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THE IDENTIFICATION AND DETECTION OF THE RATS IN NEW ZEALAND

AND

THE ERADICATION OF SHIP RATS ON TAWHITINUI ISLAND
THE IDENTIFICATION AND DETECTION
OF THE RATS IN NEW ZEALAND

AND

THE ERADICATION OF SHIP RATS

ON TAWHITINUI ISLAND

by David P. Taylor

1984

This dissertation is submitted to Lincoln College, Canterbury, as
partial fulfilment of the requirements of the Diploma in Parks
and Recreation.

Cover: Rat and Talon poison inside a bait station used on
Tawhitinui Island.
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INTRODUCTION

1.1 Preamble

1.2 Objectives in dissertation

1.3 The importance of rat control in New Zealand
1.0 INTRODUCTION

1.1 PREAMBLE

In compiling this dissertation I have two broad aims in mind. Firstly, to present the necessary information for the detection and identification of the rats found in New Zealand. Much of this information is already existing, however its scattered nature presents delays in its accumulation and therefore its effectiveness. In the selection of appropriate material, I hope to facilitate the ease of rodent detection and identification. This should lead to more efficient monitoring for rodents in reserves by the local staff.

Secondly, to present all details and results of the Tawhitinui Island campaign, an experiment aimed at testing a practical eradication method against ship rats (Rattus rattus).

1.2 OBJECTIVES OF THE DISSERTATION

a) To provide information on the rat species in New Zealand which will be useful to the resource manager in the detection, identification and control of these rats.

b) To present the results of a case study aimed at achieving practical methodologies in rodent control in island reserves.

c) To increase awareness of the effects rodents have on New Zealand's indigenous flora and fauna and encourage further research.

1.3 THE IMPORTANCE OF RAT CONTROL IN NEW ZEALAND

It is now a commonly regarded view that the introduced rats have an impact, often detrimental to the flora and fauna of New Zealand. This is of special concern in regard to the possibilities of rats reaching valuable biological reserves. Indeed, island habitats are the saving homes for many rare species of the New Zealand fauna.

Mainland New Zealand has seen the destruction of habitats, along with the spread of mammalian predators, such as rats and stoats, and the spread of browsing mammals such as possums, deer and goats. A combination of these three factors has lead to a dramatic reduction in the country's native and especially endemic species of flora and fauna.
With a past history of such destruction, surely it is our duty as humans, to try and conserve nature and maintain healthy populations of species for their continued survival. In New Zealand, the control of predators such as rats, is one way in which nature conservation can be helped.

Compared with the mainland, a predator free island is a relatively "safe" environment, but just how safe are these islands from the introduction of rats? Historically, man's activities associated with shipping, fishing and transportation of goods, have transported rats. While modern day regulations and the monitoring of vessels have lowered the chance of this occurring, the possibility is still real.

The deliberate release of rats is an increasingly real prospect. Such a release could be the result of political decisions. The possibility of this occurring has recently been highlighted with the management considerations of the Snares Islands Nature Reserves. The management conflict occurs with the lobster fishermen who fish and obtain shelter around these islands. Their vessels are seen as possible carriers of rats to the islands. Conservation of the Snares is therefore posing a threat to the livelihood of the fishermen fishing these waters. Ill-feeling amongst these men concerning this issue could easily result in a deliberate release of rats.

Nature itself can transport animals to islands, especially those close to the mainland. Floating debris and/or sea currents could carry rats to islands.

The big problem of how far a rat can swim, must also be considered. Research carried out by the Department of Scientific and Industrial Research (DSIR) has provided some evidence that both the European species swim not much further than 300 metres (1). Once rats invade an island, and if conditions are favourable, the population will boom, exceeding environmental carrying capacity until competition for food lowers the population. It is at the peak numbers that most damage is likely to occur. This exact situation occurred on Big South Cape Island, off Stewart Island in the early 1960's. Ship rats (Rattus rattus) established on the island and rapidly spread. Within a few years, 5 endemic species of bird were completely eliminated (2). These were the saddleback (Philesturnus c. canunculatus), Stewart Island snipe (Coenocrypha aucklandica iridalei), Stead's bush wren

(1) Taylor (pers. comm.).  (2) Bell, 1978.
(Xenicus longipes variabilis), Stewart Island fernbird (Bowdleria punctata stewartiana), and the Stewart Island robin (Petroica australis rakiura).

Within the National Park and Reserve systems there are at least 77 Nature Reserves, many of which are islands (3). These reserves in many cases provide a habitat for some of our rarest flora and fauna. Some of these reserves, along with other islands, could have their wildlife potential greatly increased should rodent populations be removed.

It is therefore obvious to me, that the administering staff of important biological reserves (Department of Lands and Survey) be aware of the detection and control methods available for the control/eradication of rodents.

The professional experts in this field are mainly employed by the DSIR and the Wildlife Service. Such personnel are not always immediately available to become involved in regular island inspections or eradication campaigns.

In my opinion, greater care and efficiency in the monitoring of islands is necessary, as is the feasible removal of rodent populations on otherwise valuable island habitats. This can be achieved if the local staff are at least capable of detecting the presence of rodents and capable of implementing eradication/control techniques such as the Tawhitinui Campaign.

Park Service staff usually have access to the resources and facilities, enabling them to be involved with regular inspections of islands and eradication campaigns. In many cases, it is the background knowledge I have collected in this dissertation that they lack.

(3) Coad, 1978.
2

RAT IMPACTS - FLORA - FAUNA - MAN

2.1 Introduction

2.2 Effects on flora

2.3 Effects on fauna

2.4 Man/rat conflicts in parks

2.5 Past - present - future research
2.0 RAT IMPACTS - FLORA - FAUNA - MAN

2.1 INTRODUCTION

Rats are opportunity feeders, that is they feed on whatever food sources are available to them at any particular time (1).

The differing habits and capabilities of the 3 species of rat enable them to exploit, to a certain degree, differing food sources.

For example, the agility and climbing skills of ship rats (R. rattus) enable them to feed on foods available on the ground and in trees where seeds, flowers and tree nesting or inhabiting animals are available. It is the latter on which R. rattus has the greatest impact.

Norway rats (R. norvegicus) on the other hand, are predominantly ground dwelling. This species therefore has the greatest impact on food resources available on or near ground surface. Fallen seeds, bark of plants and ground or burrowing animals.

The kiore (R. exulans) is basically intermediate between the other 2 species. It spends some time feeding above ground, but the majority is spent at ground level. Kiore are generally regarded as being the least aggressive rat, feeding predominantly on plant material. However, kiore are still known to predate on animal foods, but the magnitude of the impact is largely unknown (2).

Due to the differing demands of the 3 species, it is just as important to prevent rats reaching uncolonised islands as it is to prevent a new species reaching an island that already has one or two species present.

2.2 EFFECTS ON FLORA

Plant material including leaves, fruits, seeds, shoots and roots are a dominant food source for rats. This is the case probably more so on an island situation, where rats have eliminated or reduced animal food sources.

However, it is difficult to isolate and measure rodent impact alone. Vegetation is also subject to other impacts such as disease, insect predation and browsing from larger animals such as birds and in many situations possum, deer, goats and pigs.

The major question regarding such impacts, is whether the forest can maintain its composition and ability to regenerate throughout its natural life span.

Several studies have been undertaken and some are still in progress, to try and determine the impact rats have on vegetation. One such study involved the monitoring of vegetation in a kiore (R. exulans) proof enclosure on Cuvier Island, Hauraki Gulf. Results from this study illustrated a variety of seedlings become dramatically more abundant inside the enclosure, suggesting therefore, that kiore (R. exulans) can influence the composition and regeneration of a coastal forest (3).

Another study by Beveridge (1964) in a central North Island podocarp forest showed that almost an entire seed crop of important podocarp and hardwood species can be consumed by ship rats (R. rattus) (4).

I have made similar observations with the work on Tawhitinui Island. Prior to the poisoning programme it was very difficult to find seeds still intact, especially those of hinau (Elaeocarpus dentatus) and miro (Podocarpus ferrugineus). On visiting the island the following season, the greater abundance of intact seeds was obvious.

Nonetheless, vegetation on Tawhitinui appears to be regenerating very well with young miro, rimu (Dacrydium cupressinum) and hinau trees relatively common and ranging in size from seedlings to several metres. However, this is not to say that regeneration would not be more prolific in the absence of rats.

Indeed rodents must have an impact on the flora of an area, but once again the long term impact is unknown. It must also be recognised that rodents probably have an indirect effect as well. For example, predation and consequent decline or elimination of birds which act as seed dispersal agents.


(4) Beveridge, 1964.
2.3 EFFECTS ON FAUNA

It is well known that animal material provides a major constituent in the diet of rats. Species of the 3 main categories of the New Zealand fauna, birds, reptiles and invertebrates, are all affected either through direct predation or indirectly through competition for resources such as food and territorial space.

Birds are often affected at all stages in their life cycles - egg, chick and adults can all be directly predated on.

Circumstantial evidence exists, indicating that all 3 species of rat have caused local extinctions of bird populations (5).

