CONSERVATION
TE PAPA ATAWHAI

• PROCEEDINGS OF THE •

NATIONAL PREDATOR MANAGEMENT WORKSHOP

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Craigiebum, Canterbury
13 to 16 April 1992

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Editors

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On behalf of the workshop participants we would like to thank Alan Saunders for initiating and facilitating this workshop and assisting with the editing and publication of these proceedings.

Elaine Murphy, ably assisted by Craig Watson and with help from John Andrew and John Dowding organised the facilities, equipment and local transport. Amanda Baird, Joy Comrie, Dave Kennedy and Colin O'Donnell helped with transporting people while other staff from Canterbury Conservancy Office and Waimakariri Field Centre helped with logistic support and the supply of equipment. We all appreciated the excellent food provided by Dianne Davies and Yvonne Taylor and also thank Steve Farrell for his care of the ski lodge facilities.

We are appreciative of the prompt action by all contributors to this document in both submitting their text and subsequent editing. These texts are supported by the fine front page and section dividing page artwork by. Todd Harding and the technical drawings of the traps by Dave Harding of Bay of Plenty Conservancy.

The workshop would not have been the success it was without the excellent participation of all concerned in the discussions and debate. This was particularly important in the preparation of the working group and workshop outcomes now included in this document.

WORKSHOP GOAL

Through detailed discussion between field staff promote the improved effectiveness and efficiency of departmental control and eradication programmes aimed at cats, rodents and mustelids, and to stimulate the investigation and development of new techniques.

Objectives

1. Consider the ecology of cats, rodents and mustelids in New Zealand ecosystems, and discuss the implications of their control or eradication.

2. Review the effectiveness and efficiency of techniques already developed.

3. Identify techniques worthy of further investigation and development.

4. Foster effective dialogue between people engaged in predator control or eradication programmes.

5. Raise the awareness of field staff to the issues surrounding predator control and eradication, and of the range of techniques currently available or which may be so in the future.

CONTENTS

continued.......

RODENTS

MUSTELIDS

continued......

WORKSHOPS

APPENDICES

WELCOME

Maika Mason

Welcomed participants on behalf of the Regional Conservator. Commented on the importance of predator management as a tool for conserving New Zealand's native fauna. Saw this workshop as a valuable opportunity for people with specialist knowledge to discuss opportunities to improve our effectiveness as managers.

Observed that nowhere in the agenda was there acknowledgement of "the human predator" - perhaps the most significant predator of all. There is a growing awareness amongst the tangata whenua of cultural values, and of Aotearoa's natural taonga. Cited the recent example of the transfer of a kakapo chick from Whenua Hou (Codfish Island) as an indication of this awareness, and of the need to gain the support of the tangata whenua for such actions.

Maika saw no conflict between the Department of Conservation's endeavours to preserve biological diversity and the tangata whenua's needs to preserve cultural values. DOC may need to look closely, however, at establishing new and more appropriate goals which encompassed both natural and cultural values. He advised workshop participants that past freedoms enjoyed by conservation managers may be restricted in the future.

He stressed that managers will need to "focus on the people as well as the birds" if they are to take the people with them.

Maika wished participants well in their discussions.

WORKSHOP INTRODUCTION

Alan Saunders

Mammalian predators are having a significant influence in the decline of many species throughout the world - impacts clearly evident in a range of New Zealand's threatened species ("Threatened" is defined in Appendix 7). Their survival will be largely dependent on our ability to ameliorate the impacts of introduced predators.

In New Zealand there have been significant recent advances in eradicating predators from important island habitats, and controlling them at key sites during critical periods. These advances have resulted from field managers employing innovative techniques and adapting them to local conditions.

An ability to think laterally and a commitment to conserve threatened species are features common to all successful predator managers.

Another common feature is that managers often work in isolation and, as a result, developments may not be passed on to others. A primary goal of this workshop is to promote good dialogue between managers.

While most people think of "managers" as field operators, scientists, planners and advocates are also managers and should be closely involved in predator management programme development and implementation.

There is growing public interest and involvement in conservation management with tangata whenua, land owners, conservation interest groups and the general public all being stakeholders. We need their acceptance and support.

This workshop focuses on three groups of predators: cats, rodents, mustelds.

We need to consider specific management techniques, the ecology of predators and other prey and the ecological implications of intervention management.

The workshop format will be:

1)	Case studies	-	specific techniques and results
2)	Working sessions	-	split into small groups to develop specific recommendations.
3)	Field session	-	practical ideas/skills sharing
4)	Workshop discussions	-	summarise key issues and recommendations for change

This is your workshop. Interest in it has been very high. Its success will depend on your participation.

PREDATOR MANAGEMENT OPPORTUNITIES IN NEW ZEALAND

Ian Atkinson

A recent synthesis of presence/absence records of alien mammals on New Zealand islands (Atkinson & Taylor 1992) provides an opportunity to reassess priorities relating to predators on islands. This contribution discusses some aspects of rodents and stoats *(Mustela erminea)* on offshore islands (islands which are less than 50 kilometres from the mainland).

The total offshore island area known to be free of rats and mice (*Mus musculus*) is 12,142 ha, distributed across 86 islands (> 5 ha). However, 29 of these islands are either inhabited or visited by stoats. Those remaining, free of all introduced mammalian predators, total only 2012 ha.

Using existing ground-based techniques, rats and mice could be eradicated from a further 21 islands of up to 350 ha in area. This would increase significantly the conservation value of all these islands and more than double the area of island habitat free of mammalian predators to a total of 4623 ha.

With improved techniques there is the possibility that rats can be eradicated from one to four large islands: Hen (500ha), Codfish (1396ha), Kapiti (1965ha) and Little Barrier (3083ha). All are of very high conservation value and removal of rats would raise the area of mammalian predator-free islands to a maximum of 11,572 ha. This would leave at least 18 islands with populations of kiore *(Rattus exulans).*

The conditions under which kiore become predators of threatened species are not properly understood. The effects of kiore as competitors for foods eaten by native animals are even less well understood.

Finding a method of preventing stoats from swimming to an island, or establishing temporary residence there, would increase the conservation value of the island estate to a degree comparable to that which can be achieved by eradicating rodents.

Reference:

Atkinson, I.A.E. & Taylor, R.H. 1992. Distribution of alien mammals on New Zealand islands (second edition). Department of Scientific and Industrial Research Land Resources Contract Report No. 92/59. Department of Conservation Investigation No. 547.

PREDATOR CONTROL ACTIVITIES CONDUCTED IN HAWAII/PACIFIC ISLANDS: CAN NEW ZEALAND'S MODEL BE APPLIED IN THIS AREA?

Ernie Kosaka

Predator control problems in Hawaii/Pacific islands are very similar to those in New Zealand. In Hawaii, predator control efforts are directed to controlling mongooses *(Herpestes auropunctatus),* feral cats *(Felis catus),* dogs *(Canis familiaris),* pigs (*Sus scrofa),* sheep (*Ovis aries),* and goats *(Capra hircus)* in refuges or sanctuaries on the islands of Hawaii, Maui, and Oahu. These areas are similar to the "island" concept guiding control efforts at Mapara. With the exception of the mongoose, the Department of Conservation (DOC) controls the same species in very similar situations. Eradication projects for feral cats on Jarvis Island, and the Polynesian rat *(Rattus exulans)* on Rose Atoll, American Samoa actually used DOC techniques described in the literature. The only different control situation is on Guam where efforts are being made to control/eradicate brown tree snakes *(Boiga irregularis)* from the island.

However, the methods used to implement control programs differ considerably from the DOC model. Most predator control work is conducted through cooperative agreements with the U.S. Department of Agriculture, Animal and Plant Health Inspection Service (APHIS), through its Animal Damage Control unit. This organization provides staff trained in using chemical toxicants, traps, firearms, snares, etc. US Fish and Wildlife Service and other resource agency staff function only as participants. In effect, resource agencies pay APHIS to do their predator control work.

In-house resources are used when staff already possess necessary training certification, the toxicant formulations are certified for use by the Environmental Protection Agency (EPA), and a bait/delivery system is commercially available. A cooperative agreement with APHIS is used when staff resources are not available for this activity or when they do not have the necessary training certification for applying specific toxicant formulations. It is much easier to contract with APHIS since they have the expertise to prepare all necessary documentation to comply with EPA requirements, thus minimizing red tape and delays in obtaining required Federal and/or State authorizations. In addition, APHIS has the expertise to follow through with assessing secondary effects on non-target species.

The New Zealand model utilizes a wide range of toxicant formulations. DOC staff are skilled in formulating and implementing predator control activities over both small and extensive areas, and are highly motivated, dedicated and innovative in addressing unique predator problems. Most importantly, regulatory constraints are minimal when compared to Hawaii/Pacific islands.

Can the New Zealand model be applied in Hawaii/Pacific islands? Probably not, because: 1) regulatory constraints frequently preclude the use of the most effective toxicant(s); 2) red tape in obtaining required permits and approvals is a formidable, time-consuming obstacle; 3) the cost of registering a toxicant and delivery medium is prohibitively expensive (minimum of US$750,000) and lengthy (about 5-10 years); 4) resource agency staff lack the experience and skills of DOC staff; and 5) it is more cost-effective to contract with APHIS for predator control work.

PREDATOR MANAGEMENT ON NORFOLK ISLAND.

Derek Greenwood.

Norfolk Island lies approximately half-way between Auckland and New Caledonia, at 29° S latitude. The island covers some 3,500 hectares, of which 460 hectares are National Park. As happens on many islands, aggressive predators and competitors accompanied early settlers and the endemic wildlife suffered. Combined with hunting and over-zealous habitat removal, several species are extinct, and others are threatened.

