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Rakiura Tïtï Restoration Project

Mitigation of the *Command* oil spill injury by eradication of rats from Sooty Shearwater breeding colonies in New Zealand

FINAL

2010 Annual Report

Prepared for the Command Restoration Council

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Rakiura Tïtï Restoration Project

Mitigation of the Command oil spill injury by eradication of rats and other introduced predators from Sooty Shearwater breeding colonies in New Zealand

Abstract

The Rakiura Tïtï Restoration Project seeks to repair the injury to Sooty Shearwater (Puffinus griseus) caused by the T/V Command oil spill in September 26, 1998 through the eradication of introduced black rats (Rattus rattus) and Polynesian rats or Kiore (R. exulans), and weka (Gallirallus australis) from shearwater breeding colonies on four Big South Cape Islands, New Zealand: Taukihepa, Pukeweka, Rerewhakaupoko and Mokonui Islands. The primary objectives include (1) eradicate non-native rats and weka, (2) establish quarantine protocols to prevent re-introduction of rodents and ensure long-term benefits, (3) monitor and predict restoration success of the project, and (4) create education and outreach products to inform the people in California and New Zealand about the project.

Here we report on project activities up to the end of 2010. These activities included weka removal, quarantine, and surveys of ecosystem indicators (e.g. insects, land birds). Our 2010 results indicate rodent eradications on all four islands have been successful. NZ partners Ka Mate Nga Kiore (KMNK) and Department of Conservation (DoC) have removed weka from the three smaller islands and will continue to control them on Taukihepa with support of the birding community. KMNK will continue to promote the quarantine message, “Keep the Tïtï Islands Rat Free” and implement outreach through community meetings, and distributing calendars and signage at transport locations. Ecosystem recovery metrics surveyed in 2010 (land bird abundance) indicated that rat eradication has been successful. We presented our results in three recent publications and two conferences in 2010.

In 2011, we will continue to produce the widely used calendars and other outreach materials in collaboration with the birding community and upkeep of signage around arrival and departure sites for the Tïtï islands. We will conduct the first re-surveys of shearwater colonies to document population-level response to the successful restoration. Oikonos will continue to coordinate all activities with New Zealand partners and provide reporting to the Command Trustee Council. NZ partners will facilitate communications with tribal entities and landowners.

Introduction

Sooty Shearwaters (*Puffinus griseus*) are the most abundant seabird off central California during May to September. They aggregate in coastal waters in large flocks, which may extend for many kilometers and number in the 10-100,000s, which makes them vulnerable to oil spills. On September 26, 1998, Tank Vessel *Command* leaked oil off central California causing injury to Sooty Shearwaters and other seabirds. As most Sooty Shearwaters that occur off California migrate from New Zealand breeding colonies, where they are known as "tïtï" by Rakiura Maori (New Zealand's southern indigenous people), a cross-collaborative international project was developed to compensate for the oil spill damages.

The Rakiura Tïtï Restoration Project (hereafter, "project") seeks to repair the injury to Sooty Shearwater caused by the T/V Command oil spill (the spill) through the eradication of introduced mammalian and avian predators from breeding colonies on four southern islands of New Zealand. The restoration team combines the traditional Knowledge of the "kaitiaki" (Mäori environmental stewards) represented by the Ka Mate Nga Kiore Incorporated Society (KMNK) with technical and scientific expertise of the New Zealand Department of Conservation (DoC), a University of Otago team of ecologists, and United States environmental education and seabird experts from Oikonos Ecosystem Knowledge (Oikonos).

Specifically, the objectives of the project were:

- Eradication —of introduced black rats (*Rattus rattus*), Polynesian rats (*R. exulans*), and weka (*Gallirallus australis*) from Sooty Shearwater breeding colonies on four of the Big South Cape Islands, New Zealand: Taukihepa, Mogonui, Rerewhakapoko, and Pukeweka;

- Quarantine —to prevent reintroduction of introduced predators to the Big South Cape Islands to ensure long-lasting benefits of the project;

- Monitoring — to estimate the success of the eradication by measuring the impact of rats on shearwaters pre- and post- eradication by the use of population models;

- Education — of the people in California and New Zealand about the eradication project, and the cultural and environmental importance of these birds.

Actions described in this report have been specifically approved through a resolution or other means by the Command Trustee Council (hereafter "council"). The council is comprised of representatives from the natural resource trustee agencies for the spill including the U. S. Fish and Wildlife Service, National Ocean Atmospheric Administration, California Department of Fish and Game, California Department of Parks and Recreation, and California State Lands Commission.

Study Area

We targeted a predator eradication campaign on four of the Big South Cape Islands (47º13.9'S, 167º23.0'E) southwest and offshore of Rakiura (Stewart) Island off the south end of the South Island of New Zealand including Taukihepa (929 ha), Mokonui (97 ha), Rerewhakaupoko (28 ha) and Pukeweka (5 ha), and Islands (Fig. 1).

Sooty shearwaters nest on more than 30 islands surrounding Rakiura Island (collectively called "Tïtï islands"; Fig. 1). We chose the Big South Cape Islands for restoration of shearwaters for several reasons, including the island size and therefore benefit to the population, the

feasibility of the operational aspect of the project –as it would be managed by a NZ expert team, and the low potential of reintroduction of rats from the mainland of Rakiura Island.

We also chose the islands for their cultural and historical significance and multiple ecological benefits[1]. In 1964, a shipwreck was responsible for introducing ship rats to Taukihepa resulted in a globally-significant ecological disaster. This "rat spill" had a huge impact on the fragile island ecosystem —the rat introduction caused the extinction of three endemic land birds, a large flightless beetle, and a rare ground-dwelling bat (Greater short-tailed bat, *Mystacina robusta*). After the rat spill, a last ditch effort was made to translocate 36 individual South Island Saddlebacks or Tïeke (*Philesturnus c. carnuculatus*) from the rat-plagued islands to a nearby predator-free island (Poutama or Evening Island). The current population of over 700 birds is descended from the survivors of the 36 saddlebacks rescued in 1964. Restoring the Big South Cape Islands for reintroduction of endemic species, such as the saddleback, is a major long-term ecological goal of this project.

Methods

Eradication

The primary objective was for complete eradication of introduced black rats from three breeding colonies (Taukihepa, Pukeweka, Rerewhakaupoko) and polynesian rats (kiore) from a fourth (Mokonui Island). Secondarily, we planned to eradicate weka (*Gallirallus australis*), an introduced ground-dwelling bird, from these islands. During initial planning for the eradication, Harper (2006) documented weka as being potentially more destructive to nesting shearwaters than rats[2].

During the eradication, we used aerial application of Brodifacoum-poisoned pellets to kill rats (see McClelland operational plan for greater detail[3]). Weka were killed incidentally during the aerial campaign via secondary poisoning, and were later targeted directly with ground-based trapping with lures, calls and dogs. During the ground efforts, we used extensive trapping, hunting, 'passive indicators', dogging, listening for weka calls and the playing of recorded to locate and cull weka.

The eradication would not have been accomplished without significant in-kind contributions from Ka Mate Nga Kiore, New Zealand DoC, and the University of Otago research team. The project has received considerable international and national recognition for its innovative approach to conservation of migratory seabirds.

[1] Nevins, HM, J Adams, H Moller, J Newman, M Hester, and KD Hyrenbach 2009. Forum: International and cross-cultural management in conservation of migratory species. Journal of the Royal Society of New Zealand: 39(4):1175-8899 (Online); 0303-6758.

[2] Harper, G. 2006. Weka (*Gallirallus australis*) depredation of sooty shearwater/titi (*Puffinus griseus*) chicks. Notornis 53: 318-320.

