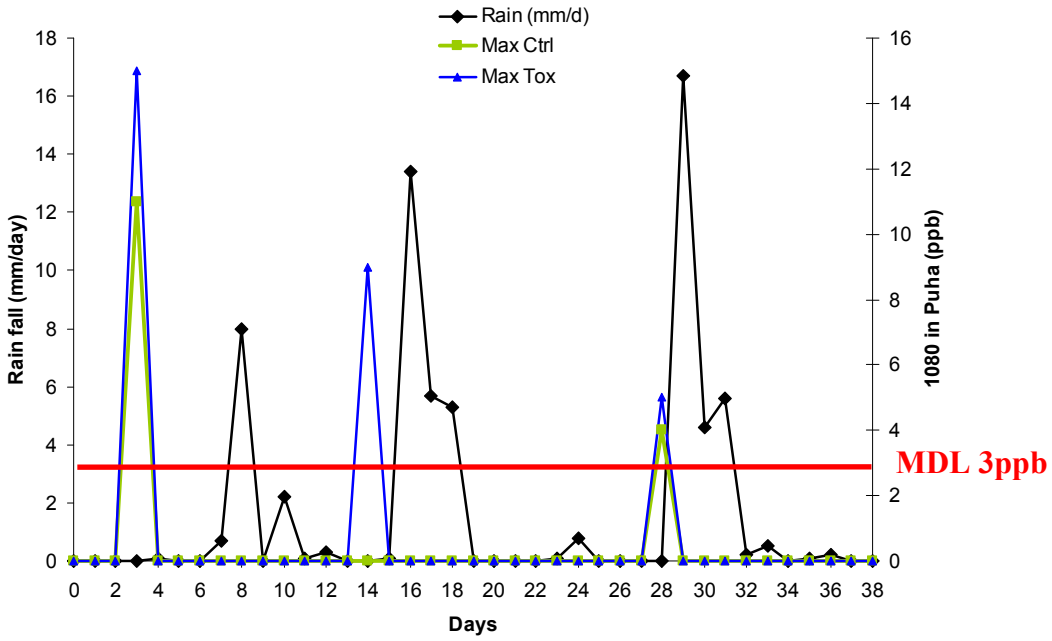

Figure 8. Maximum 1080 concentrations (ppb) seen from puha tissue samples, and rainfall (mm/day) over the duration of the study

Average air and average litter temperature (ºC) also appeared to have no affect on the maximum 1080 concentrations recovered from the puha samples (Fig. 9).

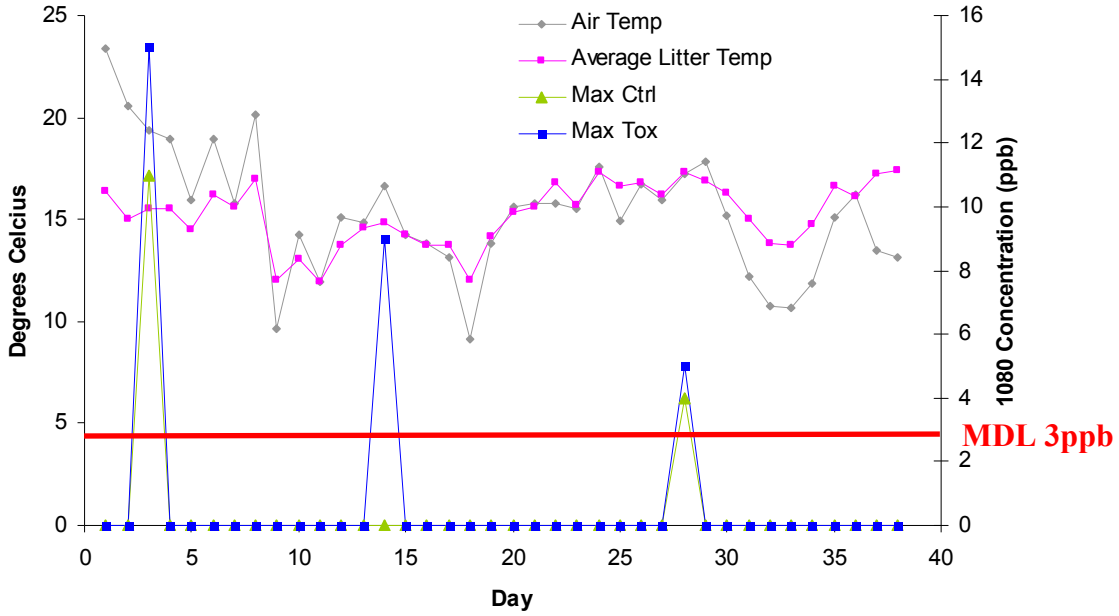

Figure 9. Maximum 1080 concentrations (ppb) seen from puha tissue samples, air temperature and average litter temperature (ºC) over the duration of the study

Adding findings to the 1080 database (www.lincoln.ac.nz/1080)

This will be done when we have the watercress data available.

