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OFFSHORE ISLANDS CO-OPERATIVE CONSERVATION PROJECT WITH ICI CROP CARE DIVISION: PHASE ONE (STANLEY ISLAND)

by

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ABSTRACT

Following establishment of a sponsorship agreement between ICI Crop Care and the Department of Conservation an eradication campaign against rabbits (*Oryctolagus cuniculus*) and Pacific rats (*Rattus exulans*) on 100 ha Stanley Island (Kawhitu, formerly Atiu), in the Mercury Islands group was conducted on 25 September 1991. The campaign used two brodifacoum-based products: 1.75 tonnes of Talon 20 P dropped by helicopter and 0.1 tonnes of Talon 50 WB laid by hand. Stanley Island was subsequently checked in October and November-December 1991 and March and May 1992. No sign of rabbits or rats was seen, and it is likely that both were eradicated on the first attempt. Field tests of non-toxic Talon 20 P pellets were used to estimate their attractiveness to non-target species, especially saddlebacks (*Philesturnus carunculatus*). These were found to have low attractiveness (when fresh). Checks of a colour banded population of saddlebacks during and following the air drop indicated that there may have been between 1 and 5% mortality due to the air drop. This had no measurable effect on total population size because overall mortality was not significantly different from that recorded before the campaign. Fecundity of saddlebacks does not appear to have been impaired by potential sublethal doses of brodifacoum with successful breeding recorded in the 1991-1992 season. Other species susceptible to the operation were introduced blackbirds (*Turdus merula*), finches and sparrows, but only a few dead birds were found. Lizards can be susceptible to Talon 20 P but their numbers in November 1991 were the highest ever recorded for the island. Total gross cost of the operation to ICI (commercial value of product), other sponsors (San Deido and Dallas Zoos) and the Department of Conservation was $36 603. Stanley Island is now the fifth largest island free of predatory mammals in northern New Zealand, and the third largest of them inhabited by tuatara (*Sphenodon punctatus*).

1. INTRODUCTION

In mid 1990 the public relations company for ICI Crop Care Division suggested to the Department of Conservation (DOC) that a proposal could be developed for a co-operative conservation project involving the use of ICI rodenticide products. A proposal subsequently presented by Towns (1990) in conjunction with the Department's Threatened Species Unit (Protected Species Policy Division) and Waikato Conservancy, was accepted by DOC and ICI in November 1990. This "Offshore Islands Co-operative Conservation Project", centred in the Mercury Islands, was based on provision of TALON baits *gratis* by ICI Crop Care for use against rat and rabbit infestations for a three-phase operation that might last for up to five years. ICI was committed to Phase One of the project (Stanley Island). Whether the company would proceed further was subject to success of this first phase.

The following report details how Phase One of the agreement was conducted and examines the costs and benefits of the exercise.

The Mercury Islands, and Cuvier Island to their north, were chosen as the focus for this project because: they contain threatened species with high national profiles; have been the subject of projects with a proven record of success; and have provided a testing ground for new conservation methods (Atkinson 1988, Towns *et al.* 1990, McFadden and Towns 1991, McFadden 1992).

The Mercury Islands have retained an outstanding array of relict species and communities. These include rare milktree (*Streblus banksii*) forest, the only known habitat of the tusked weta (as yet without a scientific name); two rare species of large skink, robust and Whitaker's skink (*Cyclodina alani* and *C. whitakeri*); five populations of tuatara (*Sphenodon p. punctatus*) (with the inclusion of Cuvier population), and the largest population of the rare Pycroft's petrel (*Pterodroma pycrofti*).

However, all of the larger Mercury Islands (>15 ha) have been modified either by human activities or the effects of introduced mammals associated with humans. As a result of these effects, three populations of tuatara on large islands are on the verge of extinction (Cuvier, Red Mercury and Stanley), viable milktrees are confined to 13 ha Middle Island, the tusked weta and other large flightless insects are highly vulnerable to invasion by rodents, and lizard communities on most islands are severely depleted. The status of the rare species on these islands is such that the two skink species, tuatara and tusked weta are included in Department of recovery plans either approved (Whitaker's and robust skink; Towns 1992) or in draft (A. Saunders pers comm.).

The problems faced by threatened species and communities in the Mercury Islands required development of a successful, cost-efficient method of eradicating rodents from large islands. The agreement with ICI was that their products would be used in this operation, that they would be advised of any difficulties so that formulation of the products could be changed if necessary, that they would collaborate with DOC in the production of publicity material, and that DOC scientific staff would be involved in the development and implementation of any experimental baiting procedures.

The agreement was launched on Stanley Island on 29 July 1991 in the presence of ICI representatives, DOC Head Office and Waikato Conservancy staff, the local Conservation Board Chairman, local Maori representatives, a news team from Television New Zealand and reporters from the Waikato Times.

2. STUDY AREA

The Mercury Islands (Fig. 1), 6 km off the Coromandel Peninsula, consist of seven islands ranging in area from 2 to 1860 ha and several small unnamed stacks and islets. Cuvier Island is 15 km north of Great Mercury Island. All of the islands except Great Mercury and its satellite islets are in the Hauraki Gulf Maritime Park.