[3] P. J. McClelland, R. Coote, M. Trow, P. Hutchins, H. M. Nevins, J. Adams, J. Newman and H. Moller. 2011. The Rakiura Titi Islands Restoration Project: community action to eradicate *Rattus rattus* and *Rattus exulans* for ecological restoration and cultural wellbeing. pg x-xx *In:* Veitch, C. R.; Clout, M. N. and Towns, D. R. (eds) 2011. Island Invasives: Eradication and management. IUCN, (International Union for Conservation of Nature), Gland, Switzerland. 2011. [In press]

Quarantine

The objective of establishing quarantine measures was to (1) provide outreach to people traveling to the islands through main ports of entry (e.g. harbors, airports) to prevent reintroduction of rats and other pests to the Big South Cape Islands to ensure long-lasting benefits of the project and (2) to establish contingencies on targeted islands in the case of an pest introduction.

Rats are likely to be re-introduced from boats traveling to the Tïtï Islands to offload passengers and gear, originating from either the South Island at Bluff, or from Stewart Island at Halfmoon Bay. Fishing vessels may also pose a problem, as they may originate from various southland ports and occasionally visit the islands, but may not stop at a local port (i.e. Halfmoon Bay) prior to transiting to remote Titi Island. Gear is also transported by helicopters directly from personal homes to island sites.

The implementation of quarantine measures included providing information to the island-traveling community regarding staging and preparing "rat-free" gear by means of yearly calendars, signs at loading/departure areas, brochures and public displays. KMNK quarantine personnel target quarantine efforts with both the helicopter and boat charters at the most likely points of re-introduction.

Introduced predator specialists from DoC, with guidance from *Ka Mate Nga Kiore*, developed action plans for quarantine protocols to avoid reintroduction of rats and other invasive pests to restored islands (see 2006 Annual Report).

Monitoring

The objective of developing a monitoring component to the project was to measure the success of the predator eradication by measuring indices of shearwater population growth and proxies for ecosystem recovery through land-bird and vegetation surveys. Monitoring was conducted in three phases. Phase I, which has been completed, included measuring the impact of rats and weka on shearwaters prior to eradication. In phase II, we modeled the impact of the predators (rat and weka) on shearwaters (based on data collected by the University of Otago research team), and were then able to estimate the potential success of the restoration project given different scenarios of success. To further document the success of the restoration activities, we conducted a study to measure the density of native birds prior to eradication and therefore predict restoration outcomes and measure multi-species benefits. In phase III, we conducted bird counts post-eradication (see 2006 Annual Report for methods). Finally, in phase IV (2011-2013), we will directly measure the number of burrows of breeding birds with repeated island surveys post-eradication. We will used two techniques – multiple one meter radius circular plots and pre-established transects encompassing 20 burrows. Vegetation cover in the understory and canopy will be quantified on a percentage of cover in each plot or transect.

During re-surveys, the research team will visit treatment islands (rats killed) (e.g. Taukihepa, Mogonui, Rerewhakapoko, and Pukeweka), and rat-control islands (with rats) (e.g. Tia, Joss'), and rat-free control islands (without rats) (e.g. Putahinu, Pohowaitai). These surveys will take place during two to three field seasons (2011-2013).

Education

The objective of the education component of the project was to create awareness of the project by people in California and New Zealand and develop understanding of the cultural and

environmental importance of this migratory seabird. The main outreach component of the project outside the birding community was a documentary video.

Results & Accomplishments

Eradication

The main goal of the project was to enhance Sooty Shearwater breeding habitat by removing introduced predators –rats and weka– on nesting islands. To this end, we have successfully completed the first and main objective to remove introduced rodents on four islands. In July 2006, we deployed bait to eradicate black rats on Taukihepa, Pukeweka, Rerewhakaupoko Islands and Kiore on Mokonui Island, New Zealand (Fig. 1). Since the bait drop in 2006, four birding seasons have passed without signs of recent rat activity on any the targeted islands. Weka were eradicated from all three of the smaller islands (Mokonui, Pukeweka, and Rerewhakaupoko). By the end of 2006 it was clear more weka survived the bait-drop on Taukihepa than was expected. The larger size of Taukihepa (2295 ac) likely reduced the chances that every weka was exposed to poison. It should be noted that the weka take during the bait drop was considered incidental to the main objective of eradicating rodents. During 2007-2008, concerted efforts by the birding community and DoC trapping teams were made to control weka. KMNK consulted with birders through the manu supervisors regarding weka removal and received agreement on removing the weka from the four target islands. Three DoC contractors spent time trapping and shooting weka on Taukihepa, Pukeweka, and Mokonui/Mogoiti Islands during July 2007 (see 2007 Annual Report).

In 2009, Ka Mate Nga Kiore and DoC reassessed this issue and decided that the weka eradication on Taukihepa would require significantly more resources than available through the Command fund. Robert Coote (KMNK) remarked that “The 2007 and 2008 weka trips to Taukihepa did not appear to translate into a perceptible curtailment of weka population growth in the subsequent birding seasons”. KMNK also determined it would take substantially more additional resources (~$260k USD) than are available through the Command trustees. Currently, KMNK is leading efforts and providing support in the birding community to continue to control weka. A larger funding source is needed to attempt a future total eradication of weka on Taukihepa.

Quarantine

New Zealand partners *KMNK* continued to promote “Keep the Tïtï Island Rat Free” message through outreach at community meetings, calendars, DVDs and signage. There is a continuing discussion on quarantine taking place within the birding community, KMNK and with input from specialists in DoC. Several milestones have been met and the community has found innovative ways to spread the message of preventing re-introduction of invasive mammals to the Tïtï Islands. The *Rakiura Titi Islands Rodent Quarantine Strategy* was approved and the long term contingency plan for re-invasion will be covered under the *DoC Biosecurity Plan* per Andy Roberts, Southland Conservancy (see update 3 May 2006). The quarantine poster and brochure have been printed and widely distributed. The quarantine poster was turned into a 2006 calendar, which proved very popular. New calendars were reprinted in 2007, 2008, 2009 and 2010. A quarantine message of “It’s up to you...keep our islands rat-free” was printed with catchy graphics on a calendar for 2008 and distributed to members of the birding community who visit the islands regularly. Calendars were also distributed to helicopter and boat charter companies who transport people and gear to the islands. We noted that the pictures from previous years were posted in ferries and at public terminals around Rakiura Island. In 2009-2010 ballpoint pens with the message “Look after your Taonga” (treasured birds) were made and distributed. These types of outreach are simple, cost-effective and have a wide impact.

Finally, we have developed novel quarantine protocols, methods, and educational materials to support the restoration activities, including creating a documentary film. In 2008 we completed a 50 min educational film entitled "The Tïtï Islands: A Paradise Restored" (South Coast Productions, Te Anau, NZ) about this unique project. This DVD is available online in NZ to support continued quarantine work and the first 2,500 copies were made freely available in the US and NZ for educational purposes through Oikonos.org. In 2010, KMNK continued to promote "Keep the Tïtï Island Rat Free" message through outreach at community meetings, calendars and signage.

Monitoring

Shearwater Monitoring

Henrik Moller at the University of Otago led the tïtï research team monitoring shearwater nesting islands pre-eradication. In 2005-2006, the tïtï team surveyed shearwater nesting habitat on targeted and control islands to estimate burrow density and occupancy, and vegetative cover in study plots. From these data, Peter Dillingham and others of the tïtï team modeled the expected positive response of shearwaters equivalent to the projected damages within 10 years post-eradication (see 2009 Report "Predation Report"). This projection will be compared with empirical data to be collected in the final phase of the project during 2010 – 2013.

Monitoring Ecosystem Response

To date we have initiated a native bird study designed to measure the impacts of rats prior to eradication and the benefits to the island ecosystem post-eradication. In 2008, the first post-eradication monitoring report indicated a positive beneficial response of vegetation, insects and land birds to the removal of rats (2009 Annual Report). A 2010 survey and report by Harper indicated continued increases in the proxy indices – land bird abundance – of successful seabird habitat restoration (see fig. 2). The abundance of native birds on Taukihepa has increased in the two surveys since the 2006 eradication of rats.

