

The Rakiura Tītī Islands Restoration Project: community action to eradicate *Rattus rattus* and *Rattus exulans* for ecological restoration and cultural wellbeing

P. J. McClelland¹, R. Coote², M. Trow², P. Hutchins², H. M. Nevins³, J. Adams⁴, J. Newman⁵, and H. Moller⁵

¹ Department of Conservation, P.O. Box 743, Invercargill, New Zealand. <pmcclelland@doc.govt.nz> ² Kā Mate Ngā Kiore, P.O. Box 47 Te Anau, New Zealand. ³ Oikonos - Ecosystem Knowledge, P.O. Box 1932, Benicia, C. 94510, USA. ⁴ U.S. Geological Survey, Western Ecological Research Center, 400 Natural Bridges Drive, Santa Cruz, C. 95060, USA. ⁵ Centre for Study of Agriculture, Food and Environment, University of Otago, P.O. Box 56, Dunedin, New Zealand.

Abstract In 2003, a non-profit group, Ka Mate Nga Kiore, was set up to oversee the restoration of four Māori-owned islands off the south coast of Stewart Island, New Zealand. The first step in the restoration was to eradicate ship rats (*Rattus rattus*) from three islands and Pacific rats (*R. exulans*) from another. The eradication was funded by the *Command Oil Spill Trustee Council* which managed the mitigation money from an oil spill off the Californian coast in 1998. The funding was coordinated via *Oikonos Ecosystem Knowledge*, a non-profit USA group primarily involved in seabird research and restoration. The project was primarily to benefit sooty shearwater (*Puffinus griseus*) and to sustain a culturally important customary harvest of their chicks by Rakiura Māori. However, like all island eradications, a wide range of other species also benefited from the removal of rats. The New Zealand Department of Conservation provided technical advice and assistance for the planning and implementation of the eradication programme. This paper describes how, with appropriate funding, community and technical support, rodent eradications can be achieved on private islands. In this case, a range of institutions and individuals joined to achieve a common goal that highlighted a significant international conservation action. We urge that more international and local-community-led restoration projects be initiated in the future.

Keywords: Ship rats, kiore, sooty shearwater restoration, muttonbirding, *Puffinus griseus*, international and local community collaboration

INTRODUCTION

Approximately 21 million sooty shearwater (*Puffinus griseus*) form breeding colonies in New Zealand (Newman *et al.* 2009), mostly (53%) on the 35 'Tītī Islands' (Muttonbird Islands) around Rakiura (Stewart Island) in southern New Zealand (Fig. 1). The indigenous people of southern New Zealand are Rakiura Māori, who own these islands and have a legal right to harvest the near-fledgling chicks, which they call 'tītī' or 'muttonbirds'. Tītī harvesting is a fundamental part of being Rakiura Māori (Moller *et al.* 2009), an important source of income (Wilson 1979), spiritual inspiration (Lyver and Moller 2010) for the birding families, and a nationally important example of *kaitiakitanga* (Māori conservation management) and environmental co-management in action (Moller *et al.* 2000; Stevens 2006). Sustaining the abundance of sooty shearwaters is therefore a fundamentally important goal of the Rakiura Māori community.

On 26 September 1998, the tanker vessel "Command" released approximately 3000 gallons (11,356 litres) of oil off the California coast (Anon. 2004). Thousands of seabirds were killed by the spill, including between 2 and 32 thousand (median estimate 15,500) sooty shearwaters (Moller *et al.* 2003). One of eleven sooty shearwaters recovered on beaches during the spill had been banded by an Otago University research team on Whenua Hou/Codfish Island off the north west coast of Rakiura (Stewart Island). This individual provided the required nexus to allow for mitigation funds to recover damaged natural resources under a consent decree signed by the guilty party and the US multi agency Command Spill Trustee Council. The banding programme was part of *Kia Mau Te Tītī Mo Ake Tōnu Atu* / "Keep the Tītī forever", a 14-year study into the productivity of the species and the sustainability of the muttonbird harvest (Moller 1996; Moller *et al.* 2009).