In New Zealand lizards are fairly common and well distributed on the 3 main islands and many offshore islands. In fact, the absence or scarcity of lizards on small offshore islands is often a good indication that rats are, or were, present. Lizards are not only exposed to direct predation from rats but must compete for similar foods, as all lizards are primarily insectivores (6).

The tuatara (*Sphenodon punctatus*) is an ancient species of reptile now restricted to offshore islands. Its relationship with rats provides a good example of direct predation, competition for food and the upset of environmental conditions favoured by the tuatara. Tuatara bury their eggs and abandon them, giving rats the opportunity of digging up the nest and destroying the eggs. The tuatara feeds mainly on insects, other small lizards and sometimes petrels, all of which are food for rats too. It has also been suggested that a healthy tuatara population requires a healthy petrel population in order to modify the island favouring the tuatara's foraging habits (7). Petrels' burrowing nature prevents undergrowth vegetation becoming too thick, and their nutrient rich droppings facilitate a high insect fauna. Rats could very easily destroy a population of petrels and in doing so upset the conditions favoured by the tuatara.

As already mentioned, invertebrates are an important food source for rats, especially the larger species such as wetas (8), beetles, moths and land snails.

Perhaps the best evidence for the impact rats have on invertebrates is the present distribution of these species, many of which would once have been widespread on mainland New Zealand. Today, as with many species of lizard, they are confined to offshore islands (9).

2.4 **MAN/RAT CONFLICTS IN PARKS**

Rats not only play havoc with the flora and fauna of New Zealand but in association with man are considered distasteful intruders. In buildings, such as huts and shelters, rats foul living areas with droppings and pungent smells and destroy food. For this reason, rat control is not only of significance for biological reasons but also human comfort and hygiene.

Most lowland tramping huts and other park buildings are vulnerable to rat infestations. Unfortunately, rat damage does not stop at fouling and polluting a building. Often serious, expensive structural damage may result. For example, in many huts, I have seen mattresses with rat burrows, the bottoms of doors, walls and cupboards gnawed and wall and roof insulation shredded.

To prevent such damage occurring it is necessary to control rat populations outside the hut. However, setting traps and laying poison in park areas exposes risks to non-target species, including humans. It will be necessary therefore to distribute poison in bait stations or cover traps and locate them out of sight or reach from the public.

A network of permanent poison stations could easily be arranged around a hut, checked and replenished with poison at each hut check or maintenance visit.

THE HOLLY HUT RAT PROBLEM

Plate 2(b). The bottom of a door gnawed.

Plate 2(c). Back of drawer gnawed.
Plate 2(d). Foam mattress gnawed for a nest.

Plate 2(e). Some of the rats removed from the ranger's small room. The mangled heads are acts of cannibalism on those rats that obviously died first.
2.5 **PAST - PRESENT - FUTURE RESEARCH**

The main thrust in rodent research in the past and to a certain degree at present, has been involved in obtaining a greater knowledge of species ecology and behaviour, involving topics such as diet, reproduction and territory size.

While some past research has been aimed at investigating the direct effects of rodents on native flora and fauna, much of this lacks the scientific evidence deemed necessary to produce justified conclusions. New studies are required to combat this problem and aid the future management and selection of natural areas for the conservation of native species.

Control/eradication research in natural environments is relatively unresearched, with little published material available. However, several control/eradication experiments are presently under way in New Zealand. These involve two island eradication experiments and one mainland control operation. The island operations include the Tawhitinui/Awaiti experiments in Tennyson Inlet, Marlborough Sounds and an eradication campaign against Norway rats (*Rattus norvegicus*) by the Wildlife Service on the Noises Islands in the Hauraki Gulf. On the mainland, control of ship rats (*Rattus rattus*) has recently been experimented with in a 40 hectare block of Pureora State Forest Park. This programme carried out by the Forest Research Institute was an attempt to increase the breeding success of the North Island kokako (*Callaeas cinerea wilsoni*) by reducing predatory mammals, particularly ship rats (*Rattus rattus*). The programme proved successful in reducing the rat population for a short period but more research is required before the real value of such a predator control programme can be determined and therefore justified.

It is important that control/eradication projects continue to be instigated as a safety precaution in the event of rat infestations occurring on valuable wildlife habitats and as a means of creating or improving existing habitats.

While it is important to experiment with control/eradication techniques, it has been recommended by the Wildlife Research Liaison Group (WRLG) that the most important research at present is to gain a

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(10) Innes, J. 1984. (pers. comm.)
greater knowledge of the distribution of rats throughout New Zealand and more accurate assessments of their effects on native flora and fauna (11).

The mapping of rodents throughout New Zealand is an operation that the land administering bodies should be assisting in. It has been suggested by the WRLG that a programme similar to the bird mapping scheme currently practised in many National Parks and Reserves, could be implemented (12).

(11) (12) W.R.L.G. 1984
IDENTIFICATION OF RATS

3.1 Introduction
3.2.1 Ship rat (Rattus rattus)
3.2.2 Distribution
3.2.3 Habitats and characteristic behaviour
3.3.1 Norway rat (Rattus norvegicus)
3.3.2 Distribution and habitats
3.3.3 Characteristic behaviour
3.4.1 Kiore (Rattus exulans)
3.4.2 Distribution and habitats
3.4.3 Characteristic behaviour
3.0 IDENTIFICATION OF RATS

3.1 INTRODUCTION

Three species of rat and one species of mouse have been introduced to New Zealand. Each species is, in some ways, unique in appearance and especially in its habitat preference, habits and its detrimental impact to the fauna of an area. For this reason, it is important to be able to identify the species present, in order to calculate the likely damage that may occur and the best control/eradication method to employ.

This section deals with the basic identification methods available for each rat. The house mouse (Mus musculus) which is the most widespread rodent in New Zealand has received limited research. However, its impact to fauna is probably more related to competition for food, rather than through direct predation, and it is therefore generally regarded as less of a pest. I have considered the house mouse only where it is relevant for comparisons.

3.2.1 SHIP RAT (Rattus rattus)

OTHER COMMON NAMES: black rat, blue rat, bush rat, house rat, roof rat (1).

3.2.2 DISTRIBUTION

The ship rat is the most widespread rat in New Zealand today. It is found commonly on the three main islands and on many offshore islands (2), especially those close to the mainland or those currently or at some stage inhabited by man (3). Most reports state the ship rat as an infrequent swimmer, therefore their liberation is most likely to result from the activities of man.

3.2.3 HABITATS AND CHARACTERISTIC BEHAVIOUR

As the common names suggest, this species occupies a wide range of habitats. It is the common rat in the bush where it is regarded as essentially arboreal (tree dwelling and nesting) (4). Nests which usually consist of a loosely built ball of leaves and twigs are positioned in branches or in clumps of perching plants (5). A tree nest I discovered in Marlborough, appeared to be an abandoned birds nest, slightly modified with a roof covering of twigs and leaves.

Should the ship rat be in an environment with no substantial vegetation suitable for nesting in, it will burrow, nesting underground or in rock crevices for example. I experienced one case of this on the Sugar Loaf Stack, a sparsely vegetated rock outcrop in Forsyth Bay, Marlborough Sounds. Rat droppings were found on the stack, some of which were large enough to be those of Norway rats (see chapter 5.6). Droppings along with the presence of burrows tended to suggest that Norway rats were present. Not until a rat was finally trapped and identified as a ship rat, could we be positive of the species present.

In occupying buildings, the ability of a ship rat to climb enables it to inhabit the walls and ceilings which it appears to prefer. However, should the walls and ceilings of buildings be inaccessible to the rats, they will nestle into cupboards and shelves or anywhere they can obtain shelter to build a nest.

Ship rats do not seem to be overly cautious and individuals are relatively easy to trap or poison, even with traps and poison set for one night. However, best results are usually achieved with pre-baiting on unset traps and non-toxic foods for at least one night.

3.3.1 NORWAY RAT (Rattus norvegicus)

OTHER COMMON NAMES: brown rat, grey rat, water rat, sewer rat (6).

3.3.2 DISTRIBUTION AND HABITATS

Last century, the Norway rat was widespread and common throughout most habitats on mainland New Zealand and many offshore islands. Today

however, such widespread distributions are now found only on Stewart, Raoul, Campbell, Kapiti, Mayor, Breaksea and some other small islands (7). On mainland New Zealand these rats have a patchy distribution and are to be found abundantly only where food is plentiful in association with a safe refuge (8). Such suitable habitats predominate in man modified environments such as cities, rubbish dumps, farm yards and along river banks.

3.3.3 CHARACTERISTIC BEHAVIOUR

Unlike the ship rat, these rats are predominantly ground dwelling. They are characterised by their burrowing nature which is practised wherever the substrate permits the activity.

In association with buildings, these are the rats that will usually be under the floors or in the basement.

In natural environments they will often colonise unused burrows of other animals (9) such as petrels and rabbits. These rats do not mind cold damp conditions and are known to be frequent strong swimmers, often feeding on aquatic organisms (10).

Compared with the other two species, Norway rats are widely regarded as highly cautious animals (11). For this reason, unfamiliar objects such as traps and new foods/poisons may be avoided for several days. Baiting unset traps, the use of slow acting poison and/or pre-baiting with non-toxic baits for a couple of days will improve the kill.