Reporting research findings to the collaborative Māori community, and nationally

On November 14th members of the research team gave a presentation of these findings to members of LWHRT, TTT and local DoC representatives from the Lake Waikaremoana area. The results generated much discussion. When this data was compared with previous findings of 1080 concentrations in common tea brands, it gave perspective to the levels of 1080 being detected.

A presentation of this research was made at the National Pest Control Agency (NPCA) conference in Wellington, November 26th – 27th.

Publishing findings in a peer-reviewed journal

Once data collection, laboratory and data analyses have been carried out for the watercress component of this research, all results will be written up into a manuscript for submission to a peer-reviewed scientific journal, such as Ecotoxicology.

Discussion

Bait and Environmental Conditions

As expected, the concentration of 1080 contained within the baits used in this study started at the same concentration as that normally found in baits used for 1080 aerial possum operations, i.e. 0.15%. As such, the bait was appropriate for the objectives of this research.

Over time, 1080 concentration in the baits decreased, until no 1080 was detectable at Day 38. These baits were subject to the same environmental conditions as those used in the field study, i.e. they were left at the study site covered only by a wire mesh cage. It is likely that 1080 leached from the baits at the point of contact with the ground, where soil micro-organisms such as *Psuedomonas* and *Fusarium* species, which have been reported as being able to break down 1080, would have been in direct contact with the baits (King et al. 1994).

Highest 1080 concentration from the baits was recorded prior to the first major rainfall event. It is most likely that this rainfall event promoted the leaching of 1080; however this event occurred on Day 8, bait was sampled on Day 7 and then not sampled again until Day 14; therefore any toxin leaching immediately after this rainfall event was not measured because of the pre-set sampling regime.

Over the duration of the study, little rainfall occurred, with an average daily rainfall of 1.66 mm/day. Soil moisture content increased after the first rainfall event on Day 8, but remained relatively constant for the duration, remaining above 0.5 m^3/m^3 and below 0.65 m^3/m^3. Air temperature and average litter temperature showed slight decreases after the rainfall events.

1080 Concentration in Puha

The concentration of 1080 detected in the puha tissue samples did not follow a normal decay curve, and a number of anomalies were seen.

The first and most obvious of these anomalies was the appearance of measurable 1080 levels in both control plants. The maximum 1080 concentration observed in a control plant was 11 ppb, not much lower than the maximum 1080 concentration seen in plants treated with toxic baits, of 15 ppb. 1080 was not detected in every sample from the two control plants, but low concentrations were seen twice from one plant and once from the other control plant.

The possibility of the plants being accidentally contaminated was ruled out, as contamination events would be represented by much higher levels of toxin (P. Fairbrother *pers. comm.*), stringent handling and laboratory procedures were followed, and the amounts of 1080 being detected was barely above the MDL.

The second anomaly seen was that no 1080 was detected above the MDL in any plant on Day 7, yet on Day 14, three of the plants again showed detectable levels of 1080, and on Day 28, 8 of the plants, including both control plants, also showed very low concentrations of 1080; however these levels were barely above the MDL of 3 ppb. There is no apparent explanation for this irregularity.

Previous work done by our research team investigated the uptake and persistence of 1080 in pikopiko (*Asplenium bulbiferum*, a plant used for food) and karamuramu (*Coprosma robusta*, a medicinal plant) under field conditions (Ogilvie et al. 2004). 1080 was never detected in

pikopiko, and minimal quantities were recorded from karamuramu. Concentrations of 1080 in karamuramu peaked at Day 7, at 5 ppb, and by Day 28, no detectable levels of 1080 were measured (Ogilvie et al. 2004). Here the maximum 1080 concentration of 15 ppb was seen on Day 3, no 1080 was detected in any plants on Day 7, 1080 was again detected on Day 14 and low concentrations were seen on Day 28, but no 1080 was present above the MDL on Day 38. The 1080 did therefore decrease to levels below the MDL by the end of the study, and when present, was in low concentrations.

The maximum 1080 concentration recorded here is comparable to that seen in karamuramu (5 ppb, Ogilvie et al. 2004), but is lower than 1080 concentrations recorded from ryegrass (80 ppb after 3 days) and broadleaf (60 ppb after 10 days) (Ogilvie et al. 1998). The higher concentrations observed in ryegrass and broadleaf may have been a result of RS5 bait being used (compared to Wanganui #7 bait used here). Another contributing factor may have been that ryegrass and broadleaf plants were in pots, in controlled laboratory conditions, not in the field, as with the karamuramu and puha results obtained here.

