

# POSSUM CONTROL – HAND BROADCAST 1080 PELLET OR CARROT BAITS (with optional [deer repellent](#))

## (CONTROLLED SUBSTANCES LICENCE REQUIRED)

This document summarises research findings that underpin the key technical aspects of hand-laying 1080 baits for possum (and rat) control. This and the broader context of possum control and monitoring are reviewed in greater detail elsewhere [1].

### **Timing of operations**

- Possum feeding behaviour and body condition change throughout the year: this generally does not appear to affect the proportion of populations that eat bait [2] but the sudden appearance of ephemeral foods such as nikau flowers and hinau fruit can cause a rapid change in possum diet [3] and, though not yet verified, this may reduce possums' encounter with and consumption of baits.
- Possums are more susceptible to 1080 at lower temperatures, and kill rates tend to be higher for operations carried out on colder nights, often exceeding 90% kills on nights colder than 9° C [4]
- The traditional season of winter-early spring is therefore probably the more assured period for effective aerial 1080 operations. Furthermore, if rodents are being targeted, bait acceptance is highest in winter [5]. Local weather conditions, logistical constraints, and other factors may necessitate the operation being done at other times of the year.

### **Bait**

- Most operations use cereal-based pellet baits, though chopped carrot bait is occasionally used [6].
- Two pellet bait formulations are currently available: RS5, and No. 7 (Animal Control Products, Wanganui). Baits are cylindrical and available in three sizes: 10, 16, and 20 mm diameter with corresponding approximate mean weights of 2, 6 and 12 g.
- Carrots should be Royal Chantenay variety: this is highly palatable to possums [7]. Carrots must be washed and free of foreign objects. Carrot bait of optimal size is made using a machine in which the cutting grid has a 28-mm mesh, and small particles are then removed using a screening drum with holes measuring 18 - 22mm diameter[8]. Reliance carrot cutters are known to consistently produce good bait [9].
- 1080 is incorporated in pellets, or applied to the surface of carrot bait in the cutting machine, at 1.5 g/kg i.e. 0.15% wt:wt. Lower 1080 concentrations reduce possum kills and cause bait-shyness [10,11].
- Cinnamon oil is used to primarily to mask 1080 [12] but it also improves detection of baits by possums and enhances bait palatability [13]. At a concentration of 0.3% wt/wt, it is expected to remain effective in baits stored for up to 12 months [14]. Higher concentrations (> 0.5%) reduce the palatability of baits [7].