Two of the endangered fauna are the Norfolk Island morepork (*Ninox novaeseelandiae undulata)* and the Norfolk Island green parrot *(Cyanoramphus novaezelandiae cookii),* whose main current threats are predation by ship rats (*Rattus rattus*) and feral cats *(Felis catus).*

Random rat baiting occurs across the island, with land-owners using various commercial baits. Island-wide eradication has been widely discussed, but dismissed owing to the cost and logistics of such an operation on an inhabited island, and the lack of a guarantee of success. At present the Australian National Parks and Wildlife Service (ANPWS) has no management jurisdiction outside the National Park.

There are four main techniques currently used for the control of rats and cats

1. Exclusion of rats from the nest-sites.

This is achieved by modifying and upgrading suitable sites to achieve a secure site with a rat-proof entrance. Possible rat entry points and weaknesses are meshed and plastered, and flat-iron templates are fitted around the entrances and camouflaged. Unsuitable sites are either closed off or destroyed.

2. Permanent bait-stations at nest-sites.

Three "Novacoil" bait-stations are installed around each site, baited with "Quintox", and monitored every 6-8 weeks.

3. Supplementary kill-trapping of rats at active nest".

When green parrots are discovered using a site, one pair of break-back traps are set near each bait-station, and checked twice-weekly for the remaining duration of the breeding attempt.

4. Continual live-trapping of feral cats.

Thanks to the Endangered Species Unit of ANPWS, some ongoing additional funding for competitor and predator management activities has become available. This has enabled the implementation of continual cat-trapping within the Park. Ten cat traps are set across the Park weekly, in a four-week cycle. Tinned sardines are used as bait. Some 30-40 cats are trapped annually within the Park.

PREDATOR RESEARCH AND CONTROL IN WESTERN AUSTRALIA

Jack Kinnear

Since European settlement, Australia has lost more mammal species than the rest of the world combined. In Western Australia for example, eleven species are believed to be extinct and 27 species are threatened. The distribution and range of surviving species has also been profoundly affected. The causes of this wildlife catastrophe have been the subject of numerous reviews. In general, the explanations have focused on habitat loss and disturbance. However, recent studies have implicated introduced predators, in particular, the European fox *(Vulpes vulpes)*.

A series of predator removal experiments have revealed that fox depredations regulate marsupial populations to levels well below the carrying capacity of the habitat. When foxes are removed by sustained baiting programmes, prey populations have increased substantially. To date, six species (brush-tailed rat-kangaroo *(Bettongia penicillata*), Rothschild's rock wallaby (*Petrogale rothschildi*), black-flanked rock wallaby (*P. lateralis*), tammar wallaby (*Macropus eugenii*), brushtail possum (*Trichosurus vulpecula*) and the numbat (*Myremcobius fasciatus*)) have responded. Additional studies in progress are producing similar results.

Fox control programmes in Western Australia are now in place in selected conservation areas of the State. They are designed to protect any array of endangered species from extinction. It is viewed as a necessary holding action, that will be maintained until a method based on biocontrol becomes available. Research on biocontrol is now under way.

THE SEMI-ARID LANDS RESEARCH GROUP PREDATOR RESEARCH WORKSHOP. HALDON STATION, MARCH 1992.

Robert G. Mills

In the semi-arid lands of the South Island predators are important because they kill rabbits (*Oryctolagus cuniculus*), may transmit TB and other stock diseases and threaten some indigenous fauna. For these reasons predators, and predator research, are of interest not just to the Department of Conservation, but also to Landcare Research, the Animal Health Board, Regional Councils, Landcorp, Semi-Add Lands Research Group (SAL), Federated Farmers, Fish and Game Councils and Universities. In March 1992 the SAL organised a workshop attended by representatives of these groups. The aim was to forge links amongst the organisations, identify knowledge gaps they all face and plan to fill them, and develop a cooperative approach to predator management.

All groups share a lack of knowledge of the animals and systems they must manage. In a common search for a long term sustainable solution all are faced with dynamic changes in climate, land ownership, new tools (particularly the possible introduction of myxomatosis), funding and public perception. Each interest recognises the need for an experimental approach to the research required.

The groups differ in the geographic scale on which they deal, whether they are dollar or belief system driven, whether alternative land use is an option, and, most importantly, whether they view predators as beneficial or detrimental.

Working groups of field researchers, regional managers, national policy makers and theoretical ecologists discussed how these differences might be resolved.

The discussion resulted in better understanding of the differing perspectives of each group, the identification of key issues that research must address, the research approach that should be taken, and whose research encompasses each question. Many groups felt the need to establish a steering committee to maintain liaison amongst interested parties and coordinate future research and management.

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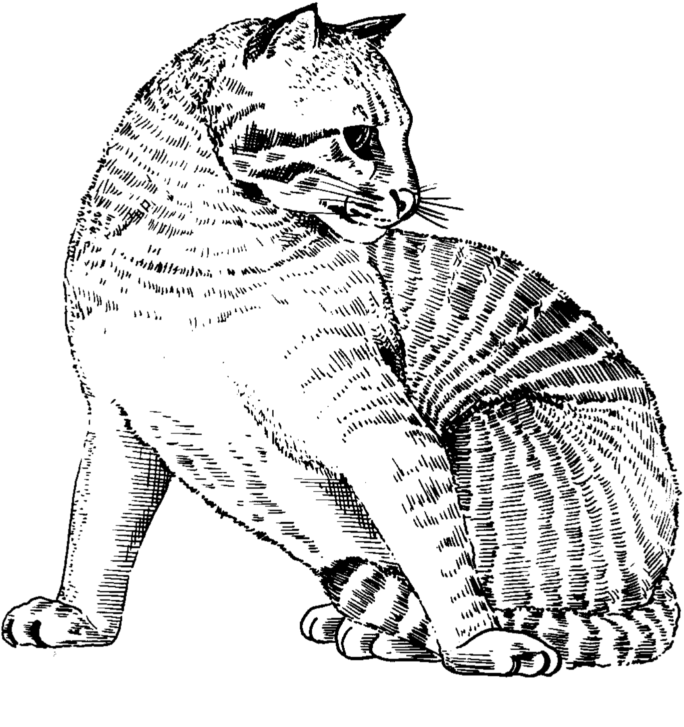

ECOLOGY OF FERAL CATS IN NEW ZEALAND

Mike Fitzgerald

Despite the widespread view that cats *(Felis catus)* are important predators of birds, reviewing the many studies of the diet of feral cats worldwide shows that cats prey primarily on small mammals, especially rodents and young rabbits *(Oryctolagus cuniculus)* and prey to a lesser extent on birds. On islands, though, birds are a more important part of their diet. When cats have been introduced to islands, bird populations have declined dramatically or become extinct, but the impact of cats is often difficult to separate from that of other introduced mammals, especially rats, and from human activities.

Studies of the diet of cats on New Zealand islands illustrate the range of diet and some of the impacts. On bird islands such as Herekopare which have no mammal prey, cats can thrive as long as sufficient populations of breeding seabirds remain. Most islands with cats on them also have rats and they and seabirds form the bulk of the diet. Cats prey on kiore *(Rattus exulans)* and ship rats (*R. rattus)* of all ages but take mainly young Norway rats *(R. norvegicus)* because adults are too large and aggressive. On Raoul Island Norway rats are more common than kiore but form less than 10% of the rats eaten by cats. There and on Campbell Island Norway rats have probably had serious effects on seabird populations. Removing cats from islands where rats, especially Norway rats and ship rats are present, is of little value unless the rats are also eradicated.

On mainland New Zealand things are more complex. In the Orongorongo Valley, a forested valley near Wellington, cats and their prey have been studied by DSIR staff since 1970. Rats and rabbits are the most important prey, and birds (mainly ground-feeding introduced species) are minor prey. Cats were common in the 1970s but declined to low numbers in the late 1970s and early 1980s when possum *(Trichosurus vulpecula)* trapping was intensified during the period of high prices for possum skins. Cats were accidental victims in the gin traps and we removed some additional cats to keep the population low. The rat population then increased dramatically. Any benefits to the bird life from the reduction in the number of cats was probably more than cancelled out by the increase in the rat population.

There is also some evidence that cats are important in limiting rabbit populations over much of New Zealand. Young rabbits are important prey of cats on most farmland. On developed pastures rabbits breed throughout the year, and cats (and ferrets *(Mustela furo))* keep the rabbit population low and stable. On other grasslands rabbits breed for only about six months and predator populations, reduced during the months when young rabbits are not available, are unable to control rabbits. We do not yet know enough to assess the present effects of cats on mainland bird and lizard populations.

Effective policies for the management of cats have probably been easiest to develop on islands, with their simpler systems and limited areas and where eradication is usually the aim, than for the more complex systems of the mainland, where cats are just one of many interacting factors affecting species.

SELECTED REFERENCES ON CATS

Fitzgerald, B.M. 1988. Diet of domestic cats and their impact on prey populations. *In* D.C. Turner & P. Bateson (Eds.): *The domestic cat: the biology of its behaviour.* pp. 123-147. Cambridge University Press, Cambridge.

Fitzgerald, B.M. 1990. House Cat. *In* C.M. King (Ed.): *The Handbook of New Zealand Mammals.* pp. 330-348. Oxford University Press, Auckland.

Fitzgerald, B.M. & Karl, B.J. 1979. Foods of feral house cats *(Felis catus L.)* in forest of the Orongorongo Valley, Wellington. *N.Z. Journal of Zoology 6:* 107-126.

Fitzgerald, B.M., Karl, B.J. & Veitch, C.R. 1991. The diet of feral cats *(Felis catus)* on Raoul Island, Kermadec Group. *N.Z. Journal of Ecology 15:* 123-129.