Removal of the Method Detection Limit (MDL)

A further anomaly became apparent when the MDL was removed from the raw data. The standard laboratory procedures adopted by the Landcare Research Laboratory impose an MDL of 3 ppb, as below this, the confidence of accuracy in any 1080 detected decreases (±45% CI above 3 ppb, becoming larger below 3 ppb); therefore with the 3 ppb MDL in place, all readings below this are reported as "Below MDL". However, due to the unusual nature of the data, it was decided to investigate the data with the MDL removed.

With no MDL imposed, ***59 of 60*** samples showed 1080, including tissue samples taken on Day 0 – *prior* to the addition of toxic 1080 baits; however confidence in the accuracy of readings at these concentrations is diminished. Where previously "Below MDL" had been recorded, levels from 0.1 ppb – 2.9 ppb were recorded, although again, these are all extremely low concentrations. As already mentioned, these levels are comparable to levels of 1080 seen in common brands of tea leaves, i.e. Bell Tea, Tiger Tea, PG Tea, where the concentration of 1080 detected ranged from 0.2 – 1.2 ppb (Eason et al. 1995). What this indicates is that the natural occurrence of 1080 in puha plants cannot be ruled out. As this experiment was not designed to show if 1080 occurs naturally in puha, further work is needed to make a firm conclusion on whether 1080 does naturally occur in puha.

An assessment of toxicity risk to humans

The maximum concentration of 1080 seen in puha in this study was 15 ppb, or 0.000015 mg/g. The 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 equivalent to a dose of 140 mg. The amount of puha that would contain 140 mg of 1080 is:

$$\frac{140 \text{ mg}}{0.000015 \text{ mg/g}} = 9{,}333{,}333 \text{ g}$$

Therefore a 70 kg person would need to consume 9.3 tonnes (9,333,333 g) of puha containing the maximum 1080 concentration of 15 ppb recorded here, in a single sitting, to receive an LD_{50} and therefore have a 50% chance of dying. It is therefore reasonable to conclude that there negligible risk of humans being poisoned by 1080 through the consumption of puha that has taken up 1080 after an aerial 1080 operation.

Conclusions

- 1080 can leach from baits under field conditions.
- Puha appears to take up 1080 that has leached from bait, as 1080 was detected at very low concentrations (maximum 15 ppb in leaf material on Day 7).
- 1080 doesn't persist in puha plants that take it up; after the 38 days duration of the study, no 1080 was detected above the Method Detection Limit (MDL).
- When the MDL was removed, 1080 was apparent in 59 of the 60 plant tissue samples taken.
- Based on this data, we cannot rule out that 1080 may occur naturally in puha.
- At the maximum concentration of 1080 recorded (15 ppb), a 70 kg person would need to eat 9.3 tonnes of puha in a single sitting, to receive an LD_{50}, therefore based on this risk profile, we would conclude that there is negligible risk to humans of 1080 poisoning after an aerial 1080 operation.

Recommendations

- The poisoning of humans by the consumption of puha after an aerial 1080 operation should not be considered as a significant threat to human health.
- Consideration could be given to observe a withholding period of at least 38 days on harvesting wild grown puha immediately after an aerial 1080 operation.
- Further research to confirm whether 1080 does occur naturally in puha would be of great interest to Māori communities, Pest Control Operators, and the wider public.

Acknowledgements

Thanks to Lynn Booth at Landcare Research for discussing laboratory procedures with the research team, and to Charlie Eason for lending his extensive knowledge on 1080 to these discussions, as well as recommending useful references.

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Appendix 1 – Medical Officer of Health Permit

HAWKE'S BAY District Health Board

MINISTRY OF HEALTH
MANATU HAUORA

PERMIT FOR USE OF VERTEBRATE TOXIC AGENT(S)

Pursuant to section 95A of the Hazardous Substances and New Organisms Act 1996

To: Dr. Shaun Ogilvie

Of: Bio-Protection and Ecology Division, LINCOLN UNIVERSITY

Application Identification Code: **LINCOLN(Tuai Study)11-2007:2.4ha approx.**

Purpose of Application: **Research on 1080 uptake in plants of cultural importance**

Application Location: **Tuai, Lake Waikaremoana, Northern Hawke's Bay**

Start Date: **19th November 2007**

Finish Date: **18th January 2008**

I, Noel Watson, a person acting under powers delegated by the Environmental Risk Management Authority (the Authority), GRANT PERMISSION for the use of the following vertebrate toxic agent(s):

Sodium Monofluoroacetate (0.15%w/w): Cereal Pellet

This permission issued on the 7th November 2007, is subject to the CONDITIONS set out in SCHEDULE 1 attached hereto.

Signed

Name: **Noel Watson**

Title: **Health Protection Officer/HSNO Enforcement Officer**

Date: **7th November 2007**

Appeals: Section 125 (1A) of the Hazardous Substances and New Organisms (HSNO) Act: A person may appeal to the District Court against a decision of the Authority, under section 95A about the terms and conditions of a permission held by the person.