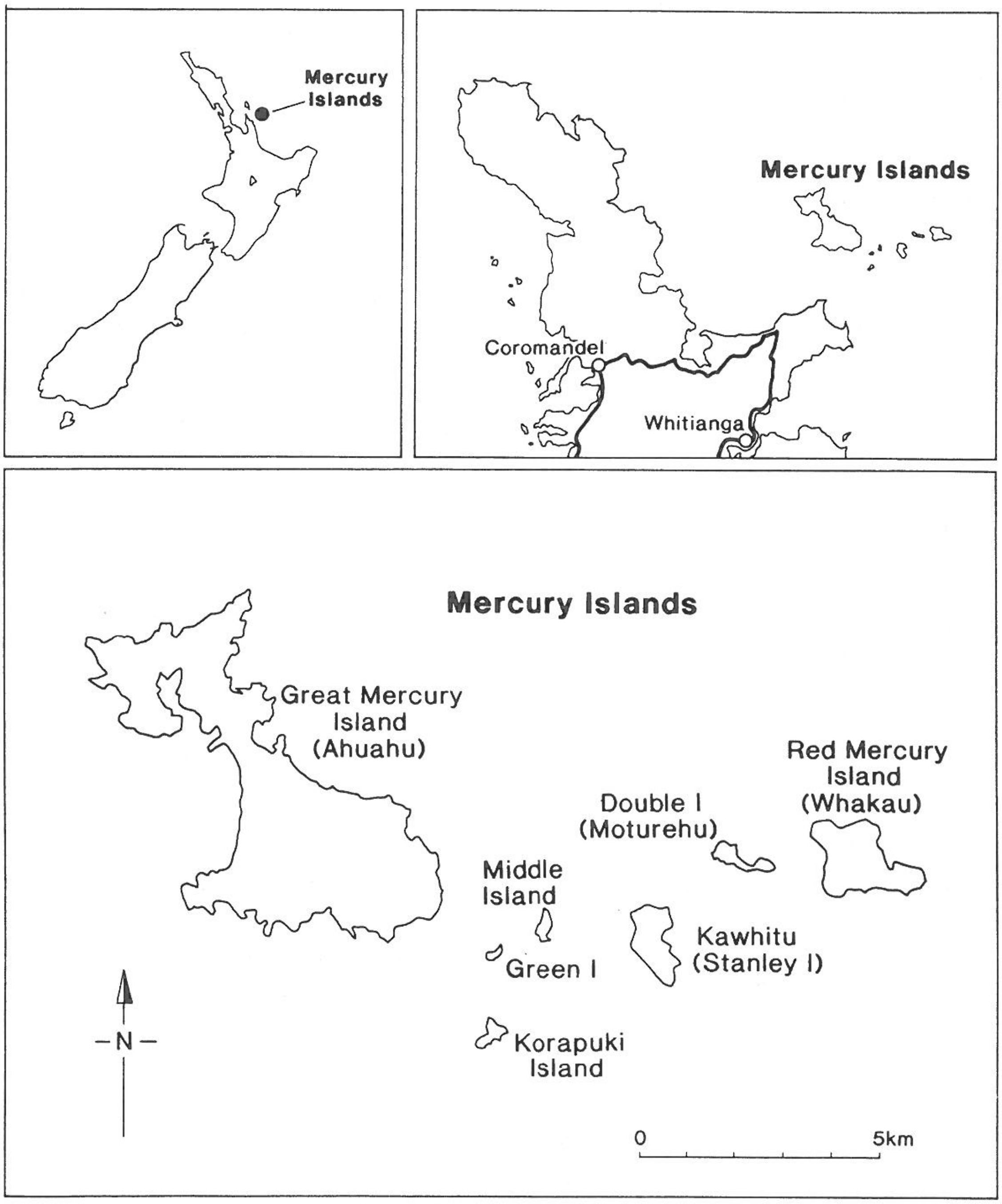

Fig. 1. Position of the Mercury Islands in relation to New Zealand (*upper left*), and the Coromandel Peninsula (*upper right*). Islands of the Mercury group are shown (*lower*).

The islands are volcanic peaks that were contiguous with the North Island during the last ice age, and became separated from the mainland by rising sea levels. For the Mercury Islands, this happened between 10 000 and 8 500 years ago. Cuvier Island, which is further offshore, was isolated at least 12 000 years ago.

Like other islands in the Mercury Group Stanley Island (Kawhitu or Atiu) is a Pliocene - lower Pleistocene produced largely by eruptions onto a terrestrial surface in the form of basaltic flows, intrusions, and other formations (Hayward 1986, Hayward and Moore 1972). Cliffs on the northwestern side of the island have a high proportion of laminated pale tuff of rhyolitic origin, possibly from the Miocene centres of Great Mercury or the Coromandel Peninsula. The predominant basalt has resulted in an island that appears somewhat tabular from the sea, with an undulating surface topography rising to 137 m, steep cliffs, and coastal caves and bouldery slopes. There are no permanently flowing streams, and as on Red Mercury Island (Hayward and Moore 1972), erosion by running water probably had little influence on the island's present shape.

Climate in the Mercury Islands is strongly influenced by the north-south aspect of mountains on the Coromandel Peninsula, which place the islands in the lee of the predominant west and south-west winds. The islands are also prone to occasional particularly heavy rainfall during northeasterly conditions which derive from cyclonic disturbances of tropical origin. Shelter from the west but exposure to the east combine to produce wet winters (30% of annual rainfall) with 400-450 mm precipitation, dry summers (<250 mm rainfall), and high between-year variability in total precipitation, depending on the intensity and frequency of tropical influences (Garnier 1958).

The most dramatic changes to biota in the group occurred with the arrival of humans about 1000 years ago. Great Mercury Island has a long history of Maori occupation and is regarded by some anthropologists as the actual site of the Hawaiiki referred to in New Zealand Maori folklore (Ell 1982). Archaeological evidence and local tradition suggest that it was a major population centre for Maori, who either departed after a disastrous fire in about 1670 (Wright 1976), or stayed to be decimated by tribal wars in 1820 (Ell 1982).

By the 19th Century Pacific rats (Polynesian rats or kiore: *Rattus exulans*) were apparently established on the larger islands and periodic burning, possibly to ease access for mutton-birding, had destroyed much of the original vegetation. Rabbits (*Oryctolagus cuniculus*) were introduced to Stanley and Korapuki Islands at around the turn of the century, and then both islands were extensively burned again. Red Mercury also experienced a major fire in the 1930s (Millener 1972). All of the larger islands have therefore been heavily modified by human activity, and until recently, these modifications have placed relict populations of rare species at risk. On both Stanley and Korapuki the recent fires and presence of rabbits led to highly modified vegetation dominated by pohutukawa (*Metrosideros excelsa*) over a subcanopy of mahoe (*Melicytus ramiflorus*). Fortunately the smaller islands, of which Middle (13 ha), and Green (3 ha), are the most important, have remained relatively unmodified and free of all introduced mammalian predators (Towns et al 1990). In 1986 a successful rabbit and rat eradication campaign on Korapuki Island began the process of rehabilitating the more modified islands (McFadden and Towns 1991), leading to the reintroduction of Whitaker's skink to Korapuki Island in 1988 (Towns in prep: Translocation as a conservation measure for the rare Whitaker's skink (*Cyclodina whitakeri*) in New Zealand). With further removals of pest mammal species it will be possible to:

1. restore coastal and lowland communities that have become extremely altered on the mainland;
2. extend the area of unique seabird-reptile-plant-invertebrate communities now confined to one or two small islands;
3. rehabilitate up to three populations of tuatara close to extinction; and
4. establish new populations of the less "glamorous" species such as lizards and insects.

3. METHODS

3.1 The toxin used: TALON

Two Talon products were intended for use in this campaign: Talon 20 P and Talon 50 WB. The active ingredient in both products is brodifacoum, a chronic anticoagulant rodenticide that has a delayed action of 3-7 days before becoming lethal. Such compounds are recommended for island conservation campaigns (Moors *et al.* 1989, Eason 1991). Brodifacourn is toxic to mammals, birds, and in some cases to reptiles (Merton 1987). but is not known to be toxic to insects (Taylor and Thomas 1989). The compound is not water soluble, so does not affect life in streams or groundwater. Brodifacoum washed into soil from baits is estimated to have a life of approximately three months until it is degraded by soil micro-organisms (Eason 1992).

Talon 20 P is an extruded cereal-based (pollard) pellet of approximately 0.8 g containing brodifacoum at 20 ppm. The formulation used on Stanley Island was designed for 70% bait disintegration following 25 mm rainfall (ICI data, M. Shirer pers comm.). The pellets were developed for use against rabbits and are dyed green to reduce their attractiveness to birds. Talon 20 P is licensed for aerial application by DOC on stocked off-shore islands.

Talon 50 WB is an egg-shaped 16 g bait with toxin-coated cereal grains imbedded in a wax matrix and contains brodifacoum at a concentration of 50 ppm. The baits are resistant to moisture and were designed specifically for use against rats.

3.2 Delivery methods

At present two different approaches to the delivery of rodenticides on islands are possible:

1. Fixed bait stations such as silos with long-term delivery capability (McFadden 1984) or ‘Nova-coil’™ tunnels loaded using pulse-baiting methods (Taylor and Thomas 1989).

2. General broadcast methods either by hand or by air (McFadden 1992).

As long as appropriate procedures are followed each can effectively eradicate rats from islands. The differences arise when comparing the various methods by cost and potential risk to non target species. The use of fixed bait stations is a highly labour intensive operation; labour is the largest single cost identified in the use of these methods (McFadden and Towns 1991).