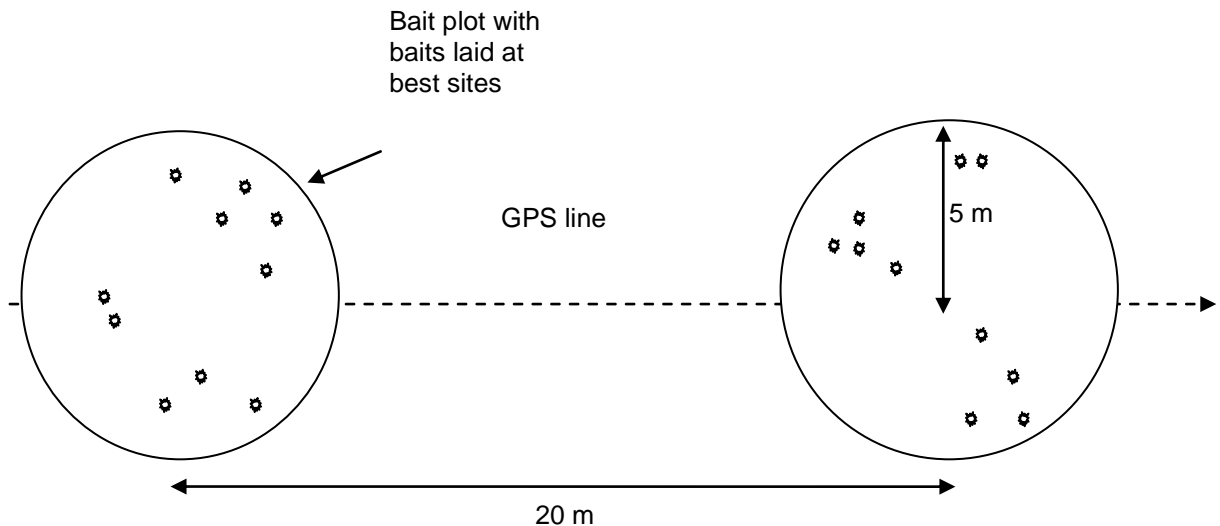
- Baits need to be hard enough to resist fragmentation during transport, handling and aerial distribution. Fragments increase the risk of sub-lethal poisoning of possums [15] and increase the hazard posed to small non-target animals [8,16]. However, palatability of baits declines with increasing hardness [7]. To avoid these problems, specifications have been developed for both maximum and minimum bait hardness, and practical methods designed for pest managers to check bait hardness [17].
- Green dye is included in bait as a bird-deterrent. Together with improved bait quality (i.e. greatly reduced fragmentation), this has reduced the risk to most bird species studied [18,19]. Risk assessment procedures [20] have been developed, and deterrent bait additives are being developed for some species that may be put at risk during 1080 operations, such as kea [21].
- Where it is necessary to protect deer, baits should be used that contain Epro Deer Repellent (EDR). EDR is effective in deterring deer from eating baits but does not deter possums [22]. Prefeed baits should also be treated with the repellent. Cinnamon is generally used at a reduced concentration of 0.075% when deer repellent is applied to baits: operational experience indicates that it may reduce the effectiveness of the deer repellent if used at higher concentrations (K. Stafford, pers.comm.) but this has yet to be experimentally verified.
- Generally, RS5 bait is used where a shorter exposure period is required (e.g. where livestock have been temporarily shifted) and where there is little chance of rain ruining the bait on the first night. 16 mm RS5 baits begin to disintegrate after 5 mm of rain, and about 40% of the 1080 leaches out of the baits with 10mm of rain [23].
- In wet forest and where a longer exposure period is sought, the No.7 bait is generally preferred as it is more water resistant [23]. 1080 begins to leach out rapidly after the first 10 mm rain [23]. This will increase the chances of possums being sub-lethally poisoned and becoming bait-shy thus jeopardising future control attempts [11]. Wet weather also reduces possum activity on the forest floor [2,24,25].
- Carrot bait is considerably more rain-resistant: almost all the 1080 was retained following 200 mm of rain [23].
- Bait must be stored in a suitable building (i.e. secure, dry, well ventilated, with a concrete floor) with no direct sunlight on stored bait. Shrink wrap around pallets should be removed to prevent the bait sweating.
- Correctly stored baits will remain adequately toxic and palatable for 12 months [14].

### **Bait application**

- The following method is based on research trials that showed it to be as cost-effective as aerial-1080 poisoning on flat, dissected terrain [26,27]. This was achieved by carrying out prefeeding aerially, then following GPS-logs of flight paths to hand lay 1080 baits. Prefeeding with non-toxic baits increases the average possum kill [28-30]. Prior exposure to non-toxic bait (i) reduces possums' wariness (neophobia) to toxic bait [28,29], (ii) leads to possums revisiting the prefeed sites [31] increasing the likelihood that possums will subsequently discover toxic baits, and (iii) reduces the likelihood of bait-shyness occurring in possums that may survive [32,33].
- Where pellet baits are used, small 10 mm baits can be used for aerial prefeeding, giving the advantage of more baits on the ground and, hence, increased rate of encounter by possums. Subsequently, it is preferable to use 20 mm baits for toxic baiting. This ensures

that possums are always exposed to a lethal dose of 1080 [10,34], and is especially important when baits are distributed in clusters covering only a small proportion of the entire area [35].