Notice of appeal: Section 127 of the HSNO Act: Before or immediately after the filing and service of a notice of appeal, the appellant shall serve a copy of the notice on The Authority, and every other party to the proceedings, and any other person who made a submission to the Authority.

SCHEDULE 1- PERMIT CONDITIONS

Application Identification Code: **LINCOLN(Tuai Study)11-2007**

Application Location: **Tuai, Lake Waikaremoana, Northern Hawke's Bay**

In addition to the requirements specified under the Hazardous Substances and New Organisms Act and its regulations, including the Hazardous Substances (Vertebrate Toxic Agents) Transfer Notice 2004 the following conditions shall apply:

Copies of the Transfer Notices can be found on the ERMANZ web-site at www.ermanz.govt.nz/hs/transfer-docs/
Please ensure you are complying with all aspects of this legislation.

1. **All statements of intended action that the applicant makes in the application form dated the 29th October 2007 (including documented Public Health Unit/applicant communication) in answers to each section shall be complied with as a self-imposed condition. If there is a discrepancy between the applicants self-imposed, and the conditions in this approval then the more stringent condition shall be applicable**

2. All complaints relating to the operation that may impact on public health shall be documented and notified to the Public Health Unit, (excluding lost, spilt, or unintended application of vertebrate toxic agent(s) as these are required under HSNO. See condition 3). Please contact Noel Watson on (06)834-1815 or (027)279-3892, or the On-Call Health Protection Officer on either (06)834-1815 or (06)878-8109, particularly if Noel Watson's office voice mail advises that he is away.

3. The applicant shall be aware of the notification requirements in case of lost, spilt, or unintended application of vertebrate toxic agent(s). These are contained within the Hazardous Substances (Vertebrate Toxic Agents) Transfer Notice 2004, or the controls relating to this/these specific VTA(s) on the ERMA web-site. Copies of Transfer Notices can be found on the ERMANZ web-site at www.ermanz.govt.nz/hs/transfer-docs/
It is the applicant's responsibility to ensure they are familiar with these legal requirements.

4. Any work vehicle used to transport vertebrate toxic agent(s) or its wastes shall be operated according to statutory requirements and kept locked when the applicant is away from the vehicle.

5. If any circumstances relating to the application or the operation change, the Public Health Unit shall be informed immediately and retains the right to withdraw permission.

11. **No ground baits shall be laid within 20 metres of human drinking water intakes and feeder water sources. Water sources include springs, streams, rivers, lakes, ponds, and reservoirs.**

12. Persons who take drinking water from immediately downstream of the operational zone (i.e. water supplies with intakes inside the operational area or on adjoining properties) shall be notified of the operation and its duration.

13. **No baits shall be laid within 150 metres of dwellings unless the occupier agrees in writing with the applicant to a lesser distance.**

14. **The applicant shall send information on the types of Vertebrate Toxic Agents being used, operational area's involved, time period of application, and contact details for the applicant through to the following local health and medical services:**
    - **Wairoa Health Centre, Kitchener St., Wairoa.**

    The applicant shall send a copy of this letter to Noel Watson, Public Health Unit, PO Box 447, NAPIER.

15. Residents and landowners adjacent to the operational area shall be identified by the applicant and shall be provided with information on safety and precautions with respect to the vertebrate toxic agent being used.

16. **The following educational institution shall be provided with information on the operation and the VTA being used before the operation begins. The information is for distribution from the institution to parents/caregivers of children who may gain access to the operational area, therefore the information provided shall state in writing this to be its purpose.**
    - **Te Kura O Waikaremoana School**
    - **Waikaremoana Te Kohanga Reo, Waimako Pa, Tuai**

    The applicant shall send a copy of this information to Noel Watson, Public Health Unit, PO Box 447, NAPIER.

17. This approval shall expire on the 18th January 2008. If the applicant wishes to continue the operation outside these dates, under the same conditions, they should re-submit it with a covering letter to this effect, at least a month before the expiry date.

Note:

The requirements under HSNO are minimum requirements and stricter conditions may be imposed by a person acting under a delegation from the Authority. The delegation includes the power under section 95A of the HSNO Act:

A.I.W.

(i) to decide an application for a permission; and/or
(ii) to add, delete or otherwise vary any condition on a permission; and/or
(iii) to revoke a permission

for the use of vertebrate toxic agents in a catchment area from which water is drawn for human consumption or in any other area where a risk to public health may be created if the substance is applied or used where such a control has been set under section 95A of the HSNO Act.

Conditions in the permission form may be modified or waived with the agreement in writing of the person acting under a delegation from the Authority unless they relate to other regulatory requirements.

Appendix 2 – Department of Conservation Collection Permit

Department of Conservation
Te Papa Atawhai

Low Impact, Collecting and Research Application Form/Permit.