Oikonos Ecosystem Knowledge, an American non-profit research group, recognised this event as an unprecedented opportunity for *Command* mitigation funds to repair the oil spill injury to sooty shearwater populations in New Zealand. The eradication of introduced predators on New Zealand islands containing colonies of sooty shearwaters was considered the most effective way to repair the oil spill

injury and also provide substantial additional multi-species benefits.

This paper describes how the funds from the oil spill, with community and technical support, enabled rodent eradications to be achieved on private islands. We also outline how institutions and individuals collaborated to achieve a significant international conservation action.

STUDY SITES

Four islands were chosen as a priority for rodent eradication, based on their importance for birding (the taking of muttonbirds) (Newman *et al.* 2008, 2009), historical significance, conservation potential, and the feasibility and cost effectiveness for predator eradication. These were Taukihepa / Big south Cape (939 ha), Rerewhakaupoko / Solomon (30 ha), Pukeweka (3 ha), and Mokonui / Big Moggy (86 ha) (Fig. 1).

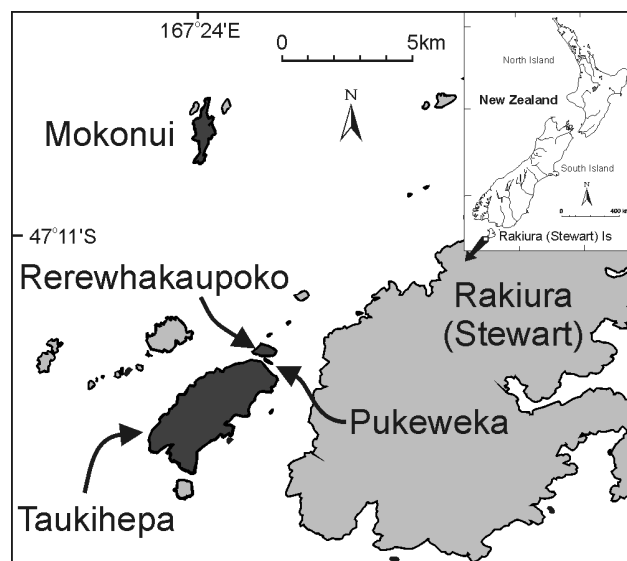


Fig. 1 The Tītī Islands, where the Rakiura Restoration Project research and rat eradication took place in 2006.

The Taukihepa group (Taukihepa, Pukeweka and Rerewhakaupoko) had been historically recognised as one of New Zealand's ecological jewels as the last refuge for several species of birds and the greater short-tailed bat (*Mystacina robusta*) before ship rats (*Rattus rattus*) invaded the group in 1963. The rats caused extinction of Stead's bush wren (*Xenicus longipes variabilis*) and Stewart Island snipe (*Coenocorypha aucklandica iredalei*), and perhaps also the greater short-tailed bat, and potentially the local extinction of an unknown number of species of birds, lizards, and invertebrates (Bell 1978; Ramsay 1978). It is particularly poignant that the Rakiura Restoration Project targeted rats on the Taukihepa group because it was the 1964 rat irruption and ensuing ecological disaster - more than any other event in New Zealand - that triggered widespread realisation of the ecological impacts of introduced rodents and the need for their eradication from islands (Dingwall et al. 1978). These three islands were effectively treated as one landmass during the eradication because the rat populations can easily swim between them.

The eradication of Pacific rats (kiore: *Rattus exulans*) from Mokonui, which is approximately 5 km to the west of Taukihepa, was included in the project during the early stages of planning at the request of its beneficial owners. This extension imposed only a minimal increase in planning and implementation costs, yet promised significant ecological gains because of its relatively large size.

