The State of New Zealand's Birds 2008

Special Report

Conservation

of

Birds on the Mainland

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CONSERVATION OF BIRDS ON THE MAINLAND

Compiled and edited by Kerry-Jayne Wilson

For millions of years New Zealand's birds throve in a land where bats were the only non-marine mammals. Consequently our birds lost any defence strategies their ancestors may have had to deal with predatory mammals and the rats, cats, stoats, ferrets, and weasels introduced by humans have devastated this country's native birds. Even the mainly plant eating brush-tailed possums and pigs have had major impacts on some birds, and the herbivorous species such as deer and hares have indirectly affected birds by competing with some species for food, by killing seedlings of palatable plants, and by changing the forest structure. As on many other islands, but in contrast to the situation on continents, introduced mammals are the major threat to New Zealand's native birds. In New Zealand, introduced mammals pose a much greater and more immediate threat to most native birds than even habitat loss.

Introduction

New Zealand has a proud record in saving endangered birds. However, most of our early successes took place on small islands where birds were free from the ravages of introduced mammals. The Chatham black robin survived on a single tiny island and its rescue from the brink of extinction involved transfer to other rat-free islands. The South Island saddleback was rescued in the nick of time after ship rats invaded Big South Cape Island, its last refuge, by moving them to other islands. Decades later, the robin and the saddleback are still confined to small, mammal-free islands

For some species – certain kiwi, the wrybill, black-billed gull, black-fronted tern, and kaki (black stilt) – there are no suitable refuge islands, and these species must be managed on the mainland amongst the dangers that made them rare. For others such as kokako and takahe, islands offer only limited refuge and mainland populations are essential for their future. Although mammal-free offshore islands remain crucial to the survival of many endangered species, and they probably will always play a vital role in species management, conservation involves more than saving species on rat-free islands. Today we are also interested in the restoration of mainland ecosystems and this entails the reintroduction of some of those birds now confined to islands, in particular the seabirds that have been eliminated from the mainland.

The need to control or eradicate introduced mammals is beyond question: the debate is on how and where to do it. Put simply, the options are poisons, traps, or fences. All three are expensive, all have their limitations, and none is without controversy. Yet each has proven highly successful in allowing the return of some species to parts of their former range and have allowed significant improvements in breeding success and population increases in others. During the past decade there have been great advances in trap and fence technology, new toxins are being trialed and old poisons can now be used in smaller amounts with greater effect. This report provides an independent overview of some of these recent advances, the risks and costs associated with traps, poisons, and fences, and records some of the gains made in the conservation of birds on the North and South Islands and on the Chatham Island mainland.

The views expressed by the contributors to this report do not necessarily represent those of the Ornithological Society of New Zealand, Inc., the New Zealand Department of Conservation, or employers of contributing authors.

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The Key Findings

Introduced predatory mammals pose the greatest threat to most of the native birds that remain on the New Zealand or Chatham Island mainland.

At present, aerial application of the poison 1080 is the most cost-effective method of controlling introduced predators over large areas of rugged or remote terrain.

The use of 1080 or other poisons is not universally popular. There is often vociferous local and international opposition to its continued use.

There is widespread distrust of the Department of Conservation and other authorities responsible for the use of 1080 and other poisons. Wider consultation with *iwi* (Maori) and other interest groups could reduce the current level of distrust. There is an urgent need to promulgate unbiased information about the costs and benefits of poisons and other control methods used.

At present the reality is that continued use of 1080, or other predator control measures, will be necessary to prevent the extinction of kaki (black stilt), Chatham taiko, and, in the longer-term, wrybill and Hutton's shearwater, and the loss of various other species from the mainland, including other petrels, kaka, mohua, kokako, black-billed gull, black-fronted tern, and (on Chatham Island) the Chatham Island oystercatcher.

More effective and more humane poisons are under investigation, as are ways to achieve greater and longer-lasting reduction in predator numbers while using less poison, improved use of lures and traps in predator control, and the use of disease for the control of introduced mammals.

Trapping of introduced predatory mammals is often an, albeit more expensive, alternative to 1080 over smaller, more accessible areas.

Predator fences, with eradication of all introduced mammals within the enclosure, require a large capital investment, but where terrain allows, fencing can protect relatively large areas (up to several thousand ha) with little or no further use of poisons.

A predator fence is a good option for the protection or establishment of a seabird colony, where a relatively small area can support a viable population.

Operation Nest Egg (ONE) – in which kiwi eggs are taken from the wild parents, hatched in captivity, and the chicks raised in safe locations and then released when they are large enough to defend themselves against stoats – has enabled kiwi populations to increase in some areas and their reintroduction to places where they had become locally extinct. Although ONE is a cost effective way to protect kiwi, trapping and poisoning also provide incidental protection for other species.

Most conservation research in New Zealand is short term and deals with only the most immediate threats. Only long-term, large scale, multispecies projects such as the Eglinton Valley study can reveal the complexities of the interactions between native and introduced species. More long-term projects are required.

Control of stoats and feral cats in some habitats can allow rat numbers to increase, offsetting any conservation gains. We urgently need to find out more about predator-prey dynamics when just rats, cats, or stoats are controlled.

Predatory mammals are universal threats to mainland birds, but some species also face other threats. For example, Hutton's shearwater burrows are trampled by chamois and deer, and Chatham Island Oystercatchers lose breeding habitat to introduced marram grass. In beech forests European wasps threaten the survival of birds and other native biota.

Braided rivers are particularly challenging: they require predator control over vast areas, and weed invasion, water abstraction, power generation, and habitat loss all directly threaten several endemic birds.

Many of the management programmes reported here, including some key Department of Conservation projects, depend heavily on volunteer labour and community and corporate finance.

Projects such as the Karori Sanctuary and the Ark in the Park are important for advocacy. For many New Zealanders, visits to these management areas provide their only opportunity to see species such as hihi (stitchbird) and kaka.

This report focuses solely on birds, but the control of introduced mammals for bird conservation also benefits native plants, bats, reptiles, and invertebrates.

Birds to Watch

These birds will be lost from the mainland unless predators are controlled or eliminated from significant areas: Hutton's shearwater; sooty shearwater; grey-faced petrel; kaka (both subspecies); wrybill; kaki (black stilt); mohua (yellowhead). For all but sooty shearwater and grey-faced petrel, this would represent a major reduction in their remaining range, for the wrybill and kaki, extinction.

When predators are controlled or eliminated, most native birds can increase their range and numbers. The species that will benefit most from predator control include penguins and petrels, wrybill, banded dotterel, black-billed gull, black-fronted tern, Chatham Island oystercatcher, kaka, kea, hihi, and kokako. Some of these species may soon come (back) to a town near you.

Mammals to Watch

All introduced mammals destroy native birds or their habitats, but most damaging are the, ship rat, brush-tailed possum, stoat, feral cat, and, in river beds and open habitats, ferrets and hedgehogs. Unrestrained dogs kill many medium to large ground birds such as kiwi, penguins, and weka.

