



Agreement on the Conservation of Albatrosses and Petrels

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New Zealand Management of Introduced Mammals - Bibliography

Department of Conservation, New Zealand

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One of the greatest threats to seabird populations is the introduction of alien species to new environments. Many seabird species now only breed on offshore islands that have not been colonised by introduced mammals. Seabirds breeding in New Zealand are preyed upon by Norway rats, ship rats, kiore, cats, stoats, ferrets, pigs, and dogs. These predators are capable of killing adults of smaller seabird species as well as chicks and eggs. Storm and diving petrels are particularly impacted by the presence of mammalian predators. Seabirds are also affected by introduced mammalian herbivores that destroy habitats through browsing, trampling nests (killing adults, eggs, and chicks), increasing erosion, reducing nesting cover or competing for burrows. Problem species include goats, rabbits, possums, deer, chamois, wild sheep, and feral cattle.

The eradication of introduced mammals, both predators and herbivores, is an important conservation tool to protect seabird species. New Zealand has pioneered many eradication techniques resulting in the successful removal of introduced mammals from both offshore islands and mainland sites. Below is an annotated bibliography of published material outlining eradication programmes employed in New Zealand to control or remove introduced mammals.

Brown, D. A. (1997). An operational plan for the eradication of feral pigs (*Sus scrofa*) from the Auckland Islands Nature Reserve, New Zealand. Department of Conservation, Southland Conservancy. 62 p.

Describes the effects that the Auckland Islands pig population has on the natural community and reviews the plan for their eradication. This review states that pigs could be eradicated within 4-7 years using techniques that include aerial shooting, poisoning, trapping, dogs and hunting. Bait stations with warfarin-loaded baits would be the main means of population reduction.

Brown, K., Keedwell, R. (1998) Alphachloralose control operations at southern black-backed gull colonies in the Tekapo and Ahuriri Valleys. RCD Predator Control Programme Report No. 1. Department of Conservation, Twizel, N. Z.

Reviews the control of black-backed gulls (*Larus dominicanus*) at colonies near nesting black stilts (*Himantopus novaezelandiae*). Operations were carried out in November and December 1997 using alphachloralose. The objective of this project was to minimise the risk of black-backed gull predation on black stilt chicks.

Brown, K. P., Sherley, G. H. (2002). The eradication of possums from Kapiti Island, New Zealand. In: Turning the Tide: the eradication of invasive species. IUCN SSC Invasive Species Specialist Group. IUCN, Gland, Switzerland and Cambridge, UK. Veitch, C. R., and Clout, M. N. (eds.). Pages 46-52.

<http://www.hear.org/articles/turningthetide/turningthetide.pdf>

Reviews the eradication of brushtail possums (*Trichosurus vulpecula*) from Kapiti Island. Control began in 1980 with eradication being achieved in October 1986 through the use of traps, dogs and guns. From this operation we have learned that dogs and intensive trapping are effective tools for eradicating possums from large areas of land where re-invasion is prevented.

Brown, K. P., Ulrich, S. C. (2005) Aerial 1080 operations to maximise biodiversity protection. *DOC Research & Development Series 216*. Department of Conservation, Wellington. 36 p.

<http://www.doc.govt.nz/Publications/004~Science-and-Research/DOC-Research-and-Development-Series/PDF/drds216.pdf>

Identifies important aerial 1080 strategic and operation issues to maximise biodiversity protection: Biodiversity objectives must be defined, biodiversity health and possum abundance should be used to determine control return times, and an adaptive management approach should be used to determine whether or not aerial 1080 operations can enhance and maintain communities.

Carlaw, G., Julian, A., Cutting, M. L., Jamieson, A., Clunie, N. M. U. (1998) Possum control in the Auckland Region. Part 1, Possum control in the Auckland Conservancy. Part 2, Setting Priorities for possum control in areas of indigenous vegetation in the Auckland Region. Auckland, N. Z. Auckland Regional Council. 184 p.

Summarises possum control operations undertaken before and during 1997, and provides information on possum control proposed for the future.

Clapperton, B. K. (2006) A review of current knowledge of rodent behaviour in relation to control devices. *Science for Conservation 263*. 55 p.

<http://www.doc.govt.nz/Publications/004~Science-and-Research/Science-for-Conservation/PDF/sfc263.pdf>

A review of the literature on rodent behaviour in relation to control devices, in particular bait stations and baits. Their behaviour in response to sounds, repellents and traps are also summarised. Overall this may provide a better understanding of how best to manage the four introduced rodent species in New Zealand.

Clapperton, B. K., Day, T. D. (2001) Cost-effectiveness of exclusion fencing for stoat and other pest control compared with conventional control. *DOC Science Internal Series 14*. Department of Conservation, Wellington. 19 p.

<http://www.doc.govt.nz/Publications/004~Science-and-Research/DOC-Science-Internal-Series/PDF/DSIS14.pdf>

A review outlining the advantages and limitations of using exclusion fencing for pest control. Generally fencing is a cost-effective option for larger reserve areas and may also be for smaller areas.

Clapperton, B. K., Porter, R. E. R. (2005) Efficacy of micro-encapsulated zinc phosphide as a poison for ferrets. *DOC Internal Series 197*. Wellington, N. Z. Department of Conservation. 11 p.
<http://www.doc.govt.nz/Publications/004~Science-and-Research/DOC-Science-Internal-Series/PDF/dsis197.pdf>

A report on the efficacy of MEZP as a poison for ferrets (*Mustela furo*). MEZP was demonstrated to be an effective poison, but whether or not it is humane needs to be discussed.