Aside from cost considerations, however, DOC needs to develop a system of rapid delivery of rodenticide on islands newly invaded by rats following ship wrecks or accidental introductions. Aerial application of rodenticide has the potential to be both cost effective and allow for rapid response to newly recorded invasions.

An added complication on Stanley Island was the presence of rabbits. The operation was therefore designed initially to follow two phases:

1. Aerial application of 1.5 tonnes of Talon 20 P using helicopter and monsoon bucket to achieve a ground spread averaging two pellets/m^2. This application was to be primarily against rabbits. It was recognised that a proportion of the Talon 20 P would be taken by kiore and that the aerial application alone might eradicate the rat population.

2. Ground application by hand of 0.5 tonne of Talon 50 WB at a rate averaging 1 block per 30 m^2. This application was primarily against remaining kiore.

The use of helicopter and monsoon bucket to spread Talon 20 P was previously trialed as part of a separate operation in the Mokohinau Islands, the details of which will be reported elsewhere (by IM).

3.3 Precautions against effects on non-target species

To minimise the hazard to non-target species, DOC was required by ICI to give ICI Crop Care and their advisors the opportunity to comment on protocols established for the use of Talon products for the Mercury Islands project. These protocols were compiled by Towns and McFadden (ND) and were approved by both ICI and the DOC Animal Ethics Committee.

The broadcast of Talon 20 P had two identified potential side effects, one specific to the method used, and the other common to all such campaigns:

1. Susceptibility of ground-feeding birds to accidental ingestion of pellets and of insectivores to ingestion of invertebrates carrying brodifacoum. This problem is greatest with the broadcast method.

2. Secondary poisoning of predatory or scavenging birds eating near-dead rats and rabbits and the carcasses of those that had died. This problem is common to all methods, including those using pulse baiting at bait stations (Taylor and Thomas 1989).

In our analysis of species at risk on Stanley Island we concluded: (a) harriers (*Circus approximans)* and moreporks (*Ninox novaeseelandiae*) would be at risk through eating rats carrying lethal doses of brodifacoum and from scavenging carcasses; (b) introduced finches (e.g. chaffinch; *Fringilla coelebs*) would be attracted to the pellets; and (c) ground-feeding insectivorous blackbirds (*Turdus merula*) and saddlebacks (*Philesturnus carunculatus*) might have a low risk through accidental intake of pellets.

Tuatara were also identified as being potentially at risk. Partly because of this risk, but also to mitigate against an apparent recruitment failure, almost the entire population (17 individuals) was removed from the island in 1990, and housed at Auckland Zoo (Cree *et al.* in press).

3.4 Trials on Stanley

Of the species at risk, only saddlebacks were likely to show any long-term detrimental effects because of their insectivorous diet and limited flight capabilities (inability to recolonise from neighbouring islands). The susceptibility of wild saddlebacks to Talon 20 P pellets in non-toxic form was assessed by bait trials conducted on Stanley Island (by IM) between 23-29 July 1991.

Twenty 600 x 300 mm wooden trays were set out at 50 m intervals on Stanley Island, with alternating trays set at ground level (where they would be available to kiore) and on 50 x 50 mm fence battens at 60-90 cm above ground where kiore could not reach them. Saddlebacks were attracted to the raised trays using orange halves. These trays were visited by saddlebacks within two days.

After two days 150 mm saucers containing 30 non toxic pellets and an array of cheese, sultanas and apple (to attract saddlebacks) was placed on each raised tray (along with the orange already there). Non-toxic pellets were placed on the trays at ground level. Unlike the toxic pellets, the non-toxic pellets were not dyed green.

3.5 Study population of saddlebacks

As a further test of the effects of the operation on saddlebacks, either directly through ingested pellets or indirectly through invertebrates, a population of birds previously banded as part of an independent study, was followed during and after the air drop. At the time of the air drop 35 colour-banded saddlebacks were identified and this number was increased to 43 during subsequent visits.

Banded birds were checked immediately following the air drop (26 September-1 October 1991) between 22-29 October 1991, between 26 November and 3 December 1991, between 25 February and 3 March 1992 and between 26 May and 1 June 1992 (Appendix 1). Five-minute bird counts were also conducted in October 1991 and May 1992 (Appendix 1).

3.6 Study population of lizards

As part of a separate study observation transect lines of pitfall live traps for lizards (Towns 1991) were established on Stanley Island in one forest and two coastal sites.

Between eight and twenty traps were set on each transect line using an array of (Towns 1991). Contemporaneous comparative samples were obtained from rat-free Middle Island.

3.7 Invertebrates

Immediately following the air drop and for up to nine months subsequently opportunistic samples of ground-inhabiting invertebrates were obtained by hand and in pitfall traps. These invertebrates were tested by Forest Research Institute (now Research New Zealand) for traces of brodifacoum.

3.8 Bait spread by helicopter

The air drop of bait was timed to provide several days of fine weather before the brodifacoum is leached from the pellets by rain. It was also timed to coincide with the time of year when rabbits and rats are few in number and foraging widely for the limited food resources available. Bait was dropped from a standard fire-fighting monsoon bucket beneath a Squirrel helicopter. Further details of the methods used for the aerial application and follow-up procedures on Stanley Island will be reported separately (IM).

The potential effects of rainfall on longevity of baits was estimated from rainfall data collected on the coast adjacent to the Mercury Islands (Ring's Beach 20 km from Stanley Island) by staff of Mercury Bay Area School.

3.9 Public relations

One of the stated reasons for the ICI involvement in this project was because of the high public interest in conservation issues. It was therefore in the interests of both DOC and ICI to ensure that the public (especially residents of the Coromandel Peninsula) was informed at all stages of the campaign.

This has been achieved by:

1. A brochure on the project produced by ICI, but with considerable input from DOC. This brochure was made available to the Waikato Conservancy of DOC for distribution, and was also given to local businesses with interests in the Mercury Islands (e.g. charter boat operators). A copy of the brochure is shown in Appendix 2.

2. Regular press releases and invited television coverage of key stages of the project.

3. Consultation with and involvement of local Maori groups, including Ngati Maru, Ngati Hei and Hauraki Maori Trust Board prior to and during the project (J. Greenwood, pers comm. 1992).

4. RESULTS

4.1 Bait trials

All trays at ground level had been cleared of pellets by kiore within five nights. Only one of the raised trays was visited by saddlebacks (or possibly by blackbirds) which appear to have taken four of the non-toxic pellets, and these after they had been moistened by rain. Kiore succeeded in reaching this tray after four days (evidence from droppings), and removed all remaining food and pellets. These results indicated that kiore were highly attracted to the pellets and were likely to remove most of them within a few days of their spread. Saddlebacks were unlikely to be attracted to the pellets. Because toxic pellets are died green, their attractiveness to saddlebacks should be even further reduced.

4.2 Bait spread by helicopter

The air drop, which was increased from 1.5 to 1.75 tonnes Talon 20 P, was conducted on 25 September 1991 and coordinated by IM. Following the air drop the weather remained fine for three nights. Kiore were only caught in snap traps for one night following the drop but were seen for four nights. Because of the increased quantity of Talon 20 P dropped by air, the quantity of Talon 50 WB was reduced from 500 kg to approximately 100 kg and was spread by hand between 22-29 October.