- Aerially prefeed the site along GPS-defined flight paths 100 m apart using 10-mm cereal pellets or, if carrot is used, small baits produced by an appropriate cutting grid. This saves on cost (of bait and aerial sowing) while achieving the aims of prefeeding.
- Adjust sowing equipment to deliver the bait in a swath of 60 m and at a rate of 1.7 kg/100m of flight-path. This will produce an area-wide (i.e. over the entire area, not just the baited swaths) distribution of bait of 1 kg/ha.
- Using the same GPS-defined flight paths as used for aerial prefeeding, lay toxic baits at around 5-7 days after prefeed bait has all been removed (usually 2-3 days). Follow the lines and record baiting points at 20 m intervals as waypoints.
- At each baiting point, lay 10 toxic 12-g pellet baits or carrot baits (screened to remove chaff [8]). The 1080 baits are laid by placing them at ‘best’ sites (i.e. runs, open ground, or alongside bark bitten trees etc) within an approximate radius of 5 m at each baiting point:



- Toxic bait should be broadcast onto dry ground [36] and applied during a fine weather window of at least 3 nights. Wet weather reduces possum activity on the forest floor [24,25].

### **Sustaining control over the long term**

- Monitoring conservation outcomes is essential to judge effectiveness of the control programme. Control operations are useless unless outcomes are achieved.
- Pre- and post-operational monitoring is essential to determine the effectiveness of the operation. A comparison of pre- and post- data gives the most robust estimate of the kill result. Post- data cannot reliably be compared between operations.
- It is not advisable to use the same bait more frequently than once every 3 - 4 years. This time period can be reduced if good results were achieved during the previous operation,

and the current operation is preferred, and the lure is changed. Surviving possums are highly likely to be bait shy, making frequent repeated use of 1080 cereal ineffective [37].

- Pre-feeding, and using alternative bait types and lures can improve possum kills where 1080 bait shyness has been induced when using cereal bait [11].
- Reinvasion of possums into controlled areas can be reduced using, natural boundaries e.g. waterways and pasture, and treating buffer zones of at least 3km wide [38].

## Limitations

- Incorrect use of 1080 baits can cause bait shyness that probably lasts for the lifetime of individual possums and can be significant in a possum population for at least 3 years [39].
- Labour costs increase in difficult terrain and with size of area.
- Community views on 1080 can vary, effective consultation is required.
- This technique is incompatible with other conservation work that use dogs, e.g. goat hunting, threatened species and predator work.
- Toxic carcasses can wash out of operational area posing risks to dogs.
- Handlaying operations are highly weather dependant making the exact timing of the operation unpredictable.
- Incorrect use of 1080 cereal bait can cause bait shyness that probably lasts for the lifetime of individual possums and can render further 1080 operations ineffective for at least 3 years [39].
- Reinvasion of possums into controlled areas can be reduced using natural boundaries (e.g. waterways and pasture), or treating buffer zones of at least 3km width [38].

## References

1. Warburton B, Livingstone P (2015) Managing and eradicating wildlife tuberculosis in New Zealand. *New Zealand Veterinary Journal*, 63. doi: 10.1080/00480169.2014.981315.
2. Morgan DR (2004) Maximising the effectiveness of aerial 1080 control of possums (*Trichosurus vulpecula*). PhD thesis. Lincoln University, New Zealand. 187 p. doi: 10.13140/2.1.3354.9607.
3. Nugent G, Sweetapple P, Coleman J, Suisted P (2000) Possum feeding patterns: dietary tactics of a reluctant folivore. In: Montague T, editor. *The brushtail possum: biology, impact and management of an introduced marsupial*. Lincoln, New Zealand: Manaaki Whenua Press. pp. 10-23. doi.
4. Veltman CJ, Pinder DN (2001) Brushtail possum mortality and ambient temperatures following aerial poisoning using 1080. *Journal of Wildlife Management* 65: 476-481. doi.
5. Gillies C, Campbell J, Marsh N, Gembitsky M (2003) Seasonal differences in bait acceptance by forest dwelling rats following simulated aerial 1080 possum control operations in New Zealand: interim results. *Rats, mice and people: rodent biology and management*. Pp. 343-345. doi: [http://aciar.gov.au/files/node/451/mn96rats\\_mice\\_and\\_people\\_rodent\\_biology\\_and\\_man\\_29893.pdf#page=336](http://aciar.gov.au/files/node/451/mn96rats_mice_and_people_rodent_biology_and_man_29893.pdf#page=336).
6. Morgan DR, Hickling GH (2000) Techniques used for poisoning possums. In: Montague TL, editor. *Possums in New Zealand. The biology, impact and management of an introduced marsupial*. Lincoln, New Zealand: Manaaki Whenua Press. pp. 143-153. doi.
7. Henderson RJ, Frampton CM (1999) Avoiding bait shyness in possums by improved bait standards. Landcare Research Lincoln, New Zealand. Unpublished Contract Report LC 9899/60. 56 p. doi.
8. Batcheler C (1982) Quantifying 'bait quality' from number of random encounters required to kill a pest. *New Zealand Journal of Ecology* 5: 129-139. doi: <http://newzealandecology.org/nzje/1555.pdf>.
9. Batcheler D (1996) Assessment of carrot bait produced by Gibson, Reliance, and Urquhart carrot cutters. Landcare Research, Lincoln: LC9596/52. 10 p. doi.