Education & Outreach

In 2008, Ka Mate Nga Kiore worked with South Coast Productions, NZ, to produce the final version of a video entitled "Restoring Paradise" documenting the story of the shearwaters killed by the Command spill and the unique restoration plan to eradicate rats on shearwater nesting islands in New Zealand. Oikonos will be working with KMNK to find resources to distribute this film in the US and NZ.

2010 Papers/Presentations:

- Jamie Newman (University of Otago) presented a poster at the World Seabird Conference in Victoria, BC, September 2010, entitled, "California Oil Spill Kills Rats in New Zealand" or Pan-Pacific mitigation and international conservation of seabird-dominated ecosystems: the Rakiura Tïtï Islands Restoration Project" by Newman et al.

- A significant accomplishment by our colleagues in a special section of New Zealand Journal of Zoology, Vol 36, 2009. This volume includes several papers on the research from the NZ Rakiura Shearwater Restoration Project (Appendices).

- Pete McClelland (Dept. of Conservation) participated in an "Island Invasives" Symposium in NZ in 2010 and drafted the manuscript entitled, "The Rakiura Restoration Project: Community action to eradicate *Rattus rattus* and *Rattus* exulans for ecological restoration and cultural wellbeing" by P.J. McClelland; R Coote; M Trow; P Hutchins; H. M. Nevins, J Adams, J Newman and H. Moller to be published as proceedings of this symposium (D. Veitch, ed.).

2011 Work Plan

- **Quarantine:** We will continue to produce the "Keep Tïtï Islands Pest-Free" calendars and other outreach materials for 2011. We will continue outreach with the birding community and upkeep of signage around arrival and departure sites for the Tïtï Islands.
- **Monitoring:** We will conduct the first re-surveys of shearwater colonies in 2010/11 birding seasons. These surveys are key in documenting restoration success with empirical data to compare to past modeling results. Burrow density (number of borrows km-1) will be the metric used for comparisons as occupancy may be variable depending on interannual changes in food available to the breeding birds and may not be reflective of population-level changes. Surveys will be conducted on a suite of islands including those in the treatment sites (target islands: Taukihepa, Mogonui, Pukeweka, and Bench), and islands that still harbor rats (Tia, Joss') and those without rats (Putahinu, Pohowaitai). Experienced observers will be used to increase efficiency in relocating transect markers. Jamie Newman from University of Otago will summarize and present results from modeling and bird surveys to date in a manuscript for the journal of Conservation Biology.
- **Project administration:** Oikonos will continue to coordinate all activities with NZ partners and provide reporting to Command council. NZ partners will facilitate communications with tribal entities and landowners.
- **Education:** Outreach videos will be distributed locally to California state Parks and in NZ as requested. A short web trailer will be posted on the Oikonos website.

Budget

Budget Justification

Since the project began, we have met the project objectives using resources within our estimated budget and in many years we have made significant cost saving with additional in-kind support from NZ partners. The US economic slump has decreased the value of the US dollar compared to foreign currencies and thus in recent months the exchange rate has increased in favor of the NZ dollar, resulting in higher than expected costs for the project (~$1700 increase for 2011). Despite these changes, we are confident in our ability to complete the tasks outlined with the resources that are available.

We request a budget of $25,114 USD to support continued shearwater conservation activities included under the projects goals of weka eradication, quarantine, monitoring and administration outlined in 2011 work plan (Table 1). Specifically, we require funds to support

ongoing financial/ and administrative management of the project by NZ partners ($2,947); production and distribution of quarantine materials and attendance at meetings ($5,164); shearwater monitoring salary, transport and equipment ($8,503); and report writing, preparation and meeting attendance by US project managers ($2,704); and 30% indirect costs ($5,796). All of these tasks meet the outlined objectives in the scope of work for the Rakiura Tïtï Restoration Project approved previously by the Command Trustee Council (See Table 2 budget for projected expenses for 2011-2013 [to end of project]).

Summary & Conclusions

To date the Rakiura Tïtï Restoration Project has successfully completed phases of permitting and planning (phase I), implementation of rat and weka eradication (II), and initiation of post-eradication monitoring and quarantine (III). The project has received a favorable letter of support from the NZ Minister of the Environment, Chris Carter, acknowledging the importance of this international conservation effort and garnered significant funds by NZ partner Ka Mate Nga Kiore from the NZ National Biodiversity Fund (~70k NZD). Partnerships with the NZ Department of Conservation provided significant in-kind support for the operation amounting to ~39k USD (~55k NZD).

Surveys since the poisoned-baits were dropped on The Big South Cape Islands in July 2006 indicate there have been no rat sign on any of the targeted islands. In 2006-07, a team concentrated weka trapping and culling efforts on the three smaller islands (Mogonui/Mogoiti, Pukeweka, and Rerewhakapoko) and were successful in removing the remaining weka. Removal of weka from the large area of Taukihepa, however, will require a greater commitment of time, effort and money. The islander community is dedicated to controlling this invasive species during the shearwater nesting season.

Surveys of native bird abundance indicates that the eradication of rats from Taukihepa and surrounding islands has made significant changes in abundances of land birds in a short time (i.e., <2 years) and is still evident 4 yrs post-eradication. Continued monitoring of land birds as well as other ecosystem and biodiversity indicators (bats, insects, herptofauna) is sure to provide metrics of the success of this restoration project.

We hope that the film will enhance educational displays in state visitor centers and classroom audiences and ensure the longevity of the conservation message this project strives to communicate.

Recommendations for future management tasks

We recommend that the council consider other projects in NZ to remove invasive species from island and mainland refuges. Given the dramatic impact rat and weka depredation has on shearwater chicks, the removal of these non-native predators will ensure the continued long-term benefits of the Rakiura Shearwater project.

Sooty Shearwaters continue to face human-induced threats throughout their non-breeding and breeding range including chronic oiling, plastic ingestion and fishery bycatch. Recent mass strandings in Chile prompted concern for this species –investigations suggested fishery bycatch was responsible. Future mitigation projects to address this issue are warranted. This will require involvement of international partners and creative approaches for the conservation of this species.

Expense Report

Table 1. Summary of budget and actual expenses allocated for 2010 work. Significant in-kind contributions were made to the project from collaborators and partners Ka Mate Nga Kiore*, NZ Department of Conservation, and the University of Otago Tïtï research team.*

2010 Budget and Expense Report
09-1001 New Zealand Shearwater Project

Prepared by H. Nevins, Oikonos Ecosystem Knowledge 03.07.2011

		2010		
Objective	Budget Item[a]	Budget[b]	Expenses	Balance
Eradication				
	NZ project management	2,600	2,600	-
Quarantine				
	supplies (outreach)[c]	4,555	4,555	-
Shearwater-Titi Monitoring				
	Planning & Implementing Field Surveys (contract to KMNK)		$ 28,286	-
	Salary	18,713		
	Supplies	3,108		
	Accomodation	1,596		
	Transportation	2,244		
	Data entry and checking	2,625		
	Report writing			
	salary (US project manager)	2,600	2,600	-
Subtotal		38,041	38,041	-
	Overhead (0.30)	11,412	11,412	-
Total		**49,453**	**49,453**	-

[a] Costs based on exchange rate of 1 NZ$ = 0.70 USD. Significant changes in the exhange rate will require adjustments to these expenses.

[b] Expenses Approved by Command Council in 2009.

[c] Education & Outreach materials designed to promote rat quarantine including posters, brochures, articles, signs.

Projected Budget: 2011-2013

Table 2. Proposed Budget for final phase of Rakiura Titi Restoration Project for post-eradication monitoring during 2011-2013.

