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Traditional ecological knowledge and harvest management of Tītī (*Puffinus griseus*) by Rakiura Māori.

Jane C. Kitson

A thesis submitted for the degree of
Doctor of Philosophy in Zoology
At the University of Otago, Dunedin,
New Zealand

August 2003
FRONTISPICE: Sooty Shearwater adults. (*Puffinus griseus*; tītī)

*(Photo: Jamie Newman)*
MIHIMIHI

Ka tangi te tītī
Ka tangi te kākā
Ka tangi hoki ahau
Tihei mauri ora!

Ko Takitimu te maunga
Ko Aparima te awa
Ko Rakiura te moutere
Ko Uruao te waka
Ko Ngāi Tahu, Ngāti Mamoe, me Waitaha ngā iwi
Ko Kati Atawhiua ō te hapu
Ko Te Takutai ō Te Tītī te marae

Kua hono te iwi ō Rakiura me te Whare Wānanga ō Otakou.
Ki te honono ngā tari ō te Rakiura mātauranga, mo te tītī me te rangahau taiao ki te pūtaiao.
Kei te whakamoemiti ahau kia koutou mo to koutou manaaki mai i ngā mahi ō te Te Tari ō Whakaaro Kararehe.
Kia koutou ngā whanau ō Putauhinu moutere,
Kia koutou ngā kaumātua ō Rakiura.
He mihi aroha mo o awhina mai i ahau i ngā wā ō tuku mahi.
Ki te kimi, ki te tiaki i ngā taonga me ngā mea pai ō ka moutere ō te tītī.
Kia mau te tītī mo ake tōnu atu
Mo tatou a mo ka uri a muri ake nei.
Abstract

ABSTRACT

Rakiura Māori continue a centuries old harvest of tūtī chicks (sooty shearwater, *Puffinus griseus*) which is governed primarily by Traditional Ecological Knowledge (TEK). The sustainability of tūtī harvesting is of high cultural, social and ecological importance. Some commentators view contemporary use of TEK as insufficient to ensure sustainability because it is no longer intact, too passive, and/or potentially inadequate to meet new ecological and technical challenges. Such assertions have been made in the absence of detailed description of TEK and associated social mechanisms. This thesis describes Rakiura Māori TEK practices and management systems that are in place and asks whether such systems are effective today, and whether they will remain effective in future.

Ecological, social and cultural factors are intertwined in cultural wildlife harvests so the methodology used was a combination of quantitative ecological methods and semi-directive interviews of 20 experienced harvesting elders. The research also used ecological science to evaluate potential harvest monitoring methods and to determine what sets the limits on harvest. These ecological studies focused on harvesting by four families on Putauhinu Island in 1997-1999.

Harvest is divided into two parts. In the first period (‘nanao’) chicks are extracted from breeding burrows during daytime. In the second period (‘rama’) chicks are captured at night when they have emerged from burrows. Nanao harvest rates only increased slightly with increasing chick densities and birders’ harvest rates varied in their sensitivities to changing chick density. Although harvest rates can only provide a general index of population change a monitoring panel, with careful selection of participants, may be the only feasible way to assess population trend and thereby harvest sustainability or the resource’s response to changed management.

Rakiura Māori harvesting practice constitutes common property resource management based on birthright and a system of traditional rules. Protection of island habitat and adult birds, and temporal restrictions on harvest are considered most important. Legislation and a belief system of reciprocity and connection to ancestors and environment aid enforcement of the rules.
Abstract

Ecological knowledge is learnt through observation, hands-on experience and storytelling. Younger Rakiura Māori now spend less time harvesting which puts pressure on the transmission of knowledge. Paradoxically, use of modern technology for harvesting aids transfer of essential skills because it is easier and faster to learn, thereby contributing to the continuance of a culturally important harvest.

Limits on harvest are passive, with the numbers of chicks taken determined by the time spent harvesting and processing. Processing is more limiting during the rama period. Future innovations that decrease the time to process each chick during rama could greatly increase the total number of chicks caught. Recently introduced motorised plucking machines decrease the time required to pluck each chick. However, on Putauhinu Island, use of plucking machines did not increase the number of chicks harvested, indicating social mechanisms were also limiting. Elders identified changing values between the generations, which may reduce the future strength of social limitations on harvest pressure.

Global climate change may reduce the predictability of traditional knowledge. Rakiura Māori have identified this risk and sought to examine ecological science as a tool to complement traditional knowledge for monitoring harvest sustainability. Climate change, declining ōī numbers and potential changes in technology or markets all threaten the effectiveness of current social limits to harvest. Rakiura Māori have previously shown the ability to adapt and must look to add resilience to their institutions to ensure we keep the ōī forever.
ACKNOWLEDGMENTS

It is hard to know where to start in thanking those who have helped me through the journey in life and study that was my PhD.

