GUIDELINES ON

USING BRODIFACOUM

PURPOSE

- These Guidelines are to be used by Project Managers conducting rodent and cat eradication projects based on the PII Resource Kit for Rodent and Cat Eradication.
- The Guidelines provides information on Brodifacoum – the most widely used toxin.
- See the Guidelines on Rodent Bait and Baiting for details on the methods for applying toxic bait.

1 BACKGROUND INFORMATION

- Brodifacoum is a synthetic compound developed a couple of decades ago.
- It is a very potent anti-coagulant that interferes with blood clotting in vertebrates. Death is caused by haemorrhaging. It is not thought to be lethal to invertebrates as they have a different clotting system.
- As a second-generation anti-coagulant, it is far more potent than first generation anti-coagulants such as warfarin and pindone.
- Brodifacoum is a very effective toxin for rodents because it is highly toxic (a lethal dosage can be consumed in one feeding) and slow acting (symptoms do not appear for a couple of days after feeding). The delayed onset of symptoms avoids animals becoming bait shy by associating feeling sick with eating the bait.
- Death occurs in rats within a week of eating a lethal dosage.
- Brodifacoum is not substantially metabolised, leading to the toxin remaining in the body of sub-lethally affected animals for long periods.
- Brodifacoum is the most widely used toxin in rodent eradications. Howald et al 2007 report that 71% of all successful rodent eradication projects and 91% of the total island land area eradicated of rodents used brodifacoum.

2 BRODIFACOUM IN THE ENVIRONMENT

2.1 IN WATER

- Brodifacoum has a very low solubility in water so it is highly unlikely to leach from soil into water. If eroding soils containing brodifacoum reached a waterway, the brodifacoum is likely to remain bound to organic material and settle out in sediments. Even when baits have been sown directly into streams during pest eradication operations, brodifacoum residues have not been recorded in water

- Two fenced areas on Mt Maungatautari (35ha and 65ha) in New Zealand each received two bait drops of Pestoff 20R brodifacoum cereal bait in September and October 2004. The first drop was applied at 15kg/ha and the second drop at 8kg/ha. The area immediately around the inside of both fences was hand spread. A total of 183 stream water samples were taken from four streams flowing out of the area that was baited. In each stream, samples were taken at the fence boundary and again 800m downstream. Time intervals after each drop for taking samples were 1hr, 2hrs, 3hrs, 6hrs, 9hrs, 12 hrs, 24hrs, 48hrs, 72hrs, 2 weeks, 3 months. No brodifacoum was detected in any of the samples (Mitchell & Fisher, 2005).

2.2 IN THE MARINE ENVIRONMENT

- Baits are not intentionally dropped into the marine environment but because of the need to sow bait evenly around coastal areas some inevitably goes into the sea. However, no marine species are likely to be affected given the small amount of bait that will enter the marine environment, the insolubility of brodifacoum in water, the rapid breakdown of the bait pellets and the diluting effects of wave surge.

2.3 IN SOIL

- Brodifacoum is not mobile in soil. Soil type, moisture/temperature and the presence of soil micro-organisms capable of degrading brodifacoum all affect its degradation in soil (Fisher & Fairweather 2006). Pestoff 20R baits are designed to break down following absorption of soil moisture or after rain. Where toxic baits disintegrate on the ground, brodifacoum attaches to organic matter in the soil where it is broken down by soil micro-organisms into non-toxic products. Breakdown of the poison starts as soon as rain begins to fall following bait application (Haydock & Eason 1997).

- Baits break down by swelling, cracking, then crumbling, depending on the temperature and humidity. Mould and fungi can appear rapidly. Once this happens the baits are less likely to be eaten by non-target species. Although the cereal component of the bait disappears quickly, the toxin takes longer to breakdown (Department of Conservation 2004).

- Pestoff 20R breakdown and soil residues measured at Tawharanui Regional Park in New Zealand showed that brodifacoum does not appear to contaminate soil. In this study caged baits were found to completely disintegrate after 110 days in all habitat types. Soil samples taken from directly below the baits (i.e. the worst case scenario) had residues on or below the minimum level of detection (0.02µg/g) after 110 days (Craddock, 2005).

- The low solubility of brodifacoum means that there are no effects on plants

3 RISKS

- As brodifacoum is highly toxic the risks to non-target species and people must be carefully managed throughout the project.
- Due to the persistence of brodifacoum in (target and non-target) animals that have eaten bait, secondary poisoning is a significant risk.

3.1 PEOPLE

- Humans are susceptible to brodifacoum poisoning but this could only occur if a person ate a large number of baits or they ate a large quantity of an animal that had consumed bait (such as crabs).
- People using bait in an eradication operation are unlikely to be affected. However, precautions are always taken such as pre-eradication training, wearing gloves during use, keeping bait separate from food preparation or eating areas.