09-1001 New Zealand Shearwater Project

11/11/2010 H. Nevins, Oikonos Ecosystem Knowledge

Objective	Budget Item[a]	Phase 4 2011	2012	2013	Totals
Eradication					
	operations - weka				
	NZ project management	2,947	3,065	3,188	9,200
Quarantine					
	supplies (outreach)[c]	5,164	5,370	5,585	16,119
Shearwater-Titi Monitoring					
	Planning & Implementing Field Surveys	Island Group 2	Island Group 3	Island Group 4	
	Salary	3,830	12,160	4,622	20,612
	Supplies	183	977	244	1,404
	Accomodation	710	1,053	610	2,373
	Transportation	919	2,827	767	4,513
	Data entry and checking	2,861	2,861	2,861	8,584
	Report writing			11,445	11,445
	salary (US project manager)	2,704	2,812	2,925	8,441
Subtotal		19,319	31,125	32,247	82,691
	Overhead (0.30)	5,796	9,338	9,674	24,807
Total		**25,114**	**40,463**	**41,921**	**107,498**

[a] Costs based on exchange rate of 1 NZ$ = 0.79 USD (11/11/10). Significant changes in the exhange rate will require adjustments to these expenses.

[b] Expenses Approved by Command Council - Dec 2008

[c] Education & Outreach materials designed to promote rat quarantine including posters, brochures, articles, signs.

[d] Group 1 = Taukihepa, Mogonui, Pukeweka; Group 2 = Piko, Joss', Tia; Group 3 = Earnest, Betsy, Pohowaitai, Timore, Putahinu, Nuggets; Group 4 = Whenua Hou.

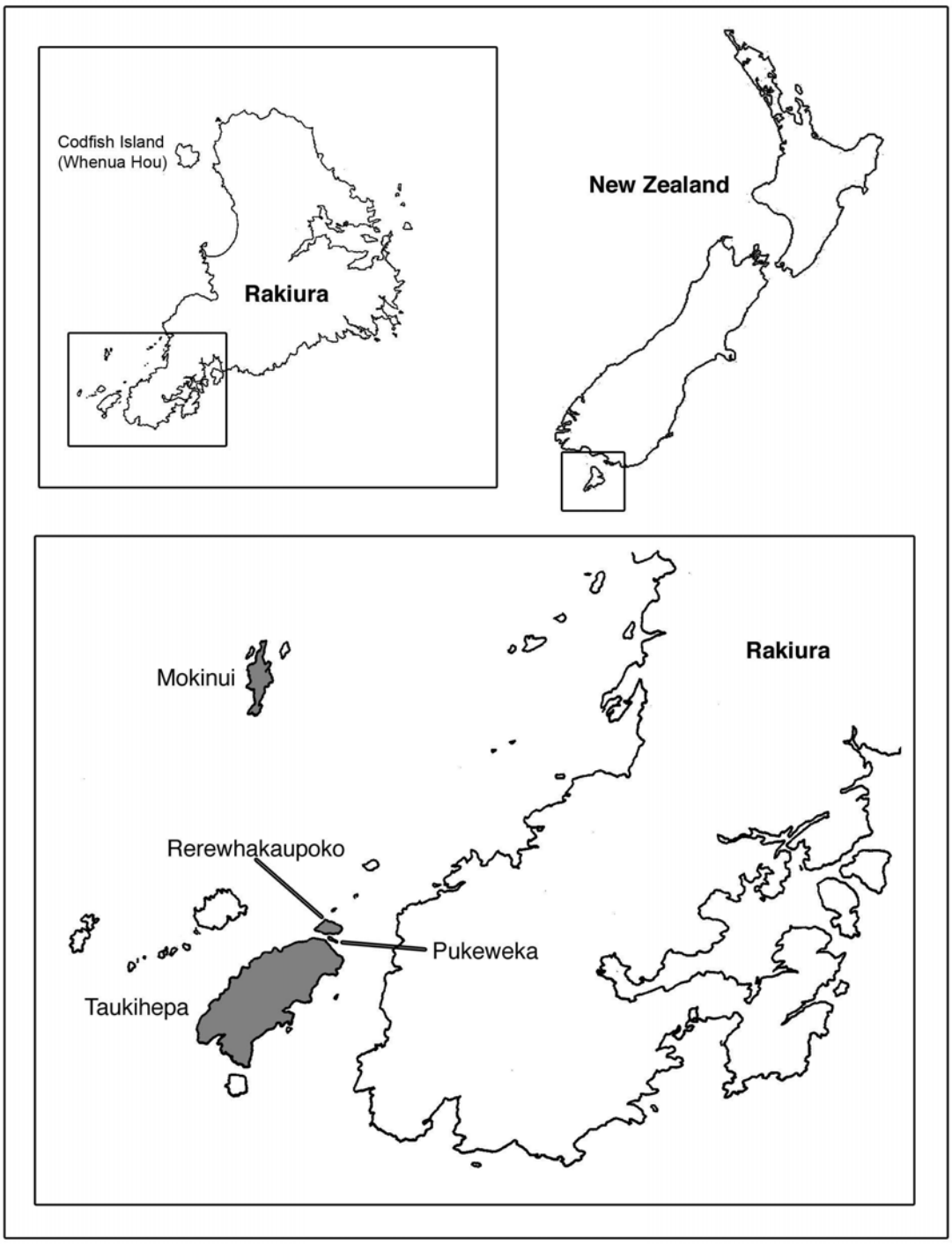


Figure 1. Location of four breeding colonies of Sooty Shearwaters (*Puffinus griseus*) in the Tïtï Islands targeted for rat eradications. The four islands targeted for rat eradication are Taukihepa, Pukeweka, Rerewhakaupoko (south of Taukihepa), and Mokonui Islands (dark shading). The banded shearwater killed during the 1998 Command oil spill was a breeding bird from Whenua Hou (Codfish Island). Figure from McClelland et al. 2011.

Appendix A: Harper, G. 2010 Report

Changes in relative abundances among forest birds before and after the eradication of ship rats on Taukihepa Island, Tïtï Islands, New Zealand (Report 2)

DRAFT

Grant Harper

Report prepared for Ka Mate Nga Kiore (Kill the rats) Incorporated Society

April 2010

Introduction

The Taukihepa (Big South Cape Island) ship rat *Rattus rattus* invasion of 1963 is one of the most infamous and well-documented introductions of an exotic species to an island. The ensuing irruption of ship rat numbers led to the extinction of several endemic and native bird species, an endemic bat, a large, ground dwelling weevil and other invertebrate species (Bell 1978).

Taukihepa (900ha) has several million burrowing seabirds on the island, mainly the titi, or sooty shearwater (*Puffinus griseus*) and mottled petrels (*Pterodroma inexpecta*). They breed on the island during the austral summer and the majority migrate to the northern Pacific (mainly the coasts of California, Alaska, Kamchatka, and Japan) during austral winter (Shaffer et al. 2006). Titi are subject to customary harvest by Rakiura Maori.

The breeding success of titi were probably being adversely affected by predation by ship rats during the chick stage. Large petrel species elsewhere were negatively affected by this rat species (Seto & Conant 1996, Jouventin et al. 2003, Igual et al. 2006). The affects of predation on titi by ship rats and weka (*Gallirallus australis*), a large native rail, have only recently been investigated (Harper 2006, Harper 2007).

In July 2006, ship rats were eradicated from Taukihepa and the nearby islands of Pukeweka, Rerewhakauopoko (Solomon) and kiore/Pacific rat *Rattus exulans* were eradicated from Mokonui Island. Funding for the eradication was provided by the *Command* Trustee Council as reparation for mortality of sooty shearwaters during an oil spill off the California coast during September 1998. The spill coincided with the sooty shearwater migration, and assessment data indicated that titi were the species most affected numerically.

Benefits from ship rat eradication were anticipated to extend beyond titi as other native forest birds on the islands were also likely to be adversely affected by ship rat predation (Moors 1983, Brown et al. 1998). Therefore, counts of forest birds were initiated to measure the response in numbers of birds after removing rats. It was expected that this response would be very quick once the adverse effects of predation and competition for food were removed. This is in contrast to measures of the response of titi to the removal of rats, which was not expected to be apparent for six to seven years when 'post-eradication' titi chicks begin to return to breed for the first time.

This is the second report of an ongoing study to record the changes in the relative abundances of forest birds after the removal of ship rats.