3.4.1 KIORE (Rattus exulans)

OTHER COMMON NAMES: Maori rat, Polynesian rat, native rat (12).

3.4.2 DISTRIBUTION AND HABITATS

The kiore was carried to New Zealand in the canoes of Polynesian man (13). It rapidly became widespread and was an important food source for the Maori (14).

(9) Twigg, 1975
Once European man colonised, the kiore declined and by the end of
the 19th century was virtually extinct in the North Island and rare in
the South Island (15).

Today, it is found only on some offshore islands, especially around
the north eastern coast of the North Island, some islands in the Marl­
borough Sounds, Stewart Island and some of its outliers and in some
locations in Fiordland (16).

R.H. Taylor, 1978, has examined reasons for the decline of kiore and
has come to the conclusion that competition from mice has been a major
factor. He suggests that once Norway rats, ship rats and mice become
established a niche for kiore no longer exists.

3.4.3 CHARACTERISTIC BEHAVIOUR

The kiore is intermediate between the other two species. While it
lives chiefly on the ground, it is partly arboreal (17). Nests are
usually in hollow logs, under rocks, in shrubs and trees and sometimes in
short unbranched burrows (18).

In high numbers, kiore are very easy to trap - I experienced this on
Little Barrier Island. Snap traps were set in the ranger's garden every
night and in the same position. Without fail, rats were trapped. One
night a live cage trap was set, somehow four rats managed to be caught!

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4

BREEDING
4.0 BREEDING

The three rat species have the ability to increase their numbers rapidly. This is due to a short gestation period of around twenty-one days, the ability of females to become pregnant straight after they have given birth, early maturation of juvenile females, a long breeding season and large litter sizes (19).

The breeding season in New Zealand usually commences in spring and may continue into the autumn and winter following heavy seedfalls in the autumn (20).

The average number of young in a litter for ship rats is 6, 8 for Norway rats (21), and 7 for kiore (22). Adult female ship rats and Norway rats may produce up to 5 litters in a normal breeding season (23), kiore usually have 2 or 3 (24). Thus the annual production can be quite high. Accounting for a 25 percent death of embryos, the actual annual production of young is 22 for ship rats, 30 for Norway rats (25), and about 15 for kiore.

DISTINGUISHING CHARACTERISTICS.

5.1 Head
5.2 Body/tail length
5.3 Number of nipples
5.4 Fur colouring
5.5 The skull
5.6 Droppings
5.0 Distinguishing Characteristics

5.1 Head

The head is useful for distinguishing the ship rat and kiore from Norway rats, but is of little use in distinguishing between ship rats and kiore.

Features to watch for include:

EARS (1)

Ship rats - Ears cover eyes when pulled forward.
   Fine hairs do not extend beyond edge of ear.

Kiore - As for ship rat.

Norway rats - Ears do not cover eyes when pulled forward.
   Hairs do extend beyond edge of ear.

Figure 1. Top ship rat; lower Norway rat.

(1) Cunningham and Moors, 1983.
(2) Food and Fertiliser Technology Centre for the Asian and Pacific Region.
5.2 **BODY/TAIL LENGTH** (3)

Ship rats - Tail usually much longer than the head and body length.
Kiore - Tail length equal to or either slightly longer or shorter than head and body length.
Norway rats - Clearly shorter than head and body length.

![Diagram of Norway rat, Ship rat, and Kiore]

Figure 2. Body/tail lengths and nipples of females of the 3 species.

5.3 **NUMBER OF NIPPLES**

Ship rats - Usually 10, up to 12.
Kiore - Usually 8.
Norway rats - Usually 12.

(3) Cunningham and Moors, 1983.
5.4 FUR COLOURING

Fur colouring varies within the species especially with the ship rat, and is a likely cause of misidentification.

Ship rats (5) - This species has 3 distinct differing colour forms:
(i) 'rattus' - Uniformly black back (sometimes has a bluish look) uniformly grey belly. The juveniles of this species are sometimes confused with kiore.
(ii) 'frugivorus' - Brown back with long black guard hairs; uniformly white or creamy white belly.
(iii) 'alexandrinus' - Brown back with long black guard hairs; uniformly grey belly.

NB 'frugivorus' is the most common form in the North Island (6) and 'alexandrinus' in the South Island (7).

Kiore - Usually a greyish brown back and a pale grey on the belly (8).
Norway rats - As for kiore (9).

5.5 THE SKULL

If the remains of a rat is found, keep the skull for later identification.

It is relatively easy to distinguish Norway rat skulls from those of ship rats and kiore, but not so easy to identify small ship rat skulls from those of kiore skulls (see figure 3).

To distinguish kiore skulls from those of small ship rats requires precise measuring of the rows of teeth in the upper and lower jaws. Referring to figure 4, the measurements are: If the upper tooth row is longer than 6.45 mm it is unlikely to be a kiore. If the tooth row length of the lower jaw is over 6.15 mm, it will not be a kiore (10).

It is unlikely for parks and reserve staff to have access to the precise measuring equipment needed to identify kiore skulls. I therefore recommend that skulls which cannot be clearly identified be sent to an

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(5) Cunningham and Moors, 1983
(6) (8) (9) Watson, 1959
(7) (10) Taylor (pers. comm.).
Ecology Division of the D.S.I.R. or to the head office of the New Zealand Wildlife Service, for measuring.

Figure 3. Top view of skulls. Norway rat (left), ship rat (right). Note the difference in the shapes of the cranium (main section protecting the brain) (11).

If >6.45 mm unlikely to be a kiore.

If >6.15 mm will not be a kiore.

Figure 4. Distinguishing measurements of kiore skulls. Information (12). Diagram (13).

(12) Taylor (pers. comm.).
(13) Twigg, 1975.
5.6 DROPPINGS

Identifying rats from their droppings is possible but often difficult and should be taken with caution. For example, kiore droppings cannot be distinguished from those of ship rats (14). Not only is there overlap in the size of droppings between the rat species, but insects, for example the bush weta and lizard droppings can easily be mistaken for rat droppings (see plate 3).

If droppings are found, collect some, ensuring to collect a good cross-section of shapes and sizes in order to determine the dominant forms present.

Ship rat - Dropping lengths 6.8 - 13.8 mm (15). Regarded as thinner, often slightly curved and generally scattered where rats have been running (16).
Kiore - Dropping lengths 6.4 - 9.0 mm (15), otherwise as for ship rat (16).
Norway rat - Dropping lengths 13.4 - 19.1 mm (15). Often spindle-shaped, long oval with pointed ends, often deposited in groups (16).

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Plate 3. The droppings of Norway rat, ship rat, bush weta and mouse.
Plate 4. Comic of New Zealand rodents.
(Taken from Cunningham and Moors, 1983)
DETECTING RATS

6.1 Introduction
6.2 Observation
6.3 Where and what signs to look for
  6.3.1 Intermediate-aged forest
  6.3.2 Runways
  6.3.3 Burrows
  6.3.4 Feeding stations
  6.3.5 Evidence of predation
6.4 Trapping
  6.4.1 Which trap to use
  6.4.2 What bait to use
  6.4.3 Where to set traps
  6.4.4 Trap covers
  6.4.5 Results
  6.4.6 Information to record from trapped rats
  6.4.7 Preserving specimens
6.5 Tracking tunnels
  6.5.1 The ink solution
  6.5.2 The tracking papers
6.6 Gnawing sticks
6.0 DETECTING RATS

6.1 INTRODUCTION

Detecting the presence of rats can prove to be a very difficult task, especially after a poisoning operation when rat numbers will be very low, and remaining rats are likely to be very cautious of man-made objects such as traps.

This is a field which requires new research and a greater array of methods. Future areas of research may include: use of unpoisoned bait, devices for catching hair, systems for obtaining rat tracks, detection of urine by fluorescence in ultra-violet light and the use of specially trained dogs (1).

In this section I will describe the traditional methods which still constitute the most practical means currently available to the resource manager for detecting rats. These include: observation, trapping, tracking tunnels and gnawing sticks.

6.2 OBSERVATION

Straight forward observation is a simple, comparatively quick, cheap and effective method for the detection of rats. Once those involved know the signs, where and what to look for, this method becomes an invaluable tool and MUST be included in any detection survey.

A wealth of valuable material can be accumulated from periodic visits to areas and the systematic recording of information such as bird numbers. After a while, it will become clear as to what wildlife is present in an area and what constitutes stable populations. In the event of predators such as rats becoming established, their presence may be indicated by the sudden decline of various species.

Populations may also increase following the reduction of rat numbers. On Tawhitinui Island for example, the common bush weta (an important food for rats) became dramatically more numerous in the years following the eradication campaign. This was detected by the significant increase in weta droppings.

6.3 WHERE AND WHAT SIGNS TO LOOK FOR

6.3.1 INTERMEDIATE AGED FOREST

A study carried out by Moors in Kowhai Bush near Kaikoura, showed that ship rats were most numerous in intermediate aged forests and mature broadleaf forests which grew on good soils. Likewise, predation by rats was also highest in these areas (2).

6.3.2 RUNWAYS

Rats are creatures of habit (3) and therefore are often active in the same areas night after night. This results in small tracks which usually run parallel with contours on hilly ground. For ship rats, branches and decaying logs often provide bridges in their nightly movements. These are often good places to search for droppings.