Langham, NPE 1990. The diet of feral cats *(Felis catus L.)* on Hawke's Bay farmland, New Zealand. *N.Z. Journal of Zoology 17:* 243-255.

Langham, N.P.E. & Porter, RER . 1991. Feral cats *(Felis catus L.)* on New Zealand farmland. I. Home range. *Wildlife Research 18:* 741-760.

Pierce, R.J. 1987. Predators in the Mackenzie Basin: their diet, population dynamics, and impact on birds in relation to the abundance and availability of their main prey (rabbits). Report for Wildlife Service, Department of Internal Affairs, March 1987.

Tabor, R. 1983. *The wild life of the domestic cat.* Arrow Books, London.

Veitch, C.R. 1985. Methods of eradicating feral cats from offshore islands in New Zealand. *In* P.J. Moors (Ed.) *Conservation of island birds.* pp. 125-141. International Council for Bird Preservation technical publication No 3.

Veitch, C.R. 1991. Cat eradication: the New Zealand perspective. In C. Potter (Pd.): *The impact of cats on native wildlife.* pp. 82-89. Australian National Parks and Wildlife Service.

CATS: CURRENT RESEARCH AND MANAGEMENT CONSIDERATIONS

Ray Pierce

Questions of cat *(Felis catus)* impacts and whether control or eradication is needed are usually complex, particularly for mainland situations. In deciding whether a control programme is needed to meet objectives of recovery plans, etc., some basic data are needed:-

1. Actual detection of predation and assigning it to a predator species. Detection is often interpretive. Standardised recording of predator sign is needed.

2. Impact on sensitive species. A high frequency of one prey species in the diet does not necessarily correlate to high impact on that species' population. Knowledge of population dynamics of sensitive species is required, i.e. recruitment rates, causes of mortality and the relative importance of cats.

3. Would cat control/eradication assist the sensitive species? In many cases, yes. However, other factors could also ultimately control populations of sensitive species, e.g. food supply, other predators including by way of a changing predator-prey regimen. Depressing cat numbers alone may make an area more attractive for rats and/or small mustelids which could exert greater pressure on sensitive species than cats do. Often control of these other predator species will be needed to achieve the objective.

Having decided to implement control, one must decide on timing, duration, area, methodology etc. all of which should reflect the vulnerable life history patterns of the protected species but also the seasonal abundance and behaviour of predators. Avoid 'one - off killings which may have negative impacts on the sensitive species, e.g. by destabilising intra- and inter-specific territorial behaviour, thereby exposing sensitive species to a greater number of individual predators and a wider range of hunting techniques. Where cats need controlling in mainland habitats, wildlife managers should consider undertaking multi species control to minimise possible ripple effects.

Questions requiring further research include effects of manipulations e.g. 1080 possum (*Trichosurus vulpecula)*/rodent operations on cat/mustelid populations and behaviour; costs versus benefits of cats to some wildlife in urban or heavily settled areas; and technological advances especially with poison baits, multi-species approaches to control.

LITTLE BARRIER CATS AND LESSONS LEARNED

Dick Veitch

Prior to 1977 we had succeeded in eradicating animals from islands on some 40 occasions and of these, four were cat *(Felis catus)* eradications. We had previously attempted, and failed in, the eradication of cats from Little Barrier Island on two occasions and we had also started work on cat eradication from Raoul Island.

This experience enabled us to prepare a plan of action well before work on Little Barrier Island started.

In total, 143 people actually worked on the island using 40 cage traps, 1,000 Lanes Ace traps, spreading more than 26,000 poison baits and walking dog teams during 18 months work during the winters of the four years from 1977 to 1980. The job was successful and we can use that success for recommendations for future operations.

There must be good communication links among the people involved, both on the island and between the island and mainland.

Do not disturb the target population before the operation starts. When predator numbers go down prey species become more abundant and hence the predator is less likely to take poison baits or visit traps.

We often turn to volunteers to give us assistance, and they certainly have their place in conservation work, but many projects may be better if knowledgeable and dedicated staff are employed from the start.

Regarding baits, traps and other killing methods there are two ways one can approach an eradication project - test, test, test and then use - or use what is already known and be prepared to change.

From the eradicator's point of view, all the monitoring you have to do is to know that you have got the last animal. On the other hand, monitoring so that you know there has been change as a result of your activities will be well worthwhile for the future of conservation in New Zealand.

The media can also be used to advantage - or they can turn your whole project upside down. Ensure that they are always told the story from the beginning - the damage the predator is doing. And handing them written material does not achieve this - you must take time out to talk to them.

A similar pro-active approach is needed wherever there is a requirement to gain permission - be it a legal or moral requirement. Do not leave it to the last minute - get in early. Indeed, having permission to do a particular part of the job can often smooth the way over other difficulties. This is called `using the system to your own advantage'. I recommend it for all future projects.

FERAL CAT CONTROL IN THE STEWART ISLAND KAKAPO AREA

Andy Roberts

The kakapo *(Strigops habroptilus)* study area covered about 20% of Stewart Island's 170,000 ha., and is bounded by Cooks Arm, Doughboy Bay, Tin Range and Lords River. In 1980 a study of kakapo was commenced and through the use of radio telemetry it was revealed that cat *(Felis catus)* predation was having a disastrous effect on the kakapo population. Between 1980 and 1981 predation of kakapo was in the order of 50-60% of the population per annum. Surveys also revealed a large number of track and bowl systems (courtship display areas) which had probably been active in recent times but were currently unused. This was further evidence that the population was in decline. Some form of control of the feral cat population was required in order to buy time until other management options for kakapo became available.

Eradication of cats from all of Stewart Island was proposed but not considered feasible. A cat control programme was developed using techniques previously used on Herekopare, Little Barrier and Raoul Islands with some new techniques developed specifically for this task. Factors including the density of the kakapo population, topography and cost-effectiveness limited cat control efforts to the central kakapo area where intensive kakapo research was being carried out.

The initial reduction of cat numbers in 1981 was achieved using a helicopter to spread (by hand) fish bait which had been injected with 1080. This method continued to be used until 1984.

Several problems were encountered with the aerial poisoning programme, these included

* the ability to obtain enough fresh fish (frozen fish is not suitable) at the correct time when weather conditions were optimal.
* having enough workers available to prepare the baits and inject the 1080, often at short notice.
* the weather conditions remaining suitable throughout the period between the fish being caught, the baits prepared and applied and the next 48 hours, in which the baits were likely to be most attractive to cats.
* having no real ability to retrieve old baits which were possibly either beginning to decompose and/or suffered from poison leaching out and thereby increasing the chance of a cat encountering a bait with a sub-lethal dose of 1080 and then developing bait or poison shyness.
* no method was available to monitor the effectiveness of this cat control, apart from the use of radio telemetry to check that known kakapo were still present.
* there was no ability to inspect baits after distribution to check for baits missing (taken by cat) or for sign of a cat having regurgitated baits it had fed on.

During the same period, trapping of cats using Lanes Ace leg hold traps was carried out in the coastal podocarp forest near the kakapo area. This strategy was based on a belief in the greater attractiveness of such habitats to rats and cats. It was hoped that the removal of cats from the coastal habitat would have two benefits: lowering the rate of cat reinvasion of the kakapo area from the coastal zone, and encouraging migration of cats from the poorer inland area to the more productive coastal fringe. As kakapo tended not to be found in this forest, although they probably occurred there once in greater numbers than in the study area. It was considered safe to use leg hold traps.

Trap sets were of the standard type used with a trap placed at the base of a tree and fenced to direct the cats paw toward the plate and to discourage non-target species. Bait (usually fish) was attached to the tree about a wide handspan width beyond the plate. This method is considered more effective than poisoning because if the trap site is well selected and the trap well set, all the cat has to do is investigate the bait, rather than consume the bait. Trappers ran up to seven traplines consisting of about 20 traps each on any one trip, usually of about a month's duration. Non-target species at risk included kiwi (*Apteryx australis lawryi*), kaka (*Nestor meridionalis meridionalis*), blackbird (*Turdus merula*), rat (three species) and possum (*Trichosurus vulpecula*).

The trapping programme around the coastal area and ground-based poisoning inland was begun and continued opportunistically as finance allowed. The quality of trap sets and preparation, application and removal of baits was of prime importance. Risks of cats becoming shy of traps, baits or poisons were important considerations and the reason quality control was so important. Good instruction of new workers was vital as was continual quality control by all staff involved. It was assumed that in any population of target animals there will be some individuals that, by their own inclination, will be neophobic and therefore unlikely to be trapped or poisoned. All efforts should be made to prevent this percentage of the population increasing through non-fatal encounters with baits or traps. It was also assumed that during the duration of any control operation the effectiveness of techniques diminishes due to bait, poison or trap shyness and the search for new techniques should be encouraged. They should not be used in the field situation until the experimental phase is completed.

In 1984 the cat control project received an increase in financial support and a team of workers was able to be directed solely to this task on the basis of a control trip every second month. Emphasis changed from aerial poison and supplementary ground based spread to ground application only. This included allocating time to retrieve old baits and to monitor, albeit somewhat cmdely, bait take. The area of control through poisoning may have decreased somewhat, but still covered the core of the kakapo study area and was being poisoned on a more frequent basis with an improved quality of operation. The major problems encountered were a rapid decline in the local availability of fish in Port Pegasus which were used as bait for both poisoning and trapping operations, and inadequate field accommodation, until a but was provided by sponsorship support from BP Oil N.Z. Ltd in late 1985.

