Early ecological research on rodents in New Zealand: personal recollections

Rowley Taylor

Ecological research into rodents in New Zealand commenced in the late 1940's with the creation of the Animal Ecology Section, Department of Scientific and Industrial Research. Field surveys of rodents were backed by study skins and skeletal material. These collections accrued over the next 40 years from animals sent in by the Wildlife Service, museums and the public. This laid the foundation of our present knowledge of rodent distribution.

In 1951, J.S. Watson joined the DSIR from the Bureau of Animal Population, Oxford, and brought much needed experience in rodent biology and control - gained on the London Docks and in the Middle East. Publications followed on the identification, distribution and interrelations of rodents with native fauna, but such research waned temporarily following his death in 1959.

In the early 1960's, Forest & Bird Protection Society members and the Wildlife Service used pre-packaged warfarin baits to control rats on small islands in the Hauraki Gulf and the Marlborough Sounds, but the full significance of these operations was not understood for many years, it being widely held that complete extermination of rats was impossible.

The 1964 ship rat invasion of Big South Cape Island and the extinction of several species of endemic vertebrates sent shock waves through conservation circles. This disaster led to an increased interest in the ecology of rodents and their impact on native species. The mid 1960's saw the start of intensive research into Norway and ship rats.

The next decade was one of intensified rodent research culminating in the historic 1976 symposium on the *Ecology and Control of Rodents in New Zealand Nature Reserves*. This further boosted interest in rodent distribution, food habits, reproduction, dispersal ability, interspecific competition, interactions with other species - and the steady development of eradication techniques now employed worldwide.

The legacy of Big South Cape: rat irruption to rat eradication

Brian D. Bell, Elizabeth A. Bell, Don Merton

Wildlife Management International Ltd., PO Box 607, Blenheim 7240, New Zealand

Big South Cape (Taukihepa) is an offshore island on the southwest coast of Stewart Island. This island was rat-free until the incursion of ship rats (*Rattus rattus*) in 1964; suspected to have been accidentally introduced via local fishing boats used to transport the mutton birders to the island. This incursion was reported by the mutton birders – local Iwi who culturally harvest sooty shearwaters (*Puffinus griseus*) – to the then New Zealand Wildlife Service. Investigation into the reports found ship rats had reached the island and decimated the local land bird populations. Brian Bell and Don Merton attempted translocations of South Island saddleback (*Philesturnus c. carunculatus*), South Island snipe (*Coenocorypha iredalei*) and Stead's bush wren (*Xenicus longipes*) with only the saddleback being successful. Extinctions of the snipe, wren and short-tailed bat (*Mystacina robusta*) were recorded. This was the first time rats were definitively recognised as the cause of extinction and directed further debate into the impacts of rats and how to deal with it. Although discussions at the 1976 symposium in the ecology and control of rats following this irruption suggested that "compete extermination of rodents from islands was unlikely", eradications of rats from islands had already been occurring unintentionally starting with small islands like Maria Island (in 1960) and Titi Island (in 1970) by the sporadic use of first-generation rodenticides and even by snap-trapping on Motuhoropapa (in 1979). These successful eradications led to the development of techniques to specifically target rats on islands starting with ground-based bait station or hand-broadcast operations to aerial applications and included the development of second-generation rodenticides.

Conservation benefits accrued from the 1986 Hawea Island and 1988 Breaksea Island rat eradication campaigns, Fiordland.

Bruce Thomas

Ka Mate Traps Ltd, Nelson

The ground-based poison campaign to eradicate Norway rats from Breaksea Island, the first large island (170 ha) ever attempted, was achieved amid considerable controversy.

Research and management strategies implemented in conjunction with the preliminary eradication of rats from Hawea Island (9 ha) included translocations of kakaruai (robins) from Breaksea Island and Fiordland skinks from Wairaki Island. Once the rats were gone from Breaksea Island, experimental translocations of knobbled weevils and flax weevils were undertaken from two nearby islets and tieke and mohua were introduced as part of a broader Fiordland National Park management plan. Fiordland skinks, however, recolonised Breaksea through natural water-borne dispersal from an adjacent stack.

A comprehensive programme to monitor and document the ecological benefits of the eradications was set up - in part to demonstrate to a doubting public the value of investing in what at the time was perceived as unachievable dream … an expensive waste of tax-payer dollars! Unfortunately, funding cuts meant intensive monitoring could not be sustained but long-term, low key monitoring of a few key indicator species was continued from 1994 – 2010 through generous logistic and financial support from Fiordland Ecology Holidays. Not only were predictable outcomes documented, but the research has provided fascinating insights into the vulnerability of littoral habitats and the biological communities that inhabit the dynamic interface environment of Fiordlands' rugged exposed outer coast.