In subsequent visits (October and November 1991, March and May 1992) trap lines of standard snap traps were set for kiore for up to 720 trap nights, and searches for both kiore and rabbit sign were undertaken using methods outlined by and Towns (1991). No fresh sign was found, no rats were caught and no rabbits were seen. An array of passive indicators that might indicate the presence of kiore from gnaw sign were also trialed, including candles, soap and apples. None of these has indicated the presence of rats. The potential effectiveness of these will be discussed elsewhere along with details of the trapping methods (IM).

An indicator of the absence of rabbits was the appearance of seedlings where previously none had been seen. A grove of taraire (*Beilschmiedia tarairi*) in the south of the island had by November produced approximately 100 seedlings. These may be the first taraire seedlings produced on the island for 100 years. Other species potentially palatable to rabbits that are now producing seedlings include kohekohe (*Dysoxylum spectabile*) and tawapou (*Planchonella novo-zelandica*). By November 1991 there were scattered small *Clematis* sp. under mahoe and the first young ngaio (*Myoporum laetum*) around the coast.

4.3 Survival of banded saddlebacks

Forty one of the 43 study saddlebacks were located in October 1991 and 38 in May 1992. Mortality attributable to the presence of Talon was <5%, but may be as low as 1% (four suspected deaths out of an estimated 250-300 birds). Whether these deaths were directly due to ingestion of brodifacoum is unclear (see 4.5 below), but the 1991-1992 mortality was within the range of annual mortality recorded prior to the eradication campaign. There was no evidence at the population level of the sublethal effects of brodifacoum on fecundity reported for mammals (Eason 1991). On the contrary, productivity of juvenile saddlebacks in the breeding season directly following removal of the rats was not significantly different from other seasons on Stanley Island. A summary of the report on distribution and abundance of saddlebacks is attached (Appendix 1).

4.4 Survival of lizards

Previous lizard studies on Stanley Island while kiore were present indicated that numbers there were particularly low (Towns 1991). No lizards have been caught on the standard transect line in forest. Captures in two coastal transects in traps set on five occasions in November or March while rats were present ranged from 1-15/100 trap-days. The capture rate at these same sites two months after the removal of rats in November 1991 was 21/100 trap days, or 29% higher than the previous best result (March 1987) and 52% higher than the best previous result for a November sample while rats were present. Contemporaneous lizard samples on rat free Middle Island in November 1991 produced 20/100 trap days. This was a relatively low capture rate for the island and was probably due to indifferent weather conditions that might also have lowered the potential capture rate on Stanley.

4.5 Other non-target species

During the October visit Stanley Island was carefully searched for dead birds. The following birds were found: five saddlebacks, three chaffinches, three blackbirds, two house sparrows (*Passer d. domesticus*), one morepork, one kingfisher (*Halcyon sancta vagans*), one red-crowned kakariki (*Cyanoramphus novaeseelandiae*) and one tui (*Prosthemadera novaeseelandiae*). The state of decomposition of several of these birds (including one saddleback, the red-crowned kakariki and the tui) was such that they almost certainly died before the application of rodenticide. A similar check in November produced two blackbirds and one hedgesparrow. The state of decomposition of these latter birds was such that they had most likely died several months previously (possibly as a result of the eradication campaign in September) (P. Thompson, pers comm.).

A sample of dead birds was forwarded to FRI (Landcare Research New Zealand) to analyse for traces of brodifacoum. However, because of the advanced state of decomposition, assays were only possible from one house sparrow and one blackbird both of which contained sufficient brodifacoum for it to have been the cause of death (C. Eason, pers comm.).

None of the invertebrates tested contained any traces of brodifacoum.

4.6 Longevity of the bait

Heavy rain in the Coromandel Peninsula during the two months immediately following the air drop (183 mm) meant that the Talon 20 baits had limited life on the ground.

Pellets were found scattered around the island in October, but these showed signs of decomposition. Only a small number of pellets in an extremely decomposed state could be found in November despite extensive searches. These pellets contained between 30 and 55% of their original brodifacoum loading and would still have been toxic (G. Wright pers comm.). No pellets were found on Stanley Island after November.

4.7 Media coverage

Aside from the brochure produced by ICI and DOC, there has been wide media coverage of the project including feature articles in the New Herald (28 November Waikato Times (3 August 1991) and Hauraki Herald (18 April 1992). Much of this coverage specifically mentioned the contribution by ICI and the other institutions involved (San Diego and Dallas Zoos and Victoria University of Wellington). The project was featured in an extended coverage by Television New Zealand news. In addition, the co-operation of all parties is acknowledged in two papers recently published or in press overseas (Daugherty *et al*. 1992, Cree *et al.* in press).

5. DISCUSSION

5.1 Effectiveness of the air drop

The absence of any sign of rats and rabbits within a month of the air drop of Talon 20 P indicates that the method can be highly effective against rats and rabbits. The previous use of Talon 20 P against rabbits on islands such as Browns Island in Auckland Harbour and Quail Island in Lyttelton Harbour have not succeeded on the first attempt (D. Merton, pers comm.). In light of these results it was regarded as unrealistic to hope for the eradication of rabbits from Stanley Island in one attempt, particularly since rats would also be removing the bait. In fact the application of Talon 20 P was sufficiently effective to reduce the need for follow up of Talon 50 WB to only 20% of the amount allocated.

5.2 Susceptibility of non-target species

The relatively small number of dead birds found following the aerial drop may result from a number of causes. Those most likely to be directly or indirectly affected by Talon were the ground-feeding birds (sparrows, and blackbirds) and the morepork. It should be noted that comprehensive searches for dead birds of this kind are not routinely undertaken on these islands, so with the exception of saddlebacks (see Appendix 1), there is no background information on natural mortality against which these figures can be measured.

There was no evidence of the previously recorded brodifacoum accumulation in invertebrates, although this has been reported for insects in bait stations containing Talon 50 WB (Wright and Eason 1991). Wax Talon 50 WB baits kept dry in bait stations can persist indefinitely. By contrast most of the Talon 20 P used on Stanley Island bad disintegrated within one month and almost all had gone within two months of the application. This rapid disappearance of the pellets was helped by conducting the campaign in late winter-early spring, when annual rainfall is high, and by using the rapid breakdown formulation.

There was no sign of any dead birds on Stanley Island other than those found soon after the air drop. However, a continuing (although low level) loss might have been expected from insectivorous birds if their insect prey was carrying brodifacoum. Sublethal doses of brodifacoum may have been ingested by some individual saddlebacks and such doses might have persisted for some months (e.g Eason 1991). Since sacrifice of saddlebacks was regarded as unjustified, the persistence time and effects of sublethal levels of brodifacoum in birds remain unknown. On the other hand, the productivity of saddlebacks after the campaign against rabbits and rats indicates that secondary poisoning via insects or sublethal ingestion of brodifacoum had no measurable effects at the population level. Instead the number of juvenile birds was higher than might have been expected in view of the unusually dry and cool conditions experienced throughout northern New Zealand (National Institute of Water and Atmosphere meteorological data 1992) (Appendix 1).

Some lizards are known to be susceptible to Talon 20 P (Merton 1987). However, despite indifferent weather conditions, the capture rate of lizards along fixed transect lines at two coastal sites on Stanley Island in November 1991 was higher than ever recorded previously on the island. The November 1991 result may foreshadow the rapid increase in numbers of lizards in coastal areas found when kiore were removed from Korapuki Island (Towns 1991).