Important Note: This form should not be used if the activity involves commercial use of the material, collection of DNA samples (except for purely taxonomic classification purposes), genetic modification, material being removed from New Zealand, significant adverse effects on a species or its habit, any other invasive collection methods or other significant effect. In any of these cases please use the High Impact Application Form.

Applicants are required to cover the costs of processing their application. A *processing fee deposit* of $56.25 (including GST), plus $50 per additional conservancy is payable in advance. Application processing fees are not refundable if your application is unsuccessful. Applicants will be advised if further information is required before this application can be fully processed by the Department. Applicants are strongly encouraged to contact the relevant Conservancy Office to discuss the application prior to filling in this form. National Permit Number: ECHB-13533-RES

Office Use Only Application *processing fee deposit $nil* received on 10/08/03

A. Applicant

Legal Name of Applicant (company/individual in full)	Dr Shaun Craig Ogilvie Ecology and Entomology Group Soil, Plant and Ecological Sciences Division Lincoln University
Contact Person	Dr Shaun Ogilvie
Postal Address	PO Box 84 Lincoln University Canterbury 8150

Phone	03 325 2811 ext 8378	Cell Phone	021 0417459	E-mail	ogilvies@lincoln.ac.nz

B. Area and Details of Proposed Activity

Describe the areas of your operation in detail (eg track names and hut names) and attach map. Identify the status of the area(s) (ie national park, conversation area, forest park, nature or recreation reserve etc).

Land block status and name.....	State Forest 100
Study area (study species) New Zealand Grid Map Ref. (NB each reference point marks the southern-most point of a 50 m radius circular area, within which experiments will be undertaken)	Site 1 (pikopiko) E 2861485 N 6252803 Site 2 (pikopiko) E 2861546 N 6252765 Site 3 (kāramuramu) E 2861680 N 6252740

What is the proposed activity? Include details of the reason for the collecting or research to be undertaken. (Append a copy of the research outline. Include FORST programme reference if applicable.)

Examine the uptake of compound 1080 (from baits used to control possums) in two plant species of cultural

significance to Ngāi Tūhoe. This is part of a research contract being undertaken for the Animal Health Board.

Methodology

Following a preliminary hui on 15-16th April and a pre-assessment hui on 13-14th August 2003, kāramuramu (*Coprosma robusta*) and pikopiko (*Asplenium bulbiferum*) were rated high on the priority list of plants in the Tūhoe region to be considered for this research; kāramuramu because it is one of the more widely used as a rongoa (medicinal) species, and pikopiko because it is commonly harvested throughout the year for human consumption.

In conjunction with Andrew Wilke (Biosecurity Manager, Hawkes Bay Regional Council and co-ordinator of the planned 2004 aerial 1080 operation on the southern reaches of the Panekiri Range) an assessment of a proposed aerial 1080 application area has been carried out with members of the Waikaremoana Hapū Restoration Trust, and Dave King of DoC. Within a subset of this area (see map and map co-ordinates) the study species have been identified and classified according to their maturity for harvesting for rongoa or kai. Experimental replicates of each species will be a random selection of mature specimens that are of a similar size. A 1080 bait will be placed at the base of each of 10 experimental plants of each species. Baits will be enclosed in animal-proof cages that are open to normal weather conditions. Because pikopiko are browsed by deer the whole fern with the emerging pikopiko will be enclosed in a stainless steel mesh and secured on to the ground by steel pegs. Control plants will not have any baits placed within the root "catchment area". Pikopiko or kāramuramu leaves and stem will be collected for 1080 analysis at 0, 3, 7, 14, 28 and 56 days. The samples will be stored frozen at -20°C, for later analysis of 1080 concentration (described below). Soil and atmospheric temperature, and daily rainfall will also be recorded throughout the duration of the exposure.

These experiments will be done in collaboration with two representatives of the Lake Waikaremoana Hapū Restoration Trust (Ngāi Tūhoe) who have an excellent knowledge of the bush and terrain. Michelle Lambert, a final-year environmental science student from Te Whare Wānanga o Awanuiarangi is of Ngāi Tūhoe descent, and also a local of Tuai, the nearest settlement to the proposed 1080 aerial application site. She will be employed as a researcher that will be involved in all phases of the field experiment and 1080 analysis and will play an important role in the presentation of experimental results and research experiences to the relevant Māori organisations. Neuton Lambert, also of Ngāi Tūhoe decent, has relevant health and safety training as well as an extensive knowledge of study area and forest flora. He will be employed as a field guide and assistant.

The 1080 concentration of each sample will be quantified by gas chromatography, using methods modified from those developed by Ozawa and Tsukioka (1987). Each sample will be homogenised in an alcohol/water mixture, deproteinised, centrifuged, filtered, and passed through an ion-exchange column. The eluent will be acidified with hydrochloric acid and converted to the dichloraniline derivative, using dicyclohexylcarbodiimide and 2,4-dichloraniline. The derivative will be 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 0.0015 ppm.