Both techniques were successful in reducing numbers of feral cats. From 1982 onwards the number of cat-killed kakapo declined, the last one being found in August 1983. All 29 kakapo known during the period 1984-1989 remained safe. Since cat control operations ceased in 1989, a further 12 kakapo have been found although not all were in the cat control area.

It was assumed by the control team that not all cats were kakapo killers, rather that it was a learned behaviour and a few individuals were responsible for the periodic occurrences of kakapo predation. This control programme was responsible for halting the incidence of known kakapo predation and was therefore considered successful. Between 150 and 200 cats were trapped and an unknown number poisoned. Evidence was obtained that at least six cats were poisoned.

CHATHAM ISLAND PREDATOR CONTROL PROGRAMME

Andrew Grant and Rex Page

The predator control programme in the Tuku/Awatotara Valley, south-eastern Main Chatham Island, was put into place in 1989 primarily to protect the endangered taiko *(Pterodroma magentae)* during its breeding season. The total taiko population is currently estimated to number 60 birds. It was hoped that another endangered species, the Chatham Island pigeon or parea *(Hemiphaga novaeseelandiae chathamensis),* estimated to number 100 birds, which also lives in this area, would benefit too. There were three main goals:

I. To prevent further loss from predaton by feral cats *(Felis catus)* of adult taiko when they are prospecting and clearing out burrows in September and October.

2. To protect taiko chicks from predation by feral cats just prior to their fledging during March, April and early May.

3. To reduce predation of parea by feral cats.

Lanes Ace traps, baited with fresh fish, were set at 100 metre intervals along existing and specially cut tracks around the two taiko nesting colonies and through the surrounding bush out to the coast. The number of traps in each trapping period varied depending on operator experience and lengths of tracks being covered, but was in the order of 300 to 400 for each trapping period. In autumn 1992 the fish baits were substituted with a fish-meal based polymer pig bait enclosed in a protective container to exclude rats and to protect them from weather.

Chatham Island Predator Control Trapping Results	30/8-30/10 SPRING 1989	27/2-27/4 AUTUMN 1990	14/9-3/11 SPRING 1990	4/4-8/5 AUTUMN 1991	5/9-8/11 SPRING 1991	2/4-6/5 AUTUMN 1992	TOTAL
CATS	33	23	26	30	33	13	158
POSSUMS	590	300	600	130	626	256	2502
WEKA*	155	154	590	126	184	101	1310
RATS	33	57	112	111	142	31	486
OTHER	14	12	10	13	8	6	63
Corrected Trap Nights	11,931	14,921.5	20,210	10,736.5	11,263	9,174.5	78,137
TOTAL per 100 TNs	6.914	3.66	6.62	3.818	8.89	4.436	5.783

* *(Gallirallus australis hectori)*

Has the programme achieved its goals?

Taiko:

Prior to the trapping programme there were only three burrows being used, one of which regularly produced a chick. Over the three years of this trapping programme a number of old disused burrows around the existing ones have been partially excavated, one has been fully cleared out and an egg laid in it. Up to three burrows have contained chicks in any one season but only one chick has fledged each season and always from the same burrow. The other chicks have not reached a stage where they are old enough to fledge and have either died or been killed in their burrows.

Goal 1 has been achieved in that there is no obvious evidence of adults being preyed on, and there is evidence that birds are now able to clear out new burrows without being preyed on, and, if allowed to continue, this will certainly result in a more densely populated colony.

Goal 2 has been partially achieved in that the chicks that did reach fledging stage were able to fledge successfully. Mortality within the burrows was not cat predation, it may have been due to predation by rats, disturbance by possums (Trichosurus vulpecula) or lack of food out at sea.

Chatham Island pigeon (parea):

No evidence has been found of parea being preyed on by cats during this programme. The parea population has increased in the trapped area from about 18 birds before 1989 (this has been the parea population estimate in this area for the last twenty years) to almost 50 in February 1992. This is likely to be partly due to birds moving into the area from the surrounding area. The 1991-92 breeding season produced 14 fledged chicks.

Goal 3 has been achieved as no evidence of preyed-on parea has been found, but the tremendous increase in parea numbers and activity in the area is due more to an improvement in the habitat as a consequence of the removal of a large number of possums rather than decreasing the cat population. Possums compete directly with parea for food items and reduce the general health of the habitat - hence it may be assumed that a reduction in their numbers improves the availability of food for parea. This is an additional, and largely unplanned, benefit of the trapping programme.

DEVELOPMENT OF A PELLETED POISON BAIT FOR FERAL CAT CONTROL

Dave Morgan and Charles Eason

Current feral cat *(Felis catus)* baiting techniques are very expensive, not target specific, and hazardous to operators. To overcome these drawbacks we have developed a pellet bait for cat control.

A range of eight unmodified pellet baits were compared with a highly palatable proprietary cat food and one, a polymer-fishmeal bait, was found to be equally palatable. Twenty four additives were tested to further enhance bait palatability: the amino acid L-alanine was the most preferred and it was superior to commercial cat food flavour and attractant. The luring effectiveness of 28 substances was tested in pen and field studies and catnip was found to be the most successful. Both L-alanine and catnip applied to the surface of baits improved bait palatability, and when both were applied palatability was further enhanced.

The toxicity and humaneness of 1080 to cats was tested by offering to 48 cats one 1080 pellet and 5 gm of mince. Of the 42 cats that ate the mince, 38 ate the bait within 1 hour and a dosage of 2 mg 1080 per bait was estimated to be sufficient to kill cats up to 5 kg. After eating 1080 pellets, cats became lethargic and disoriented without the violent symptoms seen in other carnivores such as dogs, and death occurred in 6 - 24 hours: it is therefore a humane poison for cat control. Of six other toxins evaluated only "Glyftor" showed potential as an alternative to 1080 for cat control.

Field trials were carried out using a blood serum marker in non-toxic bait to determine the proportion of cat populations accepting bait. A total of 79 cats was caught. Of the 25 cats caught up to 1 week after bait was laid, 23 (92 %) were marked; by 2 weeks after bait laying 43 out of 57 (75%) were marked; and by 4 weeks 49 out of 76 (64%) were marked. Baits presented in a swath on the ground and in specially designed bait stations were eaten by equal proportions of cats (89% and 89%, respectively). The bait in bait stations remained in good condition three times as long (42 days) and after three times as much rain (105mm) as baits laid on the ground (14 days and 33 mm rain). The bait was highly target specific: apart from cats, only hedgehogs *(Erinaceus europaeus)* ate the pellets. An initial small scale control operation using the toxic bait successfully removed all cats within seven days.

When used in bait stations suitable for cats to feed from, the bait is highly acceptable to cats but unacceptable to other wild animals except hedgehogs. The technique is therefore a very efficient way of controlling and possibly eradicating feral cats.

CAT WORKING GROUPS

Participants broke into six working groups to discuss the topics summarised below. Note that groups 1 and 2 considered the same topic. In these summaries recommendations or suggestions are shown in bold type.

1. BAITS, BAIT STATIONS AND LURES FOR CATS I

Research into foraging behaviour of cats in natural ecosystems in relation to their ability to find lures or baits is needed. **The highest priority for is knowledge of cat movements and home range so that we can improve our placement of baits and lures**. The cost effectiveness of spreading baits may then be calculated through a comparison of aerial sowing, hand sowing and bait stations. **In relation to toxins, the Department of Conservation needs to support work on alternatives to 1080, used at present.**

New bait types may almost be a non issue because we already have a promising bait. However, because there is always a chance that we may lose this bait, we need to keep our options open and continue to look for alternative bait types and of course to continue to work to improve the present bait types.

Just how important are lures? If luring can be successful, it would have great advantages by cutting the coverage and labour need to spread bait or place traps. There is also a need to continue research into other types of lures, such as sound or visual attraction. While lures are not a high research priority it would be great if in the long term we could find something more magnetic than we have today.

How important is bait placement and layout as it relates to our knowledge of cat ecology? We need to draw together this knowledge and make it available to people working in the field. There is of course the recognition that there is a huge variability of home range size and the movement of cats in different environments. The effort and returns from various methods of controlling cat numbers, such as trapping, bait spreading and bait stations needs to be compared and this information made available to field personnel.

How important is bait station design? Where do we put the bait station and what physical state and size should it be? There needs to be considerable research on this and there is no point in having good research unless it can be translated into good management. We need to foster the exchange of information between all sides of research and management.

2. BAITS, BAIT STATIONS AND LURES FOR CATS II

What we want is a bait or lure that is durable, cost effective, portable, highly acceptable to cats and readily available for the manager to use. The conclusion was that there is no alternative to a synthetic bait or lure. **As a first priority we need a species specific bait, that is specific to cats.** As a second longer term priority we should be looking towards broad spectrum baits, we must not ignore any repellents that we find in the course of this research.

In considering the ways the baits are presented to cats we need to look closely at bait stations or other baiting regimes and the field effectiveness of these methods, and that in turn has to be related to the confidence users will have in the effectiveness of these various methods.

There needs to be a greater pooling of information, probably at a central repository and dissemination of that information to managers. We should not rely solely on the present poisons available to us, we should continue to search for better toxins, or ones which are more acceptable in general terms.

So how do we get our desired needs?

Firstly synthetic bait. There needs to be continued support for the current Landcare Research work in this area. **It is imperative that DOC make a commitment to participating in field trials for the baits we already have and those to be developed. It is also imperative that the Landeare Research make a commitment to continue to work with DOC.**

Species specific baits and lures.

Continued research is needed here, with more input by field centres in conservancies into field testing and use of such baits. There is a management responsibility to actively test bait stations for their effectiveness, both from the managers point of view and the acceptability to cats.