THE PROJECT

Funding

The bid to eradicate rats from the Tītī Islands was prepared by scientists assisting the joint Oikonos-Rakiura Tītī Islands Administering Body (Moller et al. 2003). This successful bid to the *Command Trustee Council* provided US\$513,000 for restoration including: rat eradication (70% of expenditure); scientific monitoring of outcomes (10%); reporting and administration (10%); educational video about the project (5%); and initiating community-level quarantine programmes after the rats were removed (4%).

Community Involvement

The Tītī Islands are managed under two different management committees, membership of which is based upon the history of each island. Once eradication funding had been secured, in order to facilitate the two committees working together, and effectively to provide a sub-committee which could focus on the eradication, a NZ non-profit incorporated society was formed. This group could act on behalf of the islands' owners, communicate independently with Oikonos and the *Command Trustee Council*, and feed back to the committees as required. The community called this group *Kā Mate Ngā Kiore* (KMNK), which loosely translated means "death to the rats". KMNK's main tasks were to: 1) link the various parties involved in the planning and operational aspects of the project with the thousands of owners of the islands; 2) keep all parties informed of progress; and 3) get a consensus on approvals from the owners for relevant actions when required. KMNK also coordinated the involvement of birders in the operational aspects of the project, which were guided by New Zealand's Department of Conservation (DOC).

Understandably, some of the American public opposed the transfer of reparation funds to New Zealand. However, the Tītī project was seen by the Trustee Council as an important part of mitigating the impact of the oil spill. The *Command Trustee Council* had confidence to support investment outside the USA because: 1) a comprehensive ecological research programme had already developed methods and collected some of pre-eradication baseline data, which built confidence in adequate documentation of

repair to the oil spill injury; and 2) a research team (*Kia Mau Te Tītī Mo Ake Tōnu Atu*) had population parameter estimates on hand to demonstrate the size of the injury to sooty shearwaters and to simulate prospects for recovery.

Accountability and security of funding streams was paramount. One of KMNK's roles was to financially manage the project within New Zealand, contracting in assistance as required and ensuring that the required reporting was completed. *Oikonos* was actively involved in project management and became the liaison between USA and New Zealand entities. Effectively, a trusted local US agent oversaw funding, while the KMNK performed a similar and crucial role in New Zealand for operations and community involvement.

Planning the eradication

Planning for the eradication started in 2003 when KMNK obtained the final mandate from the islands' owners to make any decisions required to carry out the eradication. This was crucial as it was impractical to go back to all the owners every time a decision was required. In 2004, a Memorandum of Understanding (MOU) was drawn up between DOC and KMNK so that the roles and responsibilities of the two groups concerning preparation for the eradication were clearly defined (DOC 2004). The MOU recognised DOC's international expertise in rodent eradications. Technically, the eradication was considered by DOC to be relatively straightforward. However, the large number of owners of the islands, and the fact that the islands are inhabited for up to two and a half months a year, added novel complications. The trust and guidance of KMNK therefore became fundamentally important for the success of this project. KMNK also ensured that all cultural and spiritual concerns were considered. These included: 1) a blessing ceremony prior to the eradication to keep the operators safe and ask for overall success of the venture; and 2) ensuring that ancestral guardians of the islands understood the need to break a traditional *rāhui* (prohibition) that normally bans all muttonbirders from visiting the islands except during the late fledging stage. The *rāhui* protects habitat and minimises disturbance to the adults' breeding attempts (Moller and Lyver 2010).

The eradication was originally planned for the winter of 2005. However, planning and financial hold-ups delayed the operation for a year. KMNK and the *Command Trustees* agreed that it was important to not rush the eradication operation. In 2006, a contract for service was signed by DOC and KMNK for the bait drop (DOC 2006a). This replaced the MOU and detailed the roles of the two parties for the eradication itself. We believe that clear MOUs between community representatives and government agencies or researchers are essential to allow co-ordination of diverse contributions, all of which are needed for the success of the overall endeavour. In general, investment of time and resources to allow extensive communication between stakeholders slows the process down, but the multi-stakeholder buy-in to the overall goal is thereby more solid and lasting. Local knowledge of the community was also essential for putting the eradication plan into action. DOC prepared the applications for all the legal consents required, although they were applied for and issued to KMNK. This simplified the consultation process because KMNK had direct contacts with most of the affected parties and were in a better position to convince them of the benefits of the project, whereas DOC had the legal and technical experience required to obtain the consents for the release of poison bait into the environment. A significant concern for New Zealand public opposition to aerial poison baiting was addressed by having DOC manage the overall consents process.