Through the well planned reporting and publicity given to Breaksea and the many New Zealand campaigns that followed, rodent eradication as a conservation management tool is now a global phenomenon. Over time, techniques have become more sophisticated (both ground-based and aerial) but the considerations and simple strategies deployed during our early campaigns are just as relevant today as they were when the Breaksea project was first contemplated 40 years ago.

Mercury Islands: a personal history of their role in understanding island restoration

David R. Towns

Department of Conservation and Auckland University of Technology

Rodent eradications in the Mercury Islands began in 1986 and led to the systematic development of methods for effective mechanised aerial spread of rodenticides. These earliest eradications, although successful, were much less sophisticated than the GPS-guided bait drops completed on Great Mercury in 2014. The progressive removal of invasive mammals from the Mercury Islands led to 25 years of field study based on Korapuki Island and designed to test the processes of restoration of these seabird-driven island ecosystems. Resulting from this work, four key restoration questions can now be identified as fundamental to designing island restoration programmes. The questions are: what is the regional context of the island (biogeography); how do the island ecosystems operate (functional endpoints); how did the invasive species change the ecosystem (response effects); and when is the restoration process complete (outcome measures)? Examples of how these questions influenced restoration in the Mercury Islands are provided. However, unpredicted and subtle responses can eventuate. In the Mercury Islands these included a hitherto unknown honeydew parasite-bird-gecko food web and subtle effects of rats on plant regeneration. Promising outcome measures of restoration progress are now being developed, including indices of marine influence using stable isotopes of nitrogen and the use of network analysis to analyse the composition and resilience of invertebrate food webs.

Tiritiri Matangi island – rat eradication and beyond

Mel Galbraith

Unitec

Tiritiri Matangi Island has international recognition as a successful ecological restoration project, a status accorded for biodiversity gains and community participation through the contribution of volunteers. Ecological restoration has included translocations to the island of bird and lizard species, and one invertebrate. The success of the island from a biodiversity perspective is evident in the repeated translocation of a number of species off the island to establish new populations at other restoration projects.

The eradication of kiore (Pacific rat, *Rattus exulans*) from the island in 1993 was one of the restoration events, and was accompanied by a debate exploring a variety of both positive and negative views. Benefits to biodiversity following the successful eradication are evident, particularly an increase in the populations of invertebrates and reptiles. The 'discovery' of formerly unrecorded fauna species more than a decade after the kiore eradication is especially significant, and perhaps indicative of the impact that rats have on island communities.

This presentation will include an overview of the Tiritiri Matangi project, the eradication event, biodiversity changes to biodiversity following the eradication, implications of the rat-free status of the island with respect to species translocations, and highlight some key lessons learned over 30 years of restoration.

Rangitoto and Motutapu - A legacy of New Zealand's leadership in the field of invasive species management

Richard Griffiths

Island Conservation, Santa Cruz

New Zealand has successfully removed IAV's from more islands than any other nation and has exported its local knowledge and experience to other countries generating benefits to island biodiversity globally. A culture of innovation and a willingness to take calculated risks have been two key ingredients essential to New Zealand's success and these attributes have led to more complex and challenging eradications being completed. The Rangitoto and Motutapu pest eradication completed within 3km of New Zealand's largest city epitomizes these principles. The project relied on traditional methods to remove the IAV's present but in contrast to many other eradication projects, carefully deployed these techniques in one operation to remove eight introduced mammalian species. A high risk of reinvasion was reduced through a non-traditional mix of advocacy and enforcement to establish voluntary and compulsory standards applicable to all island users. The island's pest free status has been maintained since the project was declared successful in 2011. In contrast to many pest control operations that have actively sought a low public profile, engagement with the media and stakeholders occurred throughout the Rangitoto and Motutapu project and allowed key conservation messages to be communicated and stakeholder support to be maintained throughout the project. New Zealand faces many challenges to maintain its position as a world leader in the field of IAV eradication. With a diminishing number of uninhabited islands where IAV's are still present, overcoming the social barriers to traditional eradication methods will be required. The publicly transparent approach to pest eradication employed for the Rangitoto and Motutapu project may be one mechanism that will help achieve this.