Top Left: Wild kaki/black stilts on the Tasman River, in the shadow of Aoraki/Mt Cook. Kaki, and other river bed species such as the wrybill, provide some of New Zealand's most challenging conservation problems because they do not have refuges on offshore islands. Kaki breed in the wild only where intensive trapping reduces the numbers of stoats, ferrets, cats, and hedgehogs **Photo by Abby Smith**

Above Left: Eigill Wahlberg removes a stoat (*Mustela erminea*) from a trap in the Tasman Valley Photo by **Kierston McKinley**

See articles on predator control research in the Tasman Valley, Project River Recovery, and the kaki, on pages 7 & 8

Below: View down the main valley of Karori Sanctuary towards Wellington. Situated a few minutes drive from the centre of the city, this pioneering fenced predator-exclusion zone reserve now has populations of birds not seen near Wellington in more than a century. See article on page 11

Photo by **Raewyn Empson**

Poisons: What is Good? What is Not?

CURRENT OPTIONS

There are two classes of vertebrate pesticide: anticoagulants (including pindone, diphacinone, coumatetralyl, and brodifacoum) and non-anticoagulants such as sodium cyanide, 1080 (sodium fluoroacetate), and cholecalciferol. Vertebrate pesticides are normally delivered using baits, usually cereal pellets or pastes.

Acute-acting compounds

Sodium fluoroacetate (1080) has been used for pest control since the 1950s and is the only poison commonly used for aerial control of pests. Animals receiving a lethal dose mostly die within 24 hours. The compound occurs naturally in plants native to Brazil, Africa, and Australia, where some plants have 1080 concentrations far greater than that used in possum baits: 1080 can even be present in very low concentrations in tea leaves. 1080 is converted in the vertebrate's body to fluorocitrate which inhibits energy production in the Krebs cycle. There is debate about the humaneness of 1080. It is not as humane as cyanide, but it is more humane than anticoagulants. There are polarized views on the use of 1080. Possums poisoned with 1080 are hazardous to dogs and there is no antidote. New Zealand is the only country that uses relatively large amounts of 1080: 1080 use remains under scrutiny.

Sodium cyanide is registered for possum control. Pea-sized pieces of paste are placed with some flour and icing sugar (or other lures such as cinnamon or eucalyptus oil) on a rock, leaf, or stick. Feratox® (a small cyanide pellet) was developed to increase the effectiveness of cyanide and reduce the risk to operators. The pellets are placed in a bait station with either similar-sized cereal pellets, or in a paste. Cyanide is potent and fast-acting: it is the most humane vertebrate poison. Possums poisoned by cyanide become unconscious in less than five minutes and die soon after. Opponents of 1080 favour cyanide and extending ground control. Cyanide does not cause secondary poisoning of dogs.

Cholecalciferol (vitamin D_3) was developed in the 1980s as a rat poison. In New Zealand it is registered as an alternative to 1080 for possum and rodent control because of its relatively low risk of secondary poisoning of dogs. At toxic doses this active metabolite mobilizes calcium stores resulting in calcification and death from heart failure. Birds are much less susceptible to cholecalciferol than to 1080.

Slower acting anticoagulant compounds

First-generation anticoagulant rodenticides (e.g., pindone, diphacinone, coumatetralyl), and the more toxic second-generation anticoagulants (e.g., brodifacoum) all interfere with the synthesis of blood clotting factors, which results in haemorrhage and death. First-generation anticoagulant rodenticides were developed in the 1950s and 1960s; second-generation anticoagulants in the 1970s and 1980s.

Pindone has proved most effective for rabbit control. Diphacinone is more toxic than pindone to rats and mice and here is registered primarily for field control of rodents. Diphacinone and pindone are both eliminated rapidly and do not bioaccumulate as do second-generation anticoagulants. Coumatetralyl is registered in New Zealand for rodent control and is less persistent (in sub-lethally poisoned animals) than brodifacoum, but is considerably more persistent than diphacinone.

Brodifacoum is the best known and widely-used rodenticide worldwide. It has been used to successfully eradicate rats from islands, but is also used to control possums. Field use of persistent second-generation anticoagulants such as brodifacoum has been controversial. At sub-lethal doses they accumulate in wildlife tissues. Contamination extends to native birds as well as game species when second-generation anticoagulants are used repeatedly. Brodifacoum is extremely toxic in many animals and there is a high risk of secondary poisoning to non-target species. The problems related to persistence are compounded by its being inhumane when used to control larger animals such as possums.

ALTERNATIVES TO 1080 AND BRODIFACOUM

Bio-control of vertebrate pests has been a major research focus for over 20 years in New Zealand and Australia. Despite extensive research, alternatives such as virally-vectored immunocontraception remain a challenge to implement. In response to the issues with the use of 1080 and brodifacoum, efforts are being made to introduce alternative technologies within 1-10 years. Experience gained in the introduction of cholecalciferol (Feracol®) and diphacinone (RatAbate®) for possum and rodent control and Feratox® (first registered in 1997) underpins the new intiatives.

"Improvements to old technology" presently focus on cyanide, because, in an appropriate dose and formulation as Feratox®, cyanide kills possums humanely without risk of secondary poisoning. Feratox® is now under development for control of Dama and Bennett's wallabies, and is being evaluated for ferret control.

New "low-residue" poisons - zinc phosphide and a combination of coumatetralyl and cholecalciferol – are being developed in new bait formulations. These are being registered as alternatives to 1080 and brodifacoum, respectively, and are effective for possum, rodent and rabbit control with low secondary poisoning risks and limited environmental persistence.

In parallel the registration of completely novel humane poisons e.g. para-aminopropiophenone (PAPP) – a new poison for control of stoats, has been accelerated. The toxic effects of PAPP are due to the rapid formation of methaemoglobin. High methaemoglobin levels reduce the red blood cell's ability to carry oxygen. Hypoxia and central nervous system depression precede death. Mammalian carnivores appear to be much more susceptible than birds, so PAPP potentially has some degree of target specificity. PAPP paste has the potential to become the second vertebrate pesticide product designed with humaneness as a primary consideration and the first new such compound to be developed for 30 years, and could be an important tool for stoat control and kiwi protection. PAPP is humane, not persistent, has an antidote and does not cause secondary poisoning. Looking to the future, we anticipate more, and better, control tools combining "low-residue" characteristics with humaneness.

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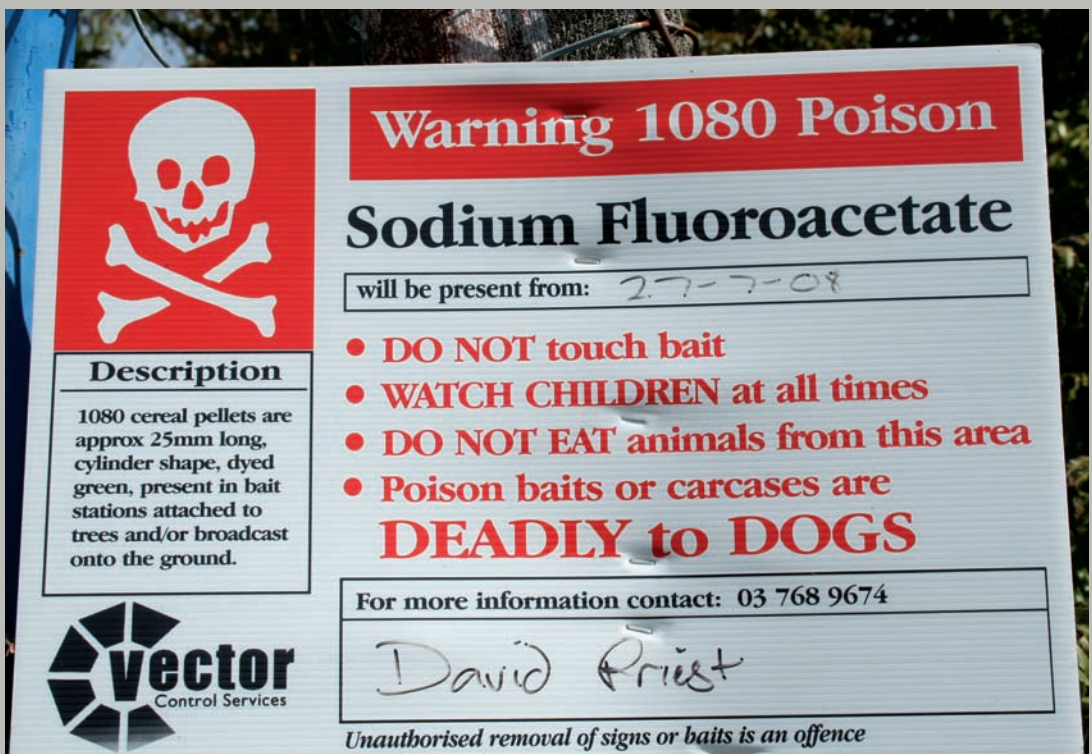