Cook, P., Maloney, R. (1999) Black stilt predator control report. *Black Stilt Project Internal Report No. 99/03*. Department of Conservation, Twizel. 25 p.

A report on the predator control at the Mackenzie-Waitaki Basin during the 1998 black stilt breeding season. Nests and chick rearing attempts were also monitored in trapped and un-trapped sites. Trapping was shown to have a significant effect on increasing chick rearing success and overall losses of nests to predators were low.

Cowan, P. E. (1988) The eradication of possums from Kapiti Island progress report 1987/88. New Zealand. Department of Conservation. Science and Research Directorate New Zealand. Ecology Division.

A report on the monitoring of trapper activities during possum control in 1980-82 and the final eradication of possums in 1983-86.

Cowan, P. E. (1992). The eradication of introduced Australian brushtail possums, *Trichosurus vulpecula*, from Kapiti Island, a New Zealand nature reserve. *Biological Conservation* 61(3): 217-226

Reviews the eradication of possums from Kapiti Island. Eradication began in 1980 with the island being divided into blocks. The operation was deemed successful in 1986, after the use of trapping, aerial poisoning and dogs. Comments are made on why the eradication was successful and lessons for future eradication attempts are outlined.

Cowan, P. E. (1996) Possum biocontrol: prospects for fertility regulation. *Reproduction, Fertility and Development* 8(4): 655-660

Much of the information necessary for the development of possum immunocontraception is lacking. This paper discusses the key components for the

success of this approach to possum control and also reviews the political and social issues around such an approach.

Cowan, P. E. (2000) Factors affecting possum re-infestation – implications for management. *Science for Conservation* 144. 23 p.
<http://www.doc.govt.nz/Publications/004~Science-and-Research/Science-for-Conservation/PDF/sfc144.pdf>

Reviews the literature on possum dispersal and reinvasion after control and from this identifies changes in management procedures that might help to minimise re-infestation.

Cromarty, P. L., Broome, K. G., Cox, A., Empson, R. A., Hutchinson, W. M., McFadden, I. Eradication planning for invasive alien animal species on islands – the approach developed by the New Zealand Department of Conservation. In: *Turning the Tide: the eradication of invasive species*. IUCN SSC Invasive Species Specialist Group. IUCN, Gland, Switzerland and Cambridge, UK. Veitch, C. R., and Clout, M. N. (eds.). (2002) Pages 85-91.
<http://www.hear.org/articles/turningthetide/turningthetide.pdf>

A review of the Department of Conservation's approach to invasive animal species eradication. This approach can be applied wherever eradication of invasive alien animal species on islands is planned.

Department of Conservation 1999: Progress in mammal pest control on New Zealand conservation lands. *Science for Conservation* 127, x + 74 p

- 1) Spurr, E. B. (1999) Developing a long-life toxic bait and lures for mustelids. *Science and Conservation* 127A: 1-24.**
<http://www.doc.govt.nz/Publications/004~Science-and-Research/Science-for-Conservation/PDF/Sfc127A.pdf>

A study testing potential baits and lures for mustelids. Of all long-life baits tested only one, a developmental cat bait called PussOff®, was found to be reasonably palatable to stoats (*Mustela erminea*). Stoats were highly attracted to the smell of dead day-old chickens, dead mice, raw meat and raw hen eggs but not to any of the artificial odours or flavours tested. Suitable toxins were found to be sodium monofluoroacetate (1080), diphacinone and cholecalciferol.

- 2) Spurr, E. B., O'Connor, C. E. (1999) Sound lures for stoats. *Science for Conservation* 127B: 25-38.**
<http://www.doc.govt.nz/Publications/004~Science-and-Research/Science-for-Conservation/PDF/Sfc127B.pdf>

A study testing the effectiveness of sound lures for stoat capture. Bird and mammal distress calls were used. Analogue recordings of starling, silvereye and house-sparrow calls did not attract stoats but digital recordings of chick, mouse

and stoat calls did. As the interaction of these two effects (sound quality and call type) was not tested, this study was unable to determine the effect to which the stoats were reacting.

- 3) **Thomas, M. D. (1999) Feasibility of using wax blocks to measure rodent and possum abundance and changes in populations size. *Science for Conservation 127C*: 39-48.**
<http://www.doc.govt.nz/Publications/004~Science-and-Research/Science-for-Conservation/PDF/Sfc127C.pdf>

A study testing the feasibility of an alternative rodent and possum monitoring technique. Bite marks in wax blocks were tested as a possible way of indicating the presence of a species, as well as the species' abundance both before and after poisoning operations. This method was found to be suitable and more user-friendly than the current monitoring method.

- 4) **Thomas, M., Young, N. (1999) Preliminary trial of a water-resistant bait for feral pig control. *Science for Conservation 127D*: 49-55.**
<http://www.doc.govt.nz/Publications/004~Science-and-Research/Science-for-Conservation/PDF/Sfc127D.pdf>

A study investigating the development of a baiting method as an alternative to shooting feral pigs. Water-resistant pig bait containing warfarin was developed that could be both buried and used in bait stations. Further trials are recommended, using encapsulated cyanide as the toxin, which would be both more humane and environmentally friendly.

- 5) **Wickstrom, M. L., Eason, C. T. (1999) Literature search for mustelid-specific toxicants. *Science for Conservation 127E*: 57-65.**
<http://www.doc.govt.nz/Publications/004~Science-and-Research/Science-for-Conservation/PDF/Sfc127E.pdf>

A literature search to determine whether or not mustelids appear to be sensitive to a particular class of foreign compound which could be exploited for the design of a targeting toxicant. It was found that mustelids appear to be unusually sensitive to planar organochlorine compounds, oestrogen analogues, pyrethrin / pyrethroid-type insecticides, methaemoglobin inducing agents, and possibly non-steroidal anti-inflammatory agents. Of these, methaemoglobin-inducing agents are the most humane and non-persistent.