Baiting regimes require research support to extract existing data, summarise it and proceed to develop the best baiting regime. There needs to be for all aspects of cat work a better exchange of data, collation of written reports and abstracts, creation of mailing lists to disseminate the data and transfer skills around the country. This is a cumulative process where we all learn and build on experience and mistakes.

3. TRAP TYPES FOR CATS

Any trap which requires the cat to grasp the bait in its mouth and push or pull something to trigger the trap is a poor choice. This is due to the low capture resulting as cats are not inclined to grasp such baits in their mouths. The use of cage traps may be justified in some very public places. Traps which need to be set in tunnels are also a poor choice as cats are not inclined to walk into such tunnels.

The Lanes Ace and Victor 1.5 soft jaw are both proven as efficient cat catchers but to be permissable and more effective both need to modified. The Lanes Ace needs rubber jaws and a spring in the chain. The Victor l.5 needs the trigger plate to be modified to avoid jamming.

Trap setting skills need to be improved and producing a manual will assist in this. Advocacy about the need to eradicate or control cats is needed at all times, not just during a particular project. This needs to be accompanied by information on the humane nature of the traps in use.

Research is needed to develop a method of killing cats which does not require them to eat bait or be mechanically captured. This killing needs to be species specific and non labour intensive.

4. TECHNIOUES FOR MONITORING CAT NUMBERS

The monitoring required depends on the objectives of the operation. If the operation is control of cats to protect or enhance a valuable species, then the most important monitoring is of the number of that species surviving. The number of cats killed is not important as long as remaining cats do not kill any of the valuable prey.

If you are interested in evaluating the technique used to control cats, it is necessary to took at different techniques for estimating cat abundance.

For eradication operations the presence or absence of cats is the bottom line. 8 indexing techniques were discussed: Nighttime spot light counts of cats seen; A trapping index; Mapping the presence of cat scats or prey remains; Placing tracking plates at appropriate sites; Sightings at any time; An age, sex analysis of the captured portion of the population; Remote sensing with cameras or video to record the presence of cats; A record of the number of times baits are taken or interfered with by cats.

All these indexing techniques have drawbacks and benefits. The criteria for the method selected should consider the terrain and nature of the habitat, the need for precision, such as statistical analyses, confidence intervals and the avoidance of bias, the costs of the operation and resources available and the need not to harm animals, especially in non treatment areas. We see the most promising technique as being the tracking tiles with a grid line. We accept this is a fine weather technique but suggest it could be developed into useful technique with wider application. Where possible more than one technique should be used.

We identify as research needs, the development of a good attractant, whether it be sign, sound or scent and **there is a need for a manual to verify characteristic sign left by cats** compared to other predators.

5. PRIORITIES FOR THE CONTROL OR ERADICATION OF CATS

a) **Top priority is to develop a system for national and regional ranking of eradication and control proposals**. The first step in this would be to assemble a national list of locations where cats are thought to impact on conservation values or where removal or control of cats will increase options for management of threatened species or ecosystems.

We envisaged an hierarchal or cascading system for ranking proposals. Criteria to be considered include: area, priority of species or ecosystem at risk, expected costs, achievability, risk of reinvasion, land tenure, presence of people, presence of other mammals, suitability of the method for the particular location eg 1080 poisoning may not be appropriate in inhabited or farmed areas.

Islands to be considered include Raoul, Campbell, Auckland, Pitt, Stewart, Big Moggy, Great Harrier, Waiheke, Rangitoto, Chatham and Mayor. Mainland localities include: Mckenzie Basin, Otago Peninsula, Banks Peninsula, Te Paki, North Taranaki coast, Mangawhai Heads, Paparoa National Park and South Okarito.

b) **Our next priority is the development of new techniques for cat control.** This might include epidemic diseases, biological control, genetic engineering, chemosterilants etc.

c) **Third priority is research on ecological interactions between cats and other predators and between cats and their prey**. This is important for predicting the impacts of cat control on threatened species or habitats. The ecology of cats during long term control programmes should also be investigated to see whether the control programme needs to be modified to allow for changes in behaviour, breeding biology, diet etc.

d) Fourth priority, the preparation and maintenance of a manual, or data base on techniques and strategies of cat control and eradication including identification of cat sign.

e) Fifth priority, studies of cat distribution, cat density and cat ecology in different habitat types. There is also a need to determine criteria for the success or failure during cat control programmes.

6. BARRIERS FOR CATS

Barriers can be used to exclude cats from seabird colonies, particularly where these are on cliffs or sandspits or to create cat-free "islands", such as may be desirable around petrel colonies or threatened species colonies in larger land masses. Cat barriers can be used to protect traditional nesting sites of birds, or to protect the larger flightless invertebrates which cats prey on.

Possible techniques include ultra sound, electric fences, floppy barrier which a cat would have difficulty to climb over, water in the form of a moat or a river, the tinning of trees, or more seriously the putting of the species in an aviary, or the use of repellents, some scents or sound which the cat will not like.

There is also the possibility of conditioning the cat to not like birds or threatened species as a prey item, while the cat still hunts rats.

Research is possible into many of these possible techniques to test fence designs and other exclusion designs, and to consider the animal behaviour approach. There are of course problems with creating physical barriers, in that these need to be maintained and if the area is large it may be difficult to remove the predators from the inside of the area. We may subsequently then have to live with our mistakes after protecting an area for some years of time and then having it fail. The costs of the methods are unknown and the methods themselves of course are not well tested.

Possible benefits from barriers is that it conveys a positive message to the public, land owners and sponsors. Using these methods we can effectively create island of mainland habitat and we can be very specific in the areas that we target. Physical barriers are removable or can be left there for long term. They do not have a detrimental effect on the cats such as traps or poisons. They do have a higher capital cost, but a lower cost of travel and labour once installed. These methods allow conservation officers to take a holiday from time to time.

CONSERVATION
TE PAPA ATAWHAI

• RODENTS •

AN INTRODUCTION TO RODENTS IN NEW ZEALAND

John Innes

The four rodent species in New Zealand - in order of time of spread here, *Rattus exulans* the kiore or Polynesian rat; *Rattus norvegicus* the Norway or brown rat; *Mus musculus* the mouse and *Rattus rattus* the ship or black rat - are world-famous mammalian weeds. Their widespread distribution on the NZ mainland and many offshore islands is typical of islands lacking an indigenous rodent or mammalian carnivore fauna.

All four species arrived and spread from ships and the spread - or risk of it - continues today. The rodents are all well adapted to this mode of spread being small, shy, primarily nocturnal, omnivorous, agile, explorative and also rapid breeders and good swimmers. Today the kiore is found only in South Westland and Fiordland on the mainland, but it occurs on many offshore islands. The Norway rat has a wide but patchy distribution on the mainland and is found on nearly as many islands as kiore. Ship rats and mice are nearly ubiquitous in mainland forests and some other habitats, but they are on fewer islands.

An accurate picture of the impact of the four species on indigenous biota is only just emerging. It is complicated by the enormous range of habitats the rodents occupy (from the coastline to alpine tussock), the simultaneous impacts on biota of many other cultural events such as habitat loss; the co-occurrence of two or more rodent species, and often other predators (cats *(Felis catus)*, stoats (*Mustela erminea))* as well, and our lack of knowledge of the original or natural population dynamics and distribution of the prey biota. Despite these difficulties, the picture that rodents and other predators currently limit many endemic vertebrate and invertebrate prey populations is largely true.

Extraordinary successes in rodent eradication from islands and temporary control on the mainland have characterised the 1980's. Indeed, New Zealand leads the world in such exploits. The papers presented at this Workshop and summarised here largely describe these successes (Taylor, McFadden, Thomson, Hook & Todd, Bradfield, Jansen & Speed); Empson's paper discusses plans for rodent eradication on Kapid Island; Brown outlines steps taken to prevent arrival of maents on rodent-free Maud Island; Hallam describes a ship rat eradication project on Coringa Islet, near Cairns, Australia.

Eradications and successful control have two quite separate, valuable outcomes. One is the hoped-for release of the prey population from limitation by the predator, for conservation reasons - sometimes to save endangered species from extinction by providing predator-free refuges to which they can be safely translocated. The second is in the nature of a manipulative experiment. The removal of the predator provides the opportunity to directly measure the response of the prey, although such interpretations must be made carefully and with due regard to unexpected ecological linkages within that community.

NEW ZEALAND UNIVERSITY THESES ON RODENTS, POST-1985

A. Dick MSc (Massey) 1985 Rats on Kapiti Is., NZ; coexistence and diet of *Rattus norvegicus* and *Rattus exulans.*

Kathleen Smith MSc (Canterbury) 1986 The diet of the ship rat *Rattus rattus rattus L.* in kauri forest in Northland, New Zealand.

A. Sturmer MSc (Massey) 1988 Diet and coexistence of *Rattus rattus, Rattus exulans* and *Rattus norvegicus* on Stewart Island.

Elaine Murphy PhD (Victoria) 1989 Comparative study of house mouse populations on islands and on the mainland.

Mere Roberts PhD (Auckland) 1990 Ecological parasitology of *Rattus exulans.*

C.1. Miller MSc (Auckland) 1992 Aspects of the ecological restoration of Rangitoto and Motutapu islands. [Includes chapter on population dynamics and diet of rodents on Rangitoto so as to provide information for their eradication]

CURRENT/RECENT RESEARCH

Repeated trapping `longlines'

- Orongorongo Valley August 1971 - present (Landcare Research, Taita)
- Mt Misery (Nelson Lakes; Landcare Research, Nelson)
- Pureora Forest Park 1982-87 (C.M. King; Landcare Research, Rotorua)
- head of L. Wakatipu (H. Moller; Dip. Wildlife Management students, Otago University)

Radio-tracking

- ship rats in Orongorongo Valley, 1989-90 (Landcare Research, Taita)
- ship rats in Rotoehu Forest, Bay of Plenty 1991-92 (Landcare Research, Rotorua)
- Norway rats on Ulva Island (Landcare Research, Nelson)

House mouse diet in Orongorongo Valley beech forest (hard versus silver beech), especially the role of invertebrates in mouse population fluctuations following beech flowering and mast (Landcare Research, Taita).