6.3.3 BURROWS

Burrows are a special feature of Norway rats, but the other two species are occasionally known to live in burrows or rock crevices. Often droppings are left at the entrance to burrows. Cobwebs across the entrance to a burrow are usually a good indication that it is not in use.

6.3.4 FEEDING STATIONS

These are usually associated with runways. Such stations are often at the base of trees, rocks or some other form of shelter. The remains of insects and opened seeds with their kernels extracted are often found under trees such as miro and hinau (see plate 1). Coastal regions with the intertidal zone provide a good food source for rats. Nearby banks above the high tide line are often good places to search.

(2) Moors, 1983
(3) Erlinge, 1968
6.3.5 Evidence of Predation

Rats are usually "messy" predators. For example, shattered or partly eaten eggs and chicks are left in disarranged nests (4). In contrast, stoats are "clean" predators and usually little or no evidence is left as their prey is often carried away.

6.4 Trapping

6.4.1 Which Trap to Use

Rat traps come in a variety of types. The most commonly used by the D.S.I.R. and the NZ Wildlife Service is the "Ezeset Supreme". In my experience however, I have found this trap to be of poor durability and often becoming difficult and exceedingly frustrating to set. It therefore often requires maintenance to keep in good working order. I have found traps known as "The Nipper" much more durable and easier to set. The trap also has a large trip plate which holds bait more securely and provides a greater chance for the trap to be sprung. Both these traps are usually available from most hardware outlets.

It is a good idea to soak the traps in a fish or linseed oil. This will ensure the traps operate smoothly and also prevents springs rusting and weakening - a real problem when traps are used on islands or near to the sea.

Traps should always be tied down to prevent un killed rats carrying the traps away or scavengers such as wekas or gulls carrying the rat and trap away.

6.4.2 What Bait to Use

Rats will generally be attracted to most human foods. However, it is best to use a variety of baits and ones that will keep reasonably fresh.

Renew baits whenever their attractiveness has been reduced, e.g. by rain, hot weather, mould or partial consumption by non-target species (5).

(4) Moors, 1983.

(5) Cunningham and Moors, 1983.
Some good baits to use include:
(a) Peanut butter and rolled oats mixed. Keeps fresh, highly palatable, easy to apply.
(b) Ham or bacon rind. Keeps reasonably well, pungent odour, usually obtainable free from butchers.
(c) Cheese. Keeps reasonably well, easy to apply.
(d) Apple slices. If the rat is not trapped, characteristic tooth grooves are often left in the apple.
(e) Dog or cat food. Good, but only suitable for 1-2 days as it rapidly becomes fly blown.

6.4.3 WHERE TO SET TRAPS

When trying to determine if rats are present and their species, the spacing between trap sites is not too important. A distance of 20-50 metres should be suitable. What is important is to place traps where it looks as though rats have been active. For example, if droppings, food remains or runways are visible, set traps nearby (6). Make sure traps are level and stable. Rats, especially the Norway rat, are likely to be shied off by objects that move (7). If traps are consistently unsuccessful, shift them to other locations after about a week.

6.4.4 TRAP COVERS

It may be necessary to cover traps to exclude non-target species and to reduce unwanted disturbance, e.g. if wekas and/or possums are present, covers will be vital as well as extra barricades of stones or sticks to prevent the entry of these animals. Whenever possible, place traps near or under natural cover (8). This not only helps camouflage the trap giving it a more natural appearance but should reduce unwanted human interference should this be a problem.

Covers should be made from durable, light materials that can be stacked together and easily transported. Aluminium, plastic sheet and wire mesh are suitable materials. The covers should be long enough to take two rat traps, placed end to end and still allow for about 80-100 mm clearance at each end. The trap arm must also have a clear swing, as any disturbance may be enough to let the rat escape.

6.4.5 RESULTS

Keeping a good record of your trapping results is important to provide a reference point for later trapping programmes. You should always:

(a) Record location, trap line and date.
(b) If possible check traps early the next morning. Fresh rats are much more pleasant to handle and easier to identify. In warm weather, tissue deteriorates quickly and carcasses become fly blown (9).
(c) Record the previous night's weather as this can affect animals' behaviour and therefore trapping results (10).
(d) Record what baits have been used.
(e) Record where rats are trapped; whether each trap is sprung or unsprung; whether the bait is gone, partly eaten or left untouched (11).

(f) Record any other disturbance or signs of rats being present. For example, hair in trap or droppings nearby.

I have found the following abbreviations useful when recording results.

Bp Ts = Bait present, Trap set
Bp Tsp = Bait present, Trap sprung
Bg Ts = Bait gone, Trap set
Bg Tsp = Bait gone, Trap sprung

For final records, the corrected number of trap nights must be calculated allowing for those traps which have been set off. This is done by subtracting half a night for sprung traps, whether or not a rat has been trapped. Unsprung traps with baits gone should not be included as they are still theoretically capable of trapping a rat.

For example, 50 traps set for 3 nights, 4 rats were trapped and 9 traps were sprung with no rats caught.

50 traps x 3 nights = 150 trap nights
Trap nights lost = \( \frac{4 + 9}{2} \) (captures and sprung empty traps)
\[ = \frac{13}{2} = 6.5 \]

Therefore corrected trap nights
\[ = \text{Total trap nights} - \text{trap nights lost} \]
\[ = 150 - 6.5 \]
\[ = 143.5 \] (12).

6.4.6 INFORMATION TO RECORD FROM TRAPPED RATS

Prior to any trapping programme, I recommend liaison with Ecology Division of the D.S.I.R. and/or the head office of the NZ Wildlife Service. They may be interested in acquiring data from your work over and above that which I consider necessary for the resource manager. For example, these departments may be interested in carrying out body measurements or studying the gut contents. The resource manager however is more interested in the presence or absence of rats, the species present and the possibilities for control or eradication. For this reason, unless he is uncertain of the species present, he does not need to collect specimens. Other material to note includes: juvenile or adult, general physical condition and for ship rats the colour form (see section 5.1).

(12) Cunningham and Moors, 1983.
6.4.7 PRESERVING SPECIMENS

Should it be necessary to collect and preserve specimens, field staff must be equipped with the necessary materials.

Freezing is the best method of preserving samples (13) but in isolated locations or if samples have to be transported long distances, this method may be impractical. Apart from freezing, the next best method is to use 75 percent alcohol (14). This is usually obtained commercially as 96 percent ethyl alcohol. Dilute four parts alcohol with one part water. Always use in EXCESS and open the gut cavity to ensure the alcohol reaches all parts of the body. Do not over-fill containers with samples if it can be avoided. If it is unavoidable however, replace the alcohol twice within the first week. The cost of alcohol and containers is minimal compared with the cost of obtaining those samples (15).

If in the situation of having no alcohol or freezer, vinegar, methylated spirits or a very strong salt solution can be used for a short time. This must be replaced with 75 percent alcohol as soon as possible. The preserving agent used, must be soluable in water to penetrate body tissues (16).

If it is proving difficult to obtain the alcohol and suitable containers, Ecology Division, D.S.I.R., or the NZ Wildlife Service should be able to help out.

With specimens that are to be kept, the first important step is to accurately label the animals. This should be done on card tags which are attached to the animals by string loops. Details should be written in pencil, not ink as this will run when in contact with alcohol. The containers must also be well labelled. This should not be done by simply writing on the container in ink, as wet hands or spilt alcohol will remove it. A card sealed in clear plastic and taped to the container is preferred.

After handling rats, wash your hands thoroughly. Most wild rats are not health hazards but some carry diseases such as leptospirosis (17).

6.5 TRACKING TUNNELS

Tracking tunnels work on the principle of recording an animal's footprints. From these prints the animal can be identified, e.g. rat, stoat, hedgehog.

The tracking tunnel commonly used by the D.S.I.R. consists of an aluminium cover, a wooden base and aluminium tray. The aluminium tray has a central section for a flannelette ink pad and at either end two slots for tracking papers (see figure 5).

These tunnels can be placed on the ground and secured in trees. A small amount of bait placed in the middle and to one side of the tunnel will help attract rats.

The main disadvantages of this method are the time inputs and expense of constructing the tunnels and from footprints alone, the rat species cannot be determined (19).

For parks which administer important biological islands, it would be worthwhile constructing a set of tunnels, e.g. 50-100. The D.S.I.R. are often, but not always able to lend tunnels. It is therefore beneficial to be independent in such work.

6.5.1 THE INK SOLUTION

The solution comprises 80 g ferric nitrate, 120 g polyethylene glycol, 40 g 'Nonident' detergent and is made up to 270 g with water. A brown viscous liquid results which keeps indefinitely when bottled (19).

6.5.2 THE TRACKING PAPERS

A coarse grade wrapping paper is used, rough side up. Using a hand held atomiser a solution of 5 percent tannic acid in 75 percent ethano1 is finely sprayed over the paper, saturation is not necessary. Allow a few minutes for the paper to dry off then cut to the size required for the tunnels. It is helpful to mark the papers with a small cross, indicating which side is up (sprayed).

Once again, these chemicals may be difficult for park staff to acquire. The D.S.I.R. or NZ Wildlife Service will probably be able to supply them, pre-mixed.