The 1080 concentration data from the experimental plants through time will be used to construct uptake and persistence curves for these plant species. The data will also be used to advise on the potential risk (or lack thereof) of humans being exposed to 1080 via plant material following aerial application of 1080 baits.

Purpose of collecting/research	Research	✓	Educational		Commercial Use		
Type/species of material to be collected/researched	kāramuramu (*Coprosma robusta*) pikopiko (*Asplenium bulbiferum*)						
Quantity of material to be collected/researched	10 g plant tissue/sample ⇒ 10 samples/time point/plant species ⇒ 6 time points = total of **600 g plant tissue/plant species**						
How many people are involved	6 (5 researchers and 1 guide)						
Proposed dates	22nd September 2003	to	18th November 2003	Alternative dates			
Please describe the method of collection/research	Researchers will be transported to the research site on each sampling day. 10 g of plant tissue will be removed from the selected experimental plants (n = 10 of each study species) by hand						
Method of transportation to the area	Four-wheel drive vehicle (to the end of Panekiri Rd) and walking to study sites.						

D. Identification of Actual and Potential Effects of Proposed Activity

Please describe the direct and indirect effects that your proposal will have on the conservation values. Failure to complete this section may result in a decline of your application. All activities have effects.

Describe the effect of your activity on the species or its habitat

One bait will be laid at the base of each plant selected for this experiment. This is not expected to have any toxic effects to the plant, or have any detrimental impacts on the habitat in the immediate vicinity. Sub-samples of each study plant will be collected for 1080 analysis (10g) but this is not expected to kill the plant.

Natural waterways or bodies of water?

This research will not be conducted near significant bodies of water.

Any disturbance of native vegetation?

Disturbance to the native vegetation, outside of the sampling procedures is expected to be minimal.

Disturbance to soils, wetlands or any other natural feature either during the initial start-up phase or on an ongoing basis?

The effects to soils, wetlands, and any other natural feature will be negligible.

Wildlife species either within or near the area where you want to operate? e.g. kea

Baits that are laid at the base of the selected plants will be protected with a stainless steel wire cage that is anchored into the substrate with wire pegs. This will exclude large vertebrate species from accessing the baits.

Historic or archaeological sites?

This research project has been undertaken with considerable input from the Waikaremoana hapu. With their guidance this research will not be undertaken at sites of significant cultural and spiritual importance to them.

Other visitors, commercial or private? What other visitor will be present?

No visitors will be present at the study sites.

What aspects of your activity will be visible from within or adjoining the areas where you want to conduct your activity (please explain)?

The minimal amounts of research equipment and time spent at the study sites will mean that the research activity will not be visible to a great extent. Although the public will be informed of the research activity flyers will be posted on trees around the study site describing the experiment and potential hazard.

Is it possible that your activity will introduce weeds, including lake weeds, or seeds of weeds into the area (please explain)?

No. Please see section E.

What is the risk of fire from your activity (please explain)?

Nil. None of the research activities described above have a requirement for fire, nor are any of the described activities expected to create a risk of fire.

What noise will be caused by your activity (please explain)?

Any noise created from this research activity, outside the noise created from vehicular access to sites, will be negligible.

Is there any aspect of your activity that will effect current or future public access to the area (please explain)?

We will be limiting public access to the study sites for the duration of the experiment through the use of notices placed around the study site and public notification. User groups that may pass through the site (eg. pig hunters) have been identified and they will be informed of the research. At the conclusion of the experiment access restrictions will be lifted.

What effects will your activity have on plants, animals or sites of traditional importance to Maori and who have you consulted over this matter?

At all phases of planning tangata whenua have been consulted and have agreed that the minimal impacts that this research will cause to the environment are justified given the nature of the results that this research will provide.

Will your activity have any positive effects on natural or historic values (please explain)?

This research will provide information relevant to land managers attempts to reduce vertebrate pest damage. In this respect this research will have a positive effect on natural values.

Will your activity promote understanding of conservation (please explain)?

Already extensive consultation with tanagata whenua has resulted in a significant two-way sharing of information and knowledge that underpins sustainable environmental management practices from both a Māori and Western Science perspective. It is anticipated that this relationship will be extended through and beyond the proposed experimental work.

E. Measures to Avoid, Remedy or Mitigate

Where you identified actual or possible adverse effects in your description, please also describe the actions you propose to take to avoid, remedy or mitigate those effects.

Example: Weeds may be introduced on sampling equipment. Proposed action to avoid this: washing of sampling equipment before arriving in sampling area.