Rodent distribution, specially on islands (Landcare Research, Taita).

Impact on Pacific Islands, including NZ (Landcare Research, Taita, DOC).

Various eradication/control projects

- control and monitoring methods
- impact rodents on prey; other rodents
- interactions of rodents with their predators

(Landcare Research, DOC, Otago University)

SELECTED REFERENCES ON RODENTS

Atkinson, I.A.E. 1985. The spread of commensal species of Rarrus to oceanic islands and their effects on island avifaunas. *In* P.J. Moors (Ed.): *Conservation of island birds.* pp. 35-81. International Council for Bird Preservation Technical Publication No. 3.

Atkinson, I.A.E. & Moller, H. 1990. Kiore (Polynesian rat). In C.M. King (Ed.): *The Handbook of New Zealand Mammals.* pp. 175-192. Oxford University Press, Auckland.

Dingwall, P.R., Atkinson, I.A.E. & Hay, C. (Eds.) 1978. *The ecology and control of rodents in New Zealand nature reserves.* Department of Lands and Survey Information Series 4.

Eason, C.T. 1991. A review of the advantages and disadvantages of existing rodenticides and rat baits. Unpublished Forest Research Institute Contract Report (prepared for the Department of Conservation). 14pp.

Innes, J.G. 1990. Ship rat. *In* C.M. King (Ed.): *The Handbook of New Zealand Mammals.* pp. 192-206. Oxford University Press, Auckland.

Innes, J., Hooker, S. & Williams, D. 1992. Radio-tracking ship rats at Rotcehu Forest, Bay of Plenty. Unpublished Forest Research Institute Contract Report (prepared for the Department of Conservation). l lpp.

Moors, P.J. 1990. Norway rat. *In* C.M. King (Ed.): *The Handbook of New Zealand Mammals.* pp. 192-206. Oxford University Press, Auckland.

Murphy, E.C. & Pickard, C.R. 1990. House mouse. *In* C.M. King (Ed.): *The Handbook of New Zealand Mammals.* pp. 225-242. Oxford University Press, Auckland.

Towns, D.R. 1991. Response of lizard assemblages in the Mercury Islands, New Zealand, to removal of an introduced rodent: the kiore (*Rattus exulans*). *Journal of the Royal Society of New Zealand* 21: 119-136.

THE ERADICATION OF NORWAY RATS FROM BREAKSEA ISLAND

Rowley Taylor

The last ten years have seen very significant advances in rodent eradication on islands. Tasks that a few years ago were thought impossible are now being tackled with confidence. One important development has been the advent of new, potent and highly palatable 'second-generation' anticoagulant poisons. These poisons kill after a single feeding, but rats have ti me to eat a lethal dose long before they experience toxic effects. Unlike many other acute or chronic poisons, sub-lethal doses are not known to cause bait or poi on shyness.

Since 1981, Bruce Thomas and I have developed a rodent-eradication strategy that takes advantage of these new poisons and of aspects of rat behaviour, such as the preference of rats to feed at sites already being used and their responsiveness to 'peer pressure'. An important feature of our technique is that the poison is dispensed regularly from fixed bait stations. This allows less-dominant and/or bait-shy rats the opportunity to learn from others that the bait is palatable, and where it is available. The bait stations can also be used to exclude non-target species that may be at risk. It is possible to design stations specifically for use on islands where the presence of threatened species might rule out widespread broadcasting of poison. However, perhaps the most important recent breakthrough of rodent eradication on islands has been acceptance that the job can actually be done.

This case study deals with the eradication of Norway rats *(Rattus norvegicus)* from Breaksea Island in Fiordland. Although Fiordland's drowned coastline has over 120 islands, unfortunately nearly all are very close to the mainland and within swimming range of rats, mustelids or deer. Surveys during the 1970s and 80s showed that Norway rats were plentiful on Breaksea and Hawea Islands, but that rats had not yet reached adjacent Wairaki Island. It was also found that these three islands had high conservation value, being without red deer *(Cervus elaphus scoticus)* or stoats *(Mustela erminea).*

A successful trial at eradicating Norway rats on 9 ha Hawea Island in 1986 led to a campaign to eradicate several thousand rats from nearby forested and rugged Breaksea Island (170 ha; 354 m a.s.l.). Field preparations involved cutting and marking tracks, and laying out bait stations. The bait stations consisted of 400mm lengths of 100 mm diameter, yellow, plastic 'Nova-coil' pipe. They had a watertight lid in the centre for inserting and checking the baits, and were held to the ground by two hoops of fencing wire.

Brodifacoum poison baits (Talon 50WB) were laid in the bait stations during May 1988, and checked and replaced daily for 22 days and every few months thereafter. No sign of surviving rats has been found during numerous visits since July 1988. The campaign involved 564 person-days of which about 50% were worked by volunteers. At 1990 prices, and if all workers had been paid, the net cost of the actual eradication would have been NZ$82,117 (or $483 per hectare). Given careful planning and adequate resources, similar methods can be used to eradicate alien rodents from very much larger islands.

Breaksea and Hawea Islands now have great conservation value. Their original forest cover is intact, and many of the changes caused by rats are reversible. Native species of birds, lizards and invertebrates have already been introduced. Others have recolonised naturally.

COST EFFECTIVE KIORE ERADICATION

Ian McFadden

Bait stations are a reliable method of dispensing bait for rodent eradication. An equally effective method is to broadcast bait aerially or manually. This can result in a significant saving on costs for equipment, transport, accommodation and staff.

Bait trials conducted on Lady Alice (Marotiri) Island (155ha) showed distinct preferences for grain types and lures. Silos were considered the most suitable dispensing method for grains. By using kibbled maize and a sequence of lures, kiore *(Rattus exulans)* were eradicated from Rurima Rocks (4.5ha) in the Bay of Plenty in 1983.

Problems were encountered with 1080 but when bromadialone was used, eradication was achieved quickly. On Korapuki Island (18ha) kiore were eradicated in 1986 with one application of toxic bait after four days pre-feeding at silos. Setting out bait stations and their replenishment is a labour intensive and expensive approach. A more cost efficient and equally effective method may be to broadcast baits manually on small islands and aerially on large.

On Double (Moturehu) Island (32ha) in 1989 kiore were eradicated from the large islet with one manual application of wax block rat baits and from the smaller one by one application of toxic bait after four nights pre-feeding from silos. This allowed a direct cost comparison and resulted in a saving of 30% per hectare when silos were not used. More were subsequently eradicated from the Mokohinau Islands (Burgess 56ha and 13 smaller islands totalling 38ha) by one aerial application of cereal bait followed by two manual applications of wax block rat baits. This resulted in a 50% saving when compared to bait stations. Further reductions in cost may be achieved by reducing the application rate of bait.

STANLEY ISLAND KIORE ERADICATION

Phil Thomson

Stanley Island is a 100 ha island lying 10 km east of the Coromandel Peninsula in the Mercury Island group. Prior to kiore *(Rattus exulans)* eradication it was already of conservation value as an island refuge for populations of threatened species such as saddleback *(Philesturnus carunculatus rufusater),* Pycroft's petrel *(Pterodroma pycrofti)* and little shearwater *(Puffinus assimilis).* It also contained a remnant population of tuatara *(Sphenodon punctatus)* which were being detrimentally affected by the presence of kiore. Rabbits *(Oryctolagus cuniculus)* were present in low densities but were having a considerable effect on regeneration of palatable plant species.

The Stanley Island eradication effort was part of a three year plan for the restoration of the islands of the Mercury Island Ecological District undertaken with assistance from ICI NZ Ltd (the principal sponsor), San Diego Zoo and Dallas Zoo.

Before starting eradication work approval to proceed was obtained from the tangata whenua. Non-toxic bait trials were undertaken with saddleback. Fourteen of the 20-30 remaining tuatara were captured and placed in the care of Auckland Zoo where it is intended to breed from them before returning the progeny to the Island.

In 1991 a standard fire monsoon bucket operated by a compressed air open/shut switch was used to spread talon 20P at 15 kg per hectare. We had problems adjusting the flow rate of bait through the bucket and the resulting spread of bait was uneven and not up to the required rate on parts of the island. In October talon 50WB was spread by hand over the entire island as a precautionary measure.

Rat index trap lines caught seven rats on the first night after the aerial application of bait and none thereafter. Spotlight counts of rats at night indicated that rat numbers did not decrease over the first three nights but rather that it took part of the first night for the rats to home in on the talon baits. After that they simply ignored the peanut butter bait on the traps. No fresh rat or rabbit sign was found after the initial week of immediate post poisoning searching.

The Stanley poison drop cost $11,350 including helicopter hire, poison costs and personnel time on the drop day. The five follow up monitoring trips cost $18,500 including staff time. I suggest that there is limited value in follow up trips within nine months of the poison drop as numbers of surviving kiore will be so low that it will take almost a full year before they reach high enough numbers to begin to get caught in traps again.

I also suggest that even if kiore sign was found the chances of being successful at completing the eradication at this time would not be high as it would not be easy to put every kiore at risk due to the abundance of natural food available to the few remaining kiore.