5.3 Likely future response using Korapuki as model

The vegetation, lizard fauna and history of modifications on Stanley Island closely resemble those of Korapuki Island from which kiore and rabbits were removed in 1986-87 (McFadden and Towns 1991, Towns 1988, Towns et al. 1990). By viewing Korapuki it is therefore possible to predict the changes that will occur on Stanley now that rats and rabbits have been removed. Complicating factors on Stanley Island are its much greater size than Korapuki (almost 6 times larger), greater range of refugia for resident species, larger flora and range of seed sources, and more diverse avifauna.

Likely changes to vegetation are:

1. An influx of ngaio and *Coprosma* species in the understorey. On Korapuki most of the ngaio in forested areas died due to lack of light, but those seeding around the coast grew rapidly.

2. A more gradual increase in seedlings of karo (*Pittosporum crassifolium*) and *Pseudopanax* that will eventually predominate in the understorey over much of the island.

3. The eventual appearance of seedlings of and wharangi (*Melicope ternata*), the slowest species in the successional sequence on Korapuki.

4. Spread of seedlings of species not commonly encountered on Korapuki, but present on Stanley Island. These could include kohekohe and puriri (Vitex lucens).

Likely changes to the lizards are:

1. Rapid increase in the number of lizards in coastal areas. The increase so far on Korapuki (in physically similar terrain) has been 30-fold and has yet to stabilize (Towns unpublished data).

2. Little measurable change in the abundance of lizards in forest areas due to the previous extirpation of most forest-dwelling species by rats (Towns 1991).

Changes to the avifauna are more difficult to predict because of the narrow range of species present on Korapuki, which unlike Stanley Island lacks resident saddlebacks, pigeons (*Hemiphaga novaeseelandiae*) and moreporks.

5.4 Value of the agreement

The value of the sponsorship agreement can be calculated in a number of ways. For example, the Stanley Island phase of the operation alone would fundamentally change the status of the rare species being targeted. The northern subspecies of tuatara has undergone about a 21% reduction in the number of populations this century to a total estimated number of 10 000 individuals (Daugherty *et al.* 1992, Cree *et al*. in press). Their repatriation to a rodent-free Stanley Island could conservatively produce densities of 200/ha (compared with the total of 20-25 individuals estimated to have survived), thereby eventually increasing the total northern tuatara population by at least 200%. Whitaker's and robust skinks could benefit from estimated 990% and 570% increases in area occupied (Towns 1992). If tusked weta are established on Stanley Island they would undergo a similar proportional expansion to those for skinks.

The commercial value of the product provided by ICI for the entire three-phase Mercury Island project as agreed would bave been $34 425 ($12 300 for Talon 50 WB and $22 125 for Talon 20 P). For Stanley Island the product value was estimated at $9 263. However, by reducing Talon 50 WB to 20% of the allocation, and allowing for an increased quantity of Talon 20 P, the actual cost of Talon products was $ 5 983. Other logistic costs for Stanley Island (boat charters, helicopter time, consultants) amounted to $11 000 provided by San Deigo and Dallas Zoos and DOC. Staff time (an internal DOC cost) is estimated as $13 920 in the field and $4 500 preparing proposals and reports. Total costs were therefore $5 983 (ICI), $9 200 (San Diego and Dallas) and $21 420 (DOC); a total of $36 603 (Table 1). By comparison, the total cost of a campaign using Talon 50 WB to eradicate Norway rats (*Rattus norvegicus*) from 9 ha Hawea Island was $65 000 at 1986 prices (Taylor and Thomas 1989). Stanley Island is 11 times larger than Hawea, and even allowing for greater efficiencies from proven methods, a pulse-baiting campaign using Talon 50 WB on Stanley Island could have had a gross cost of at least $100 000.

On islands where rabbits are not present the volume of Talon 20 P probably can be reduced. With further reduction in the use of Talon *50* WB and reduced volumes of Talon 20 P both the cost of rodenticide, and the risk to non-target species, can be Future conservation work required on Stanley Island to establish the rare species listed above has not been costed out here.

The conservation value of Stanley following eradication of rats and rabbits is difficult to estimate in commercial terms. As a measure of its potential, Stanley Island is now the fifth largest island free of predatory mammals in northern New Zealand, and the third largest of them inhabited by tuatara.

Continued success of the Stanley Island project will depend on the use of appropriate follow-up and preventative measures. As part of the agreement with ICI, the company may provide further rodenticide for use in permanent bait stations that can be located near potential landing sites on the island. Further checks for the presence of rats using traps and passive indicators will also be required, as will careful searching for any sign of rabbits. It is crucial that these checks are conducted regularly over the next two years.

The goodwill and understanding of residents and visitors to the area have a role to play in ensuring that pests do not reach the island in the future. This will require continuing efforts to publicise the success and value of projects such as those under way on Stanley Island, and ensuring that the residents are informed as new advances are made.

Table 1 Costs of the Stanley Island rabbit and rat eradication July 1991–June 1992.

Item (donor organisation)	Cost ($)	
Product (ICI Crop Care)		
Talon 50 WB: 0.1 tonne	820	
Talon 20 P: 1.75 tonnes	5 163	
Sub total		5 983
Logistics (San Diego, Dallas)		
Helicopter hire, boat charters*	7 700	
Consultant (avifauna)	1 500	
Sub total		9 200
Other logistic support (DOC)		
Boat charters	2 000	
Consumables*	1 000	
Field salaries‡	13 920	
Writing reports and proposals	4 500	
Sub total		21 420
Total gross cost of campaign		36 603

* Includes some field costs (food).

‡ Field salaries are an indicative rate that includes a nominal cost for volunteers. See also McFadden and Towns (1991).

5.5 Recommendations

To ensure that the chances of reinvasion of Stanley Island by rats are minimised, and to build on the information already gained on the long term benefits from this campaign to resident birds and reptiles, the following actions are required:

1. Regular (six-monthly reducing to annual) checks of Stanley Island for rat and rabbit sign on vegetation and in bait stations.

2. Continued advocacy of the positive results of the operation to the local public through the use of brochures and strategically located signs at Whitianga wharf and on Stanley Island. The agreement with ICI proposes that they and DOC collaborate over the production of this material.

3. Further surveys of bird numbers using the base-level information provided here, as well as specific checks on the distribution and density of saddlebacks (see separate recommendations in Appendix 1).

4. Annual (November) checks of lizard capture rates for up to five years at the existing established transect lines. This will provide information on response of resident lizards and will be required as a basis for reintroduction of tuatara and rare lizards.

6. ACKNOWLEDGEMENTS

This project would not have been possible without the product donated by ICI, and the financial support provided by the Zoological Society of San Diego and the Dallas Zoological Society. We are grateful to volunteers and staff of the Waikato Conservancy of the Department of Conservation for assistance in the field and with transport, to Sandra Anderson of the Zoology Department, University of Auckland for technical assistance to TL and for the assistance provided by Dr Charles Daugherty of Victoria University of Wellington. We are particularly grateful to Alan Saunders (Manager, Threatened Species Unit) and to Gerry Rowan (Regional Conservator, Waikato) who gave this project their enthusiastic support. We also thank Graeme Taylor and Alan Saunders (DOC Threatened Species Unit) and Phil (DOC Waikato) for comments on this report and Des Bristow (Mercury Bay Area School) for providing rainfall data.