- 6) **Wickstrom, M., Thomas, M., Henderson, R., Eason, E. T. (1999) Development and evaluation of baits for feral cat control. *Science for Conservation 127F*: 67-74.**
<http://www.doc.govt.nz/Publications/004~Science-and-Research/Science-for-Conservation/PDF/Sfc127F.pdf>

A study comparing the efficacy and palatability of two sodium monofluoroacetate (1080) baits to feral cats (*Felis catus*). The two baits used were polymer-coated bait (BaitTek) and dry protein meal bait (Landcare Research). In pen trials the average consumption on the Landcare Research bait was greater than the BaitTek

bait. In field trials few cats were found dead in the areas of both bait types and it is thought that they were deterred by the abundance of natural food.

Dilks, P. J., O'Donnell, C. F. J. (1996) The effect of bait type, tunnel design, and trap position on stoat control operations for conservation management. *New Zealand Journal of Zoology* 23: 295-306
<https://www.rsnz.org/publish/nzjz/1996/109.pdf>

Tests the effectiveness of different bait types, tunnel designs and trap positions on trapping stoats. The study was carried out during stoat population irruptions in Eglinton Valley, Fiordland and Hawdon Valley near Arthur's pass in the summers of 1990/91, 1991/92 and 1992/93. Stoats were most attracted to broken and hard boiled eggs and almost equal numbers were caught in camouflaged traps compared to the more practical visible traps, and in single entrance traps compared to those that were double ended. More stoats were caught at the edges of a trapping grid than within it.

Eason, C. T., Murphy, E. C., Wright, G. R. G., Spurr, E. B. (2001) Assessment of risks of brodifacoum to non-target birds and mammals in New Zealand. *Ecotoxicology* 11(1): 35-48

Review of the risks of brodifacoum to non-target species. Brodifacoum is highly toxic to birds and mammals and will persist for a long time in organs such as the liver, kidney and pancreas. New Zealand operations using this toxin have resulted in primary and secondary poisoning of non-target species such as the weka, pukeko, southern black-backed gull, kiwi and introduced mammals. In view of this, all pest control activities require risk-benefit assessment prior to their operation and it is recommended that wildlife is monitored for pesticide residues.

Empson, R. (1996) Kapiti Island rat eradication operation plan. Wellington, N.Z., Department of Conservation, Wellington Conservancy 19 p.

Empson, R. A., Miskelly, C. M. (1999). The risks, costs and benefits of using brodifacoum to eradicate rats from Kapiti Island, New Zealand. *New Zealand Journal of Ecology* 23(2): 241-254
http://www.nzes.org.nz/nzje/free_issues/NZJEcol23_2_241.pdf

Reviews the eradication of rats from Kapiti Island. Eradication of Norway and Pacific rats began in 1996. Before this took place, baseline data on the status of vegetation, birds, invertebrates and reptiles was gathered so their response could be measured, and trials with non-toxic baits were run to determine risks to non-target species. Talon 7-20 bait with brodifacoum was used. Non-target bird deaths did occur but their loss appears to have been greatly made-up for by improved breeding success and recruitment to bird populations.

Fisher, P. (2005) Review of house mouse (*Mus musculus*) susceptibility to anticoagulant poisons. *DOC Science Internal Series 198*. Wellington, N. Z. Department of Conservation. 19 p.
<http://www.doc.govt.nz/Publications/004~Science-and-Research/DOC-Science-Internal-Series/PDF/dsis198.pdf>

House mice were found to be most susceptible to second-generation anticoagulants, particularly brodifacoum. The efficacy of toxic baits however needs to be weighed against their potential for adverse effects on non-target species.

Gillies, C. A., Pierce, R. J. (1999) Secondary poisoning of mammalian predators during possum and rodent control operations at Trounson Kauri Park, Northland, New Zealand. *New Zealand Journal of Ecology* 23(2): 183-192
http://www.nzes.org.nz/nzje/free_issues/NZJEcol23_2_183.pdf

Describes the effects of a possum poison baiting operation using 1080 and brodifacoum. Secondary poisoning was found to occur, with its effect being much reduced under continuous baiting strategies compared to initial operations. Implications for conservation are given and suggestions are made towards using secondary poisoning as a multi-species management tool.

Greene, T. C., Dilks, P. J. (2004) Effects of a non-toxic bait application on birds: Assessing the impacts of a proposed kiore eradication programme on Little Barrier Island. *DOC Science Internal Series 175*. Department of Conservation, Wellington. 16 p.
<http://www.doc.govt.nz/Publications/004~Science-and-Research/DOC-Science-Internal-Series/PDF/dsis175.pdf>

Investigates the impacts of a proposed aerial toxin kiore eradication on a number of bird species. Only 1 bird out of 105 captured showed any evidence of having eaten the bait, demonstrating that the benefits of such an eradication would far outweigh any perceived risks.

Imber, M., Harrison, M., Harrison, J. (2000) Interactions between petrels, rats and rabbits on Whale Island, and effects of rat and rabbit eradication. *New Zealand Journal of Ecology* 24(2): 153-160
http://www.nzes.org.nz/nzje/free_issues/NZJEcol24_2_153.pdf

Reviews the effects of Norway rats on the grey-faced petrel population on Whale Island and how this was facilitated by the introduction of rabbits. Baiting began in 1978 with anticoagulants and was repeated in 1980 and 1982. Brodifacoum baits were then used in 1985, leading to a great decrease in the rat population. Rabbit poisoning in later years eventually led to the eradication of both mammals in late 1987. Since then, petrel breeding success has increased.