Operational work

A detailed operational plan was developed by DOC in consultation with KMNK to ensure that all details were covered and everybody knew their roles when bait was being spread (DOC 2006b). The bait was 10 mm diameter cereal bait pellets (Pestoff 20R) containing 20 ppm brodifacoum in 25 kg bags loaded into 1.2 m³ plywood “pods” used previously on Campbell Island (McClelland 2011). The pods were loaded on to a local charter vessel and transported to Taukihepa where they were unloaded by helicopter and placed in covered rows at a sheltered site. To ensure that pods remained water tight, their condition was monitored by an experienced contractor who was accompanied by muttonbirders from the island. The pods were flown to a preselected open location near the top of the island on the day of the bait drop. The bait loading team consisted of DOC staff, experienced contractors and volunteer local birders, with a dedicated site manager to oversee loading and safety.

The eradication followed the standard procedures developed in New Zealand over the preceding 20 years: two aerial drops of 8 kg ha⁻¹ and then 4 kg ha⁻¹ (e.g., Broome 2009). Helicopters carrying underslung spreader buckets spread bait in an 80 m wide swath. Overlapping dispersal (50% for the first drop and 25% for the second) minimised the chances of gaps and two additional swaths were spread around the coast as this is recognised as a habitat typically with increased densities of rats (Taylor and Thomas 1989).

Ground baiting

More than 100 buildings are distributed around the islands, primarily near the coast. These include sleeping quarters, workhouses, and storage sheds used during the muttonbirding season. Bait was spread by helicopter over each entire island, including over buildings. However, buildings could still have provided refuges for the rats where they could obtain shelter and food and not be exposed to the bait. KMNK coordinated approximately 40 volunteer birders to go to the island on the day of the first drop and place bait in aluminium dishes in cavities within all buildings. This was a major undertaking and could not have been coordinated without local knowledge and approvals for entry into the buildings.

All water collection systems on the buildings had been disconnected during the previous birding season. After sufficient rain had fallen to clear any bait off roofs, KMNK then arranged for a team of birders to return to the island in November to reconnect the water systems so that tanks were replenished with drinking water by the time the community returned next March for the 2007 birding season.

Public outreach

As the project was recognised as being nationally significant, KMNK worked with the media, papers and television, to get coverage whenever possible. A video, recording the whole project, was produced by South Coast Productions and KMNK to highlight the cultural significance of the project as well as its technical aspects (Asher 2007). Oikonos provided updated information via The Rakiura Tītī Restoration Project webpage (<http://www.oikonos.org/projects/titi.htm>).

Outcome monitoring

Informal post-eradication rat monitoring was carried out by the birders, who are active around the island during both day and night for up to 75 days of the year while harvesting the muttonbirds (McKechnie *et al.* 2010). The many buildings should also have acted as attractants for any remaining rats hence, aiding in their detection. Although the monitoring was extensive, it was not formalised, there

was no training, and no attempt was made to record where people had been, so there could potentially have been gaps in the coverage. We therefore waited for three years (three muttonbirding seasons) without rat sign before declaring the operation a success in June 2009. There was still no sign of rats during the March–May 2010 birding season.

The funding agency required any repair to the impacted population to be quantified. Monitoring plots were established so that a ‘Before-After-Control-Impact’ design (Stewart-Oaten *et al.* 1986) can eventually be used to assess to what extent rat eradication triggers increased sooty shearwater abundance. However, the median age at first breeding of sooty shearwaters is approximately 7.8 years (Fletcher *et al.* *subm.*), so it will be at least 2014 before initial effects of the eradication on recruitment can be detected.