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APPENDIX 1

Effects of brodifacoum on bird populations of Stanley Island, with particular reference to the North Island saddleback

1.1 Introduction

One objective of the aerial application of Talon 20 P on Stanley Island was to investigate the effects of this method on non-target bird populations. Saddlebacks (*Philesturnus carunculatus*) were considered to be especially susceptible to secondary poisoning, because they spend much time feeding on terrestrial invertebrates (Towns and McFadden ND). This study therefore monitored the effects of an airdrop of Talon 20 P pollard baits on the North Island saddleback and other native and introduced forest birds.

1.2 Methods

The sample of 43 individually colour-banded saddlebacks included 29 banded between 1986 and 1989 for a previous study (Lovegrove 1992), and 14 banded at the time of the aerial drop. Survival was checked by through intensive surveys of the whole island, a month after the drop (between 22 and 29 October and eight months after it (26-31 May 1992). Survival between September 1991 and May 1992 (eight months) has been extrapolated to a twelve month period and compared with survival on Stanley Island between between 1986-1989, the population was studied intensively as pan of another investigation (Lovegrove 1992).

The territories of saddlebacks were mapped, and these will form a base line from which to monitor future changes in saddleback density.

The island was searched on all visits for dead birds. Samples were sent to the Forest Research Institute (now Landcare Research) in for brodifacoum analysis.

Five-minute bird counts (Dawson and Bull 1975) were conducted in October 1991 (after the eradication campaign), and May 1992 by TL to assess the abundance of all species and the proportions they form of the total bird population on Stanley Island. Since the counts were conducted after the eradication campaign they are of no value for assessing the effects of the on the avifauna. However, they will form a useful base line from which to monitor future changes.

1.3 Results

1.3.1 Saddlebacks Forty-one (95.3%) of the 43 saddlebacks were still alive one month after the aerial drop. One of the missing birds was found dead in its territory, and the amount of decomposition indicated death after the eradication campaign. The other missing bird was not found. In May 38 (88.4%) of the original 43 birds were still alive. This represents a mortality rate of 11.6% (1.45% per month) over an eight month period, or when extrapolated for the whole year (assuming a constant mortality rate), a mean annual mortality rate of 17.4%. Between 1986 and 1989 mean annual mortality ranged from 12.0 to 17.2% (Table 1.1). Mortality during 1991-1992 (the period affected by the eradication campaign) did not differ significantly from that of any year during the 1986 to 1989 period (Chi^2 test on eight month survival data extrapolated to one year).

Survival curves for the two cohorts of saddlebacks on Stanley Island before and during the period affected by the aerial drop show similar trends to those of saddlebacks on Cuvier and Tiritiri Islands where no such campaigns have been undertaken (Fig. 1.1). Had mortality on Stanley been significantly greater than usual, the Stanley curves would be expected to show a much steeper decline (for years five and six) compared with those of Cuvier and Tiritiri.

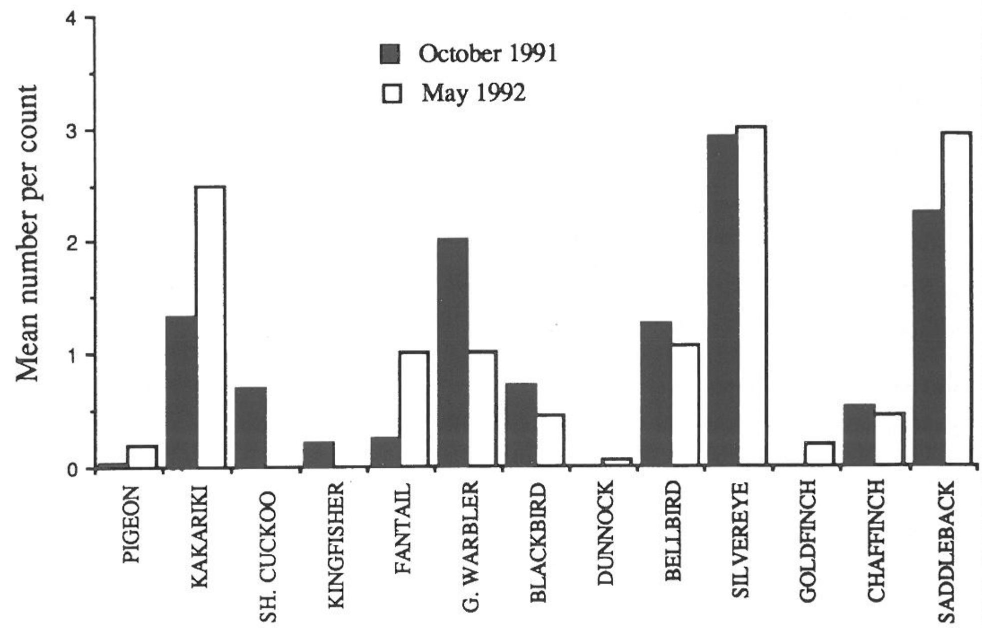
Appendix Table 1.1 **Mean annual mortality of saddlebacks on Stanley Island between 1986 and 1989.**

Year	# alive year 1	# alive year 2	Mortality	Percentage
1986–1987	50	44	6	12.0
1987–1988	87	72	15	17.2
1988–1989	80	68	12	15.0

1.3.2 Birds found dead

Seventeen dead birds of eight species were found in October 1991. Ten (59%) of these were presumed to have died after the aerial drop because corpses were still fresh flyblown. The dead birds included (figures in parentheses indicate numbers assumed to have died after the eradication campaign): saddleback 5 (3), chaffinch (*Fringilla coelebs*) 3 (3), blackbird (*Turdus merula*) 3 (1), house sparrow (*Passer domesticus*) 2 (1), morepork (*Ninox novaseelandiae*) 1 (1), kingfisher (*Halcyon sancta*) 1 (damaged bill, death due to injury?), red-crowned kakariki (*Cyanoramphus novaezelandiae)* 1, tui (*Prosthemadera novaeseelandiae*) 1. Most of the corpses were too decomposed for analysis, however a blackbird and the sparrow, which were reasonably fresh when found, had both ingested brodifacoum.

The two curves for Stanley include a cohort of 33 birds banded in 1986, and the original group of birds released in 1977. The curves for Cuvier and Tiritiri are for birds released in 1968 and 1984 respectively. On Stanley Island the aerial drop occurred during years five and six. There was no indication of significantly increased mortality during this period on Stanley.



ERRATA — The diagrams for Appendix Figures 1.1 and 1.2 have been transposed in this edition.

Appendix Figure 1.1 **Survival curves for saddlebacks on Stanley, Cuvier and Tiritiri Islands.**

populations on Stanley Island. As a result of seasonal changes in conspicuousness (and perhaps breeding success during the 1991-1992 season) the October and May counts produced slightly different proportions of species. The six most common species (listed on a decreasing scale of abundance) in October were silvereye, saddleback, grey warbler (*Gerygone igata*), kakariki, and blackbird. In May the predominant species were silvereye, saddleback, kakariki, bellbird, fantail and grey warbler. The five-minute counts (Table 1.2. Figure 1.2) indicate that the numbers of forest birds (native and introduced species) did not change significantly between October 1991 and May 1992 (Mann-Whitney U- tests).