Innes, J., Barker, G. (1999) Ecological consequences of toxin use for mammalian pest control in New Zealand – an overview. *New Zealand Journal of Ecology* 23(2): 111-127

http://www.nzes.org.nz/nzje/free_issues/NZJEcol23_2_111.pdf

Examines the effects of toxins at the community and ecosystem level through the use of foodwebs. Suggestions are made as to how research on toxin use should continue and as to how ecosystem management could be improved. This paper suggests that the ecological costs of using toxins are much less than the damage costs if they are not used.

Innes, J., Warburton, B., Williams, D., Speed, H., Bradfield, P. (1995) Large-scale poisoning of ship rats (*Rattus rattus*) in indigenous forests of the North Island, New Zealand. *New Zealand Journal of Ecology* 19(1): 5-17

http://www.nzes.org.nz/nzje/free_issues/NZJEcol19_1_5.pdf

Nine poison operations of ship rats are described using a variety of poisons (1080, brodifacoum or pindone). In general rat populations were found to decline greatly but were able to recover within 4-5 months. It is therefore suggested that operations with the aim of protecting nesting birds take place at the onset of nesting and are repeated each year. It is necessary to develop methods that maintain low pest densities after the initial knock-down to reduce the cost of sustained control.

King, S. Eradication of rats from Campbell Island: report of result monitoring for the eradication of Norway rats (*Rattus norvegicus*) on the Campbell Island Nature Reserve. Invercargill, N. Z. Department of Conservation, Southland conservancy (2003). 20 p.

A report of the Department of Conservation's project to eradicate Campbell Island's last remaining introduced mammalian species, the Norway rat. The operation began in July 2001 using aerial baiting of pellets containing 20ppm brodifacoum (see McClelland, 2001). This report discusses the results of a follow up visit which took place in May-April 2003. Results indicate that the eradication operation was successful.

Leigh, A. (1994) Goats on Great Barrier Island: a feasibility study for eradication. Unpublished Report. New Zealand, Department of Conservation, Auckland Conservancy.

Reviews the impacts of feral goats and the history of goat control at a national level and, specifically, on Great Barrier Island. Three options for feral goat control on Great Barrier Island are given, along with the conditions that need to be met prior to commencing eradication programmes.

Leseberg, A., Wahlberg, E., Maloney, R. (2005) Tasman Valley predator control project report, March 2004 – February 2005. *Kaki Project Internal Report. No. 05/04.* Department of Conservation, Twizel Area Office. 35 p.

A report of the Tasman Valley predator control project which aims at reducing predator densities in the Tasman Valley area over several years. The three aims of the project are to kill predators using mostly a combination of kill and live capture traps, to assess the effectiveness of the operation and provide targets for future pest control, and to measure the benefits of this control to native species.

**Lovegrove, T. G., Zeiler, C. H., Greene, B. S., Green, B. W., Gaastra, R., MacArthur, A. D. Alien plant and animal control and aspects of ecological restoration in a small 'mainland island': Wenderholm Regional Park, New Zealand. In: Turning the Tide: the eradication of invasive species. IUCN SSC Invasive Species Specialist Group. IUCN, Gland, Switzerland and Cambridge, UK. Veitch, C. R., and Clout, M. N. (eds.). (2002) Pages 155-163.
<http://www.hear.org/articles/turningthetide/turningthetide.pdf>**

Ecosystem-focused ecological restoration has been undertaken in Wenderholm Regional Park since 1965. During that time fencing has been used to exclude livestock, reforestation has occurred, brushtail possums and rat densities have been reduced to very low numbers, and feral cats and mustelids have been controlled. This paper reviews these operations and their results along with the translocation of North Island robins to the site.

McClelland, P. (2000) Eradication of kiore from Putauhinu and Rarotoka (Centre) islands. Invercargill, N. Z. Department of Conservation, Southland Conservancy. 10 p.

A report on the eradication of kiore (*Rattus exulans*) from Putauhinu and Rarotoka islands on August 1997 using aerial bait drops.

McClelland, P. (2001) Operational report for rat (*Rattus norvegicus*) eradication on the Campbell Island Nature Reserve. Unpublished report, DOC Southland Conservancy.

A report on the eradication of the Norwegian rat on Campbell Island. The operation took place in July 2001, using aerial baiting with brodifacoum toxin. The results of this eradication were followed up in 2003 (see King, 2003).

**McClelland, P. Eradication of Pacific rats (*Rattus exulans*) from Whenua Hou Nature Reserve (Codfish Island), Putauhinu and Rarotoka Islands, New Zealand. In: Turning the Tide: the eradication of invasive species. IUCN SSC Invasive Species Specialist Group. IUCN, Gland, Switzerland and Cambridge, UK. Veitch, C. R., and Clout, M. N. (eds.). (2002) Pages 173-181.
<http://www.hear.org/articles/turningthetide/turningthetide.pdf>**

A report on the eradication of pacific rats from Whenua Hou Nature Reserve and Putauhinu and Rarotoka Islands. The Putauhinu and Rarotoku eradications took place in 1997 in preparation for the Codfish Island eradication which took place in 1998. Bait containing brodifacoum was aerially dropped for each operation, with bait stations also being used in conjunction with this for Codfish Island. The eradications were deemed successful.

McFadden, I. (1992) Eradication of kiore (*Rattus exulans*) from Double Island, Mercury Group in northern New Zealand. *Science & Research Internal Report 130*. Department of Conservation, Wellington. 12 p.