As we move to progressively larger islands it will become more important to find a bait spreader with a spinner which will give a wider and more even coverage without shattering bait and which has a more efficient system for calibrating bait spread precisely. This calibration ability will become more critical as we attempt to refine the current bait spread of 15kg/ha down to 5-10kg/ha.

MOUSE ERADICATION ON MANA ISLAND

Trevor Hook and Phil Todd

Mana Island (217ha) is located 4km off Wellington's West Coast, out from Porirua Harbour. Despite intensive settlement and modification by both Maori and Europeans, mice *(Mus musculus)* were the only introduced mammal present.

Mice were causing major problems for management of the island as a Scientific Reserve, with a tree planting programme and endemic species of Cook Strait giant weta *(Deinacrida rugosa)*, McGregor's skink *(Cyclodina macgregori)* and goldstripe gecko *(Hoplodactylus chrysosireticus)* all being affected.

1989 saw a mouse eradication programme started on the island using Don Merton's method which combined techniques used on Round Island, Mauritius, and Breaksea Island.

Trials to ascertain bait preferences and spacings for bait stations were conducted. Mice had a slight preference for the Shell product Storm, but would take either ICI Talon or Storm bait. Spacings for bait stations was determined in a trial using 100 x 100 metre grids with stations at 10m, 17m, 25m and 50m spacings, baited with Rhodamine B-covered baits, followed by extensive trapping. The mice caught were examined under ultra violet light to detect what percentage contained Rhodamine B. These trials indicated that a spacing of 25 metres would be appropriate. Bait stations were laid every 25 metres over the entire island in June 1989.

Timing was vital and as the mouse numbers decreased in July the poisoning programme was started with an aerial drop of 1 tonne of Storm bait over the cliff areas. All stations were then filled in one day with ten blocks of Storm in each station; one week later the stations were rebaited. Stations were continually checked and rebaited for two years. A variety of baits was used as Storm proved prone to insect attack. Waxy Pack made by Kiwi Care products was used alongside Talon. In September 1989, 3 tonnes of Talon 20P were dropped by air over the whole island.

Monitoring to check for the presence of mice was carried out from February 1990; 300 snap-traps per night as well as gnaw sticks were used. As many types of lure as possible were used, including peanut butter, cheese, carrot, salami, potato, chocolate, bacon and apple.

One female mouse was caught on 5 February 1990 near the settlement. It was an old animal, about 15 months old (aged from tooth wear) but had not bred during spring 1989 or summer 1989/90.

Live box-traps (Longworths) were used giving a total of 400 traps set every night of the week. Over 60km of trap lines and 50,000 trap nights ensured total coverage of the island with no captures of mice after February 1990.

In November 1991 the 5500 bait stations were removed and Mana, was declared mouse free.

At present Mana is the only island larger than 200 ha within 50km of the New Zealand mainland coastline to be totally free of introduced mammals.

KAPITI ISLAND - PROPOSED RAT ERADICATION

Raewyn Empson

Kapiti Island (1965 ha) is 9 km long, has a maximum width of 2.3 km and a height of 521 m. About 10 ha of the island is in private ownership as are three small offshore islands.

Kiore *(Rattus exulans)* and Norway rats *(R. norvegicus)* coexist on Kapiti and are the only introduced mammals not yet eradicated. The most recent study of rat numbers and distribution was in 1983/84. It showed that, compared with earlier research, numbers of kiore had increased, and that 5896 of rats trapped were Norway rats. Density indices in 11 habitats ranged from 5.8 rats/100 trap nights at the beach to 40.0/100 t.n. at the gull colony; overall density index averaged 15.1/100 t.n. More predominated over Norway rats in only three habitats. Seasonal trends in density varied for the two species: Norway rats were fewest in summer while kiore were fewest in winter or summer, depending on habitat. Based on seasonal trends in density, the preferred time for eradicating rats is summer (January-February) assuming that natural low densities are targeted; this coincides with the seasonal low in rainfall on Kapiti.

Two techniques are being considered for the proposed eradication of rats on Kapiti; neither has been used before in a single operation against both Norway rats and kiore.

1. Aerial application - technically feasible based on experience elsewhere. Non-toxic trials on Kapiti will determine the application rate required and likely non-target effects.

2. Ground based - simultaneous poisoning across the island is not feasible so a modified technique is proposed to poison the island progressively on a 'rolling front' regime.

Issues to be considered:

(1) Eradications to date have generally been in winter - is coinciding the eradication programme with the rat breeding season a problem?
(2) Are rat dynamics likely to have changed since possums were eradicated and how important is it to have this detailed knowledge?
(3) A summer eradication programme may increase the risk of secondary poisoning as there are likely to be more invertebrates around then - is this more critical than targeting minimum rat densities?
(4) Reinvasion from non-poisoned areas - is 200 m overlap and 100 m grid adequate for both Norway rats and kiore?
(5) Is a minimum period of 3.5 months too long for an eradication programme?
(6) How/where do we trial the 'rolling front' technique to determine feasibility and requirements for Kapiti?
(7) Should kiore be eradicated?
(8) Short-term and long-term environmental impacts - what are they and are they justified?
(9) Aerial versus ground application of poison baits - effects on non-target species.

The involvement of the iwi is integral to the assessment and resolution of these issues.

SHIP RAT CONTROL AT MAPARA

Phil Bradfield

Ship rat *(Rattus rattus)* control at Mapara has taken place over the past three kokako (*Callaeas cinerea wilsoni*) breeding seasons as part of a larger programme to control browsers and predators with the objective of increasing kokako chick output. The first two years of this rat control was monitored by John Innes (then Forest Research Institute, Rotorua).

In 1989/90 poisoning was by a sustained Talon operation based on ground-based grids over ten kokako territories. Novacoil tunnels were laid 50m apart on a 8 x 8 tunnel grid (ie 64 tunnels covering 12.25 hectares). Talon 50WB baits were replaced weekly until bait take dropped to low levels. Rebaiting was then monthly. Rat monitoring was done using bait-take data and foot hacking tunnels placed between poison tunnels on four of the poison grids. Bait take dropped rapidly in the first month then levelled off at a low level, but did not reach zero because rats continually reinvaded the grids from surrounding forest. Foot-tracking indices dropped to very low levels after poisoning started and remained low for the duration of the poisoning.

In 1990/91 and 1991/92 rat control was done by the aerial application of 1080 poison over the whole reserve. Monitoring was done using foot tracking tunnels and the by-catch of rats in Fenn traps set to catch mustelids.

After the September 1990 1080 aerial poison drop not one tracking tunnel (total of 168) was visited indicating a "100%" kill. However, not all rats were killed as was evident from the initially slow, then rapid repopulation of the reserve. Foot-tracking results were well complemented by the Fenn-trapping data which also showed that rat numbers remained at very low levels for five months following the poison drop, then increased rapidly.

The October 1991 poison drop did not achieve as effective a kilt as the previous two operations. Both rat-tracking indices and fenn-trap catch indicated that rat numbers never dropped to the low levels of previous years and that repopulation was much more rapid.

Both methods of control have the potential to reduce rat numbers to low levels, as in the first two years, but control is for one bird-breeding season only. A ground-based Talon operation is more target specific than an aerial operation. Ground-based operations are more labour intensive but costs of the two operations are similar when comparing the number of territories protected.

Ship rat, mustelid and browser control at Mapara has so far not resulted in a spectacular increase in kokako chick output. There are three possible explanations for this:

1) Kokako are not attempting to breed.
2) The few rat survivors left may still be preying on nests.
3) Other predators could have been responsible for nest predatoon,

Our response to this situation was the decision to monitor nesting attempts, nest by nest. This will largely resolve which of these possibilities is the case.

PINDONE POISON TO CONTROL RATS AND POSSUMS

Paul Jansen and Hazel Speed

Pindone anticoagulant poison was aerially applied to part of Kaharoa State Forest 20 km north of Rotorua in a effort to control ship rats *(Rattus rattus)* for the duration of the North Island kokako *(Callaeas cinerea wilsoni)* breeding season. As a secondary objective possum densities were monitored to assess the impact of this toxin on the possum *(Trichosurus vulpecula)* population. The control of these species is part of on-going research to determine the causes of the decline of North Island kokako.

The use of anticoagulant poisons against rodents is well documented and accepted, however the efficiency of aerial application of these toxins has not been tested in a rigorous manner. Recent eradications of rodents using second generation poisons applied from the air have been successful.

The poison of choice for a mainland operation of this type is 1080 and this was used in 1990. Some adverse public reaction to that operation prompted a change of toxin for the 1991 operation. Pindone was chosen over other commercially available anticoagulants for the following reasons:

1. Experimental user registration allowed for greater flexibility in its use.
2. Lower cost compared to other anticoagulants.
3. Effectiveness against possums in an aerial drop situation could be tested.
4. Available in an approved bait formulation for use in kokako habitat.

Toxin was applied in one application on 24 October 1991. Four tonnes were applied to 381 ha. This exceeded, by a slight amount, the drop specification of l0kg/ha. Coverage was good with all bait disappearing after the fourth night after light rain.

Pre- and post-poison monitoring revealed a 100% reduction in the rodent tracking index and a 50% reduction in possum numbers though the sample size was small for the latter.

A RODENT CONTINGENCY PLAN IN ACTION - MAUD ISLAND

Derek Brown

The Maud Island rodent contingency plan is presented as an example of a document necessary for all islands or island groups that currently have few or no rodent species present. It clearly sets out how potential and existing threats to the natural values of an island are to be avoided or mitigated.

The plan describes the island and its current values, and explains the vulnerability of its existing communities and species to potential invasions of predators.