Monitoring of other species has been opportunistic. The removal of the rats has allowed the recovery of terrestrial bird species including Stewart Island robin (*Petroica australis rakiura*) and fernbirds (*Bowdleria punctata*), which naturally re-established from neighbouring predator free islands. However the ongoing presence of weka (*Gallirallus australis*), a large predatory rail that was introduced to the island in the early 1900s as a food source, has hindered recovery of smaller ground nesting birds, burrowing seabirds, lizards, and larger invertebrates. KMNK would like to remove weka from the islands, but currently lack the resources to do so.

Biosecurity programmes

Ongoing ecosystem and threatened species recovery depends on heightened biosecurity now the eradication is complete. Each March and April, a wide variety of vessels transfer large quantities of food-stuffs and equipment to the islands. No formal quarantine programmes existed before the eradication project. The *Command Trustee Council* and KMNK team were anxious to lock-in the benefits of the rat eradication by minimising the chances of rats re-invading by accidental transport to the islands.

New quarantine measures are focused primarily at pre-departure points and in transit because catching rodents once they reach the islands is considered unlikely. Measures include producing and disseminating posters, calendars, and other ‘promotional’ material all emphasising the importance of quarantine: giving presentations at ‘permit’ days (important pre-season administrative meetings for muttonbirders); a short film about the eradication itself, including the importance of quarantine has been produced by KMNK.

DISCUSSION

This project involved a diverse range of organisations and groups, which shows that adequate funding and the right technical advice enables private groups to carry out eradications on their own land. Direct involvement and community “ownership” of environmental management is seen as key in building ‘environmentality’ (Agrawal 2005) and commitment to ‘Adaptive Co-management’ (Berkes and Turner 2006) for long-term restoration and sustainable use of wildlife (Stephenson and Moller 2009).

The project could not have been carried out by any one of these groups without assistance from the others. *Oikonos* initiated the project and had the required understanding of the American mitigation process to convince the *Command Trustee Council* that the project was worth funding; Otago University had banded the bird that proved the vital link to the funding in the first place and had the ability to carry out the research required by the funders; DOC had the required expertise to plan and carry out the eradication; KMNK drove the whole project and co-ordinated the community

of island owners. KMNK were given DOC's Conservation award in 2007 for the effective manner in which they performed this crucial role to make the project a success.

KMNK are now working with DOC to reintroduce some species of birds which were previously present on the islands. Tieke / South Island saddlebacks (*Philesturnus carunculatus carunculatus*) will be reintroduced to Taukihepa in March 2010. The return of this sub species is especially significant as they were saved from extinction after rats invaded Taukihepa by the transfer of 36 individuals to two nearby islands (Atkinson and Bell 1973; Bell 1978). Having charismatic and culturally important species such as tieke on the island for the first time in over a generation, should emphasise to the birders the ecological impact the rats had and encourage the owners to maintain the quarantine standards required to keep rodents off the islands.

CONCLUSIONS

The eradication of rats from the Taukihepa group is a locally and internationally significant conservation event, brought to completion by private landowners, a NZ government department, a university and a US-based international non-profit working together. Participation in the restoration project, and the goal to get rid of the rats, has been enormously appreciated by the muttonbirding community. The project is also the first time that mitigation money from an oil spill off the American coast has been spent away from the USA. This sets an important precedent in recognising that negative environmental events, such as oil spills, in one part of the world can have significant impacts on another nation many thousands of kilometres away. Agencies and countries need to work together to get the best possible results for the available money and recognise that the movements of seabirds across political boundaries and jurisdictions are ultimately irrelevant from an ecological point of view (MacLeod *et al.* 2008; Nevins *et al.* 2009).