CONSTRUCTION DETAILS OF TRACKING TUNNEL

All measurements in mm

**Fig.5**

**ELEVATION OF COVER**

- Flap $130 \times 70$

**PLAN OF BASE**

Ice block sticks

Fannelette ink pad

Nailed to board

- Cover is folded from aluminium sheet $520 \times 320$ mm.
  Each fold takes about $5$ mm.

- Flaps are riveted on the inside at both ends.

- The base is made from aluminium strips $480 \times 110$ mm. Edges are folded in $10$ mm to allow a sliding groove for tracking papers.

- Shortened ice block sticks, $2$ at each end are held in place by small aluminium flaps. A rubber sealant ensures a seal between the ink pad and the tracking papers.

- The aluminium base is secured to a board $465 \times 90 \times 10$ mm by small nails.
Plate 6. Tracking tunnel base. Note rat tracks on papers.

Plate 7. Tracking tunnel cover.
6.6 **GNAWING STICKS**

This detection method consists of soaking untreated sticks (25 x 2 x 2 cm) in hot cooking oil for 24 hours and then inserting them into the ground about 80 mm in areas likely to be visited by rats.

Moors of the NZ Wildlife Service used this method on the Noises Island campaign against Norway rats and found it to be the single most helpful detection method \(^{(20)}\). Characteristic grooves from the rats incisor teeth were left in the sticks.

Gnawing sticks were used on Tawhitinui Island (ship rats) prior to the poisoning programme with no results at all. More research is required to determine if this method works with all 3 species.

7.1 Introduction
7.2 Background to the Tawhitinui campaign
7.3 Objectives in the programme
7.4 Anticoagulant poisons
7.5 The island - general description
  7.5.1 Vegetation
  7.5.2 Fauna noted during the campaign
  7.5.3 Colonisation by rats
7.6 Past trapping and use of tracking tunnels
7.7 Pre-poisoning rat and stoat trapping
7.8 The track system
7.9 Bait stations
  7.9.1 Advantages of the 'Nova pipe' station
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7.10 The staff
7.11 Distributing the poison
7.12 Poison take results
7.13 Poisoning of non-target species
7.14 Follow-up work
  7.14.2 June/July 1983 trapping
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  7.14.6 August 1984 tracking tunnels and trapping
7.15 Expenditure of campaign
7.16 Discussion of the Tawhitinui campaign
7.0 **TAWHITINUI ISLAND RAT ERADICATION EXPERIMENT**

7.1 **INTRODUCTION**

This section of the dissertation describes an experiment aimed at the eradication of ship rats on Tawhitinui Island, Tennyson Inlet, Pelorus Sound, Marlborough (see location map p 37). It illustrates the approach taken, the resources and inputs required, the results and the follow-up work necessary to determine the effectiveness of the operation.

7.2 **BACKGROUND TO THE TAWHITINUI CAMPAIGN**

In 1981 the Department of Lands and Survey was considering a rat eradication trial on Campbell Island using the Brodifacoum (anticoagulant) based poison Talon W.B. This idea was put to R.H. Taylor of Ecology Division, Department of Scientific and Industrial Research (D.S.I.R.), Nelson, for consideration. Taylor suggested that an experiment be carried out on a smaller scale, using a more accessible island of moderate size where there would be far fewer logistic difficulties and lower expenses, especially if the operation proved to be unsuccessful.

As a result, Taylor discussed the idea with the Marlborough Sounds Maritime Park Ranger at Havelock. The ranger's interest and cooperation with the D.S.I.R. initiated a programme on Awaiti Island in 1982. Awaiti is a small island which lies 200 metres to the south-east of Tawhitinui. This operation involved a division of the island with poison lines and the distribution of Talon W.B. in bait stations.

After several months of intensive poisoning on Awaiti, the operation appeared to have been successful. R.H. Taylor then recommended a similar programme be carried out on Tawhitinui Island which was also known to have ship rats. This would provide a more realistic experiment on a moderate sized island.

I became involved and responsible for liaising with the D.S.I.R. and implementing the programmes, originally as part of my practical work for the Lincoln College course in Parks and Recreation and later as summer vacation employment.
Fig. 7 LOCATION MAP OF TAWHITINUI ISLAND

TAWHITINUI ISLAND

MARLBOROUGH SOUNDS
CHRISTCHURCH

SCALE Km
0 2 4 6 8 10

HAVELock
PICTON
Plate 8. Aerial view of Tennyson Inlet, illustrating from the front, Tawhitinui, Awaiti and Tarakaipa Islands. (Photo. N. Phillips).
7.3 OBJECTIVES IN PROGRAMME

(1) An experimental programme on the feasibility of eradication of *Rattus rattus* on a moderate size island, using the Brodifacoum based poison Talon W.B. only.*

(2) To carry out a trapping programme prior to the poisoning in order to give an index of the present rat population.

(3) To achieve an ideal distribution of poison and spacing of tracks.

(4) To monitor bait stations. After a period of several months of no bait takes, a wide variety of lures or indication methods should be experimented with.

(5) To observe present fauna on the island.

(6) To observe any direct or secondary poisoning on non-target species.

(7) To record manpower and expenses required for such an operation.

(8) To render Tawhitinui Island rodent free hence increasing its wildlife value.

7.4 ANTICOAGULANT POISONS

The poison used on both Tawhitinui and Awaiti islands was the anticoagulant Brodifacoum, produced by I.C.I. Tasman Limited and distributed under the trade-name "Talon W.B." I.C.I. were most generous in donating the poison for these experiments. With a relatively new poison, such experiments are of great value in determining their effectiveness and side effects.

* Tawhitinui Island has not got a high significance value for wildlife protection. Therefore it was not imperative that rats were eradicated. It would have been detrimental to the experiment to try a variety of poisons until the use of Brodifacoum had been completely tested over a lengthy period.
The poison baits consist of 'egg shaped' wax blocks with an average weight of 30 grams, containing whole maize and 0.005 percent Brodifacoum.

Plate 9. Talon baits.

Anticoagulants were discovered in the 1940's and have since proved the most effective rodent control poison (1). However the early anticoagulants such as Warfarin, lead to the development of resistant strains of rats with resistance being passed on by heredity (2). The more recent anticoagulants to be developed, including Brodifacoum, have proved highly toxic in minute doses, even to Warfarin resistant rats (3). Rodents need only consume 6-7 percent of their daily intake in a single feeding to obtain a lethal dose from baits containing only a few parts per million of poison (4).

Anticoagulants have the same effect on all warm blooded animals. The poison halts the clotting ability of the animal's blood. As a result, internal haemorrhaging is generally the cause of death (5).

(1) (3) (4) Dubock, 1979
(2) Godfrey and Lyman-Haney
Effects usually develop after three days with most deaths occurring between three and six days. If an accidental poisoning of man or domestic animal occurs, vitamin K can easily be taken as an effective antidote (6).

During the Tawhitinui campaign, no one experienced any effect from the poison. Care was always taken to wash hands after handling the poison.

Slow acting rodenticides such as Brodifacoum provide two important benefits compared with faster acting poisons. Since several days elapse before the effects are felt, the need to pre-bait with non-toxic baits is eliminated. Also, bait shyness is less likely to develop (7). These benefits make it a very desirable poison to use.

With any poison, one of the most important considerations is that of its effects on non-target species, either directly or indirectly. Brodifacoum in varying concentrations is directly toxic to most species of bird and mammal. There are also dangers to predators or scavengers such as gulls, hawks and moreporks.

Although the poison presents problems with non-target species of birds and mammals, the risks are probably no greater than those already present in other currently used poisons.

7.5 THE ISLAND - GENERAL DESCRIPTION

Tawhitinui Island lies at the northern end of Tennyson Inlet in the Pelorus Sound. It is 21 hectares in size, rises to a height of 100 metres and lies 400 metres from the mainland. Tawhitinui is one of three islands in the inlet, the others being Awaiti Island (2 hectares) lying about 200 metres to the south-east and Tarakaipa Island about one kilometre to the south of Tawhitinui (see map p 37). All three islands fall under the Scenic Reserve status and are under the administration of the Marlborough Sounds Maritime Park.

7.5.1 VEGETATION

Tawhitinui Island would originally have had a mixture of beech and hardwood vegetation. However, within the last 100 years, clearance fires have destroyed most of this. Today, the original vegetation is limited to remnant pockets amongst a mosaic of successional vegetation types (8).

The major part of the island therefore represents a fine example of a regenerating mixed broadleaf/beech forest with seedlings and young healthy specimens of climax species such as tawa, rimu and miro.

The main ridge areas are dominantly covered in a 5-10 metre high canopy of manuka/kanuka scrub, under which grow other seral species such as fivefinger and mingimingi. A thick covering of kamahi and red beech at a height of approximately 4 metres covers the central western faces, most likely as a result of a more recent fire. The understorey here consists mainly of sapling kamahi, beech and patches of thick native grass (Uncinia species). Remnant pockets of original vegetation are restricted to the wetter eastern and southern facing slopes. Here, large beech, miro and kohekohe still remain - some 15-20 metres tall. The dominant canopy in these areas is comprised of kohekohe and hinu under which a wide variety of understorey shrubs and ferns grow. Tree ferns, nikau palms and the sprawling kie kie give it a somewhat tropical appearance. Coastal vegetation is relatively uniform right around the island. Above the high tide line, flax is the first coloniser, followed by akiraho. Other intermixing species include broadleaf, rangiora, fivefinger, karamu, kanono, mahoe, tutu and mingimingi.