Methods

Bird counts were undertaken between March 15 and March 30 in 2006, 2008 and 2010. No counts were carried out in 2007. The counts were carried out in conditions of less than 15 knot winds and at the most, only light precipitation, to reduce the adverse affects of noise. Counts were carried out between 0900 and 1800hrs NZDT. All counts were carried out between the Parata and Parikiore manu inclusive, on the eastern coast of Taukihepa. Thirty-five counts were carried out over 1-3 days.

Counts were carried out under forest cover of 70-100% tupare *(Olearia colensoi*) forest with occasional small patches of *Hebe elliptica* and southern rata (*Metrosideros umbellata*). Sites were selected with groundcover of less than 20% of shield fern and/or water fern.

Two counts methods were used. The principal method involved counting all the birds that entered a 20-m diameter 'vertical cylinder' over a five-minute period. To do this a site was selected and temporary marks (flagging tape in small stakes) were laid out in a 10-m radius from the site. These sites were at least 100-m apart from other counting sites. Each site was located by GPS and weather conditions were noted.

The second method used the standard five-minute count method whereby all individual birds seen or heard from the selected site were counted over a five-minute period. This was a secondary or back-up method, mainly to obtain presence/absence data as a few species (i.e., blackbirds) were less likely to enter the 20-m diameter circle.

The data was analysed using repeated measures ANOVA.

Results

In 2006, 35 sites were sampled from 21 March to 22 March. The count data are in Appendix 1 and the abundances of birds are graphed in Figure 1.

In 2008, 35 counts were undertaken during March 27, 29 and 30. The count data are in Appendix 2.

In 2010, 35 counts were carried out on 17 and 18 March. The count data are in Appendix 3 and the abundances of birds are graphed in Figure 1.

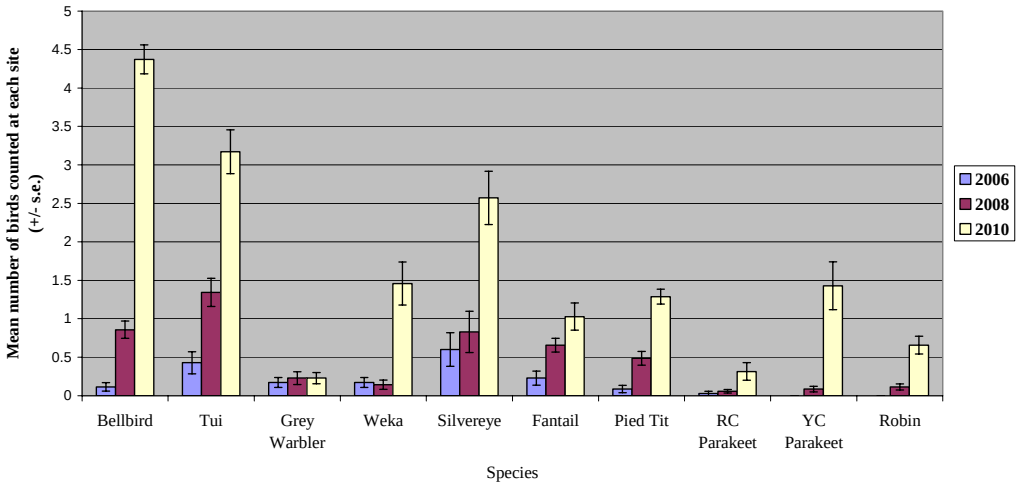
Fifteen species were recorded (Appendix 3). Nine native species were recorded in significantly greater abundances in 2010 compared with 2006: weka *Gallirallus australis* ($F_{3,35}$ = 19.2, P = 0.0005), koapara/bellbird *Anthornis melanura* ($F_{3,35}$ = 312.6, P = 0.0005), tui *Prosthermadera novaeseelandiae* ($F_{3,35}$ = 55.3, P = 0.0005), tauhou/silvereye *Zosterops lateralis* ($F_{3,35}$ = 14.3, P = 0.0005), miromiro/pied tit *Petroica macrocephala* ($F_{3,35}$ = 46.3, P = 0.0005), piwakawaka/fantail *Rhipidura fulginosa* ($F_{3,35}$ = 9.3, P = 0.0008), kakariki/yellow-crowned parakeet *Cyanorhamphus auriceps* ($F_{3,35}$ = 19.0, P = 0.0005) kakariki/red-crowned parakeet *Cyanorhamphus novaezelandiae* ($F_{3,35}$ = 5.4, P = 0.007) and toutouwai/Stewart Island robin *Petroica autralis rakiura* ($F_{3,35}$ = 24.8, P = 0.0005).

Of the native species only grey warbler/riroriro *Gerygone igata* had not increased in abundance ($F_{3,35}$ = 0.26, P = 0.77)

Introduced species
Dunnock *Prunella modularis* have increased in abundance since 2006 *(*($F_{3,35}$ = 7.7, P = 0.001) as have blackbirds ($F_{3,35}$ = 3.2, P = 0.05). A few redpolls *Carduelis flammea* were also heard.

Other bird species
On 17 March 2010, a black swan was noted flying into Murderer's Cove at 1030 hrs.

Changes in the abundance of native birds before and after a rat eradication on Taukihepa SW Rakiura/Stewart Island



Discussion

The abundances of all native birds, except grey warblers, have continued to increase since the eradication of rats in 2006. In early 2006, silvereye and tui were the most common species recorded, but bellbirds are now the most abundant bird along with tui. Whereas koapara/bellbirds were noticeably uncommon prior to the rat eradication (pers. obs.), they are now fifteen-times as common as they were three and a half years ago.

Although red-crowned parakeet were once the most common parakeet on the island, but still an uncommon bird, they have now been superseded by yellow-crowned parakeets, which were seen or heard on 24 of the 35 count sites. Prior to the rat eradication these parakeets were very rarely heard, let alone seen. Now groups of up to 10 yellow-crowned parakeets are often disturbed feeding in the leaf litter.
Weka have also made a noticeable comeback since the post-eradication count in 2008 and were regularly encountered at count sites and in occasionally groups of up to eight. They are now substantially more common than pre-eradication which suggests that rats were having some impact on their breeding success, which is surprising considering their size and aggressive nature. There was also a noticeable lack of adult dead korure/mottled petrels *Pterodroma inexpecta*. Prior to the rat eradication korure/mottled petrels carcases were commonly found in the steep forest behind Murderer's Cove. This lack of corpses suggests that only a few 'rogue' weka were actively preying on petrels or maybe titi chicks and that the behaviour was learned. The behaviour may reassert itself in future when pressure on weka numbers and food supply may force weka into preying on seabirds again.

The self-reintroduced robins have done well since their arrival on the island and were seen at 20 of the 35 count stations. This species should continue to increase in abundance for some time. Increases in the abundances of fantail and pied tit were also recorded which is not surprising as invertebrate numbers improve post rat eradication. Grey warbler continue to remain uncommon and will probably not increase much. On other islands without rats grey warbler are not particularly common, mainly due to competition from species like pied tit and bellbird.

It is expected that the increases recorded cannot continue to rise due to restrictions in habitat availability and competitive interactions between species and individuals. Another count in 2012 should note a levelling out in the mean number of individuals in all the species recorded at the sites.

Conclusion

The numbers of native birds on Taukihepa has continued to burgeon since the eradication of rats, which gives some indication of the density of birds present before rats arrived. It is likely that the growth in bird populations should level off shortly as competition between species begins to impede population growth. An additional count in 2012 should record this likely change in growth trend. In future, instead of rat predation severely restricting bird numbers, more natural limits to growth will assert themselves, namely fewer births and more deaths due to limited food supply. Normally in these situations of populations growing at the rate we have seen, there is often an 'overshoot' in numbers and a crash in the population before population return to equilibrium with the habitat and other species present. Eventually species' populations will level off around an optimum for the tüpare habitat. Whether we have reached that yet is to be seen. A complicating factor for some species will be the reintroduction of tïeke/saddleback, a species that will likely compete with some of the other species present. It has been very heartening and most surprising watching the incredible increase in abundances of native birds on the island since the eradication, which has certainly exceeded my expectations.