New Zealand's Forest Birds and the Use of 1080

The impact of introduced mammals on the nesting success of forest birds is illustrated by their effects on robins, kukupa (New Zealand pigeon), and kaka at sites with no predator control. Chicks successfully fledged from only 4 (12%) out of 35 North Island robin nests in Pureora Forest in 1996-97, and four (28%) of the females disappeared. Every one of 13 kukupa nests at Motatau failed at the egg stage in 1997. During the 1998/1999 summer, six of 10 kaka nests in an area of Whirinaki Forest failed and one female was killed in her nest cavity. To maintain populations of these and other forest bird species, populations of introduced mammalian predators and competitors must be reduced to very low numbers.

Above: Base station for aerial spreading of 1080 poison baits; note helicopter at top
Photo by **Ralph Powlesland**

Several methods are available, but aerial distribution of 1080 baits is the most cost-effective over large tracts of forest, especially in rugged terrain. Almost all rats, possums, stoats, and feral cats are killed. Some native birds may die too, but most survive to breed successfully and their numbers increase while mammal numbers are low.

When baits are dropped over large areas (> 10,000 ha), rat populations in the centre of the treatment area often take more than a year to recover to pre-poison levels. Possum populations may take several years to recover, but stoats can reinvade within 4-5 months. After an aerial 1080 operation in Pureora Forest in September 1996, nesting success of robins was high (72%), no females disappeared, and one year later there were 29% more robins present than prior to the poison operation. Similarly, aerial 1080 operations have benefited the survival of kiwi chicks in the Tongariro Forest Kiwi Sanctuary. Before an aerial 1080 drop in 2005/06, only 27% of 11 radio-tagged chicks survived to reach 1100 g in weight (large enough to ward off a stoat attack). However, 69% of 21 chicks survived after an aerial 1080 pest control operation the following year. In years following poisoning operations, rats and stoats may increase to levels that threaten the gains made. Sites where 1080 is used must be monitored every year to determine when further pest control will be required.

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Above Left: The South Island robin (*Petroica longipes*) benefits from pest control by 1080

Far Left: Warning sign during poisoning operation

Left: Protest sign

Photos by **Kerry-Jayne Wilson**

Kiwi Chicks Benefit from an Aerial 1080 Operation

Stoats can easily kill kiwi chicks that weigh less than 1 kg. A research project in Tongariro Forest Kiwi Sanctuary has been assessing the effect of a large-scale 1080 operation on survival of North Island brown kiwi chicks, by determining the survival rates of wild-hatched kiwi chicks before and after 1080 was spread from the air in September 2006. The operation was principally to control possum numbers, but it was done in a way that would also kill as many rats, stoats, and other mustelids as possible. Before the 1080 operation, small mammal indices were at 70% (i.e. 70% of tracking tunnels contained rat tracks). After the 1080 operation, the rat tracking index was 0.9%. The mustelid tracking index of 18.7% before the 1080 operation, dropped to 0 afterwards. In November 2007, a year after the 1080 operation, the rat tracking index had increased to 33%, and mustelid index to 8%, but both were still only half the pre-poisoning levels.

The survival rate of 11 kiwi chicks radio-tagged in the season before the 1080 operation was 27%. In the season following the poison operation, 69% of the 21 chicks monitored survived. Two seasons afterwards, 59% of 19 monitored chicks survived. These results show that the 1080 poisoning operation aimed at reducing possum numbers was extremely beneficial to the kiwi, because chicks that hatched when stoat numbers were artificially low could survive to reach a size at which they were able to defend themselves against stoats.

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Māori Perceptions of 1080

Māori, as do other New Zealanders, hold a continuum of opinion on 1080, ranging from strong support to strong opposition. Over half of Māori who made submissions to the recent Environmental Risk Management Authority (ERMA) reassessment of the use of 1080 poison stated that there was not enough consultation with *iwi* in areas where 1080 use is planned. Many submissions expressed distrust in the information provided because the relevant research is mostly done, or funded by, the organisations that use 1080.

Many of the submissions indicated that Māori believed that there was insufficient investigation into the environmental effects of 1080. Although many of the Māori submitters acknowledged that the use of 1080 was essential to control pests, the submitters hoped that alternatives to 1080 could be found.

Many Māori supported greater involvement of *iwi* in research and in pre- and post-control monitoring, with some advocating that *iwi* should be employed in these processes. Such involvement would increase Māori ownership of management plans; that in turn would enhance Māori participation and responsibility for pest control, fulfilling their *kaitiakitanga* responsibilities.

Nearly a quarter of submissions indicated a perception that the aerial applications of 1080 reduce cultural values, especially of the *mauri* and *wairua* of people, animals, rivers, trees, mountains, forests, land, and seas. This was seen to be especially important in *wāhi tapu* and *mahinga kai* areas. The death of non-target *taonga* species was of particular concern.

To local *iwi* the most economic method of pest control – aerial application of 1080 – is not always the most culturally appropriate. Preference was for other more expensive but more suitable methods, such as ground baiting, to be used. This would allow greater precision in the use of the poison, which would help to reduce concerns about the effects this toxin has on the environment. The way 1080 is used at the moment restricts customary practices. Many of these concerns are also shared by many other New Zealanders.

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Above Left: Female kea (*Nestor notabilis*), a juvenile (with yellow cere and eye ring) from her first brood, and a second clutch, in her nest cavity in South Okarito Forest Photo by **Francesca Cunninghame and Brent Barrett**
Above: Stoat (*Mustela erminea*) trap, a common sight on forest tracks today Inset: Double set trap for stoats. Photos by **Kerry-Jayne Wilson**

1080 and Kea

A recent preliminary study showed that different aerial 1080 drops have had different effects on kea numbers; it is therefore unclear what net effect aerial 1080 baiting has on the parrots. Aerially-spread 1080 may allow kea numbers to increase by removing nest predators such as stoats and possums. Conversely, kea are more likely than other birds to be directly poisoned by the baits because they forage on the ground, investigate novel objects, and try novel foods. A new research programme funded by the Department of Conservation, the Kea Conservation Trust, and the Animal Health Board is aimed at resolving these possibilities. The programme entails intensive monitoring of individual kea as well as long-term counts of kea at sites where 1080 poison is, and is not, used.