It details practices to be undertaken to prevent (as far as possible) the establishment of any rodent species on the island. These measures include establishment of permanent bait stations on the island and on visiting boats, the use of appropriate (i.e. rodent-proof) storage and packing facilities and containers, enforcing regulations on the supervision and number of visits to the island, and general advocacy.

The plan also covers requirements for preparedness (including staff training and acquisition of necessary equipment) for any potential invasion, and contains a plan of action to be followed should rodents actually reach Maud Island.

Policies and action plans within the contingency plan clearly state which individual person or position is responsible for seeing each specific task carried out. Specialists in rodent eradication and experts on species vulnerable to rodents are listed in an appendix, so advice and support can be sought if necessary.

The plan has several different aims but principally lists operational requirements and assigns responsibilities for staff involved in day to day management of the island to reduce as far as possible the prospects of rodents ever reaching or establishing on Maud Island.

The contingency plan is also an important advocacy tool to inform senior managers (and indeed a much wider audience) of the vulnerability of such islands and the necessity and priority for effective contingency operations.

RATS AND RAT CONTROL ON CORINGA ISLET

Mark Hallam

The Coringa - Herald National Nature Reserve (NNR), located some 400 kilometres east of Cairns, encompasses an area of 8856 square kilometres. There are six islets, in three groups of two islets, with a total land area of 124 hectares in the Reserve.

Coringa (South West) Islet, an oval-shaped islet measuring about 580 metres long by 400 metres wide, is almost entirely covered by mature *Pisonia grandis* forest. The islet is important for its large populations of breeding sea birds including boobies, noddies, frigates, shearwaters and land rails.

The introduced ship rat *(Rattus rattus)* was first recorded on Coringa Islet in 1961. Rats, however, could have been present since the ship Coringa Packet was wrecked near there in 1845.

Following a successful rat eradication programme from West Islet in Ashmore Reef NNR, located in the Timor Sea, the Australian National Parks and Wildlife Service (ANPWS) began a rat eradication program on Coringa Islet in 1985.

Bait stations were set out on a 30 x 30m grid to cover the islet. They have been serviced infrequently by ANPWS personnel using a variety of poison baits - namely bromadiolone (as Bromakil wax blocks), brodifacoum (as Talon-G pellets) and cholecalciferol (as Quintox pellets).

The bait stations comprise 400mm lengths of angle-cut, 70mm diameter polythene pipe. To avoid hermit crabs taking the bait, the tubes are pushed into the sand at a 45 degree angle with the opening about 125mm above ground level.

Problems encountered were

- The navy patrol boats used to transport ANPWS officers to the Reserve were often unavailable when needed.
- Time spent on the islet has sometimes been short and consequently not all bait stations were refilled each trip.
- Vegetation on the southern end of the islet is low and very dense, making access to bait stations very difficult.
- Hermit crabs *(Coenobita perlata)* readily fed on the bait.

A recent extended search over a nine day period failed to find any evidence of rats on Coringa Islet and it now appears the eradication programme has been successful.

RODENT WORKING GROUPS

Participants broke into six working groups to discuss the topics summarised below. In these summaries recommendations or suggestions are shown in bold type.

1. MONITORING RODENT NUMBERS

Accurate and efficient assessments of rodent numbers are needed in two very different situations:

a) Monitoring an established population

Methods currently available for this are satisfactory, although key assumptions underlying index trapping and tracking (such as equal catchability between age/sex classes, and in different seasons) should be tested.

b) Detecting presence or absence of rodents, especially when densities are very low near the end of an eradication attempt or when rodents may have just reached an island.

Methods available for this include cage traps, kill traps, tracking tunnels, direct observation, observation of natural sign, gnaw sticks, bites on fruit especially placed for the purpose, analysis of gut contents of rodent predators, and special tunnels that sample rodent hair. The main problem with all these devices is luring the rodent to the device.

We need to methodically test lures for all four rodent species at all times of year and in different habitats. An "experimental island" would be ideal for experimental refining of the effectiveness of preferred monitoring methods in a realistic situation.

New technology such as infra-red cameras and other remote sensing devices may be suitable as rodent monitors in the future. The technology of remote surveillance is developing rapidly and useful applications of such equipment may not be far away.

2. TOXINS - THEIR REGISTRATION. AND APPLICATION FOR RODENT CONTROL

We need to protect our ability to continue to use 1080 as a rodenticide. This has been, and may continue to be, an invaluable tool for pest management. This requires continued research on environmental effects of 1080, and increased public advocacy for its use. Successful operations using 1080 should be publicised so that the public understands better its benefits and lack of detrimental effects.

As well, **alternative toxins to 1080 must continue to be sought and developed**, since 1080 is vulnerable to political pressure for its use to be reduced. To this end, **clarification to Department staff on the application of Experimental Use Permits is desirable** and the outcomes of trials must be communicated well to staff and to bait manufacturers.

We require clarification of procedures for applying to use new rodenticides, and to use existing toxins for new purposes. One action which may assist the Department of Conservation in this regard is to increase Departmental representation on the Pesticides Board.

Further, a catalogue of current rodenticides, baits and their use is needed by Department staff. The Forest Research Institute Contract Report FWE 91/46 by C. T. Eason (A review of the advantages and disadvantages of existing rodenticides and rat baits) goes some way towards this. Clarification of Departmental policy on planning for - and reporting on -rodent poisoning operations was also requested by workshop participants.

Both Workshops 1 and 2 recognised that **a manual on rodent eradication, control methods, sign and detection methods is needed as a means of bringing together existing data, sharing information and improving skills. Lists of available and permissable control methods and toxins need to be included.**

Also, improved advocacy is needed to emphasise the detrimental effects of rodents in New Zealand and to support the methods used to control or eradicate them.

3. NON-TARGET SPECIES & ENVIRONMENTAL EFFECTS OF RODENT CONTROL

Research and management efforts to date have focused on eradication and control techniques. Equal effort has not been applied to the impacts of rodenticides on non-target species and the environment at large, and knowledge of these components of rodent control now needs to catch up. This can be achieved to some degree by closer field monitoring in currently planned operations. However, existing knowledge of non-target impacts needs to be collated. Real or perceived problem non-target animals already include indigenous bats, little spotted kiwi, ground-feeding parrots and invertebrates in general. Rodenticide impacts on the wider ecosystem are generally poorly understood.

At present we assume that ground control with baits in tunnels or bait stations is safer than aerial bait distribution, and we recommend, in the interim, that ground operations are used until more is known of the non-target impacts of aerially distributed baits. Other agencies should be notified of DoC concerns in this regard, so that we are seen to be responsible on this matter.

Non-target effects can be studied with non-toxic baits and/or in captive animal situations, thus negating the need to work with real field operations.

4. NON-POISON CONTROL & DAMAGE PREVENTION METHODS FOR RODENTS

Few non-poison rodent damage prevention methods are used currently. Repellent scents (perhaps mustelid or cat) may be an effective way to keep rodents away from wharves, boats or trees and should be tried. Excellent lures in multiple-catch traps may enable capture of rodents *en masse*. Coupled with remote sensing equipment indicating rodent presence or capture, such traps could be developed to alert Departmental staff that a rodent has reached an island. Single wire electric fences and tinning of trunks may have potential to protect some trees from rat penetration.

In the longer term, research into biological control methods should be supported, and there is a need for more liaison on this with overseas researchers.

In summary, **alternative damage prevention or population control techniques including repellent scents, multiple catch traps, remote sensing equipment, electric fences and biological control - should be explored for possible use in New Zealand.**

5. AN EXPERIMENTAL ISLAND FOR RODENT RESEARCH

An experimental island is needed to enable us to test our ability to detect the arrival of rodents and to catch the invader. Research on such an island will also assist our understanding of the actions of an invading rodent, interactions between rodent species,

toxic loading of baits, effects on non-target species, downstream effects of toxins and predator/prey relationships.

If we have an island where conditions are relatively natural, we can start to experiment.

The liberation of one pregnant female rat, for example, would show how one invading rat initially reacts when placed in an environment with no other rodents. Different monitoring techniques could be tried on the island to assess the effectiveness of present contingency planning for when rodents reach islands from, say, a shipwreck. Our present knowledge of rodent behaviour when at very low densities on islands is almost zero.

The experimental island would ideally be:

- 10-30 ha; perhaps up to 100 ha
- relatively easy for researchers to reach, and to move about on
- with a diversity of shoreline and habitat types
- lacking sensitive indigenous species
- out of swimming range of all mammalian predators (i.e. more than 1.2 km from nearest predator source).

An island with one or more rodent species already present could be used and the initial eradication of rodent(s) from it could include research on the response of prey populations.

Interactions of two or more rodent species, or interactions between rodents and their predators (e.g. stoats or cats) could also be studied on the island, as could biological control techniques such as introducing several male stoats to control rodent numbers.

6. MULTI-SPECIES ERADICATIONS AND COMMUNITY RIPPLE EFFECTS

We have too little knowledge of the ecological linkages between the various predator species, their many prey, and the wider environment. Hence we have little knowledge, for example, of the best sequence of eradication if multiple eradications are to be achieved. Some options appear obvious, e.g. :` cats are removed before rats then the increasing rats may cause greater problems, whereas removing rats before cats may make the cat eradication easier.

As from Workshop 3, identification of community ripple effects of a rodent control operation on water, soil, invertebrates, lizards, etc is needed to guide responsible action.

To achieve this, we could make use of existing field programmes such as the kokako research-by-management programmes at Mapara and Rotoehu, or proposed rodent eradications from offshore islands; or study areas which are already quite well known, such as the Orongorongo Valley.

Collation of existing knowledge of community ripple effects after predator or rodent control or eradication is fast required as a step towards better understanding of the ecological consequences of these actions.

Continue to next file: TSOP03a.pdf