10. Henderson RJ, Frampton CM, Morgan DR, Hickling GJ (1999) The efficacy of baits containing 1080 for control of brushtail possums. *Journal of Wildlife Management* 63: 1138-1151. doi.
11. Morgan D, Morriss G, Hickling G (1996) Induced 1080 Bait-Shyness in Captive Brushtail Possums and Implications for Management. *Wildlife Research* 23: 207-211. doi: 10.1071/WR9960207
12. Morgan DR (1990) Behavioural response of brushtail possums *Trichosurus vulpecula* to baits used in pest control. *Wildlife Research* 17: 601-613. doi, <http://dx.doi.org/10.1071/WR9900601>
13. Morgan DR, Innes J, Frampton CM, Woolhouse AD (1995) Responses of captive and wild possums to lures used in poison baiting. *New Zealand Journal of Zoology* 22: 123 - 129. doi, <http://www.informaworld.com/10.1080/03014223.1995.9518029>.
14. Morgan DR, Arrow J (2012) Storage life of cereal pellets for possum control. Landcare Research Contract Report LC917: 19p. doi: <http://www.pestoff.co.nz/images/stories/storagetriallr.pdf>.
15. Nugent G, Morgan D, Clayton R, Warburton B (2010) Improving the efficacy of aerial poisoning of brushtail possums (*Trichosurus vulpecula*) through reduced fragmentation of bait. *International Journal of Pest Management* 57: 51-59. doi: 10.1080/09670874.2010.522265.
16. Spurr E, Powlesland R (1997) Impacts of aerial application of 1080 on non-target native fauna. *Science for conservation* (Wellington, NZ) 62: 20. doi, <http://doc.org.nz/Documents/science-and-technical/Sfc062.pdf>.
17. Morgan D (2015) Development of hardness specifications for cereal pellet possum baits. Landcare Research, Lincoln. doi.
18. Weser C, Ross JG (2012) The effect of colour on bait consumption of kea (*Nestor notabilis*): implications for deterring birds from toxic baits. *New Zealand Journal of Zoology* 40: 137-144. doi: 10.1080/03014223.2012.710639.
19. Veltman CJ, Westbrooke IM (2011) Forest bird mortality and baiting practices in New Zealand aerial 1080 operations from 1986 to 2009. *New Zealand Journal of Ecology* 35: 21-29. doi: <http://newzealandecology.org/nzje/2946.pdf>.
20. Veltman CJ, Westbrooke IM, Powlesland RG, Greene TC (2014) A principles-based decision tree for future investigations of native New Zealand birds during aerial 1080 operations. *New Zealand Journal of Ecology* 38: 103-109. doi: <http://newzealandecology.org/nzje/3101.pdf>.
21. Cowan P, Brown S, Forrester G, Booth L, Crowell M (2014) Bird-repellent effects on bait efficacy for control of invasive mammal pests. *Pest Management Science* 10.1002/ps.3887: n/a-n/a. doi: 10.1002/ps.3887.
22. Morriss GA (2007) Epro deer repellent for baits used in possum control: review of development and use 2001–2007. . . . Landcare Research, Lincoln, New Zealand. Unpublished contract report. doi, <http://www.envirolink.govt.nz/PageFiles/334/291-WCRC33.pdf>.
23. Bowen LH, Morgan DR, Eason CT (1995) Persistence of sodium monofluoroacetate (1080) in baits under simulated rainfall. *New Zealand Journal of Agricultural Research* 38: 529-531. doi, <Go to ISI>://WOS:000169111100010.
24. Ward GD (1978) Habitat use and home-range of radio-tagged possums in New Zealand lowland forest. In: Montgomery GG, editor. *The Ecology of Arboreal Folivores*. Washington D.C.: Smithsonian Institute Press. pp. 267-287. doi.
25. MacLennan DG (1984) The feeding behaviour and activity patterns of the brushtailed possum in an open eucalypt woodland in southeast Queensland. In: Smith AP, Hume ID, editors. *Possums and Gliders*. Sydney: Australian Mammal Society. pp. 151-161. doi.
26. Morgan D (2014) Ground-laid toxic baiting (with 1080 and cholecalciferol) after aerial prefeeding for possum and rat control. Landcare Research, Lincoln, New Zealand. Unpublished contract report. 37 p. doi: 10.13140/RG.2.1.2116.8162
27. Morgan D, Warburton B, Nugent G (2015) Aerial prefeeding followed by ground-based toxic baiting for more efficient and acceptable poisoning of invasive small mammalian pests. *PLoS One* In press. doi.
28. Henderson RJ, Frampton CM (1999) Avoiding Bait Shyness in Possums by Improved Bait Standards. Landcare Research, Lincoln: LC9899/60. 54 p. doi.
29. Nugent G, Turner J, Warburton B (2009) Sustained recall of bait acceptability in captive brushtail possums (*Trichosurus vulpecula*). *New Zealand Journal of Zoology* 36: 473-478. doi: 10.1080/03014223.2009.9651479.
30. Nugent G, Warburton B, Thomson C, Sweetapple P, Ruscoe WA (2011) Effect of prefeeding, sowing rate and sowing pattern on efficacy of aerial 1080 poisoning of small-mammal pests in New Zealand. *Wildlife Research* 38: 249-259. doi: <http://dx.doi.org/10.1071/WR10198>.
31. Warburton B, Clayton R, Nugent G, Graham G, Forrester G (2009) Effect of prefeeding on foraging patterns of brushtail possums (*Trichosurus vulpecula*) about prefeed transects. *Wildlife Research* 36: 659-665. doi: <http://dx.doi.org/10.1071/WR09047>.