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Recent Advances In Stoat Control

Stoats pose a major threat to many native birds but until recently their control has proven problematic. More effective baits, lures, and traps have now been developed. Researcher-friendly tracking tunnels have been designed for monitoring the presence and abundance of stoats. A new humane toxin (para-aminopropiophenone, "PAPP") has been formulated for killing stoats and feral cats and field trials are underway. The rates at which stoats can return to islands from which they have been eliminated are now known, and they have been eradicated from two large islands, Anchor and Secretary, in Fiordland. The ecology of stoats in previously little-studied habitats such as alpine and braided river valleys has been investigated: unsurprisingly, results show that stoats kill birds in these areas too. Unfortunately, in some forests, the dynamics of the interactions between stoats and rats have been found to mean that trapping stoats can lead to higher rat populations.

Possible variations in the specifications for large-scale aerial 1080 poisoning operations are being tested, with a view to optimising the control of stoats in large areas by enhancing the kill of stoats by secondary poisoning.

Stoat diseases, stoat reproductive biology, and ways to disrupt the latter have been studied. In the longer-term, these mayresult in new ways to effectively control the populations of stoats.

Stoats can be managed in most areas but control is expensive. Most current research is aimed at finding cost-effective methods of stoat control.

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Right: Eigill Wahlberg checking a predator trap in winter in the Tasman Valley
Photo by **Simon Stevenson**

Developing Predator Control Strategies for the Protection of Kokako

The number of breeding pairs of kokako has more than doubled from about 350 in 1989 to an estimated 770 in 2008. Most of these are in mainland populations exposed to the full suite of introduced mammals. The strategy for restoring kokako populations is to reduce ship rats and possums populations to low levels in largish (>500 ha) forest areas when nesting is about to start. Stoat control is regarded as helpful, but not necessary for recovery. The target indicators of abundance for possums and ship rats that will allow kokako numbers to recover are 1% trap-catch (for possums) and 1% tracking index (for rats) at 1 November, when kokako nesting begins.

Post-control indices below 5% for rats or possums are acceptable; higher values for either species means the operation failed. These levels were derived from results of an eight-year adaptive management programme undertaken in three central North Island study sites (Mapara, Kaharoa, Rotoehu). Subsequently, modelling suggested that kokako populations should increase if pests are controlled during at least three of every 10 years; of course, more often is better. Predator control should be done in pulses of at least 2-3 years in succession to avoid single poor years when few breeding attempts are made.

The overall strategy is no longer being refined by detailed research, but all kokako populations are counted at 1-4 year intervals to monitor progress. The affordable scale of annual control of ship rats is the current factor limiting kokako recovery. We are unsure when and how 'carrying capacity' factors might limit kokako demography, but, presumably, eventually predator control can be scaled back.

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Above: *Raoulia* cushionfield, Tasman Valley, Mount Cook/Aoraki National Park
Photo by **Chris Woolmore**

Left: Simon Stevenson removes a ferret (*Mustela putorius*) from a Fenn trap
Photo by **Dean Nelson**

Tasman Valley Predator Control Research

The Tasman Valley predator control project involves an area of c. 25,000 ha, of which about 45% is riverbed or river flats. These are relatively unmodified and the valley contains one of the best examples of braided river habitat left in New Zealand. At least 22 nationally threatened species are known from the study site.

The research project was set up under the umbrella of the kaki (black stilt) recovery programme. Its particular goal is, however, to see if predation rates can be reduced to levels that will allow a range of of bird, lizard, and invertebrate species to maintain either stable, high populations, or historically low populations to increase. The project is now in the fourth year of its projected five years.

Of its arsenal of nearly 1,300 traps, 773 kill traps – Mk VI Fenns, DOC 250s, Twizel cat traps (a modification to the Conibear trap, developed locally as a solution to problems of ground-based trapping) – are deployed throughout the year.In addition, if possible, one of seven blocks of leg-hold traps (mainly soft-jaw Victors, but some cage traps) is opened for 10 days each month. Target species include stoats, ferrets, weasels, cats, hedgehogs, and possums.

The effects of the trapping programme are gauged by assessing the breeding success and populations of several species, especially the black-fronted tern, banded dotterel, and wrybill. The data analysis will be completed at the end of the project, but higher breeding success has already been recorded for target species, particularly banded dotterels and wrybills.

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Above: Two feral cats (*Felis catus*) caught in a Double Conibear trap
Photo by **Eigell Wahlberg**

Above Left: A female wrybill (*Anarhynchus frontalis*), at nest with two eggs. *Above Right*: The braided bed of the Godley River delta, breeding site of wrybill, kaki, banded dotterel, and other endemic species. *Above Far Right*: The banded dotterel (*Charadrius bicinctus*), another riverbed and coastal bird which is vulnerable to predation by stoats, ferrets, cats, and hedgehogs Photos by **Dave Murray, DoC, Twizel**

Project River Recovery

Project River Recovery (PRR) is an ecological management and research programme run by the Department of Conservation (DOC) and financed by Meridian Energy Ltd under a compensatory funding agreement. The project was established in 1991 in recognition of the adverse effects that hydroelectric power developments have had on braided rivers and wetlands and their biotas in the upper Waitaki Basin. It aims to maintain the quality and integrity of braided river and wetland ecosystems, by preserving and restoring these habitats, increasing understanding of the ecology of important riverbed plants and animals, and sharing knowledge of braided river ecosystems with schools, universities, and the New Zealand public. Globally, braided rivers are unusual. Those in New Zealand support a unique assemblage of birds, invertebrates, and plants.

Several threatened birds, including wrybill, banded dotterel, kaki (black stilt), black-fronted tern, and black-billed gull, rely on braided rivers for breeding and feeding for at least part of the year. Predation by introduced mammals and loss of habitat by weed encroachment are two key factors effecting the long-term decline of these riverbed birds.

Managing the weeds encroaching on the riverbeds has been a priority for the project over the past 17 years. Invasive vegetation is being managed on 35,000 ha of braided river habitat by targeted removal of problem weeds before they become widespread. Large areas of habitat are being maintained in a near-pristine condition. Other areas have been improved by removing deep-rooting woody shrubs and trees which affect the hydrodynamics? function and braid morphology in these rivers.

In the late 1990s, definitive video evidence was obtained of predatory mammals killing significant numbers of black-fronted terns and banded dotterels in the upper Waitaki Catchment. Feral cats, ferrets, and hedgehogs were identified as being responsible for most bird deaths. With the cause of the decline in wading bird populations in the upper Waitaki then being clear, large-scale management of the predators could be undertaken.

Effective predator control strategies for protecting riverbed birds are been sought throughout the country, so far with little success. The latest initiative is an extensive, year-round, catchment-scale trapping programme in the Tasman Valley.

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Kaki/Black Stilt – Does it have a Future?

Bird-life International include the kaki or black stilt in its '*Rare Birds Yearbook 2008'* list of the world's 189 most endangered birds. Unlike most of New Zealand's other endangered birds, there are no predator-free islands that can provide a safe refuge for kaki. Their numbers must recover in the Mackenzie Basin, exposed to all the threats that made them rare,- and for braided river species that list is long: introduced predators; loss of wetland and river habitats; weed invasion; and many other human-induced pressures – or nowhere.

Two main factors limit population growth in kaki: adult mortality and failure in recruitment. The kaki recovery programme has focused on these factors by breeding large numbers (currently *c.*100 annually) of juveniles in captivity and releasing them into suitable habitat.