Regeneration on the island is occurring rapidly. Even though deer periodically visit the island their grazing impact is minimal. Hence, regeneration is at a faster rate than on the mainland.

In response to past fires and with the geography of the island allowing for wet areas, a real diversity of vegetation has resulted. For an experiment such as rat eradication, this aspect was worthy of close consideration as in the long run it may have benefited future programmes by determining habitat preferences. On Tawhitinui unfortunate interference from wekas with traps and poison baits and an apparently low population of rats inhibited such observations being made. However, obvious rat sign was noted in the areas of mature vegetation where food supply from trees such as hinu and miro were greatest.

### Common and Scientific Names of Plants Mentioned

<table>
<thead>
<tr>
<th>Common name</th>
<th>Scientific name</th>
</tr>
</thead>
<tbody>
<tr>
<td>beech (black)</td>
<td><em>Nothofagus solandri</em></td>
</tr>
<tr>
<td>beech (hard)</td>
<td><em>Nothofagus truncata</em></td>
</tr>
<tr>
<td>beech (red)</td>
<td><em>Nothofagus fusca</em></td>
</tr>
<tr>
<td>broadleaf</td>
<td><em>Griselinia littoralis</em></td>
</tr>
<tr>
<td>fivefinger</td>
<td><em>Pseudopanax arboreum</em></td>
</tr>
<tr>
<td>flax</td>
<td><em>Phormium cookianum</em></td>
</tr>
<tr>
<td>hinau</td>
<td><em>Elaeocarpus dentatus</em></td>
</tr>
<tr>
<td>kamahi</td>
<td><em>Weinmania racemosa</em></td>
</tr>
<tr>
<td>kanono</td>
<td><em>Coprosma australis</em></td>
</tr>
<tr>
<td>kanuka</td>
<td><em>Leptospermum ericoides</em></td>
</tr>
<tr>
<td>karamu</td>
<td><em>Coprosma robusta</em></td>
</tr>
<tr>
<td>kiekie</td>
<td><em>Freycinetia banksii</em></td>
</tr>
<tr>
<td>kohekohe</td>
<td><em>Dysoxylum spectabile</em></td>
</tr>
<tr>
<td>kohuhu</td>
<td><em>Pittosporum tenuifolium</em></td>
</tr>
<tr>
<td>lancewood</td>
<td><em>Pseudopanax crassifolium</em></td>
</tr>
<tr>
<td>mahoe</td>
<td><em>Melicytus macrophyllus</em></td>
</tr>
<tr>
<td>manuka</td>
<td><em>Leptospermum scoparium</em></td>
</tr>
<tr>
<td>mingimangi</td>
<td><em>Cyathodes fasciculata</em></td>
</tr>
<tr>
<td>miro</td>
<td><em>Podocarpus ferrugineus</em></td>
</tr>
<tr>
<td>nikau palm</td>
<td><em>Rhopalostylis sapida</em></td>
</tr>
<tr>
<td>akiraho</td>
<td><em>Olearia paniculata</em></td>
</tr>
<tr>
<td>rangiora</td>
<td><em>Brachyglottis repanda</em></td>
</tr>
<tr>
<td>rimu</td>
<td><em>Dacrydium cupressinum</em></td>
</tr>
<tr>
<td>tawa</td>
<td><em>Beilschmiedia tawa</em></td>
</tr>
<tr>
<td>toro</td>
<td><em>Myrsine salicina</em></td>
</tr>
<tr>
<td>tree ferns</td>
<td><em>Cyathea dealbata</em></td>
</tr>
<tr>
<td></td>
<td><em>Cyathea medullaris</em></td>
</tr>
<tr>
<td></td>
<td><em>Dicksonia squarrosa</em></td>
</tr>
<tr>
<td>tutu</td>
<td><em>Coriaria arborea</em></td>
</tr>
</tbody>
</table>
Plate 10. Regeneration on Tawhitinui Island.

Plate 11. Dark damp gullies of mature forest on Tawhitinui Island.
7.5.2 FAUNA NOTED DURING PROGRAMME

Birds - Numbers are actual counts; +, ++, +++ indicates few, several and many.

- bellbird ++
- black-backed gull ++ (nesting)
- black shag ++
- blue penguin ++ (nesting)
- chaffinch +
- fantail ++
- grey warbler +
- morepork +
- pied shag ++
- thrush +
- tomtit (1)
- tui ++
- waxeye +++
- weka +++
- New Zealand pigeon ++

Mammals - Deer pellets and grazing effects seen. Stoat faeces containing rat fur and bones found. Ship rat.

7.5.3 COLONISATION BY RATS

The means of arrival of ship rats to Tawhitinui is largely unknown. Did rats swim the 400 metre gap from the mainland to Tawhitinui and then the 200 metres from Tawhitinui to Awaiti? As noted on page 2, the D.S.I.R. have provided some evidence to suggest that rats swim not much further than 300 metres. Also, most reports (e.g. Cunningham and Moors, 1983) state that ship rats are infrequent swimmers.

According to Roy Archer, a long standing local of the area, Tawhitinui was once used as a ram paddock. It is quite possible, rats were carried to the island during such farming activities.

The other possibility is for rats to be carried inside a floating log or on debris.
Unfortunately, no conclusive evidence as to how rats arrived on the island means future results in the short term may prove difficult to interpret. For example, if rats are detected within the next 2 years it will not be known if rats were completely eradicated or if a new colonisation has occurred. If however, rats are detected after a 2 year period, it would be relatively safe to assume a new colonisation has occurred.

7.6 PAST TRAPPING AND USE OF TRACKING TUNNELS ON TAWHITINUI ISLAND

The following results have been provided mainly by the D.S.I.R., Ecology Division, Nelson, but occasional visits by Peter Notman of the Zoology Department, Victoria University, and one overnight visit carried out by the NZ Wildlife Service have helped in providing trapping information.

The results showed definite rat presence from December 1977 through to January 1982. The December 1977 to October 1980 results possibly indicate that a fairly high population existed. However, since the October 1980 results, a drop in trapping success could be the indication of a diminishing population.

In the wild, rat populations are never stable. Fluctuations are caused by various factors such as abundance of food, weather conditions and predation.

Stoat trapping was carried out from August 1981 through to January 1982 with no success. Definite stoat sign was found in December 1982. It is most likely that stoats periodically visit the island and contribute to fluctuations in the rat population.

Our 1982/83 trapping results indicate that the rat population was already very low prior to the poisoning programme.

<table>
<thead>
<tr>
<th>Trapping</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>December 1977</td>
<td>10 traps laid up a gully on the south-eastern side of Tawhitinui through kohekohe forest. Traps set for one night. 2 Rattus rattus caught.</td>
</tr>
<tr>
<td>May 1980</td>
<td>6 traps set for one night. 1 Rattus rattus caught.</td>
</tr>
<tr>
<td>June 1980</td>
<td>5 traps set for one night. 2 Rattus rattus caught.</td>
</tr>
<tr>
<td>October 1980</td>
<td>3 Fenn sets, and 10 rodent traps for three nights. 2 Rattus rattus caught.</td>
</tr>
</tbody>
</table>
November 1980  3 Fenn sets left for three weeks. No disturbance.
April 1981  10 rat traps set for three nights. No rats caught.
August 1981  7 Fenn sets set for 21 days. 1 *Rattus rattus* caught.
September 1981  10 rat traps set for four nights. No rats caught.
September 1981  7 Fenn sets set for 20 days. No rats caught.
October 1981  7 Fenn sets set for 26 days. 1 *Rattus rattus* caught.
November 1981  7 Fenn sets set for 29 days. No rats caught.
January 1982  7 Fenn sets set for 25 days. 1 *Rattus rattus* caught.

**Tracking tunnels**
November 1979  3 tracking tunnels placed in scrub behind eastern shore for five nights. No recordings were made.
August 1981  8 tracking tunnels were set just above the shore line in Big Bay for 20 days. 12 papers were recovered, 1 with rat tracks.

7.7 **PRE-POISONING RAT AND STOAT TRAPPING**

**Rat trapping**
Traps used were the common "Ezeset supreme" snap or break-back trap (see 6.4.1). These were set at 20 metre intervals, predominantly on the ground where they were tied to roots or branches and covered with aluminium tunnels. A mixture of peanut butter and rolled oats was used as bait. Traps were checked daily except during weekends.

Trapping was carried out in 2 areas (see figure 8, p 48) which covered 3 broad habitat types including coastal vegetation, an area of mature hinu forest and the manuka/kanuka scrub association.

Traps were left in the first site for a total of 201 corrected trap nights. During this time, they were continually interfered with by wekas. Not one rat was trapped, although rat fur was found in one trap.

Traps were left in the second site for 85 corrected trap nights. Considerably less interference occurred with traps in these locations, although again no rats were caught.