AMOUNT OF BRODIFACOUM BAIT EATEN BY A HUMAN TO RESULT IN DEATH BASED ON THE LD_{50}.

	LD_{50} (mg/kg)	AVERAGE WEIGHT (kg)	AMOUNT (grams) OF 0.02 g/kg BRODIFACOUM BAIT FOR LD_{50}	AMOUNT (grams) OF 0.05 g/kg BRODIFACOUM BAIT (g) FOR LD_{50}
Child	0.25	15	187.5	75
Adolescent	0.25	30	375	150
Small adult	0.25	60	750	300
Large adult	0.25	90	1125	450

These figures represent the amount of bait that would have to be eaten in one sitting for a 50% chance of death. This is a straightforward acute toxicity calculation without any 'safety factors' that are used to extrapolate the results of animal studies to humans (Fisher and Fairweather, 2006.

- To avoid secondary poisoning it is recommended that a temporary ban be imposed on people eating any animals that may feed on the bait (such as land crabs).

3.2 NATIVE ANIMALS

- Most terrestrial vertebrate species are likely to be susceptible to brodifacoum if sufficient amounts are ingested either through primary or secondary poisoning. However, eradication project experience shows that that any deaths of non-target species in the short term is far outweighed by better survival of populations in the long term following the removal of predator species. Although there may be low levels of mortality of some species as a result of the bait application, this is insignificant at a population level.

- The most susceptible species are those that may pick up bait directly (e.g. crabs) and so get primary poisoning, or animals that feed on a species which has eaten the bait and so get secondary poisoning (e.g. birds that eat crabs, insects or rodents).

3.3 DOMESTIC ANIMALS

- Livestock are potentially at risk from primary and secondary poisoning. All livestock needs to be either removed or kept away from areas where baiting is taking place by being caged or tied up.

4. BAIT BREAKDOWN

- It is important to know how long it takes the toxin to fully breakdown and become safe in the environment so that you can establish when the island is no longer at risk from non-target species poisoning.

- Breakdown is affected by a variety of factors. Much of our understanding of breakdown of Brodifacoum has been gained from experience in non-Pacific climates and conditions. If breakdown rates are not known for your location plan to measure them by undertaking field trials in the Operational Planning Stage.

- In a study at Tawharanui Regional Park in New Zealand (Craddock 2003, 2004, 2005) it was found that most brodifacoum bait pellets take around 80 days to completely degrade. Rodent-proof cages of bait were placed in a range of environments including forest, wetlands, dune lands/beach and grasslands.

- Breakdown is often quicker on sand dunes and beaches due to exposure and high variations between minimum and maximum temperatures. Sand has an abrasive and drying effect on pellets which alters physical processes involved in bait breakdown.

- Breakdown may be quicker during high rainfall, pellets can rapidly turn to mush or be washed away

- Breakdown may be slower in forests, particularly during the final stages of degradation (condition 5 on bait breakdown scale). The forest canopy gives protection from wind, rain, humidity and temperature extremes. Bait may be sitting on a mix of leaf litter, detritus and soil, which will alter the physical processes involved in bait breakdown.