Reviews the eradication of kiore from Double Island. Eradication took place in 1989 using Flocoumafen and bromadiolone on the larger and smaller islets respectively. Both eradications were deemed successful. For future eradications it is suggested that aerial applications of poisons be made on all islands greater than 50 ha, and that size should be no barrier to rodent eradication. Non-target kills should be carefully monitored however, and may be expected to increase on larger islands.

McFadden, I., Towns, D. (1991) Eradication campaigns against kiore (*Rattus exulans*) on Rurima Rocks and Korapuki, northern New Zealand. *Science and Research Internal Report 97*. Department of Conservation, Wellington. 18 p.

Describes two campaigns against kiore using 1080 and bromadiolone toxins. The toxins were dispensed amongst maize at silos. The rats were found to be able to detect 1080 but were highly susceptible to bromadiolone. Kiore were eradicated from Rurima Island after three applications of this toxin and from Korapuki Island after one application. This report concludes that the use of these methods should be effective against rats on islands up to 50 ha.

Miller, C. J. (1993). An evaluation of two possum trap types for catch-efficiency and humaneness. *Journal of the Royal Society of New Zealand*. 23(1): 5-11

Two traps, the Soft Catch™ padded leg-hold trap and the Timms™ kill-trap are compared for their catch-efficiency and humaneness. The traps were set out on two islands in the Hauraki Gulf during work on an eradication plan. The Soft Catch trap was found to be more suitable than the Timms, with both higher catch-efficiency and humaneness.

Miskelly, C. M. (1994) Management of weka on Kapiti Island during and following attempted rat eradication. Department of Conservation, Wellington. 19 p.

A report on the management of weka over the period of rat eradication on Kapiti Island. Rats were eradicated from Kapiti Island in 1996 and the weka population was expected to be extremely vulnerable to primary and secondary poisoning.

Moore, P., O'Connor, S., Hedley, G., Goomes, R. (2001) Chatham Island oystercatcher – report of 1999/2000 field season. *Science & Research Internal Report 189*. Department of Conservation, Wellington. 64 p.
<http://www.doc.govt.nz/Publications/004~Science-and-Research/Older-series/PDF/ir189.pdf>

A description of the predator control used at the Chatham Island oystercatcher colonies. A mixture of leghold traps and cage traps were used as well as fencing and results of predators caught are reported.

Morgan, D. R. (2004) Enhancing maintenance control of possum populations using long-life baits. *New Zealand Journal of Botany* 31(4): 271-282
<http://www.rsnz.org/publish/nzjz/2004/029.pdf>

Development of toxic baiting methods for 'continuous' control of possum populations is desirable to prevent re-infestation between annual operations. This study presents the results from six such methods, designed for prolonged field life. Cholecalciferol gel bait is suggested as a new tool as it was found to remain effective for greater than 2 years in the field.

Morgan, D. R., Eason, C. T., Clapperton, K. Development of a toxic bait and baiting strategy for feral cat control. Christchurch, N. Z. Forest Animal Ecology Section, Forest and Wildland Ecosystem Division, Forest Research Institute (1990) 22 p.

A description of the development of chemical control techniques for feral cat populations. Polymer-bound and cat bait should be further developed by adding the preferred flavours and using catnip as an attractant. It was found that bait toxicity or size should be increased to ensure that eating one bait is sufficient to kill all cats. Differences were also found in cats' and possums' agility and this should be further exploited to develop a cat-specific bait station, with possibilities for bird exclusion also being tested.

Morgan, D. R., Innes, J., Ryan, C., Meikle, L. Baits and baiting strategies for multi-species pest control and feral cats. Wellington, N. Z. Department of Conservation. 1996. *Science for Conservation* 40, 27 p.
<http://www.doc.govt.nz/Publications/004~Science-and-Research/Science-for-Conservation/PDF/sfc040.pdf>

A description of the development of multi-species baiting and an assessment of the use of brodifacoum and alphachloralose as toxins for feral cat control. Multi-species baiting could prove more sustainable than targeting a single-species and so a 2-year study was carried out to determine its feasibility and effectiveness. Trials testing the response of possums, cats, rats and mice to different baits after they had been stored together showed that RS5 possum bait, ACP cat bait and Talon 20p rodent bait

palatability was generally unaffected, apart from a reduction in mouse consumption of Talon 20p when mixed. A field trial to test the efficacy of multi-species control was conducted but in the end was unsuccessful, with only rat populations being successfully reduced (98% reduction). Ways of improving the success of future field trials are suggested. Neither brodifacoum nor alphachloralose toxins were found to be more effective than the commonly used sodium monofluoroacetate (1080) cat baits.

Morgan, D. R., Wright, G. R., Ogilvie, S. C., Pierce, R., Thomson, P. (1996) Assessment of the environmental impact of brodifacoum during rodent eradication operations in New Zealand. *Proc. 17th Vertebr. Pest Conf.* (R. M. Timm & A. C. Crabb, Eds.) Published at University of California, Davis.

Documents the effects of brodifacoum when aerially distributed on Red Mercury Island and distributed using bait-stations on Coppermine Island. Invertebrates, blackbirds, soil and water were monitored for residues of the toxin. Water, soil and most invertebrates were found to have no brodifacoum residues. Birds found both dead and alive were found to have low-moderate concentrations however. The unlikelihood of invertebrates accumulating the toxin suggests that birds were killed by primary poisoning. This therefore calls for further monitoring to determine the effects of baiting on population levels of such species.