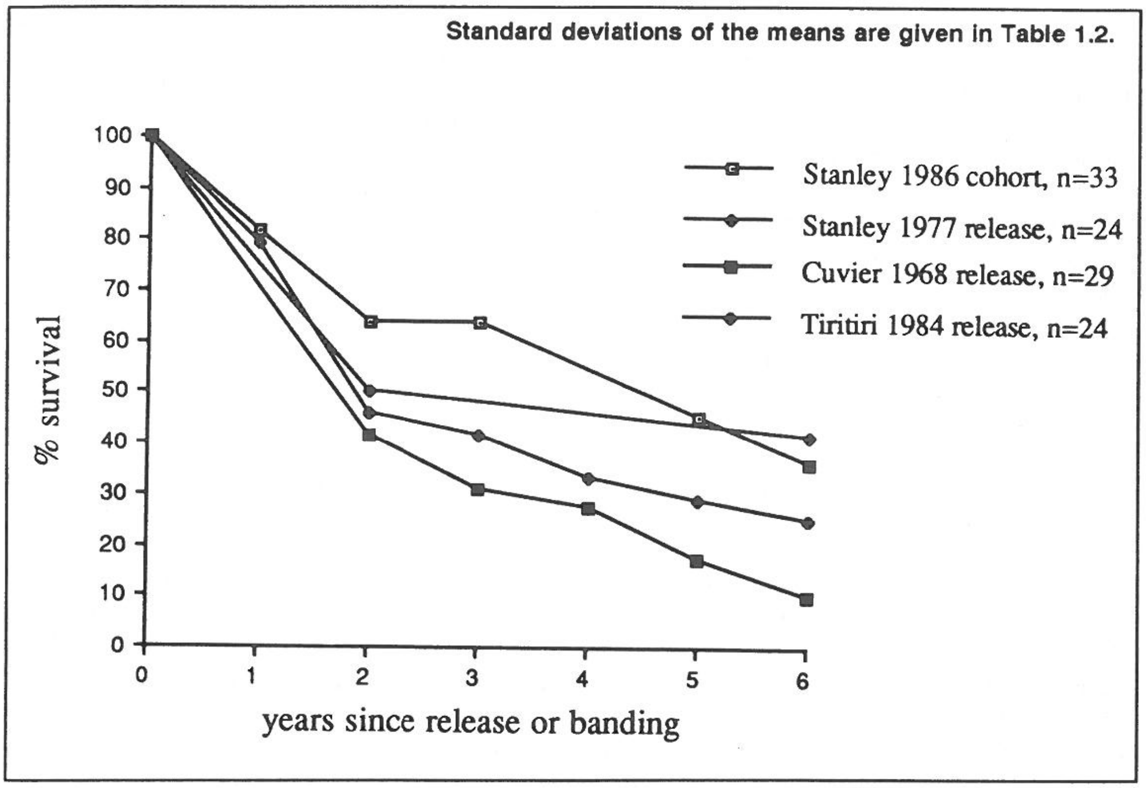
1.4 Discussion

No dead saddlebacks were found during 14 previous visits to Stanley Island by TL, so finding five dead in October 1991 was unusual. Although the dead saddlebacks were unsuitable for toxic residue analysis, three of the birds (including the bird from the sample population) had died after the aerial drop, so they may have ingested some of the toxic baits. Secondary poisoning is a less likely cause of death, because no signs of were found in any invertebrate samples. Although some saddlebacks may have died as a result of the September 1991 aerial drop, during for the whole population was not significantly greater than usual for Stanley Island, and survival curves show similar trends to saddleback populations on other islands. Moreover, the proportions of found dead in the sample of 43 (one) and for the rest of the population (four) are similar to the proportions that sample and non sample form in the total population, i.e. 43: ca 250-300; suggesting that most of the dead birds were found. The island was searched intensively for corpses, and this was greatly facilitated on Stanley by the lack of undergrowth in the forest (the result of rabbit browsing).

Appendix Table 1.2 Mean numbers of birds per count, and relative abundance of forest birds on Stanley Island. (Data derived from five minute bird counts in October 1991 and May 1992).

	October 1991			May 1992		
Species	**Mean**	**SD**	**%**	**Mean**	**SD**	**%**
NZ pigeon	0.03	0.18	0.02	0.19	0.54	1.5
r-c kakariki	1.34	1.15	11.0	2.5	2.03	19.4
shining cuckoo	0.69	0.69	5.6	0	0	0
kingfisher	0.22	0.75	1.8	0	0	0
fantail	0.25	0.57	2.1	1.0	0.97	7.8
grey warbler	2.0	0.92	16.4	1.0	0.73	3.4
blackbird	0.72	0.89	5.9	0.44	0.73	3.4
dunnock	0	0	0	0.06	0.25	0.05
bellbird	1.25	1.08	10.3	1.06	1.29	8.3
silver-eye	2.91	2.2	23.8	3.0	2.58	23.3
goldfinch	0	0	0	0.19	0.75	1.5
chaffinch	0.53	0.8	4.4	0.44	0.73	3.4
saddle-back	2.25	1.37	18.5	2.94	1.61	22.8

SD = standard error of the mean
% = relative abundance, (i.e., proportion species form of the total population).



Appendix Figure 1.2 Mean numbers of birds per five minute count on Stanley Island in October 1991 and May 1992. Counts in October and May did not differ significantly.

The five-minute counts showed no significant change in saddleback numbers between October and May, but it was clear during the May visit that they successfully during the summer. Flocks of juveniles (some containing 6-10 birds) were often encountered. The five-minute counting technique may underestimate juvenile numbers because the young birds usually feed in the leaf litter (Lovegrove and O'Callaghan 1982), and if more than about 20 metres from the observer, easily escape detection.

It has been suggested that anticoagulant toxins may persist in food chains (Wright and Eason 1991), and perhaps affect fecundity. Although some saddlebacks may have eaten sub-lethal doses either directly or indirectly in invertebrate food, there was no evidence of residual effects in the form of reduced breeding success during the 199-1992 season. However further sampling of invertebrates should be undertaken to check for possible cumulative effects of the toxin in invertebrate food chains, and any dead birds that are found on future visits to Stanley Island should be tested for brodifacoum.

Soil and litter invertebrates are likely to increase and fruiting shrubs regenerate on Stanley Island now that rats and rabbits have been eradicated, and the saddleback is one species that should benefit. If an increase of occurs it should show up in future five-minute counts, and also in the territory mapping of colour-banded birds. At present there are about 20 contiguous territories in which most of the birds are colour-banded. These will be useful for monitoring future changes in density, because any in population size would be expected to result in smaller territories, and new pairs may form new territories between existing ones.

There is no evidence that populations of other forest birds on Stanley lsland have been detrimentally affected, although some introduced birds (blackbird, house sparrow) are known to have eaten toxic baits. Seed-eating species are most likely to take the grain-based baits directly. On Stanley Island such species include red-crowned kakariki, house sparrow, chaffinch and goldfinch *(Carduelis carduelis).* Kakariki spend much time feeding on the ground on Stanley, where they consume fallen seed of trees such as pohutukawa *(Metrosideros excelsa*), mahoe (*Melicytus ramiflorus*) and mapou (*Myrsine australis*). Kakariki spend much time feeding on the ground on Stanley, where they consume fallen seed of trees such as pohutukawa (*Metrosideros excelsa*), mahoe (*Melicytus ramiflorus*) and mapou (*Myrsine australis*). Although kakariki might be expected to be at risk from eating baits directly, there was no evidence of any detrimental effects of the campaign on the species. The only kakariki found dead in October had died before the aerial drop, and this species was the third most abundant bird on the island after silvereye (*Zosterops lateralis*) and saddleback *in* May 1992. Kakariki should benefit from the removal of rats because larger quantities of seed will be available in the leaf litter. Fallen seed is probably an important winter food source for the kakariki.