I would like to thank my supervisor Henrik Moller - I really appreciated your guidance, honesty and support – I think I owe you a few wines. David Fletcher my other supervisor provided statistical support in a user-friendly and fun manner.

I would also like to express my appreciation to my other ‘supervisors’ the Rakiura Tūī Island Administering Body – your advice and guidance shaped this thesis. Aku mihi nui ki a koutou.

Without the Davis, Spencer, Lees and Fisher whanau of Putauhinu Island the fieldwork of this study would not have been possible. I am overwhelmed by your patience, hospitality and kindness. Your island is a beautiful jewel in the southern ocean – a true testament to the care you have for each other and the environment.

I am truly privileged to have been able to interview kaumātua from my community. To abide by their wishes for confidentiality I am not able to name them individually, but I want to express my gratitude to all of them – for your time, patience and willingness to share some of your knowledge and history.

Helen Frizzle from the Oral History Unit at Presbyterian Support Services, provided Oral History equipment and methodology advice. The transcription of the oral history interviews produced over 1,500 pages, so I am truly indebted to Julia Stroud, Ronda Peacock and Detta Russell who helped with this process. Each interviewee was given a booklet of their interview and again Ronda Peacock helped by doing much of the photocopying and helped with binding and laminating of the covers. She also provided me much morale support – she could bring sunlight to some of the darkest moments. Thanks Rondy!!! The transcription booklets were also brightened up with wonderful covers designed by Darren Scott and Ken Millar.
Acknowledgments

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With huge love and pride I thank my partner Zane – he has given me endless support and encouragement, not to mention continuous supplies of caffeine drinks and meals!!
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GLOSSARY

Māori and specialised Tītī harvesting terms.

Hākauí A legendary bird that has never been seen.
Harakeke *Phormium tenax*. The type of flax used to make kete.
Heke ano kai tītī The annual migration to the Tītī islands.
Hui A gathering. Also refers to when the chicks are gathered together in bunches of five at both ends of twine or flax string and slung across the shoulder for carrying.
Iwi Tribe; a large group of people of related ancestry.
Kaiaka, kaiaki Adult tītī. Also referred to as mother, parent or old birds.
Kiaka Skinny chick, too thin to take. Term also used for a poor season.
Kaitiaki (Verb): to protect or guard; (Noun): guardian; protector.
Kaitiakitanga The act of guardianship.
Karakia Prayer, charm, incantation.
Kaumātua Respected and wise elder.
Kete Flax baskets.
Kina Sea urchin (*Evechinus chloroticus*).
Kiri tōtara Tōtara bark (*Podocarpus hallii*).
Korure Mottled petrel (*Pterodroma inexpectata*).
Kuka Dead dried flax leaves (*Phormium tenax*) still attached to the plant.
Lala (rara): Twigs and small sticks used as kindling wood. Also known as ‘morning wood’.
Mahinga kai Food, and places for obtaining natural foods, methods and cultural activities involved.
Manu Birding ground, in relation to tītī harvesting often a specific families’ area.
Māoritanga Māori culture, māori perspective.
Mātauranga Knowledge.