ACKNOWLEDGEMENTS

We would like to thank the *Command* Trustee Council and Oikonos, and the muttonbirders of the Tīti Islands, particularly the birders of Taukihepa, Pukeweka, Rerewhakaupoko and Mokonui. Without them this project would not have been possible. SouthCoast Productions contributed significant support into documenting this environmental conservation success story for future generations of conservationists.

REFERENCES

Agrawal, A. 2005. *Environmentality: technologies of government and the making of subjects*. 344 pp. Durham and London, Duke University Press, U.K.

Anonymous 2004. Command oil spill final restoration plan and environmental assessment. Prepared by: United States Fish and Wildlife Service, National Oceanic and Atmospheric Administration, California Department of Fish and Game, California Department of Parks and Recreation and California State Lands Commission. 261 pp. Available at: <http://www.darrp.noaa.gov/southwest/command/admin.html>

Asher, D.R. 2007. *Restoring the balance*. SouthCoast Productions, Te Anau, New Zealand, Video, 40 mins.

Atkinson, I.A.E. and Bell, B.D. 1973. Offshore and outlying islands. In: Williams, G.R. (ed.). *The natural history of New Zealand*, pp. 372-392. A.H. and A.W. Reed, Wellington, New Zealand.

Bell, B.D. 1978. The Big South Cape islands rat irruption. In: Dingwall, P.R.; Atkinson, I.A. E. and Hay C. (eds.). *The ecology and control of rodents in New Zealand nature reserves*, pp. 33-40. Department of Lands and Survey Information Series No 4.

Berkes F. and Turner, N.J. 2006. Knowledge, learning and the evolution of conservation practice for social-ecological system resilience. *Human Ecology* 34 (4): 479-494.

Broome K. (2009). Beyond Kapiti – A decade of invasive rodent eradications form New Zealand islands. *Biodiversity* 10: 14-24.

Department of Conservation 2004. Deed of Understanding. Southland Conservancy File NHT 02-17-01-03 vol. 1. 22nd Dec 2004.

Department of Conservation 2006a. Contract for Service between KMNK incorporated and the Department of Conservation. Southland Conservancy File NHT 02-17-01-03 vol. 1 1st May 2006.

Department of Conservation 2006b. Operational plan for the eradication of rats from Taukihepa, Pukeweka, Rerewhakaupoko and Mokonui islands 9th July 2006. Southland Conservancy File NHT 02-17-01-03, Vol. 2.

Dingwall, P.R.; Atkinson, I.A.E. and Hay, C. (eds.). 1978. *The ecology and control of rodents in New Zealand Nature Reserves*. Department of Lands and Survey Information Series No 4. Wellington.

Fletcher, D.J.; Moller, H.; Clucas, R.; Bragg, C.; Scott, D.; Scofield, P.; Hunter, C.; Soehle, I.; Newman, J.; McKechnie, S.; de Cruz, J. and Lyver, P.O'B. (Subm). Age at first return to the breeding colony, juvenile survival rate and transience of sooty shearwater (*Puffinus griseus*). *Marine Ecology Progress Series*.

Lyver, P.O'B. and Moller, H. 2010. An alternative reality: Māori spiritual guardianship of New Zealand's native birds. In: Tidemann, S. and Gosler, A. (eds.). *Ethno-ornithology birds, indigenous peoples, culture and society*, pp. 241-264. Earthscan, London, U.K.

MacLeod, C.J.; Adams, J. and Lyver, P. 2008. At-sea distribution of satellite-tracked grey-faced petrels, *Pterodroma macroptera gouldi*, captured on the Ruamaahua (Aldermen) Islands, New Zealand. *Papers and Proceedings of the Royal Society of Tasmania* 142: 73-88.

McKechnie, S.; Fletcher, D.J.; Newman, J.; Scott, D.; Bragg, C. and Moller, H. 2010. Modelling the intensity of harvesting of sooty shearwater chicks by Rakiura Māori in New Zealand. *Journal of Wildlife Management* 74: 828-842.