The risk of non-target exposure to 1080 baits will be minimised by using steel wire cages that are anchored to the ground with steel pegs. Furthermore, notices placed around the study site will alert members of the public who do venture into the experimental plots to the nature and hazard of the experimental work. Equipment that will be used to set-up this experiment will be borrowed from DoC Headquarters at Aniwaniwa, thus avoiding contamination from other areas. All other equipment (including tramping boots) will either be new, or cleaned prior to arriving in the sampling area.

Collecting Permit

Her Majesty the Queen, acting by and through the Minister of Conservation (the Grantor) GRANTS to the Applicant a Permit under Conservation Act 1987 **for the purpose of Research (the "Activity") on the Site(s) specified in Schedule 1 of this Permit.**

1.. The Permittee shall pay the Concession Fee (GST inclusive) of $nil, together with the application processing fee deposit in advance to the Grantor in the manner directed by the Grantor.

2. The Permittee shall contact the local Area Manager prior to collecting in the area, in particular to ascertain any "no-go" areas, which may include areas of concern to tangata whenua. Permission to cross private land shall be obtained from the landowner prior to the conduct of this activity.

3. This Permit does not confer on the Permittee any interest in the Site, nor does it derogate in any way from the rights of the public to use and enjoy the whole or any part of the Site.

4. The Permittee shall indemnify the Grantor against all claims by any person in respect of any injury, loss or damage (including fire damage) caused by or arising out of any act or omission of the Applicant, its servants, agents, contractors, clients or invitees, or otherwise caused as a consequence of its use of the Site or as a result of the conduct of the concession activity.

5. The Permittee shall operate the collecting activity in a safe and reliable manner and shall comply with all statutes, bylaws and regulations, and all notices and requisitions of any competent authority relating to the conduct of the collecting activity.

   (a) The Permittee shall prepare a contingency plan for dealing with any mishap that may occur during the operation of collecting activities under this permit, including the recovery of sick or injured persons.

   (b) The Permittee acknowledges that the Grantor accepts no responsibility for the safety of the Permittee.

6. The Permittee shall not erect or bring onto the Site(s) (or any other land administered by the Grantor) any structure, install any facility, or alter the Site(s) in any way without the prior written consent of the Grantor).

7. The Permittee shall not, unless authorised in writing by the Grantor, interfere with, remove, damage, or endanger the natural features, animals, plants or historic resources in any area administered by the Grantor, or bring any plants or animals to the Landing Site(s), or deposit debris, rubbish, or other dangerous or unsightly matter, or contaminate any body of water. The Applicant shall ensure that its clients and invitees do not carry out any acts prohibited under this clause.

8. The Permittee shall not transfer, sublet, assign or otherwise dispose of the interest granted by this Concession.

9. The Grantor may terminate this Concession if the Permittee breaches any of the terms of this document or if the activity causes any unforeseen or unacceptable effects to the Grantor.

10. The Permittee shall comply with all reasonable notices and directions of the Grantor concerning the activities conducted by the Applicant on land administered by the Grantor. While conducting this activity, the Permittee shall carry this permit with them at all times.

11. Use of aircraft in support of the Concession Activity is subject to separate approval. Vehicles shall only be operated on formed roads.

12. The Permittee shall take all waste and rubbish out of the Site and dispose of it in an environmentally sound manner away from public conservation lands. The Permittee must adhere to the Environmental and Water Care Code while conducting the activity, attached hereto.

13. Samples are to be collected away from tracks, huts, picnic areas or areas of high public use and as far as practicable, out of sight of the public. Wherever practicable, the Permittee shall use access routes to the collection areas that avoid damage to natural features.

14. The Permittee shall not collect samples from biologically sensitive areas, or in such quantities that the taking would unduly deplete the population or damage any other ecological associations.

15. All material collected shall remain the property of the Crown. The Permittee shall comply with any reasonable request from the Grantor or tangata whenua for access to any of the collected samples. Any surplus material is to be stored and the Department of Conservation is to be consulted on ultimate disposal of such material.

16. The Permittee shall not donate, sell or otherwise transfer to any third party any material, including any genetic material, or any material propagated or cloned from such material, collected under this permit, or any information obtained as a result of research done on such material or undertake any other activity with the sample not expressly approved herein; without the written permission of the Grantor in consultation with tangata whenua. Notwithstanding the preceding constraint, the Permittee may publish the results of such research results arising from the collection of the plants.

17. No material collected pursuant to this permit may be used for commercial purposes or patenting of plant varieties or registration of intellectual property rights on any derivatives.

18. Any taxon, which is new to science, shall have type specimens and a voucher specimen lodged with a registered New Zealand herbarium, recognised national invertebrate collection or equivalent appropriate collection. The Permittee shall notify forthwith the Grantor and local tangata whenua of any such finds.