**Mowbray, S. C. Eradication of introduced Australian marsupials (brushtail possum and brushtailed rock wallaby) from Rangitoto and Motutapu Islands, New Zealand. In: *Turning the Tide: the eradication of invasive species*. IUCN SSC Invasive Species Specialist Group. IUCN, Gland, Switzerland and Cambridge, UK. Veitch, C. R., and Clout, M. N. (eds.). (2002) Pages 226-232.
<http://www.hear.org/articles/turningthetide/turningthetide.pdf>**

Eradication began in 1990 with a 1080 aerial drop. Ground work using dogs, hunting, trapping and bait stations then took place from 1990-1997 to complete the eradications on both Islands. The operations have been successful in restoring forests.

Munn, A. (1998) Operational plan for the eradication of goats (*Capra hircus*) from the Clinton Valley area of Fiordland National Park. Invercargill, N. Z. Department of Conservation, Southland Conservancy 15 p.

A report on the operational plan for the Clinton Valley goat eradication. It is proposed that goats can be eradicated within three to five years and that hunting with dogs will be the most effective method.

**Murphy, E. C., Clapperton, B. K., Bradfield, P. M. F., Speed, H. J. (1998) Brodifacoum residues in target and non-target animals following large-scale poison operations in New Zealand podocarp-hardwood forests. *New Zealand Journal of Zoology* 25:307-314
<http://www.rsnz.org/publish/nzjz/1998/30.pdf>**

Brodifacoum cereal baits were presented in bait stations in North Island podocarp-hardwood forests during ship rat control operations. Results of residue levels in non-target animals are reported and display the potential ecological and health risks of such operations.

Murray, W. (2004) Predator control on Matakana Island. August 2003-March 2004. Department of Conservation. Rotorua Conservancy. 11 p.

A report on the fourth season of the Matakana Island predator control operation. Pest control was implemented as part of the Dotterel Breeding Program. The predator kill rate was successful during this season, with the low number of pests caught indicating that consistent predator control is having an impact.

Nogales, M., Martin, A., Tershy, B. R., Donlan, C. J., Veitch, D., Nestor, P., Wood, B., Alonso, J. (2004) A review of feral cat eradication on islands. *Conservation Biology* 18(2): 310-319

<http://www.blackwell-synergy.com/doi/full/10.1111/j.1523-1739.2004.00442.x>

Reviews the history of cat eradication worldwide, including the approaches taken and the resulting successes and challenges. Feral cats have been removed from ten islands in New Zealand. These islands are mostly small however and new, more efficient techniques, as well as current techniques, will likely be needed for success on larger islands.

O'Connor, C. E. (2002) Evaluation on new toxins for mustelid control. DOC Science Internal Series 56. Department of Conservation, Wellington. 14 p.

A report of the susceptibility of stoats and ferrets, as well as non-target species, to a new predator control compound called MNT. Stoats and ferrets were found to be susceptible and death by MNT was described as relatively humane. The non-target species, possums and wallabies, were also found to be susceptible but at higher doses, however ducks were susceptible at a similar dosage to mustelids.

O'Donnell, C. F. J., Dilks, P. J. (1996) Control of a stoat (*Mustela erminea*) population irruption to enhance mohua (yellowhead) (*Mohua ochrocephala*) breeding success in New Zealand. *New Zealand Journal of Zoology* 23: 279-286

<https://www.rsnz.org/publish/nzjz/1996/107.pdf>

Tests the hypotheses that adequate control of stoats by trapping is possible and that it is a viable management option to assist mohua recovery. Breeding success of mohua is compared between trapped and untrapped areas during a year of stoat population irruption and the two years following. Eighty percent of nests in the trapped area fledged young while only 36% were successful in the untrapped area. Breeding success was also greater in the following two years, suggesting that traps should continue to be used in the year after a stoat population irruption.

Ovenden, B., Merrifield, K. (2004) Operational report for Operation Egmont aerial 1080: September 2003. Stratford, N. Z. Department of Conservation, Stratford Area Office. 18 p.

Reviews the possum control operation of Egmont National Park. The operation took place in the winter of 2002 using 1080.

Parkes, J., Murphy, E. (2004) Risk assessment of stoat control methods for New Zealand. *Science for Conservation* 237. 38 p.

<http://www.doc.govt.nz/Publications/004-Science-and-Research/Science-for-Conservation/PDF/sfc237.pdf>

Reviews current and potential stoat control methods, identifies risks and constraints and suggests possible methods to overcome these.

Parkes, J. P., Murphy, E. C. (2003) Management of introduced mammals in New Zealand. *New Zealand Journal of Zoology* 30: 335-359

<https://www.rsnz.org/publish/nzjz/2003/029.pdf>

This paper summarises the management of introduced mammals in New Zealand as both pests and resources, discusses management options and states ways in which management agencies could better integrate their actions. Of the 31 exotic mammal species in New Zealand, at least 25 are actively managed as pests in at least part of their range.

Parkes, J. P., Macdonald, N., Leaman, G. An attempt to eradicate feral goats from Lord Howe Island. In: *Turning the Tide: the eradication of invasive species*. IUCN SSC Invasive Species Specialist Group. IUCN, Gland, Switzerland and Cambridge, UK. Veitch, C. R., and Clout, M. N. (eds.). (2002) Pages 233-239. <http://www.hear.org/articles/turningthetide/turningthetide.pdf>

Goats were removed from the northern part of Lord Howe Island in the early 1970s. This paper reviews an attempted eradication of the goats that remained on the more rugged southern half of the island, that took place from September to October, 1999. This eradication was deemed unsuccessful after the presence of goats was found in 2000. Issues of animal welfare were problematic during this operation, highlighting the need for careful planning and management.