Moller, H. 1996. Customary use of indigenous wildlife - towards a bicultural approach to conserving New Zealand's biodiversity. In: McFagen, B. and Simpson, P. (eds.). *Biodiversity: Papers from a seminar series on biodiversity*, pp. 89-125. Hosted by Science and Research Division, Department of Conservation, Wellington, New Zealand.

Moller, H.; Horsley, P.; Lyver, P.O'B.; Taiepa, T.; Davis, J. and Bragg, M. 2000. Co-management by Māori and Pākehā for improved conservation in the 21st century. In: Perkins, H. and Memon, A. (eds.). *Environmental Planning and Management in New Zealand*, pp. 156-167. Dunmore Press, Palmerston North, New Zealand.

Moller, H.; Nevins, H.M. and Adams, J. 2003. The Rakiura tīti restoration project: mitigation of the *Command* oil spill injury by eradication of rats from sooty shearwater breeding colonies in New Zealand. Unpublished report for Rakiura Tīti Islands Administering Body, 78 pp.

Moller, H.; Lyver, P.O'B.; Bragg, C.; Newman, J.; Clucas, R.; Fletcher, D.; Kitson, J.; McKechnie, S.; Scott, D. and Rakiura Tīti Islands Administering Body. 2009. Guidelines for cross-cultural participatory action research partnerships: a case study of a customary seabird harvest in New Zealand. *New Zealand Journal of Zoology* 36: 211-241.

Moller, H. and Lyver, P.O'B. 2010 Traditional ecological knowledge for improved sustainability: customary wildlife harvests by Māori in New Zealand. In: Walker Painemilla, K.; Rylands, A.B.; Woofter, A. and Hughes, C. (eds.). *Indigenous peoples and conservation: from rights to resource management*. Conservation International.

Nevins, H.M.; Adams, J.; Moller, H.; Newman, J.; Hester, M. and Hyrenbach, K.D. 2009. International and cross-cultural management in conservation of migratory species. *Journal of the Royal Society of New Zealand* 39: 183-185.

Newman, J.; Scott, D.; Fletcher, D.; Moller, H. and McKechnie, S. 2008. A population and harvest intensity estimate for sooty shearwater (*Puffinus griseus*) on Taukihepa (Big South Cape), New Zealand. *Papers and Proceedings of the Royal Society of Tasmania* 142: 177-184.

Newman, J.; Scott, D.; Bragg, C.; McKechnie, S.; Moller, H. and Fletcher, D. 2009. Estimating regional population size and annual harvest intensity of the sooty shearwater in New Zealand. *New Zealand Journal of Zoology* 36: 307-323.

Ramsay, G.W. 1978. A review of the effect of rodents on the New Zealand invertebrate fauna. In: Dingwall, P.R.; Atkinson, I.A.E. and Hay C. (eds.). *The ecology and control of rodents in New Zealand nature reserves*, pp 89-95. Department of Lands and Survey Information Series No 4.

Stephenson, J. and Moller, H. 2009. Cross-cultural environmental research and management: challenges and progress. *Journal of the Royal Society of New Zealand* 39: 139-149.

Stevens, M.J. 2006. Kāi Tahu me te hopu tīti ki Rakiura: an exception to the 'colonial rule'? *Journal of Pacific History* 41: 273-291.

Stewart-Oaten, A.; Murdoch, W.W. and Parker, K.R. 1986. Environmental impact assessment: "pseudoreplication" in time? *Ecology* 67: 929-940.

Taylor, R. and Thomas, B. 1989. Eradication of Norway rats (*Rattus norvegicus*) from Hawea Island, Fiordland, using brodifacoum. *New Zealand Journal of Ecology* 12: 23-32.

Wilson, E. 1979. *Tīti heritage: The story of the muttonbird islands*. Invercargill, New Zealand, Craig Printing Co Ltd. 181 pp.