Acknowledgements

The Ka Mate Nga Kiore (Kill the rats) Incorporated Society and the Command Trustee Council provided the funding for this research. Hannah Nevins of Oikonos initiated the project and assisted with planning. Ron Bull and his whanau, once again, were supremely helpful and welcoming during my time on the island and the crew of the "Shangri La" got us onto the island. The Department of Conservation, Nelson/Marlborough Conservancy, provided for my time on the island at no charge.

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Appendix 1. Bird counts, Taukihepa March 2006

Site	2006 Bllbird	Tui	GWbl	Weka	S'eye	F'tail	P' Tit	RC P	YC P	Kaka	Robin	Dnnck	R'poll	Blkbird	Harrier
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0
3	1	0	1	0	2	1	0	0	0	0	0	0	0	0	0
4	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0
5	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0
8	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0
9	0	1	1	0	0	0	1	0	0	0	0	0	0	0	0
10	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
11	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
12	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0
18	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0
19	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
21	0	1	1	0	0	2	1	0	0	0	0	0	0	0	0
22	0	1	0	0	2	0	0	0	0	0	0	0	0	0	0
23	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
24	0	1	0	0	7	0	0	0	0	0	0	0	0	0	0
25	0	2	0	0	2	0	0	0	0	0	0	0	0	0	0
26	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
28	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0
29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
31	0	2	0	0	0	2	0	0	0	0	0	0	0	0	0
32	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0
33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0
35	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Totals	4	15	6	6	21	8	3	1	0	0	0	0	0	0	0

Appendix 2. Bird counts, Taukihepa, 2008

Site	2008 Bllbird	Tui	GWbl	Weka	S'eye	F'tail	P' Tit	RC P	YC P	Kaka	Robin	Dnnck	R'poll	Blkbird	Harrier
1	0	1	0	0	3	0	1	0	0	0	0	0	0	0	1
2	1	3	0	0	0	0	2	0	0	0	1	0	0	0	0
3	1	2	1	0	0	0	0	0	0	0	0	0	0	0	0
4	0	3	0	0	0	0	0	0	1	0	0	1	0	0	0
5	1	1	0	0	0	1	1	0	0	0	0	0	0	0	0
6	2	3	0	0	1	1	1	0	0	0	0	0	0	0	0
7	2	2	0	0	0	1	0	0	1	0	0	0	0	0	0
8	1	3	0	0	0	0	1	0	0	0	0	0	0	0	0
9	2	1	0	0	4	0	1	0	0	0	0	0	0	0	0
10	1	2	0	0	3	0	0	0	0	0	0	0	0	0	0
11	2	0	0	0	0	1	1	1	0	0	0	0	0	0	0
12	1	0	0	0	0	1	1	0	0	0	0	0	0	0	0
13	0	1	0	0	0	2	0	0	0	0	0	0	0	0	0
14	1	0	1	0	0	1	0	0	0	0	0	1	0	0	0
15	2	0	0	0	0	0	1	0	0	0	0	0	0	0	0
16	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0
17	1	1	0	0	0	1	2	0	0	0	0	0	0	0	0
18	1	2	0	0	6	1	0	0	0	0	0	0	0	0	0
19	1	1	2	0	0	3	1	0	0	0	0	0	0	0	0
20	1	1	1	0	0	1	0	1	0	0	0	0	0	0	0
21	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0
22	0	3	1	1	0	0	1	0	0	0	0	0	0	0	0
23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24	2	0	0	0	0	1	0	0	0	1	2	0	0	0	0
25	0	1	0	0	3	0	0	0	0	0	0	0	0	0	0
26	1	1	0	0	2	2	0	0	0	0	0	0	0	0	0
27	1	1	0	0	4	0	0	0	0	0	0	0	0	0	0
28	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0
29	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0
30	3	4	0	1	0	0	0	0	0	0	1	0	0	0	0
31	0	1	1	0	0	2	0	0	0	0	0	0	0	0	0
32	1	0	1	1	0	1	1	0	1	0	0	0	0	0	0
33	1	1	0	0	0	1	1	0	0	0	0	0	0	0	0
34	0	2	0	0	0	1	0	0	0	0	0	0	0	0	0
35	0	2	0	0	3	0	0	0	0	0	0	0	0	0	0
Totals	30	47	8	5	29	23	17	2	3	1	4	2	0	0	1

Appendix 3. Bird counts, Taukihepa, 2010

Site	2010 Bllbird	Tui	GWbl	Weka	S'eye	F'tail	P' Tit	RC P	YC P	Kaka	Robin	Dnnck	R'poll	Blkbird	Harrier
1	4	2	1	0	1	0	2	0	2	0	0	0	0	0	0
2	4	3	0	2	3	1	1	0	2	0	0	0	0	0	0
3	3	1	0	1	1	2	1	0	2	0	1	1	0	0	0
4	4	4	1	1	0	0	1	0	0	0	0	0	0	0	0
5	4	2	0	0	2	3	1	0	0	0	0	0	0	0	0
6	4	4	0	0	0	1	1	0	0	0	0	0	0	0	0
7	5	6	0	1	0	2	1	0	0	0	1	1	0	0	0
8	4	4	0	0	0	0	1	0	2	0	0	1	0	0	0
9	5	1	0	2	3	1	1	0	1	0	0	0	0	0	0
10	6	3	0	2	8	2	0	1	3	1	0	0	0	0	0
11	7	5	0	2	4	1	1	0	1	0	1	0	0	0	0
12	5	5	0	0	5	0	2	0	2	0	1	5	0	0	0
13	6	7	0	1	4	0	1	0	1	0	1	0	0	0	0
14	6	6	1	1	4	0	1	0	0	0	0	0	0	0	0
15	3	3	0	2	0	0	1	0	2	0	1	0	0	0	0
16	5	5	0	0	3	2	2	1	2	0	1	1	0	0	0
17	5	4	0	0	0	0	1	2	0	0	0	0	0	0	1
18	5	1	0	2	3	1	1	1	0	0	1	1	0	0	0
19	4	1	1	0	3	1	2	0	1	0	3	0	0	1	0
20	5	3	1	1	4	1	1	3	1	0	1	0	0	0	0
21	5	3	1	4	3	2	1	1	0	0	2	0	0	1	0
22	4	4	0	1	8	2	1	1	3	0	0	1	0	0	0
23	4	1	0	5	3	0	1	0	1	0	0	1	0	0	0
24	6	4	1	2	3	0	1	0	1	0	1	0	0	0	0
25	4	5	0	1	3	3	2	0	1	0	1	0	0	0	0
26	3	2	0	1	4	0	1	0	1	0	0	0	0	0	0
27	4	1	0	8	0	1	3	0	0	0	1	1	0	0	0
28	5	3	0	3	0	0	1	0	0	0	1	0	0	1	0
29	2	1	0	2	3	4	2	0	2	0	1	0	0	0	0
30	4	1	0	0	3	1	1	0	4	0	1	0	0	0	0
31	4	2	0	1	3	1	2	0	3	0	1	1	0	0	0
32	5	3	1	0	3	1	1	0	1	0	1	3	0	0	0
33	4	2	0	1	3	1	1	0	1	0	1	1	3	0	0
34	2	5	0	1	0	2	2	0	0	0	0	0	0	0	0
35	3	4	0	3	3	0	2	0	10	0	0	0	0	0	0
Totals	153	111	8	51	90	36	45	11	50	1	23	18	3	3	1

Appendix B: Nevins et al. 2009

Appendix C: McClelland et al. 2011 [in press]

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Forum

International and cross-cultural management in conservation of migratory species

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We live in an age defined by global access to information. This has rapidly increased the scale of our ecological and social awareness (e.g., fair trade movement) and helped us to identify ecological problems and conservation solutions beyond the typical scale of traditional knowledge (i.e., the foraging range of a human group) or political jurisdictions (i.e., state or national boundaries). For the first time, we can comprehend and accumulate biological knowledge for species on the scale of ocean basins (Prince et al. 1992; Burger & Shaffer 2008). Coincident with this knowledge has been the awareness of the global human footprint and some of its consequences, such as, resource over-exploitation, habitat degradation, and species extinctions. Presently, however, we have a mis-match between the scales at which management frameworks operate (local, regional, national) and the scales at which ecosystems or their components exist (Crowder et al. 2006). Significant conservation actions must be made at appropriate scales (ocean basin, continental) for migratory species, particularly when these resources (e.g., blue fin tuna) are subject to extraction by entities with a variety of national and international allegiances (Block et al. 1995).