Emphasis is now shifting to the next phase of the recovery programme: effective management of kaki in the wild. The Tasman Valley predator control project (see preceding section) was to undertake research on effective ways to control predators over large areas of riverbed.

There is no doubt that, without management, kaki would now be extinct in the wild, but its future is now looking brighter. The wild population has almost trebled since 1999, with currently 80-90 birds as against 33 in 1999, and with 20 productive breeding pairs, (only four in 1999). Kaki live in a challenging and complex environment and there is no easy way to remove or lessen the threats to their existence. Management that will allow the kaki population to continue increasing will be have to be sustained for many years and will require a range of measures to manage the variety of threats.

Left: Sub-adult kaki (*Himantopus novaezelandiae*) feeding from a dish, while undergoing "soft release" to the wild feeding from a dish, while undergoing "soft release" to the wild

Photo by **Dean Nelson**

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Above Right: A pair of North Island kokako (*Callaeas wilsoni*) in the forest at Boundary Stream Mainland Island Photo by **XXXXXX**

Boundary Stream Mainland Island

Boundary Stream Mainland Island consists of *c.*800 ha of lowland podocarp-broadleaf forest at 300 -1000 m above sea level. The complexity of the landscape provides a complex series of habitats for native wildlife.

The first control of pest species in the area was an aerial application of aerial 1080 in 1996. Since then, pest populations have been maintained at very low levels throughout the year by shooting (ungulates), trapping (mustelids, and cats) and poison bait stations (possums and rodents). Currently, over 1,200 mustelid traps are set at 100 m spacing and 943 bait stations (baited with RatAbate) are maintained in a 150 m × 75 m grid.

Intensive pest control has contributed to the dramatic recovery of resident birds including tui, kereru (New Zealand pigeon), rifleman, whitehead, and other taxa such as weta, and yellow- flowered mistletoe. There have also been significant increases in the density of seedlings, saplings, and the understorey vegetation in general. In fact, bird numbers have recovered so well that rifleman and whitehead have been transferred from Boundary Stream to establish new populations in another protected area. Species that were formerly present, such as North Island robin, kokako, and brown kiwi have been re-established successfully and are now breeding. At least 20 kokako are now present and at least 25 kiwi, and 53% of juvenile kiwi reach the 1000 g body weight that will allow them to avoid being killed by predators.

Above: Aerial view of Boundary Stream Mainland Island, from the north: forest on a rugged limestone landscape

Below: Charlie King (Ngati Pahauwera kaumatua) and Sarah King (DoC) return kokako to Boundary Stream after a century's absence

Photos by **DoC, Hawkes Bay**

Some re-introduction and pest control techniques have been developed at Boundary Stream. In addition, we have learned that pests must be controlled in the area surrounding the reserve to ensure that the native species in unfenced forest remnants are protected. We will continue to improve our management methods aimed at overcoming constant reinvasion of the unfenced reserve by pests, so that we can successfully re-introduce other vulnerable species.

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Rotoiti Nature Recovery Project

The initial goal of the Rotoiti Nature Recovery Project (RNRP), one of the Department of Conservation's (DOC) mainland islands, when it began in 1997 was the "Restoration of a beech forest community with emphasis on the honey dew cycle". Progress has been made despite the huge increases in predator numbers during beech mast years (when the trees seed heavily and provide abundant food for rodents). RNRP is supported by a community group called Friends of Rotoiti: its members and DOC personnel maintain 116 km of stoat trap lines. The low current population density of possums has been achieved by the use of toxins in the early stages of the project, and maintained by using kill traps.

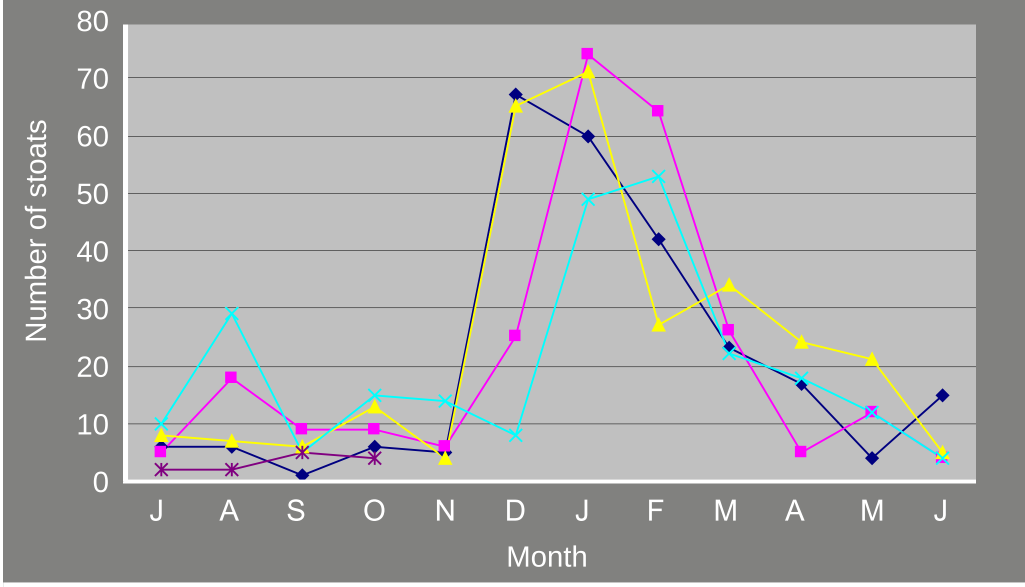
Rodents continue to be a problem. Their populations were controlled to some extent by Brodifacoum in bait stations, but since the toxin has been withdrawn from use on the mainland, control measures, either by traps or 1080 in bait stations, have been less effective. During the 2008/09 summer we conducted a three-week trial of Rat Abate (diphacinone) paste in bait stations. It was a beech mast season, so we are expecting rodent numbers to rise steeply over the next 12 months.

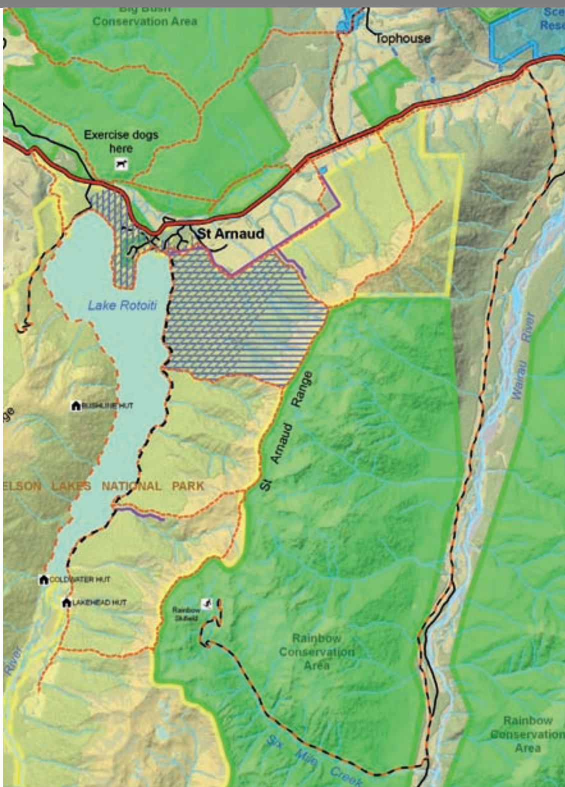
Introduced wasps have been controlled every year, when fiprinol has been used under a Landcare Research experimental-use permit. Legal issues mean that this toxin may not be available in the future, so an alternative will have to be found quickly.