32. Moss ZN, O'Connor CE, Hickling GJ (1998) Implications of prefeeding for the development of bait aversions in brushtail possums (*Trichosurus vulpecula*). *Wildlife Research* 25: 133-138. doi: 10.1071/WR97018
33. Ross JG, Hickling GJ, Morgan DR, Eason CT (2000) The role of non-toxic prefeed and postfeed in the development and maintenance of 1080 bait shyness in captive brushtail possums. *Wildlife Research* 27: 69-74. doi.
34. Frampton CM, Warburton B, Henderson RJ, Morgan DR (1999) Optimising bait size and 1080 concentration (sodium monofluoroacetate) for the control of brushtail possums (*Trichosurus vulpecula*). *Wildlife Research* 26: 53-59. doi.
35. Nugent G, Morriss GA (2013) Delivery of toxic bait in clusters: a modified technique for aerial poisoning of small mammal pests. *New Zealand Journal of Ecology* 37: 246-255. doi, <Go to ISI>://000326145200013.
36. Henderson RJ, Morgan DR, Eason CT (1999) Manual of Best Practice for Ground Control of Possums (Version 1.0). Landcare Research, Lincoln: LC9899/84. 82 p. doi.
37. Henderson RJ, O'Connor CE, Morgan DR (1999) Current practices in sequential use of possum baits. Department of Conservation, Wellington: 22. 122 p. doi.
38. Cowan PE (2000) Factors affecting possum reinfestation--implications for management. Department of Conservation, Wellington: 144. 23 p. doi.
39. O'Connor CE, Matthews LR (1999) 1080-induced bait aversions in wild possums: influence of bait characteristics and prevalence. *Wildlife Research* 26: 375-381. doi.