The morepork may be the only bird which died from secondary poisoning. In experimental studies elsewhere owls are known to have died after eating rodents poisoned with anticoagulants (Mendenhall and Pank 1980).

Although bird deaths as a result of campaigns against do occur and must be of some concern, the potential benefits of noxious animal control projects to bird populations outweigh the costs of the loss of a few individuals (Cowan *et al.* 1985, Spurr 1991). On Stanley Island the removal of rats and should result in greatly increased numbers of invertebrates in the soil and litter, and regeneration of a range of shrubs and trees formerly browsed by rabbits. Birds should benefit directly from terrestrial invertebrate populations, and indirectly from increased quantities of fruit and invertebrates in the regenerating shrub layer. Increased bird numbers on Kapiti Island following the eradication of possums illustrate how a range of forest birds can benefit directly and indirectly from the removal of mammals (Lovegrove 1988). In May 1992 seedlings of *Coprosma macrocarpa,* hangehange (*Geniostoma rupestre*), kawakawa (*Macropiper excelsum*), taraire (*Beilschmiedia taraire*) and puriri (*Vitex lucens*) were already appearing on Stanley Island. Seedlings of these species were rarely seen when rabbits were still present. In May there were large quantities of seed beneath the tawapou (*Planchonella novo-zelandica*). rats ate practically every seed that fell but there should now be renewed tawapou regeneration.

1.5 Recommendations

1. The saddleback population should be surveyed in spring for the next five years, and their survival compared with populations on nearby islands.

2. Territory mapping of the colour-handed birds should continue, to monitor possible future changes in density. More birds should be banded to facilitate monitoring.

3. Five-minute bird counts should be repeated in spring.

4. Further sampling of invertebrates and dead birds should be undertaken to check possible residual effects

APPENDIX 2

Brochure for the Stanley Island–Kawhitu Conservation Project

What's happening on the Mercury Islands?

An ambitious conservation project is being undertaken by the Department of Conservation (DOC) in partnership with ICI New Zealand Ltd.

The Mercury Islands in the Hauraki Gulf Maritime Park, off the Coromandel coast, are being managed to protect rare and endangered species.

Currently, on some of the islands, native plants and animals are being decimated by rats and rabbits. A host of species has already disappeared where rats are present.

The first step in the restoration of these islands is the eradication of introduced mammals.

ICI Crop Care has donated the means to do this – Talon poison bait.

The company has donated 2 tonnes of Talon to clear 95 hectare Stanley Island, and will donate a further 7 tonnes to tackle the larger Cuvier and Red Mercury Islands.

ICI is also assisting DOC develop bait formulations for specific conservation projects.

ICI New Zealand Ltd and the environment

The Stanley Island project is tangible evidence of ICI's commitment to the environment.

This commitment involves all aspects of the Group's operations. Its products and manufacturing processes aim to minimise environmental and human health hazards.

ICI also leads in the development of environmentally superior products, including:

- water-based automobile paint, to replace organic solvents which evaporate into the atmosphere
- diesel technology which uses cleaner burning and sustainable alcohol fuel
- biodegradable plastics
- products which neutralise toxic residues

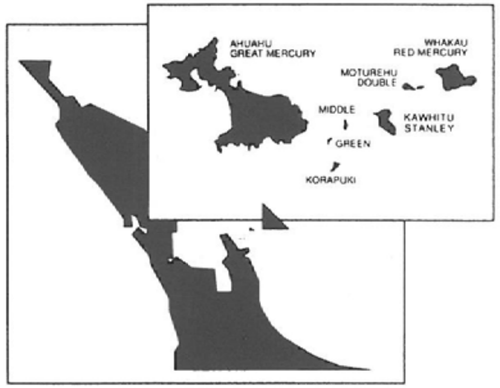
ICI has also publicly committed itself to the "Responsible Care" programme sponsored by the New Zealand Chemical Industry Council. "Responsible Care" is a set of principles and practices for the safe handling of chemicals.

CONSERVATION
TE PAPA ATAWHAI

This leaflet was produced by
Crop Care Division, ICI New Zealand Ltd,
P.O. Box 3344, Richmond, Nelson.
For further information on this and other DOC environmental restoration projects in the Waikato Conservancy, please contact: Information Officer,
Department of Conservation,
Private Bag 3072, Hamilton
Phone 0-7-838-3363

Stanley Island - Kawhitu

Conservation Project



CONSERVATION
TE PAPA ATAWHAI

One of New Zealand's most ambitious conservation projects

The problem

The wildlife and vegetation on most of the Mercury Islands are being threatened by large numbers of rats and rabbits.

Rats prey on skinks, wetas and geckos. They also eat the eggs of tuatara and birds, and compete with adult tuatara for food.

Rabbits prevent forest regeneration by eating tree and shrub seedlings, which in turn reduces insect numbers and thus food for tuatara.

Their burrows cause spectacular erosion.

The solution

Until five years ago, there was no practical way of removing rats from islands as large as Stanley. A breakthrough resulted from scientific research on baits based on brodifacoum, the active ingredient in ICI Talon baits.

Talon has already proved a success elsewhere, notably on Breaksea Island in Fiordland. This rugged bushclad island was cleared of rats within three weeks using Talon .

DOC is now repeating the process on Stanley Island with Talon rabbit baits dropped by air and rat baits placed in ground stations.

Stanley Island

Stanley Island was once home to rare and endangered species but only a handful now remain. The removal of introduced mammals will aid natural regeneration and allow the reintroduction of Whitaker's and related skinks.

Tuatara numbers are being boosted in a breeding programme at Auckland zoo, using pairs taken from the island, for eventual return to a vermin-free home.

Birds such as the saddleback and kakariki, and the milktrees found on Stanley, also rate highly in conservation importance.

Other Mercury Islands host the endangered little spotted kiwi, rare petrel seabirds, tuatara, several species of skink and gecko, as well as rare plants. Milktree forest and tusked weta only occur in the Mercury group.

Talon

Talon is a highly effective poison. Its use on the islands has been approved by DOC's animal ethics advisory committee.

Talon baits are formulated for different types of pests. Wax rat baits are generally unattractive to insects and reptiles, and are laid in bird-proof bait stations. The active ingredient is broken down in the soil.

Cereal-based rabbit and possum baits contain a green dye which makes them unattractive to birds.

An antidote - vitamin K1 - makes Talon much safer to use than 1080 and similar poisons. Humans or animals accidentally poisoned with Talon recover fully with the antidote.

It's your project too

If you visit the Mercury Islands to go boating, diving and fishing, you can help protect this irreplaceable asset by taking steps to prevent any introduced mammals or weeds colonising the islands.

Offshore islands are usually safe from invasion by predators – as long as humans take sensible precautions. For instance, rats can swim for 200 metres or more, and stoats an astonishing one kilometre.

At 6 km offshore the Mercury Islands are safe from unassisted invasion. The main danger is accidental introduction from boats. Rats can run ashore down mooring lines, and Norway rats will even jump ship to swim ashore.

This is why private landings on the islands within the Hauraki Gulf Maritime Park are prohibited for the time being.

To safeguard against accidental invasion DOC requests boat owners and divers to follow a few simple rules:

- don't land on the islands
- don't anchor closer to shore than is absolutely necessary
- place guards on mooring lines
- keep rat bait stations on board (on boats larger than 8 metres)

For its part, DOC will maintain bait stations on the wharf at Whitianga and check all equipment belonging to people visiting the island.