When the initial RNRP core area was increased to include part of Big Bush, the nesting success of kaka in Big Bush increased to 65%, against only 10% at monitored non-controlled sites. Kaka tend to breed most successfully in beech mast years, but then predator numbers also increase. Populations of smaller birds such South Island robins and tomtits increased when rodent numbers were held below a 5% tracking index, but when rodent populations increased above this level bird numbers declined again. Managing rodents at sufficiently low population levels without expending large amounts on manpower and resources is probably our biggest challenge.

Seven pairs of great spotted kiwi were liberated in the RNRP area during 2004 and 2006. Most of these have settled in well, with only one female lost to a flood, and none is known to have been killed by predators. Four chicks have been hatched so far, but because only three females have bred, the gene pool will remain restricted unless we continue to bring in birds from elsewhere. We plan to take up to 14 great spotted kiwi eggs from populations in the Gouland Downs area over the next four years, hatch them at the Willowbank Wildlife Reserve (Christchurch) and then release the chicks in the RNRP when they are large enough to resist predators. This should ensure a robust breeding population of young birds, and expand the gene pool in the short term. We would still need to introduce at least two new birds to the RNRP area every decade to maintain genetic diversity.

Figure 1: The number of stoats (Mustela erminea) caught during predator trapping operations in the Rotoiti Nature Recovery Project. ♦, 2004/2005; ■, 2005/2006; ▲, 2006/2007; ×, 2007/2008; ∗, 2008/2009





Below: Predator control in the Rotoiti Nature Recovery Project. Diagonal bars, wasp control; vertical bars, *Friends of Rotoiti* rat control; horizontal bars, DoC rat control; long red dashes, *Friends of Rotoiti* mustelid control; short red dashes, DoC mustelid control; short black dashes, cat control; dark green, Conservation Park; light green, Stewardship Area; yellow, National Park; blue, Reserve
Map: **Tammy Bruce, DoC, Nelson Lakes**

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Left: "Marama", the most recent great spotted kiwi (*Apteryx haastii*) chick hatched in the Rotoiti Nature Recovery Project, February 2008 Photo by **Paul Gasson**

Right: New chimney type cat trap that contains two Belisle traps
Photo by**Tammy Bruce**

The Ark in the Park: a Community Initiative

A century after extensive logging and farming in the Waitakere Ranges on the western edge of Auckland city forest regeneration was well advanced, 17,000 ha had been purchased for public use but only 12 species of the original fauna of native forest birds had survived. Capitalising on a possum control programme in 1997 that included the whole area, Forest and Bird, in partnership with the Auckland Regional Council, started a programme to control several predator species and this now operates over 1,100 ha. In addition, the project has supported or inspired an "Arkipelago" of other sanctuaries in the Waitakere Ranges, which total another 1,000 ha.

Whiteheads, robins, and hihi, which have all been missing from the Ranges for over 120 years, have been released and all these species have bred successfully in their new home. The species that were still present in 1997 have all increased in abundance: for example, in some managed areas tomtit numbers are now six times and ruru (morepork) numbers twice those in non-managed sites in the Waitakere Ranges.

Of particular interest is the successful reintroduction of hihi, a species which until recently survived only on Little Barrier Island. The first 59 hihi were released in 2007, and another 51 in 2008. By the end of November 2008, four broods had fledged with the prospect of more this season.

The increased numbers of birds and survival of vulnerable species has only been possible with continued predator control. Volunteers check mustelid traps every one to four weeks and they also maintain an intensive, 100 m × 50 m grid, of bait stations containing brodifacoum. Some cat trapping is also done. The greater the area where predator numbers are controlled, the safer is the inner core area for birds and other wildlife, because reinvasion of that area by predators is minimised. By placing bait in sealed bags and measuring uptake during past cycles, we found we need now use only one sixth of the bait in each bait station than was used when we started in 2003. Rodent numbers are maintained below a 5% tracking index. Because introduced wasps reduce invertebrate numbers which limits the populations of insectivorous birds, wasp control is our next challenge.

Each month volunteers contribute over 600 hours of their time to the project. It has been funded by the Waitakere and Portage Licensing Trusts, ASB Trust, Auckland Zoo, Birdlife, and many donations.

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Karori, Sanctuary in the City

In 1999, Wellington's Karori Sanctuary made a major breakthrough by returning several bird species to the New Zealand mainland after absences of over 100 years. Key to its success was the development of a specially-designed predator fence, coupled with the simultaneous eradication of 13 species of introduced mammals from the fenced area. At the time this was the largest ever single-operation eradication. The fence and predator eradication created a 225 ha predator-free refuge of regenerating forest and wetlands at the edge of the city.

Since the fence was completed, 15 locally or nationally-endangered species have been reintroduced, including hihi, North Island saddleback, and little spotted kiwi. Not only did this provide the first conclusive evidence that a fenced mainland sanctuary could be effective, but it also marked a major improvement in the accessibility and visibility of these birds to the general public. Brown teal, weka, kaka, robin, whitehead, and bellbird have also been reintroduced successfully, which has almost doubled native bird diversity in Wellington in less than five years.

The conservation gains of of the Karori sanctuary's success have been far-reaching. To date no fewer than14 fenced sanctuaries have been established or planned around New Zealand, and the idea has attracted interest from as far afield as Japan and Hawaii.

Although the fence has been breached several times, its effectiveness, in conjunction with a range of biosecurity measures, has exceeded all expectations. Ten years on, the Sanctuary is still free of pest mammals apart from mice.

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Top: The Waitakere Ranges Ark in the Park. Its rugged terrain poses problems for pest control operations. The yellow line indicates the boundary of the reserved area
Photo by **Sumich Family**

Below: Karori Sanctuary is minutes away from downtown Wellington and home. The pioneering predator-proof fence encloses a different world where rare and endangered birds are accessible to city dwellers
Photo: **Karori Sanctuary**

Fences For Seabirds

Petrels and other seabirds once bred in huge numbers on the New Zealand and Chatham mainlands but, thanks to introduced mammals, only a few small colonies remain. Predator fences are a logical solution for the protection of some surviving colonies and for allowing the establishment of new colonies. As the birds come ashore only to nest and most species can nest at high densities, even a small area can support a viable colony. For petrels in particular, cliff-top locations are ideal. At some locations a semi-circle of fence tied off at either end on sheer cliffs is all that is required. As the birds leave chicks alone at the nest for days at a time and at small colonies a single stoat can destroy all that season's chicks overnight, predators must be excluded: control does not work. On the Chatham Islands, the critically endangered Chatham petrel is now breeding in a fenced area on Pitt Island and chicks of both this species and the even rarer taiko are being moved to a hilltop on Chatham Island fenced to exclude predators.

In Taranaki, a predator exclusion fence protects one of the last grey-faced petrel colonies in that region. Again, only 550 m of fence was required to protect 35 ha on Nicks Head Station near Gisborne. Mammals were eliminated from the fenced area, a solar-powered sound system playing petrel calls was established and soon grey-faced petrels and fluttering shearwaters were visiting the site. At Stony Bay on Banks Peninsula the farmer, Mark Armstrong, fenced one of the last sooty shearwater colonies remaining on the Peninsula. When the fence was built in 1998 only a single pair bred; in the 2008/09 season that had risen to 20 breeding pairs.