Total rat trapping consisted of 286 corrected trap nights. The following results were obtained as a percentage of trap checks.
Fig. 8  TRAPPING LOCATIONS PRIOR TO POISONING

APPROXIMATE SCALE (metres)

--- = Trap line
Bait present, trap set = 63.5%
Bait absent, trap sprung = 22.4%
Bait present, trap sprung = 9.8%
Bait absent, trap set = 4.3%

Stoat trapping
Definite stoat sign was found just above the shore-line in Big Bay (see figure 8, p 48) early in December 1982. The faeces contained rat fur and bones and small remains of insect shells. The same day, a stoat trap was set near this site. One month later, it was shifted to the creek area and was finally removed one month after that. Mussels, chops and fish were used as bait. No stoats were trapped and only once were the traps sprung.

Discussion
A total of 18 man hours was spent on rat and stoat trapping. In my opinion it was unfortunate that more of the island was not covered with the trapping programme.

Having to complete the bulk of the project within the constraints of a 4 month period tended to place more importance on getting the track system completed and the bait stations distributed than to worry about trapping. The programme continued therefore in the absence of knowledge of the rat population size.

7.8 THE TRACK SYSTEM

Track work required the highest physical input, with a total of approximately 186 man hours expended on 48 tracks.

The network of tracks was necessary to facilitate the quick access to all parts of the island. Without the tracks, the whole operation would become more distasteful and time consuming. The initial manpower input was therefore well worth while in the long run. Damage to the vegetation was kept to a minimum with care not to damage young climax species. One year after the tracks had been cut, many were already starting to become overgrown. The track system therefore has not induced a long term impact.
The track system that developed was influenced by various factors. These included access to the shore, the thickness and diversity of the vegetation and the natural ridge lines and spurs. The system was also influenced both by the results of an experiment carried out by the D.S.I.R. in the Orongorongo Valley near Wellington, which showed that the majority of rats moved less than 61 metres (9) and also, by our trapping results which indicated that a low population existed and that rats could therefore easily have had greater home ranges.

With these considerations and constraints in mind, track locations were determined by visual assessment offshore from the island. With the aid of photo-copies of an aerial photograph, land features could be located on the shore-line and ridge tops, then an imaginary track line could be drawn in on the map. This process was repeated for each track until a subjective but practical coverage of the island developed. Most tracks ended up being 30-60 metres apart (see fig. 9, p 51).

More tracks could have been put in, however, time and finance did not permit this. Also, if rats continued to be present after the initial poisoning, follow-up work could have included further divisions between existing tracks in an attempt to clarify the best distance between tracks.

7.9 BAIT STATIONS

Approximately 62 man hours were spent constructing 350 bait stations.

The idea behind the nova-pipe bait station was to prevent non-target species interfering with the poison. The design originated with the D.S.I.R. and was subsequently modified by park staff. The nova-pipe idea came from knowledge that in the Pacific Islands and Malaysia, use of bamboo tubes had been successful in distributing rat poison (10).

Past use of tracking and trapping tunnels and boxes by the D.S.I.R. helped to provide a measurement for the length of the station (600 mm) which should keep out non-target species, especially the weka.

Bait stations were constructed from 65 mm diameter, yellow, non-perforated nova-flow pipe. Sections 105 mm long and 15 mm deep were cut out of the pipe to enable a clip-in/out inspection lid to be fitted. Baits were held in place by small aluminium bars approximately 85 mm long x 5 mm wide which were pushed through the pipe (see fig.10, p 54).

Figure 9.

TAWHITINUI ISLAND TRACK MAP
APPROXIMATE SCALE (metres)

<table>
<thead>
<tr>
<th>Track No.</th>
<th>No. of stations</th>
<th>Track No.</th>
<th>No. of stations</th>
<th>Track No.</th>
<th>No. of stations</th>
<th>Track No.</th>
<th>No. of stations</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>12</td>
<td>6</td>
<td>21D</td>
<td>5</td>
<td>30A</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>3</td>
<td>13</td>
<td>6</td>
<td>22</td>
<td>9</td>
<td>30B</td>
<td>4</td>
</tr>
<tr>
<td>3</td>
<td>2</td>
<td>14</td>
<td>6</td>
<td>23</td>
<td>9</td>
<td>31</td>
<td>5</td>
</tr>
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<td>4</td>
<td>2</td>
<td>15</td>
<td>6</td>
<td>24</td>
<td>10</td>
<td>32</td>
<td>5</td>
</tr>
<tr>
<td>5</td>
<td>4</td>
<td>16</td>
<td>10</td>
<td>24A</td>
<td>6</td>
<td>33</td>
<td>4</td>
</tr>
<tr>
<td>6</td>
<td>4</td>
<td>17</td>
<td>8</td>
<td>24B</td>
<td>8</td>
<td>34</td>
<td>3</td>
</tr>
<tr>
<td>7</td>
<td>7</td>
<td>18</td>
<td>8</td>
<td>25</td>
<td>8</td>
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<td>5</td>
<td>38</td>
<td>3</td>
</tr>
<tr>
<td>11</td>
<td>5</td>
<td>21A</td>
<td>9</td>
<td>29</td>
<td>4</td>
<td>ridge</td>
<td>70</td>
</tr>
<tr>
<td></td>
<td></td>
<td>21B</td>
<td>9</td>
<td>30</td>
<td>8</td>
<td>x coast</td>
<td>29</td>
</tr>
</tbody>
</table>
Plate 12. Bait station in position.

Plate 13. Checking the station.
7.9.1 ADVANTAGES OF 'NOVA PIPE' STATIONS

(1) Relatively cheap and simple to construct.
(2) Yellow colour helped to locate the stations.
(3) Materials do not deteriorate in the weather. This factor makes them suitable for permanent fixtures, ideal for use in areas such as around tramping huts, on an island where rats keep colonising or on important biological islands around landing sites.
(4) Ship rats appear to enter them freely.
(5) Light weight.
(6) After a while, the tunnels become quite a "natural" component of the landscape. Mould and leaf litter for example accumulates on and around the stations helping to blend them in with their surroundings.

7.9.2 PROBLEMS/DISADVANTAGES EXPERIENCED WITH THE STATIONS

(1) The major problem experienced was no fault of design or materials. In an attempt to economise we reduced the length of the stations by 200 mm. As a result, interference occurred from the wekas. The first 2 sets of poison take results are therefore not accurate for rat takes only. After the second check, nova pipe extensions were easily clipped on. Our attempts to economise were therefore false. It would have been cheaper in the long run to have maintained the original length.

(2) The aluminium bars simply acted as supports for the bait which resulted in the rats being able to carry baits away from the tunnel. This meant that half eaten baits lay around completely open to non-target species.

(3) Insects such as the bush weta were attracted to the poison, especially the maize seeds which they gnawed on freely. This aided the deterioration of the baits, often made it difficult to determine if it was insect or rat markings and permitted the entry of poison to the ecosystem via these insects.
(4) It proved difficult to get a good water-tight seal between the inspection lid and pipe. In many cases, water got in and depending on the slope of the station, built up. This increased the rate of bait deterioration. Ensuring that stations were on an angle permitting water to drain out helped to a certain degree.

(5) Only about 10-20 stations can be carried at any one time. We found sacks the most convenient way to carry them.

(6) Depending on the terrain, topsoil depth and character, the wire hoops holding stations to the ground were often difficult to push in and in stony ground provided little support.

Fig. 10. Bait station - construction detail (not to scale).
7.10 STAFF

Approximately 345 man hours were spent on the initial implementation of the programme. Up to August 1984, a further approximate 282 man hours were spent monitoring poison stations, trapping, tracking and searching for rat sign.

The Tawhitinui campaign was implemented by myself and 2 other Lincoln College students as summer vacation employment. Havelock park staff monitored the poison during 1983 and I, along with other park staff, implemented the follow-up work of January-February and August-September 1984.

While working on Tawhitinui, we were stationed in Godsiff Bay Hut, 6 kilometres south of the island, or 20 minutes travelling in calm weather.

Transport to the island was in a heavy 12 foot aluminium dinghy, which had the advantage of manoeuvrability but was unstable in adverse sea conditions.

Plate 14. Transport to island. (Photo. M. Thomas)
Fig. 11. Graphs showing the distribution of man hours.

- **Setting Bait Stations**: 80 hours
- **Constructing Bait Stations**: 62 hours
- **Tracks**: 186 hours
- **Trapping**: 18 hours
- **Removing Bait Stations**: 42 hours
- **Tracking Tunnels**: 100 hours
- **Checking Poison**: 90 hours

*Initial implementation.*

*Follow-up work.*
7.11 DISTRIBUTING THE POISON

All bait stations were set up prior to the distribution of poison, which was carried out in one full day. Poison was checked and replenished weekly until poison takes stopped. Checks were then carried out at approximately monthly intervals.

Replacement of poison at weekly intervals, as opposed to a continual supply prevented those rats which had already consumed a lethal dose from continuing to consume baits. I.C.I. have carried out experiments with this method which they estimate as saving 75 percent of the bait requirements otherwise used with a continual bait supply (11). Also, the reduction of the amount of available baits automatically decreases the risks to non-target species, directly through the baits and indirectly through rodent carcasses containing less poison.