Reddiex, B., Hickling, G. J., Norbury, G. L., Frampton, C. M. (2002) Effects of predation and rabbit haemorrhagic disease on population dynamics of rabbits (*Oryctolagus cuniculus*) in North Canterbury, New Zealand. *Wildlife Research* 29(6): 627-633

http://www.publish.csiro.au/?act=view_file&file_id=WR00088.pdf

A report on the level of rabbit mortality in response to predation and RHD. This study shows that rabbit population size can be reduced to low levels by predation but only in combination with other factors, such as RHD.

Shaw, W. B. (2002) Eradication of feral pigs from Auckland Island: a review of potential approaches. Draft. Dunedin, N. Z. Wildlife Consultants Ltd. 38 p.

Sherley, G. H. (1992) Eradication of brushtail possums (*Trichosurus vulpecula*) on Kapiti Island, New Zealand: techniques and methods. *Science and Research Series no. 46*. Department of conservation, Wellington. 31 p.

Describes the methods and techniques used by trappers, shooters and dog-handlers in the eradication of possums from Kapiti Island. The problems encountered and the lessons learnt during this operation are also outlined.

Spurr, E. B., Anderson, S. H. (2004) Bird species diversity and abundance before and after eradication of possums and wallabies on Rangitoto Island, Hauraki Gulf, New Zealand. *New Zealand Journal of Ecology* 28(1): 143-149
http://www.nzes.org.nz/nzje/new_issues/NZJEcol28_1_143.pdf

Bird counts and the number of bird species detected were compared before and after the eradication of possums and wallabies on Rangitoto Island. Both were largely similar over the two periods and this is thought to be due to the continued presence of other predators such as feral cats, ships rats and stoats. This highlights the benefit of eradicating all vertebrate pest species simultaneously.

Taylor, D. P. (1983) Rat eradication Marlborough Sounds, New Zealand. Parks and Recreation Course, Lincoln College, Canterbury. 67 p.

A report on the ship rat eradication experiment carried out on Tawhitinui Island. Brodifacoum poison was used, distributed in bait stations. Non-target species were also monitored and procedures are compared to the poison campaign carried out in the summer of 1981/82 on Awaiti Island. Conclusions on the success of the campaign were published later (see Taylor, 1984).

Taylor, D. P. (1984) The identification and detection of the rats in New Zealand and the eradication of ship rats on Tawhitinui Island. Lincoln College, Canterbury. 73 p.

A report on the ship rat eradication experiment carried out on Tawhitinui Island and the monitoring after eradication. The campaign appears to have been successful, with no rats being detected during monitoring. Non-target species poisoning effects were also shown, through the accidental poisoning of wekas, and valuable information on bait station design is provided.

Taylor, R. H., Thomas, B. W. (1989) Eradication of Norway rats (*Rattus norvegicus*) from Hawea Island, Fiordland, using brodifacoum. *New Zealand Journal of Ecology* 12: 23-32
http://www.nzes.org.nz/nzje/free_issues/NZJEcol12_23.pdf

Reviews the eradication of Norway rats from Hawea island (9ha). This operation was a good indicator of the feasibility and costs of eradicating rodents quickly from islands. Talon 50 WB baits were used and the 50-100 rats present on the island were eradicating within 2-weeks.

Taylor, R. H., Thomas, B. W. (1993) Rats eradicated from rugged Breaksea Island (170ha), Fiordland, New Zealand. *Biological Conservation* 65: 191-198

Reviews the eradication of Norway rats from Breaksea Island. Eradication began in May 1988 with the use of brodifacoum poisoned bait laid out in bait stations. Baits were checked and replaced over a period of 2 years and from July 1988 to April 1992 no evidence of rats were found. Since then the island has been recolonised by native species of birds, lizards and invertebrates.

Thomas, M. D., Taylor, R. H. A history of ground-based rodent eradication techniques developed in New Zealand, 1959-1993. In: Turning the Tide: the eradication of invasive species. IUCN SSC Invasive Species Specialist Group. IUCN, Gland, Switzerland and Cambridge, UK. Veitch, C. R., and Clout, M. N. (eds.). (2002) Pages 301-310.
<http://www.hear.org/articles/turningthetide/turningthetide.pdf>

Documents the development of ground-based rodent eradication techniques using bait stations in New Zealand up until 1993.

Thomas, M. D., Wright, D. A., Mason, J., Briden, K. W. (1998) Use of bait stations for possum and feral cat control. *Science for Conservation* 86, 23 p.
<http://www.doc.govt.nz/Publications/004~Science-and-Research/Science-for-Conservation/PDF/sfc086.pdf>

A study investigating methods to improve control efficiency using toxic bait delivered in baiting stations. In 1080 trials, prefeeding was found to increase possum kill and bait consumption, and the quality of prefeeder used also had some effect. Bait freshness had no effect on either possum kill or bait consumption. In Talon® trials, prefeeding reduced consumption of Talon® bait, and so is more cost effective, however possum kill with prefeeding was slightly lower. Talon® baiting following 1080 baiting had no further effect on possum numbers but decreased rat numbers by a further 23%.

Thomson, C., Warburton, B., Moran, L. (2001) Weka- and kiwi-safe possum trap sets. *DOC Science Internal Series 24*. Department of Conservation, Wellington. 16 p.

<http://www.doc.govt.nz/Publications/004~Science-and-Research/DOC-Science-Internal-Series/PDF/DSIS24.pdf>

A study testing the effectiveness of trap set methods designed to exclude weka. Modified traps were no more or less efficient at capturing possums but fewer traps than before could be set up per unit effort, reducing trapper efficiency.