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Penguins at Flea Bay: Conservation by the landowners

The white-flippered form of the blue penguin is unique to Canterbury. Their mainland colonies have declined markedly, some to local extinction, in recent years, yet at Pohatu/Flea Bay, Banks Peninsula, their population grew at 5% per year between 2000 and 2004. This growth has continued: 893 nests were counted in 2004 and 1063 in 2008. The penguins breed in grazed shrubland, on farmland, and in regenerating forest, and most nest on private farmland.

The main threats are predation by ferrets, cats, and stoats, and tunnel erosion of the steep land. Trapping of predators began in 1991. For the first 10 years we did all the trapping, until additional traplines were established by the Department of Conservation. In recent years Environment Canterbury and the Christchurch City Council have assisted with monitoring traplines.

The initial trapping strategy was to employ traplines in the colony itself plus lines along the coast, and along waterways, fence-lines, and tracks. We now operate additional traplines extending to the ridgeline between Flea Bay and Akaroa to try and intercept predators before they reach the penguins. The trapping effort means that few predators are now caught in the penguin colony itself.

The nesting habitat is grazed by sheep to control rank exotic grasses. Rodents thrive in long grass and they provide food for mustelids. Over 200 nest boxes have been provided to augment the number of natural burrows. We monitor breeding success at 130 nests and keep full records of the predators killed.

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Top Left: This predator-proof fence at Stony Bay, Banks Peninsula, was built by the landowner at his own expense, and it has saved one of Canterbury's last mainland breeding colonies of sooty shearwater (*Puffinus griseus*)

Left: New colonies of two species of critically endangered seabirds, the Chatham petrel (*Pterodroma axillaris*) and Chatham taiko (*Pterodroma magentae*) will be protected by this predator-proof fence on Chatham Island

Photos by **Kerry-Jayne Wilson**

Hutton's shearwater: Management of a Mainland-Breeding Petrel

Hutton's shearwater now breeds at only two colonies, both at high altitude in the Seaward Kaikoura Ranges. Current estimates are that the total population is of more than 400,000 birds occupy a colony at Kowhai Stream and a much smaller colony on private land at Shearwater Stream. Research in the late 1990s at Kowhai Stream showed that although stoats preyed on some chicks and a few adults this was not sufficient to cause the population to decline. The colony was considered to be so large that the few stoats present could not make a significant impact. More significant threats were thought to be trampling of burrows by deer and chamois and the possibility that pigs could colonise the Kowhai Stream and prey directly on the birds. Pigs may have been responsible for destroying other, more accessible, colonies in recent years.

Current research is showing that breeding success is much lower at Shearwater Stream. It is possible that this smaller colony is less able to withstand predation by stoats. Intensive trapping at this colony, measurement of any improvement of breeding success, and comparison with the Kowhai colony, should clarify whether stoats are seriously affecting this colony. This attempt to control stoats in a very steep, alpine environment is going to be a novel challenge.

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Above: View north into the headwaters of the Kowhai River, Seaward Kaikoura Range, where most of the world population of Hutton's shearwater (*Puffinus huttoni*) breed.

Below: Hutton's shearwater return to their colonies in September each year, and can locate their burrows even under deep, late snow

Photos by **Richard Cuthbert**

Grey-faced Petrels at Mount Maunganui

Grey-faced petrels breed in the Mount Maunganui Historic Reserve, on the slopes of Mauao, colloquially known as The Mount, with another colony on nearby Motuotau Island. Waikato Region of the Ornithological Society of New Zealand began a study of these two colonies in 1991. Work on Motuotau Island was discontinued in the 2000/01 breeding year, but on Mauao the project is now in its 18th year. Birds are monitored by volunteers, and their efforts are supported enthusiastically by the Department of Conservation, the Tauranga City Council, and Environment Bay of Plenty. These organisations have, at times, all been involved in, or responsible for, the predator control programme at Mauao.

Adults and chicks have been banded at both sites: 3,316 adults and 818 chicks on Motuotau Island; 2,191 adults and 320 chicks on Mauao.

Motuotau Island is normally free of predatory mammals. By contrast, Mauao can be reached by all the species of predator which exist on the mainland. The main predators of petrel eggs and chicks are believed to be rats and stoats. For the four years from 1993/1994 to 1996/97, burrows were monitored at both sites throughout the breeding season. In the first two years, >70% of chicks on Mauao were lost between hatching and fledging. Predators were controlled there during the next two years, during which losses were <20%, which were broadly similar to those on predator-free Motuotau Island. The encouraging increase in breeding success led to predators being controlled at Mauao in every subsequent breeding season.

During the current breeding season (2008-9), the Tauranga Branch of the Forest & Bird Protection Society has maintained additional bait stations near the summit of Mauao. Anecdotally, the bait take has been substantial, but all known chicks in the artificial burrows have survived so far to near-fledging.

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Chatham Island Oystercatcher

The Chatham Island oystercatcher is an endangered species whose population is scattered sparsely around the coast of the Chatham Islands. Low fledging success has kept the population small, and only 142 birds were found in 1998. Predators, particularly feral cats, eat oystercatcher eggs and chicks. Wave surges also wash nests away, and this problem has been exacerbated by the introduction and spread of marram, a grass which creates steep-fronted and densely vegetated dunes. The formerly sparse cover of native dune plants may have created a more favourable nesting environment. Farm stock also trample eggs and chicks; all these factors reduced annual production to <0.5 chicks per pair.

Intensive management, especially control of predators such as cats, was undertaken by the Department of Conservation along 16 km of the northern coast of Chatham Island between 1998 and 2004 in an effort to boost the oystercatcher population. Leg-hold traps were used at first to catch cats, but they also caught blue penguins, harriers, and two adult oystercatchers, so cage traps were used more. Damage by stock was controlled by erecting permanent fences in some areas and using portable electric fences around nests in others. Losses to waves were limited by moving, or raising, nests away from the high tide level, often into sprayed alcoves in the marram-covered dune.

These remedies allowed the annual productivity of oystercatchers to double, and the population rapidly increased, as young birds started breeding at 2-5 years of age (adults can live into their 30s). Colour-banded birds and an annual census allowed the population to be monitored, and by 2004 there were >300 birds, including 89 pairs. The total population appeared to level off in 2006 when productivity was low, yet ongoing recruitment of young birds into the breeding population resulted in 109 pairs present that year. The next full census is planned for 2010 when a decision about the continuation or rotation of management areas will be made.

Conservation work to help the Chatham Island oystercatcher has been a resounding success. However, because there are still fewer than 250 mature individuals, the species remains 'nationally critical' and remains a high priority for conservation management.