This 'pulsing' of baits at weekly intervals may be effective for control operations but, when eradication is the aim, especially with a high population, in my opinion supplying baits daily at least for the first week should be a consideration. This should allow most rats access to the poison before any suspicion is developed.

7.12 POISON TAKE RESULTS

For the first two weeks, the shortened bait stations (see p. 53) resulted in much weka interference. Hence the first two checks are not accurate for rat takes only. In the graphs below I have included the poison results from Awaiti Island where bait stations were the full 600 mm length.

Comparison of the two sets of results, even taking the weka interference into consideration illustrates that at the time of poisoning a much lower rodent population existed on Tawhitinui. Maximum bait takes amounted to 62 percent on Tawhitinui, of which weka interference was probably a major contributor. Awaiti had a maximum bait take of 99 percent with no weka interference.

Fig. 12. Graph showing poison take results on Tawhitinui/Awaiti Islands 1983.
7.13 POISONING OF NON-TARGET SPECIES

Wekas were the only non-target species observed to be poisoned and killed. During the first poison check, a weka was observed removing a bait from one of the stations. Weka droppings of a blue/green colour containing maize seed were also found.

Before the poison operation began, wekas were very common on Tawhitinui. After four weeks of poisoning there were no definite observations of weka presence. Subsequent visits including my latest visit to the island in August 1984, 19 months after the poison was distributed, still resulted in no definite sightings of wekas.

There was also a notable absence of wekas on Awaiti. Before the poisoning of this island in 1982, the occasional weka was seen or heard. They probably became victims from scavenging dead rat carcasses or from eating the remains of poison baits carried outside the stations by rats.

A variety of insects, in particular the common bush weta, were the only other non-target species observed to gain access to and feed on these baits. However, insects have a different blood system from mammals and are not poisoned (12). The question must be asked though, what are the risks to other animals which feed on these insects? Could a bush weta that has recently ingested some poison kill a morepork for example?

In figure 13, p. 60, I have illustrated a logical food chain through which the poison may have flown on Tawhitinui. To my knowledge, no experiments have been carried out to identify the risks or determine the concentrations of poison which may flow through a system such as that illustrated.

7.14 FOLLOW-UP WORK

The greatest problem with eradication experiments is to decide when every last rat has been exterminated.

It should not be assumed that when poison baits are no longer taken all rats have been poisoned. A variety of follow-up techniques must be experimented with to provide the evidence.

The following is a description of the follow-up work carried out on Tawhitinui Island.

(12) R.H. Taylor (pers. comm.).
Figure 13. The possible movement of poison through a food chain on Tawhitinui Island.


Until poison takes had stopped, poison was checked and replenished weekly. Following checks were carried out at approximately monthly intervals.

Baits that had deteriorated or the appeal of which was reduced, were replaced.

7.14.2 JUNE/JULY 1983 TRAPPING

8 traps were left on the island for 176 trap nights. No interference with traps or baits occurred.
7.14.3 NOVEMBER 1983 TRAPPING

13 traps set for 26 trap nights. No interference with traps or baits occurred.

7.14.4 JANUARY/FEBRUARY 1983/84 TRACKING TUNNELS

87 baited tunnels as described in section 6.5 were distributed over the track system (see figure 14, p 62). Tunnels were left for 35 days. After two weeks, all tunnels were checked, rebaited, re-inked and papers replaced as necessary.

No rat tracks were recorded during this tracking campaign.

7.14.5 FEBRUARY 1984 - REMOVAL OF ALL POISON

At the recommendation of the D.S.I.R., all poison was removed in an attempt to allow any remaining rats to build up to a detectable level.

7.14.6 AUGUST 1984 - TRACKING TUNNELS AND TRAPPING

57 baited tracking tunnels were distributed over the track system and left for one month (see figure 15, p 63). No rat tracks were recorded (13).

63 rat traps were set in 7 areas for a total of 463.5 corrected trap nights. Only one trap was sprung and no rats were trapped.

10 stoat traps were set near or in the 7 rat trapping areas, (see figure 16, p 64) for a total of 74 trap nights. No stoat or other interference was encountered during this period.

Baits used during this campaign included fish based cat food, "Chef biscats", cheese, peanut butter/rolled oats mixed and rat urine/dropping impregnated sawdust. *

* NOTE The follow-up work carried out has always been associated with careful searching for fresh rat sign.

(13) Ryan (pers. comm.).
Fig. 14. TRACKING TUNNEL LOCATION MAP
JANUARY 1984

APPROXIMATE SCALE (metres)

*=Tunnel location
Fig. 15. TRACKING TUNNEL LOCATION MAP
AUGUST 1984

APPROXIMATE SCALE (metres)

○ = Tunnel location
Fig. 16. TRAPPING LOCATION MAP AUGUST 1984

APPROXIMATE SCALE (metres)

--- Rat trap line
• Stoat trap
7.15 EXPENDITURE OF CAMPAIGN - 1982/83

The following breakdown covers the actual initial implementation costs only. The follow-up work (282 man hours) has mainly involved manpower inputs with few material costs apart from travel. However, this un-costed input will be a guideline relative to future projects.

Wages and allowances for two staff .................................................. $7361.31

Materials - pipe for bait stations ..............................................

160 m 65 mm non-perforated nova pipe ................................. $151.10
100 m 65 mm nova pipe (required for extensions of bait stations) 94.44
30 m 65 mm PVC pipe .......................................................... 85.68
1 coil No.8 wire (pegs for bait stations) .................................. 31.05
Petrol and oil (running cost of outboard motor) .......................... 163.01
Miscellaneous goods required, e.g. rope, rat traps, torches, etc. ................................. 635.45

Total expenditure - ................................................................. $8522.04
(25 kg Talon bait (donated by I.C.I. Tasman Limited) - value $166.00)

7.16 DISCUSSION OF THE TAWHITINUI CAMPAIGN

The Tawhitinui campaign has tested a relatively standard approach for what appears to have been a successful eradication campaign against ship rats on a medium sized island (21 hectares). All our attempts to detect rats since the poison operation have failed to produce evidence that rats still exist. Whether or not the follow-up work (see section 7.14) has been sufficient to give confidence that eradication has been achieved is something only time will now tell.

Valuable information has resulted from this campaign concerning the design of bait stations (see section 7.9) and the effects and possible effects of Talon W.B. (Brodifacoum) on non-target species, as was shown with the accidental poisoning of wekas. This in turn has indicated a possible method for the eradication of wekas. Weka eradication is already in operation on some island reserves on the grounds of enhancing the islands' suitability for the introduction of endangered species.
The main deficiency now apparent with the campaign has been the inadequate pre-poisoning trapping programme, which failed to give a reasonable idea of the rat population that existed before poisoning.

As P.J. Moors (NZ Wildlife Service) has found with the Noises Islands (Hauraki Gulf) campaign, against Norway rats, the Tawhitinui experiment has proved to be a highly laborious task, requiring a periodic input over a 2-3 year period. It is therefore important not to under-estimate the size of such a task. For a successful operation these aspects must be realised prior to the onset of a campaign.
SUMMARY OF DISSERTATION
Rats present problems to the resource managers in New Zealand. The survival of many rare and endangered elements of our natural history is threatened by their presence and trampling huts and other park buildings provide ideal refuges for these distasteful intruders.

For reasons of conservation and human comfort, I see benefits from resource managers being competent in the identification and detection of rats and having the ability to implement control/eradication campaigns. The Tawhitinui Island eradication experiment has emphasised this to me. While the operation was largely a D.S.I.R. initiated project, the D.S.I.R. had neither the resources nor manpower to implement such a project. The Department of Lands and Survey became an obvious source of the necessary resources and thus a valuable experiment was able to proceed.

Identifying rats in New Zealand is generally straightforward, once one is aware of what to look for. The 3 species of rat vary in their habits and habitats. For eradication campaigns this must be taken into consideration as it may in turn influence the eradication techniques employed.

The Tawhitinui campaign against ship rats employed a simple operation using only one poison, which appears to have been sufficient to achieve eradication.

To date, the only eradication campaign against Norway rats in New Zealand has been carried out on the Noises Islands by P.J. Moors of the NZ Wildlife Service. This campaign illustrated that Norway rats probably present a more difficult task than do ship rats. Moors recommends that as many methods of killing rats as possible be used and that one method alone should not be relied on (1).

Kiore eradication has not yet been tested in New Zealand. The probable reason for this is that their impact on flora and fauna is generally considered less than the other two species. More research is required to determine the true impact kiore do have.

With present techniques it appears that 75-100 hectares is the practical limit of island size that can be successfully cleared of rats (2). However, this will be influenced by factors such as location

and access to the island, the topography, vegetation thickness, the ease of movement around it, the distribution of rats and the amount of money and manpower available (3).

Rodent research must continue to be implemented throughout the country. If this is done, eradication techniques will continue to be refined and new island habitats for wildlife conservation improved or created. Similarly, regular monitoring for rodent presence on islands currently thought to be rodent free is essential, with eradication/control measures taken when necessary. This will help to ensure greater protection to the inhabitants of such refuges.

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BIBLIOGRAPHY


Innes, J. 1984: Forest Research Institute, Private Bag, Rotorua.