19. Where obligations bind more than one person, those obligations shall bind those persons jointly and separately.

20. If requested, the Permittee shall keep the Grantor and tangata whenua informed on the progress of this research. Upon completion of the research, the Permittee shall forward a copy of the research findings, reports and publications to the Grantor's office from where this permit was issued. The Permittee acknowledges that the Grantor may provide copies of these findings to tangata whenua.

21. The Permittee shall comply with the collection provisions on the attached schedule at all times.

22. **Special Conditions**

1) All care will be taken to minimise damage to vegetation, habitats and ecological associations during field visits to the site. All cages, tags, bait material etc will be removed at the finish of the field work.
2) Access to the study sites will be with the permission of landowners (or Land Managers) where private land must be crossed.
3) Signage will be put up at entry points to the relevant part of State Forest 100 prior to the commencement of the study notifying the undertaking of the study and cautioning the public regarding the presence of (contained) 1080 baits in the area. Signs will be removed at the end of the field work.
4) Reasonable efforts will be made to inform probable users of State Forest 100, particularly hunters and commercial wild animal control operatives, of the undertaking of the study and the presence of (contained) 1080 baits.
5) The Aniwaniwa Area Manager (Department of Conservation) and the Waikaremoana Maori komiti Chairman (James WaiWai) will be notified of the commencement of the field work and will each be given a copy of the results of the study as soon as is practicable.

SIGNED by	Glenn Mitchell	SIGNED by	
Dated	16-09-2003	Dated	21/9/03
ACTING BY AND THROUGH THE MINISTER OF CONSERVATION ("The Grantor")		AS APPLICANT	
In the presence of		In the presence of	
Witness Signature	James Anthony Dawson	Witness Signature	Doherty J.P.
Occupation	NWHRT Coordinator	Occupation	
Address	Thai	Address	

Schedule One

(1) Approved Site(s)

State Forest 100 specifically within fifty metres of each of the following grid reference points: a) 2861485 6252803, b) 2861546 6252765 c) 2861680 6252740.

(2) Approved Date(s)

20/09/2003 to 20/11/2003

Environmental Care Code

Protect Plants and Animals
Treat New Zealand's forest and birds with care and respect. They are unique and often rare.

Remove Rubbish
Litter is unattractive, harmful to wildlife and can increase vermin and disease. Plan your visits to reduce rubbish, and carry out what you carry in.

Bury Toilet Waste
In areas without toilet facilities, bury your toilet waste in a shallow hole well away from waterways, tracks, campsites and huts.

Keep Streams and Lakes Clean
When cleaning and washing, take the water and wash well away from the water source. Because soaps and detergents are harmful to water life, drain used water into the soil to allow it to be filtered. If you suspect the water may be contaminated, either boil it for at least three minutes, or filter it, or chemically treat it.

Take Care With Fires
Portable fuel stoves are less harmful to the environment and are more efficient than fires. If you do use a fire, keep it small, use only dead wood and make sure it is out by dousing it with water and checking the ashes before leaving.

Camp Carefully
When camping, leave no trace of your visit.

Keep to the Track
By keeping to the track, where one exists, you lessen the chance of damaging fragile plants.

Consider Others
People visit the back-country and rural areas for many reasons. Be considerate of other visitors who also have a right to enjoy the natural environment.

Respect Our Cultural Heritage
Many places in New Zealand have a spiritual and historical significance. Treat these places with consideration and respect.

Enjoy Your Visit
Enjoy your outdoor experience. Take a last look before leaving an area; will the next visitor know that you have been there?

Protect the environment for your own sake, for the sake of those who come after you, and for the environment itself.

Water Care Code

Find Out First
Find out and follow the regulations governing recreational use of waterways and access. They are designed to minimise conflict between users and protect everyone's health and safety.

Stay on Established Tracks and Use Existing Facilities
By using existing facilities, where these are provided, you run less chance of disturbing wildlife and damaging riverbanks and foreshores.

Take Care of Your Gear
Careless use of equipment can harm wildlife and other users.

Remove Rubbish
Litter is unattractive, harmful to wildlife and pollutes water. Plan your visit to reduce rubbish, and carry out what you carry in.

Dispose of Toilet Waste Properly
Improper disposal of toilet waste can contaminate water, damage the environment and is culturally offensive. Use disposal facilities where provided or bury waste in a shallow hole at least 50 metres away from waterways.

Be Careful with Chemicals
Use chemicals sparingly, and refuel with care. Dispose of cooking or washing water well away from the source.

Respect Our Cultural Heritage
Many New Zealand waterways have special cultural, spiritual or historical values. Treat these places with consideration and respect.

Take Only the Food You Need
When taking food from the sea or freshwater, don't overdo it. Sustain life in our waterways by taking only what you need and no more than the legal limit.

Consider Plants and Animals
Remember we are only visitors to water environments. Other animal and plant species live there all the time.

Consider Other People
Respect other visitors ... everyone has the right to enjoy the environment in safety.