Treasure islands helping to keep the Hauraki Gulf pest-free

Jeff Cook

Auckland Council

The number of rodent-free islands in the Hauraki Gulf Marine Park has increased rapidly in recent years, and currently stands at 36. A key component of protecting biodiversity in the Gulf is the maintenance of these islands' pest-free status. This involves surveillance (e.g. bait stations) for new incursions, but also depends heavily on public buy-in and behaviour change. Engaging the public to reduce their risk as potential pest vectors can be a harder sell than getting engagement into 'positive' conservation activities such as tree planting and translocations. Auckland Council and the Department of Conservation undertake joint biosecurity surveillance and communications within the Hauraki Gulf under the branding of "Treasure islands". This programme has successfully raised public awareness; 70% of surveyed ferry passengers had checked their gear for pests, and 27 ferry, freight and charter operators now hold voluntary Pest-free Warrants certifying best practice biosecurity standards. However, in addition to defending islands against traditional pests such as rodents, land managers now also face emerging pest threats such as Argentine ants, rainbow skinks, weeds, and kauri dieback disease. Although good progress is being made in addressing the vector risk posed by passenger vessels, commodity movement remains a high risk vector pathway which is inadequately addressed. A recent survey of high risk industries such as quarries, nurseries, landscaping and building supplies in the Rodney area found over one third of surveyed businesses had rainbow skinks and/or Argentine ants at the site, often within materials about to be transported to Hauraki Gulf islands. Future management of biosecurity risks in the Hauraki Gulf requires a vector-led rather than pest-led approach, with emphasis on encouraging public and industry adoption of general hygiene behaviours which simultaneously protect against transfer of a wide range of pests including historic threats such as rodents as well as emerging pest threats.

Mouse eradication

Jamie MacKay

Wildlands Consultants Ltd

Mice are the little brother in the rodent family, but are by no means just small rats. Their eradication has always proved challenging, and when rats are controlled or eradicated mice can explode in numbers. A review of mouse eradications found that consistent correlates of failure were difficult to identify, although poor project planning and implementation are likely a contributing factor. Intensive research on mouse eradication and (re-)invasion biology were undertaken on Te Haupa (Saddle Island) from 2007 to 2010. Mice were eradicated using a 25 bait station grid and then consecutive pairs of mice experimentally released at opposite ends of the island to study their invasion behaviour and detectability at low density. The final pair of mice released were allowed to establish a breeding population which rapidly invaded the entire 6 hectare island over 6 months, following a classic logistic growth curve. During this invasion an additional incursion of an adult female mouse was detected on the island using genetic monitoring. Such mouse incursions are problematically common, and in 2013 led to the invasion of Maud Island by mice. In 2014 ground-based mouse eradications have taken place on Moturekareka and Motuketekete Islands in the Hauraki Gulf, and aerial eradication of mice from Maud Island. Pre-eradication studies of mice on Adele Island, Abel Tasman National Park in 2007 provided valuable information to support their eradication, and in 2014 South Island saddleback were released on to the island. With sufficient attention to detail mouse eradication should be able to be achieved over large areas, such as the forthcoming Million Dollar Mouse eradication of mice from 2000 ha Antipodes Island.

Eradication of rodents and rabbits from sub-Antarctic Macquarie Island

Keith Springer

Tasmania Parks and Wildlife Service

The presence of invasive vertebrate species on sub-Antarctic Macquarie Island has had devastating impacts on the island's flora, fauna and landforms. Rodents have been present on the island probably since soon after discovery by humans in 1810, with mice *Mus musculus* recorded by 1829 and ship rats *Rattus rattus* by the early 1900s.

Previous eradication projects removed weka *Gallirallus australis* by 1989 and feral cats *Felis catus* by 2001. European rabbits *Oryctolagus cuniculus* have been subject to control efforts since the 1960s, but no broadscale control of rodents had been undertaken.

Subsequent plans to eradicate rodents and rabbits recognised that the remaining pest species could be targeted simultaneously due to commonalities in eradication methodology.

Funding of AUD$24.7M was secured in 2007 for a multi-year project based on aerial baiting targeting rabbits and rodents, followed by hunting surviving rabbits with ground-based techniques. Planning commenced for a 2010 toxic bait application however this was abandoned due to shipping delays and poor weather. Concerns over non-target species mortality resulting from the limited baiting undertaken in 2010 led to renewed consideration of mitigation options. Aerial baiting resumed in May 2011 and was completed by July 2011.