Torr, N. Eradication of rabbits and mice from subantarctic Enderby and Rose Islands. In: *Turning the Tide: the eradication of invasive species*. IUCN SSC Invasive Species Specialist Group. IUCN, Gland, Switzerland and Cambridge, UK. Veitch, C. R., and Clout, M. N. (eds.). (2002) Pages 301-310.

<http://www.hear.org/articles/turningthetide/turningthetide.pdf>

Reviews the rabbit eradication from Enderby and Rose Islands. Eradication began in 1993 with aerial baiting followed by groundwork involving hunting, dogs, spotlighting and trapping. Mice, which were present on Enderby Island, disappeared also during the poisoning phase of the operation. Non-target species impacts were assessed beforehand and there appear to have been no long-term effects.

Towns, D. R., Broome, K. G. (2003) From small Maria to massive Campbell: forty years of rat eradications from New Zealand islands. *New Zealand Journal of Zoology* 30: 377-398

<http://www.rsnz.org/publish/nzjz/2003/031.pdf>

Reviews New Zealand rat eradication with case studies from Breaksea Island, Mercury Islands, Kapiti Island and Tuhua Island due to their exceptional results or control techniques. Introduced rodents have now been removed from more than 90 islands.

Veitch, C. R. (2001) The eradication of feral cats (*Felis catus*) from Little Barrier Island, New Zealand. *New Zealand Journal of Zoology* 28(1): 1-12

<https://www.rsnz.org/publish/nzjz/2001/1.pdf>

A report on the feral cat eradication programme carried out on Little Barrier Island. Eradication commenced in July 1977. Cage traps, leg-hold traps, dogs and 1080 baits were used, but 1080 poisoning and leg-hold traps were the only effective methods. 151 cats were reported killed before the eradication was determined complete on 23 June 1980.

Veitch, C. R. Eradication of Norway rats (*Rattus norvegicus*) and house mouse (*Mus musculus*) from Browns Island (Motukorea) Hauraki Gulf, New Zealand. In: *Turning the Tide: the eradication of invasive species*. IUCN SSC Invasive

Species Specialist Group. IUCN, Gland, Switzerland and Cambridge, UK. Veitch, C. R., and Clout, M. N. (eds.). (2002) Pages 350-352.
<http://www.hear.org/articles/turningthetide/turningthetide.pdf>

Reviews the eradication of Norway rats and the house mouse from Browns Island. Eradication consisted of a single aerial drop in September 1995 of bait loaded with bromadiolone at 20ppm. The eradication was deemed successful and bait stations have been set up for ongoing monitoring and the interception of possible new arrivals.

Veitch, C. R. Eradication of Norway rats (*Rattus norvegicus*) and house mouse (*Mus musculus*) from Motuihe Island, New Zealand. In: Turning the Tide: the eradication of invasive species. IUCN SSC Invasive Species Specialist Group. IUCN, Gland, Switzerland and Cambridge, UK. Veitch, C. R., and Clout, M. N. (eds.). (2002) Pages 353-356.
<http://www.hear.org/articles/turningthetide/turningthetide.pdf>

Reviews the eradication of Norway rats and the house mouse from Motuihe Island. Eradication consisted of two aerial applications of Talon 7-20 bait containing brodifacoum in 1997. Traps placed in 1999 and 2000 failed to detect the presence of either rats or mice and so the eradication was deemed successful.

Veitch, C. R. Eradication of Pacific rat (*Rattus exulans*) from Fanal Island, New Zealand. In: Turning the Tide: the eradication of invasive species. IUCN SSC Invasive Species Specialist Group. IUCN, Gland, Switzerland and Cambridge, UK. Veitch, C. R., and Clout, M. N. (eds.). (2002) Pages 357-359.
<http://www.hear.org/articles/turningthetide/turningthetide.pdf>

Reviews the eradication of Pacific rats from Fanal Island. Eradication consisted of an aerial application of Talon 7-20 containing brodifacoum at 20ppm on 4 August 1997. The operation was successful but heavy rainfall and a bittering substance in the bait reduced its palatability, causing some concern.

Veitch, C. R. Eradication of Pacific rats (*Rattus exulans*) from Tiritiri Matangi Island, Hauraki Gulf, New Zealand. In: Turning the Tide: the eradication of invasive species. IUCN SSC Invasive Species Specialist Group. IUCN, Gland, Switzerland and Cambridge, UK. Veitch, C. R., and Clout, M. N. (eds.). (2002) Pages 360-364.
<http://www.hear.org/articles/turningthetide/turningthetide.pdf>

Reviews the eradication of Pacific rats from Tiritiri Matangi Island. Eradication consisted of an aerial application of Talon 20p rodent bait in September 1993. Measures were taken to protect identified potential non-target species and the operation was successful.

Veltman, C. J., Parkes, J. (2002) The potential of poisoned foliage as bait for controlling feral goats (*Capris hircus*). Wellington, N. Z. Department of Conservation. 21 p.

<http://www.doc.govt.nz/Publications/004~Science-and-Research/Science-for-Conservation/PDF/SFC204.pdf>

A review of an operational-scale trail to control goat using poisoned foliage. The trial was carried out in the 6380 ha Mangaotane catchment of the Raukumara Ranges in 1986. Results are then compared with other trials of similar and different methods. It was suggested that poisoned foliage may be used for high-density goat populations that are in physical refuges, out-of-reach of ground or aerial hunters.

Ward-Smith, T., Sullivan, W., Kahori, N., Abbott, P., Macdonald, P., Stephenson, B., Longanecker, A. (2006). *Boundary Stream Mainland Island annual report 2004/05*. Gisborne, N. Z. Department of Conservation, East Coast Hawke's Bay Conservancy. 122 p.

Includes details of one of the key elements of the project: pest management and result monitoring.