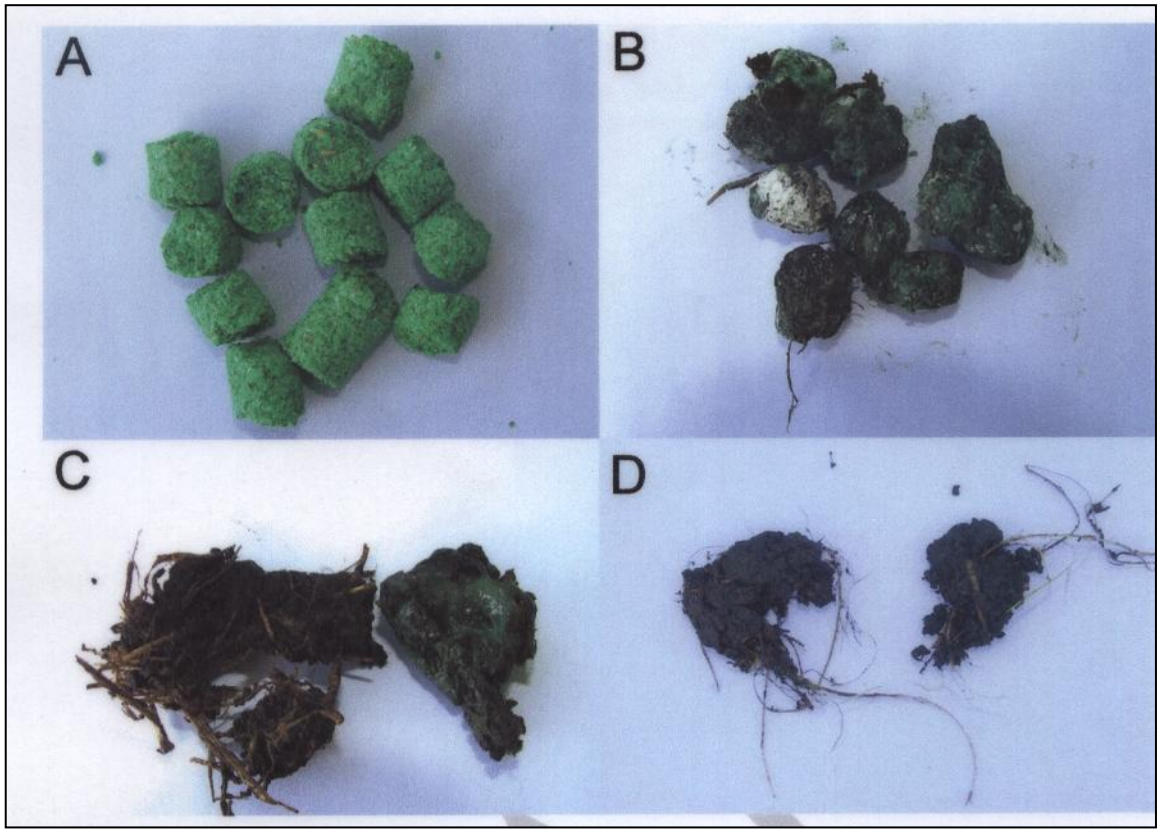
- Indirect factors that could account for the differences in bait breakdown between sites include the differences in invertebrate and fungal decomposer species using the pellets. A difference or change in these decomposer

species could potentially alter speed of pellet breakdown. Many invertebrate species were commonly observed in contact with pellets during the course of the Tawharanui trial and these are listed below.

Figure : Invertebrate species seen in contact with bait at Tawharanui

Invertebrate species	**Genus**
Spring tails	Collembola
Caterpillars	Lepidoptera
Rove beetles	Coleoptera
Snails	Gastropoda
Slugs	Gastropoda
Landhoppers	Amphipoda
Slaters	Isopoda

- Example of Bait breakdown:



Breakdown of Pestoff 20R bait after: (A) 0 days; (B) 30 days; (C) 60 days and (D) 90 days. Photo source Tim Day

5. MONITORING BAIT BREAKDOWN

- If you need to assess the rate of bait breakdown at your eradication site follow these simple steps
    - Construct a series of small cages that are rodent proof (chicken mesh works well)

Figure: Bait cage design Photo source: Paul Craddock

    - Install these in a range of representative habitats on the island.
    - Place a set number of baits (10-12) inside each cage. Make sure the cage is securely pinned to the ground to stop it being tipped over or burrowed under.
    - Use the bait breakdown condition scale to check bait breakdown each week.
    - Record the date, name of person recording, weather conditions, site number and condition of bait
    - Take photos regularly. They provide a good visual record for future work.

6. WITHHOLDING PERIOD

- Research work (Day, 2004) undertaken in New Zealand has established a withholding period for brodifacoum. This is the period of time that livestock and domestic animals need to be withheld or restricted from having access to areas where bait has been laid. The minimum withholding period is 60 days. However this may be up to 120 days and is dependent on how long it takes for 100% of the bait to completely break down. This withholding period would also apply to restrictions on harvesting species such as crabs which may take bait. This is a guide only, as the time taken for bait to break down may vary in tropical conditions.

7. BAIT PALATABILITY

- Weather patterns, particularly high rainfall, could potentially decrease the effectiveness of hand baiting or aerial baiting operations. Palatability of bait pellets to target pests is known to decrease as bait degrades (Henderson & Morriss 1996). An initial increase in rate of degradation due to high rainfall will reduce the period of time that bait pellets are palatable to pests, therefore further reducing effectiveness.

- Previous research in New Zealand has noted an effective decrease in brodifacoum concentration in pellets when they became sodden (Craddock 2003). This could potentially reduce the kill rate of these sodden pellets and thus result in sub-lethal doses in target pests.

- This shows that a period of relatively fine weather with low rainfall is required during and immediately after any aerial drop to ensure that bait pellets are at their most toxic and palatable for the longest possible time to achieve maximum kill of target pests. After that, normal rainfall will help ensure a rapid breakdown of any remaining uneaten pellets.