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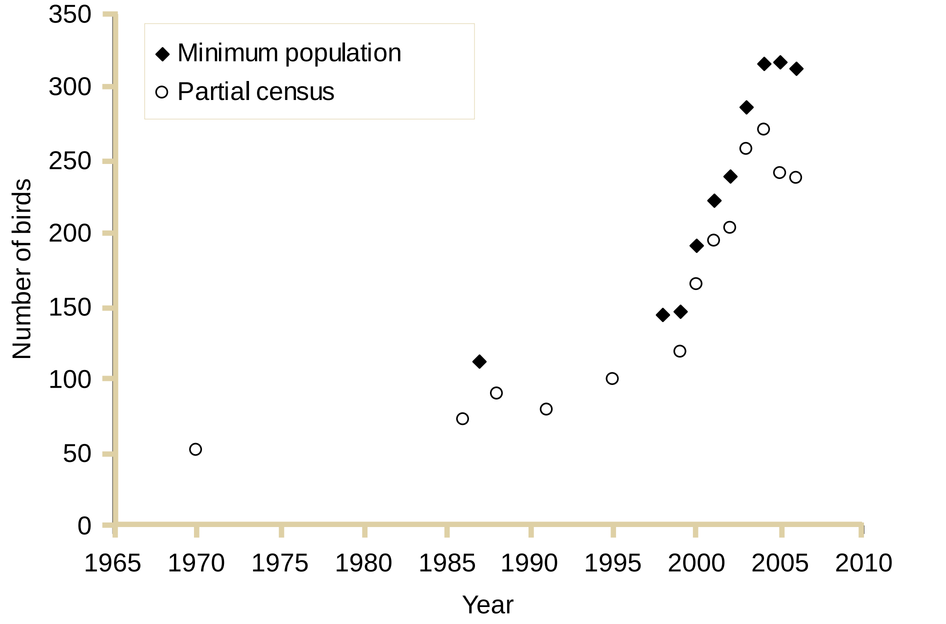
Figure 2: The number of Chatham Island oystercatchers counted during partial censuses (open circles) and minimum population estimates (solid diamonds), 1970–2006



Below Left: Adult Chatham Island oystercatcher (*Haematopus chathamensis*)
Photo by **Peter Moore**

Below Right: Wild cat (*Felis catus*) eating eggs of endangered Chatham Island oystercatcher
Image from infrared video recording: **Peter Moore**

Measuring the Long-Term Response of Multiple Threatened Species to Predator Control in Fiordland Beech Forest

In the 1980s researchers noticed that many forest birds were rarer than previously thought. The mohua (yellowhead) had, for example, vanished from 97% of its former range. A research programme was set up to see what was causing the declines. For mohua in South Island beech forests, we found that 50% of breeding females were killed in years when there were many stoats in the forests. The populations of stoats, mice, and sometimes ship rats, irrupt (increase dramatically) in the summer following a heavy beech seed fall, which happens usually every 2-6 years. The high numbers of predators kill many more forest birds. Computer simulation models that predict what would happen in the long term to bird populations should these high predation rates continue indicated that it was highly likely species such as mohua and kaka would be exterminated.

Since 1990, we have monitored populations of a range of threatened bird species in beech forest in the Eglinton Valley, Fiordland, to investigate their responses to fluctuating numbers of predators and to our predator control experiments. The Eglinton Valley contains about 8,000 ha of mixed-species beech forest. Initially, we concentrated our monitoring and research on possible causes of the decline of mohua, yellow-crowned parakeet, kaka, and bats.

Initially, research indicated that mohua should be able to recover well after a season of heavy predation. They laid large clutches and could nest twice in each breeding season. They were also long-lived, with the oldest banded bird at least 16 years old, and three or four others were at least 12 years old. The nesting success of mohua in areas trapped for stoats was much higher than in un-trapped areas: 80% of the nests in the trapped area fledged young, twice the rate in the un-trapped area. However, we did not predict that rat plagues, which appear to be rarer events, also result in many more birds being killed and when a rat plague spanned two breeding seasons and the intervening winter (1999-2001), mohua numbers dropped by over 90%. Mohua completely disappeared from the central Eglinton Valley. In hindsight, it seems likely that such large irruptions of rats had occurred regularly, though infrequently, in the past.

We have gradually expanded the research programme to include work on the costs and benefits of a range of pest control methods for several forest and wetland species, including the South Island robin, tomtit, morepork, and black-fronted tern.

We started to control stoat numbers in the Eglinton Valley in 1998 and in 2006 began to experiment with the control of rats in smaller study areas . We use kaka as an indicator of the success of stoat control, largely because ship rats seem not to prey upon them. All breeding attempts and the survival of birds carrying radio-transmitters have been monitored since 1998. With protection, 80% of kaka nests have been successful and female annual survival has been 98%. This means that their life expectancy is now 45 years, 3-15× higher than for birds in unmanaged sites (where it is only 3-15 years) and where the populations are declining. Stoats can still catch fledgling kaka after they leave the nest because they spend long periods sitting on the ground. After three breeding seasons, 19% of fledglings had died this way. In areas where only stoats are a problem, such as the silver beech forests of the Landsborough Valley, mohua numbers have also responded well to stoat trapping. Since trapping started in the Landsborough, standard 5-minute bird count indices of mohua numbers have quadrupled and are still increasing.

Much of our research is now focused on developing effective ways to control ship rats. For example, we are working on their ecology in beech forests, which toxins and delivery systems should be used to control ship rats, the best dispersal pattern for bait stations, and the optimum timing of control measures. From this perspective the Eglinton Valley is just one of a network of sites throughout the country where complementary trials are under.

So far we have used robins and bats as indicators of the success of rat control experiments. To date, results have been equivocal. Although we have achieved good reductions in rat numbers (<50%) using toxins in bait stations, their numbers seem to increase almost immediately by re-invasion from surrounding forest. Within three months numbers can return to pre-control levels. This is a particular problem for cavity-nesting birds such as robins that have long breeding seasons (late July to early January in the Eglinton Valley). They nest in holes with one entrance, so they usually cannot escape a predator. Only half of robin fledglings survive to three weeks because most are eaten by mammals or birds such as morepork. After three weeks, many disperse widely, outside areas where predators are controlled. Overall, robin numbers appear to be declining very slowly, despite their ability to breed prolifically.

The research is continuing. So far we have developed techniques that have improved our ability to predict (by monitoring beech seed fall and rodent numbers) years when predators will destroy most birds. The efficiency of stoat control has improved significantly as a result of experiments on different baits and lures, trapping layouts, and new toxins. Pest control efforts which were limited to areas as small as 50 ha in the early 1990s have been expanded to the more than 4000 ha where stoat numbers are controlled today. Several major challenges remain, particularly finding effective control techniques for rats over large areas of beech forest, and developing fully-integrated methods of controlling a range of pest species. The programme also highlights the value of long term monitoring studies because we have identified different factors that at different times over the past 20 years have influenced the long-term viability of bird populations.

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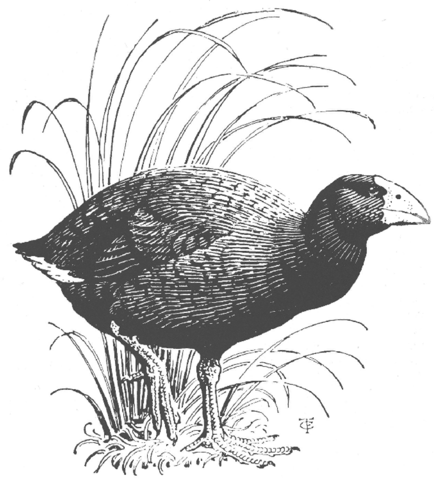

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www.arkinthepark.org.nz
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The future is looking brighter for the critically-endangered Chatham Island oystercatcher (*Haematopus chathamensis*). With control of cat and rat populations and management of its breeding sites, its population has more than doubled since 1988, but the population is still tiny. Only ongoing careful management will ensure its survival

Photo by **Peter Moore**

The North Island kokako (*Callaeas wilsoni*) is a conservation management success story, but its recent history also shows that managers cannot relax their efforts if it is to survive into the 22nd century

Photo by **Rogan Colbourne**

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