The expected outcome of aerial baiting was eradication of both rodent species, and a kill rate of >99.5% of rabbits. The rabbit hunting phase commenced in August 2011 using hunters and dogs and located twelve surviving rabbits by December 2011, including one litter of four kittens – the only evidence of post-baiting breeding. Monitoring continued until March 2014. Rodent detection dogs were deployed to assist in determining rodent eradication success, along with the use of other monitoring methods.

Three years after baiting vegetation recovery is already evident and increased burrow and surface nesting seabird activity has been observed. Invertebrate abundance is also greater.

No rodents have been detected post-baiting. The estimated rabbit population has been reduced from over 150,000 to zero, and the eradication of rodents and rabbits was declared successful in April 2014, making Macquarie Island the largest island worldwide to be cleared of rabbits, ship rats and house mice.

North American eradications

Araceli Samaniego

Conservación de Islas, Mexico

New Zealand is acknowledged as a pioneer and a pest eradication leader. Rodent eradication techniques developed and tested in New Zealand have been applied on hundreds of islands around the world, with remarkable success. This talk outlines the influence of New Zealand on island rodent eradications in the highly diverse geographical region of North America – Canada, USA and Mexico. Of the ~ 55 North American islands where rodent eradications have been completed, six case studies will be presented (Langara Island, Murchison & Faraday Islands, Anacapa Island, Rat Island, San Pedro Mártir Island and Banco Chinchorro Archipelago) and the valuable input from New Zealand will be commented based on contributions from the project managers. Most projects had seabirds as flag species; however, this restoration work is facilitating the recovery of a wide range of native flora and fauna, from invertebrates to native rodents.

Predator-Free New Zealand

Andrea Byrom

Landcare Research

The concept of a ‘Predator-Free NZ’ (PFNZ) has gained hold since Sir Paul Callaghan spoke about this grand vision. While PFNZ is widely accepted as an ‘aspirational goal’, it has captured the imagination of a great many people, enabling us to think about the widespread suppression or even local eradication of mammal predators. As progress is made towards a zero or low predator environment, managers of large areas of New Zealand or some of our largest inhabited islands may well tackle full eradication of selected pests. Re-visiting the ‘rules for eradication’ – applied routinely to island eradications – will be extremely useful in this context. In this talk I explore the utility of the ‘rules for eradication’ when applied at the scale of PFNZ. These rules provide an excellent framework. However, (1) they will need to be applied to multiple species simultaneously; (2) pest species that cannot be removed in one hit will have rapid rates of increase at low densities; (3) recolonisation will be an ongoing challenge; (4) some methods of control will generate public debate; (5) even if eradication is a more logical option than sustained control, the one-offcosts may still be too high; (6) managers need to get smarter in detecting re-emerging pests; and (7) removal of individual pest species may have adverse ecological consequences. Nevertheless, the rules will keep managers grounded in reality as they begin to think about local elimination of multiple pests at very large scales on mainland New Zealand.

Concluding remarks and the future

James Russell

University of Auckland

New Zealand has come a long way in 50 years of rodent eradications and control. In 1964, 0.5% of offshore island area was free of introduced mammalian predators. Today we have increased that mammal-free island area to 10%, by eradication or natural die-off of mammals from over 100 islands (about a third of New Zealand's offshore islands). Although 10% of the total island area is not large, it compares favourably with marine reserve targets. The size of islands from which rodents have been eradicated increased by an order of magnitude every decade from 1964 (1 ha) through to 2004 (11,330 ha Campbell Island), leveraging step-changes such as the aerial distribution of bait, but has plateaued since then. This is not due to a lack of islands to eradicate introduced mammals from, instead the 'wall' appears to be the challenge of pest management on inhabited islands. Attitudes to pests and their control is playing an ever more important role in conservation decision-making. Eradication of invasive predatory mammals from Aotea (Great Barrier Island) and Rakiura (Stewart Island), would increase offshore island predator-free area to over 50%. Today we can also keep rodents off islands after eradication, with a 100% success rate in the Hauraki Gulf intercepting incursions, despite an average reinvasion timeframe of ten years. Scientific research has always played an important role in rodent management. Recent advances include understanding the role of rodents in multi-species complexes, the application of genetic tools to understanding rodent invasion history and modern dispersal, and the development of software applications for improving rodent management (e.g. analysing tracks and trapping records). In addition to rodents we must also consider eradication and biosecurity in a multi-species context, especially targeting other taxa for eradication. What might happen in the next 50 years is hard to imagine, but discussions around a predator-free New Zealand inspire us to continue innovating.