Geopolitical boundaries arbitrarily delineate sub-populations and hinder effective management and understanding of these species. This is particularly true for far-ranging or migratory species, where foraging, moulting, or nesting ranges can be widely dispersed. Knowledge about habitat connectivity among neotropical migratory songbirds and butterflies that breed in nearctic (North America) and winter in the neotropics (Central and South America) has led to the recognition of flyways or migratory corridors and the development of international conservation consortiums. In 1990, the "Partners in Flight/Compañeros en Vuelo/Partenaires d'Envo", an international conservation programme, was formed in response to growing knowledge of wintering area habitat loss and concerns about population declines. Such international programmes can address conservation issues at the appropriate (and in some cases, global) ecological scale and can be used as models for species not covered by such conservation initiatives.

The *Kia Mau te Tītī mo Ake Tōnu Atu* (Keep the Tītī forever) project exemplifies a cross-cultural collaboration of scientists and Māori community members to inform co-management of an important seabird resource (Moller et al. 2009a,b). Building upon this established partnership, we initiated the *Rakiura Tītī Islands Restoration Project*, an international collaboration

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between a United States non-profit conservation organisation, University of Otago scientists, and Rakiura Māori, with support from New Zealand conservation managers. Our shared resource, taonga tītī (the treasured sooty shearwater, *Puffinus griseus*), brought us together and facilitated an effective international partnership with the common goal of restoring damages to the New Zealand sooty shearwater population suffered as a result of the *T/V Command* oil spill off central California, United States in 1998 (Anon. 2004).

Pan-Pacific shearwaters face anthropogenic threats throughout their migratory range both on land (e.g., habitat disturbance, invasive species predation, over-harvesting) and at sea (e.g. oil spills, fishery bycatch, marine pollution, climate change; Croxall et al. 1984). Based on this knowledge, the New Zealand and United States scientists, with *iwi* support, proposed to the Command Oil Spill Trustee Council the removal of invasive predators (rats and weka) on nesting islands in the Southern Hemisphere. This was determined to be the best action to restore the equivalent shearwater losses from the oil spill, ensure multi-species benefits to important island ecosystems, and provide the greatest long-term conservation success.

Setting an empowering new precedent, the Command Oil Spill Trustee Council approved this international restoration project in 2003. This decision faced intense scrutiny and public criticism for allocating funds to be spent outside of the United States, where the perceived damages had occurred; however, despite strong opposition, the science-based assessment of threats to the population remained valid and the request for international stakeholder involvement was justified.

Throughout this experience of getting the project approved we found the greatest hurdle to conservation solutions for this migratory species was expanding the scale of the bureaucratic framework to seek and include indigenous stakeholders. And yet, without *iwi* (tribal) participation, this conservation action would not have been possible. Coordinated knowledge or establishment of a "community of learning" (Robson et al., this issue) and the regular inclusion of indigenous and non-indigenous peoples who benefit from shared resources will be required to make shared conservation gains in the future (Allen et al., this issue). In the marine biome, this problem is magnified as resource management and extraction are overseen by fishery management councils (which are industry-based) and international commissions and national treaty boards, such as the North American Free Trade Agreement or NAFTA (politically-based). It is rare to see inclusion of indigenous or scientific stakeholders.

Recent efforts to include a broader international approach to migratory marine species conservation has been planned and implemented through the Commission for Environmental Cooperation (CEC) supported in large part by NAFTA. Identified marine icons—the migratory leatherback sea turtles (*Dermochelys coriacea*) and pink-footed shearwaters (*Puffinus creatopus*)—illustrate the problem with defining even the scope of conservation and management action based on geo-political boundaries rather than ecologically meaningful boundaries. For example, these turtles are limited to nesting on islands in Papua New Guinea while the shearwaters are restricted to several small islands in Chile—both countries which are; (1) not part of the NAFTA tri-national group (United States, Canada, Mexico), (2) arguably the only places where significant conservation actions maybe accomplished, and (3) home to indigenous peoples who have a significant stake in conservation outcomes and resource use but have not been included (but see Anon. 2007).

We need to increase the scale of these "communities of learning" to include all stakeholders in future conservation work. At the same time we can not underestimate the strength and value of indigenous knowledge streams which involve time scales not often encompassed in modern western science (Wehi et al., this issue). For example, Lyver et al. (1999) provided an example of how Māori sooty shearwater chick harvest records were used to develop powerful predictors of future oceanographic change. Further, interviews with local inhabitants on

Bougainville Island suggest that leatherback turtle numbers had declined within the last 30–50 years (Kinch et al. 2009). Temporal scales of understanding can be greatly increased with the inclusion of traditional knowledge in our assessment of conservation issues and solutions.

In this new age of information, we must look to global co-management approaches to match the ecological scales of conservation issues we aim to solve. Because we desire to sustain natural resources which ultimately will sustain us, our *tamariki* (children), and our *mokopuna* (grandchildren), we will benefit by incorporating new approaches and more complete international and cross-cultural partnerships to understand and conserve our natural world.

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

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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 (*Rattus 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 on private islands can work. 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: *Rattus rattus*; *Rattus exulans*; sooty shearwater restoration; muttonbirding; international and local community collaboration

INTRODUCTION

There are approximately 21 million sooty shearwater (*Puffinus griseus*) associated with New Zealand breeding colonies (Newman et al. 2009). The majority (53%) breed on the 35 'Tītī Islands ('Muttonbird Islands) around Rakiura (Stewart Island) in southern New Zealand (Fig. 1). Rakiura Māori (the indigenous people of southern New Zealand) 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. 2009c), an important source of income (Wilson 1979) and 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 Californian coast (Anon. 2004). Thousands of seabirds were killed by the oil spill, including between 2 and 32 thousand (median estimate 15,500) sooty shearwater (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. 2009c).

Oikonos Ecosystem Knowledge, an American non-profit research group, recognised this event as an unprecedented opportunity to request *Command* mitigation funds to remove invasive species from sooty shearwater colonies in New Zealand in order to repair the oil spill injury to sooty shearwater populations. All mitigation proposals were required to redress the injury to affected species and 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.

The islands

Four islands were chosen as a priority for rodent eradication, based on their importance for birding (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). The first three islands were effectively treated as one island during the eradication because ship rats can easily swim between them.

The Taukihepa group (Taukihepa, Pukeweka and Rerewhakaupoko) had been historically recognised as one of New Zealand's ecological jewels, including being the last refuge for several species of birds and the greater short-tailed bat (*Mystacina robusta*) before ship rats (*Rattus rattus*) invaded the Taukihepa 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 that—more than any other event in New Zealand—triggered widespread realisation of the ecological impacts of introduced rodents and the need for their eradication from islands.

Mokinui, 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 both the planning and implementation costs required, yet promised significant ecological gains because of its relatively large size. Mokinui had *kiore* (*Rattus exulans*) present.

Funding

The joint Oikonos-Rakiura Tītī Islands Administering Body bid to eradicate rats from the Tītī Islands was prepared by assisting scientists (Moller et al. 2003). It was successful, and the *Command* Trustee Council granted an initial US $513,000 for restoration including, rat eradication (70% of expenditure), scientific monitoring of outcomes (10%), reporting and administration (10%), and 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 being based upon each island's history. Once funding had been secured, 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 which 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 task was to link the various parties involved in the planning and operational aspects of the project and the thousands of owners of the islands, keeping them informed of progress and getting a consensus on approval for the relevant aspects when required. They 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 but this project was seen by the Trustee Council as an important part of mitigating the impact of the oil spill. Several factors gave the *Command Trustee Council* confidence to support investment on the other side of the Pacific. The existence of a comprehensive ecological research programme that had developed methods and already provided some of the before-eradication baseline data undoubtedly helped build confidence that the repair of the oil spill injury would be successful and adequately documented. Having a research team (*Kia Mau Te Tītī Mo Ake Tōnu Atu*) with population parameter estimates on hand to demonstrate the size of the injury to sooty shearwaters and to simulate prospects for recovery was a fortuitous circumstance that also helped guide the *Command* Trustees' decision.

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* continued to have an active involvement in the project management and became the liaison between USA and New Zealand entities. We believe it was important to have a trusted local US agent oversee the project from the funding end, while the KMNK performed a similar and crucial role in New Zealand for the operational and community aspects.

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 needed to be made. While significant work had gone on before this, 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). DOC is recognised internationally for its expertise in rodent eradications and it was considered that, from a technical aspect, the eradication was 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, did add complications which had not previously been encountered. 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. This included preparing a blessing ceremony prior to the eradication to keep the operators safe and ask for overall success of the venture. It was also important that ancestral guardians of the islands understood the reason for breaking with 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).

It was initially planned that the eradication would take place during 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 covering the bait drop, 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 makes the overall process slower and less certain, but the multi-stakeholder buy-in to the overall goal is thereby more solid and lasting. Local knowledge of the community is essential for putting the plan into action more effectively. DOC undertook to prepare the applications for all the legal consents required, although they were applied for and issued to KMNK. This simplified the consultation process as 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, yet 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 on the drop days (DOC 2006). The bait (10-mm diameter cereal bait pellets [Pestoff 20R] containing 20-ppm brodifacoum) was loaded in 25-kg bags into 1.2 m^3 plywood "pods" which had been used for the Campbell Island eradication in 2001 (McClelland pers comm). These 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. The condition of the pods, to ensure they were water tight, 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 was carried out following the standard procedures developed in New Zealand over the proceeding 20 years. This consisted of two aerial drops of 8 kg ha^{-1} and then 4 kg ha^{-1} Pestoff 20R. 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

There are greater than 100 buildings distributed around the islands, primarily near the coast. These include sleeping quarters, workhouses, and storage sheds used during the muttonbirding season. While the bait was spread over the whole of the islands during the aerial drop, including over the buildings, it was recognised that the buildings provided possible refuge 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 approval to get 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 themselves as they 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). It was also believed that the many buildings which are scattered around the islands would act as attractants for any remaining rats hence, aiding in their detection. Although the monitoring was extensive, it was not formalised as no training was given and no attempt was made to record where people had been, so there could potentially have been gaps in the coverage. Therefore, it was decided to

wait for three years (three muttonbirding seasons) before declaring the operation a success. This milestone was reached in June 2009. —Nor was there any sign of rats during the March –May 2010 birding season.

As a requirement from the funding agency, it was necessary to quantify repair to the impacted population. Monitoring plots were established so that a 'Before-After-Control-Impact' approach (Stewart-Oaten et al. 1986) can eventually be taken 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 and not coordinated. The removal of the rats has allowed the recovery of many of the bird species on the islands. Stewart Island robin (*Petroica australis rakiura*) and fernbirds (*Bowdleria punctata*) have both naturally re-established from neighbouring predator free islands. However the ongoing presence of weka (*Galliralus australis*), a large predatory rail introduced to the island in the early 1900s as a food source, has meant that the smaller ground nesting and burrowing seabirds as well as well as lizards and larger invertebrates have not recovered. KMNK would like to remove weka from the islands, but currently lack the resources to do so.

Quarantine programmes:

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Quarantine is an ongoing issue now that the islands are rat-free. Each March and April, boats of a wide variety of sizes transfer of large quantities of food-stuffs and equipment to the islands. No formal quarantine programmes existed before this project and 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.

Long-term ecosystem and threatened species recovery depends on heightened quarantine now the eradication is complete. Quarantine is focused primarily at pre departure and in transit as catching rodents once they get to the islands is considered unlikely. Measures include, producing and disseminating posters, calendars, and other 'promotional' material all emphasizing the importance of quarantine. Giving presentations at 'permit' days (important

preseason administrative meetings for muttonbirders). A short film about the eradication itself, including the importance of quarantine has been produced by KMNK.

DISCUSSION

That the project involved such a diverse range of organisations and groups shows that it is possible for private groups, with adequate funding and the right technical advice, to carry out eradications on private 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 the groups without 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 of the birds which were previously present on the islands. The continued presence of weka on Taukihepa will prevent some species, especially ground nesting birds including smaller seabirds, from re-establishing. Tīeke / 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 only saved from extinction, after rats invaded Taukihepa, by 36 individuals being transferred to two nearby islands (Atkinson and Bell 1973, Bell 1978). It is hoped that by having charismatic and culturally important species such as tīeke on the island for the first time in over a generation, the birders will appreciate the ecological impact the rats had and will work harder 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, with private landowners, a NZ government department, a university and a US-based international non-profit working together to complete the project. While it is clear that 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 America. 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 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 large-scale movements of seabirds across political boundaries and jurisdictions that are ultimately irrelevant from an ecological point of view (MacLeod et al. 2008, Nevins et al. 2009).

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409 Fig. 1 Location of the Tītī Islands, Whenua Hou and The Snares where the Rakiura
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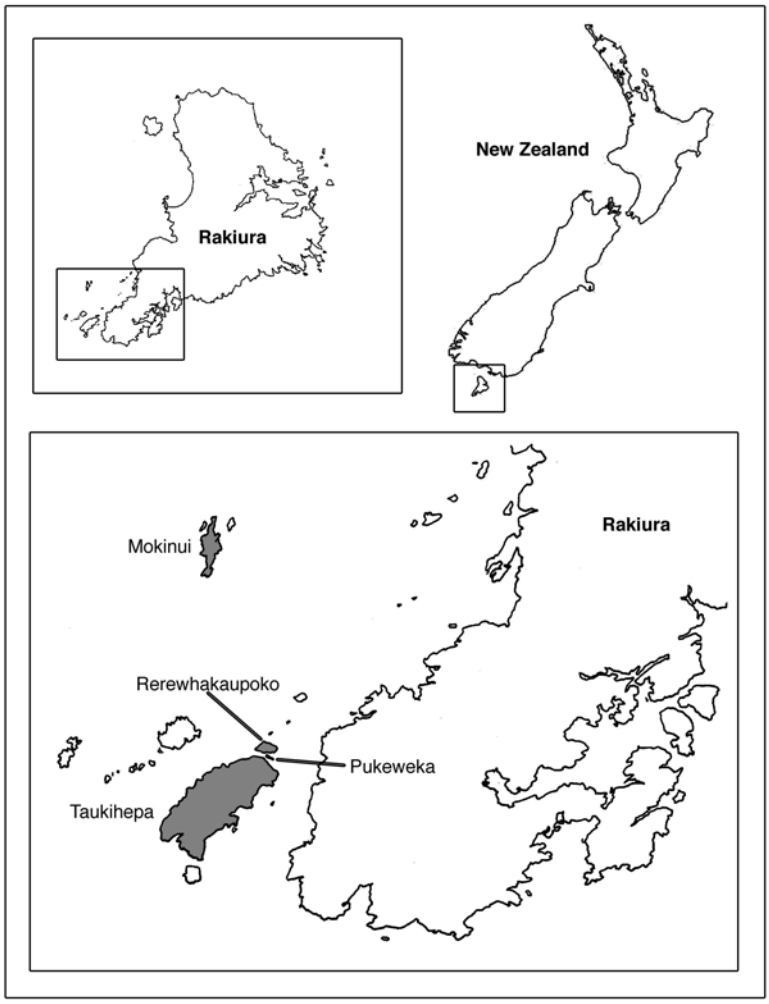

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