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<td>Spiritual essence, Life force.</td>
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<td>Mokopuna</td>
<td>Grandchild, younger generation.</td>
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<td>Morepork</td>
<td>See ruru.</td>
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<td>Muttonbirding</td>
<td>Colloquial term for all aspects of harvesting tītī.</td>
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<td>Nanao</td>
<td>First part of tītī season when chicks are extracted from burrows.</td>
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<td>Pahure</td>
<td>A period of the harvest when harvesting occurs over ground already worked during nanao.</td>
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<td>Pākehā</td>
<td>Non-Māori person.</td>
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<td>Pakahi</td>
<td>Open country above the bush-line on some of the tītī islands.</td>
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<td>Parara (‘paras’)</td>
<td>Broad Billed Prion (<em>Pachyptila vittata</em>).</td>
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<td>Paua</td>
<td>Abalone (<em>Haliotis iris</em>).</td>
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<td>Pōhā</td>
<td>Kelp bag made from <em>Durvillea antarctica</em>.</td>
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<td>Pōua</td>
<td>Grandfather; can also refer to an old male relative.</td>
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<td>Pūnui (būnui)</td>
<td>A herbaceous plant that can grow up to 1m with large glossy green leaves (30cm or more in diameter) <em>Stilbocarpa lyalli</em>.</td>
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<td>Puru</td>
<td>A plug. A hole dug into a breeding burrow requires to be plugged to ensure the burrow is water tight.</td>
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<tr>
<td>Rāhui</td>
<td>To impose a prohibition.</td>
</tr>
<tr>
<td>Rakiura</td>
<td>Māori name for Stewart Island.</td>
</tr>
<tr>
<td>Rakiura Māori</td>
<td>Means any person who is a member of the Ngāi Tahu or Ngāti Mamoe tribe and is a descendant of the original Māori owners of Rakiura.</td>
</tr>
<tr>
<td>Rama (‘torching’)</td>
<td>The last period of the tītī harvest when the chicks are caught at night after they have emerged from their burrows.</td>
</tr>
<tr>
<td>Raupō</td>
<td>Native bullrush, (<em>Typha orientalis</em>).</td>
</tr>
<tr>
<td>Ruru, Morepork</td>
<td>A small native owl (<em>Ninox novaeseelandiae</em>).</td>
</tr>
<tr>
<td>Split</td>
<td>To cut open a chick with a knife, lengthways through sternum, in order to remove internal organs.</td>
</tr>
<tr>
<td>Te Ao Hurihuri</td>
<td>The changing world.</td>
</tr>
<tr>
<td>Tā</td>
<td>Placing bark, raupō or dried flax around the pōhā with an open network of twine or flax.</td>
</tr>
<tr>
<td>Taiao</td>
<td>Environment.</td>
</tr>
<tr>
<td>Taipo</td>
<td>Ghost.</td>
</tr>
<tr>
<td>Term</td>
<td>Definition</td>
</tr>
<tr>
<td>--------</td>
<td>----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Tapu</td>
<td>Sacred, forbidden, taboo.</td>
</tr>
<tr>
<td>Tāua</td>
<td>Grandmother or old female relative.</td>
</tr>
<tr>
<td>Tētēaweka</td>
<td>A tree that grows on the tītī islands <em>Olearia oporina</em>.</td>
</tr>
<tr>
<td>Tikanga</td>
<td>Custom, the correct way of doing something; lore or law.</td>
</tr>
<tr>
<td>Tītī</td>
<td>Māori name of sooty shearwater, (<em>Puffinus griseus</em>).</td>
</tr>
<tr>
<td>Tūpare</td>
<td>A tree that grows on the tītī islands (<em>Olearia colensoi</em>, leatherwood).</td>
</tr>
<tr>
<td>Tupuna</td>
<td>Ancestor/s.</td>
</tr>
<tr>
<td>(tūpuna pl.)</td>
<td></td>
</tr>
<tr>
<td>Water-clean</td>
<td>Method of removing down and feathers from tītī using hot water.</td>
</tr>
<tr>
<td>Weka</td>
<td><em>Gallirallus australis</em>, woodhen. A rail similar in size to a domestic chicken.</td>
</tr>
<tr>
<td>Whakatauākī</td>
<td>Proverb.</td>
</tr>
<tr>
<td>Whakapapa</td>
<td>Genealogy, family tree.</td>
</tr>
<tr>
<td>Whakaputa</td>
<td>Make come out, bring forth. Used to describe digging a hole in the top of a tītī burrow to enable extraction of the bird.</td>
</tr>
<tr>
<td>Whawhao</td>
<td>The act of filling pickled tītī into the kelp bag (pōhā).</td>
</tr>
</tbody>
</table>
Chapter One

General Introduction
GENERAL INTRODUCTION

*Tūtū* and harvesting

*Tūtū* (sooty shearwater, muttonbird, *Puffinus griseus*) are probably the most ecologically important and abundant of the Procellariiformes that breed in New Zealand (Richdale 1944; Warham and Wilson 1982). The centre of breeding abundance in New Zealand is on the islands adjacent to *Rakiura* (Stewart Island; New Zealand’s third largest island). Large populations are also found further south on the subantarctic Snares Islands (Warham and Wilson 1982; Marchant and Higgins 1990).

Adults spend April to August in the Northern Pacific and Atlantic for the austral winter, before migrating to Southern Hemisphere breeding colonies in September and October to breed (Warham *et al.* 1982; Spear and Ainley 1999). Breeding and non-breeding adults return to colonies from late September for courtship and to prepare nesting burrows which can be 0.2m to 4m in length (Hamilton *et al.* 1996; Warham 1990). Each breeding pair lays a single egg between mid November and early December (Richdale 1944; Warham *et al.* 1982). Lost or unsuccessful eggs are not replaced. Hatching occurs mid to late January and the chick emerges and fledges mid-April to late May (Falla 1934; Richdale 1963; Warham *et al.* 1982).

When on land *tūtū* are almost completely nocturnal. Adult birds leave by dawn, to search for prey such as crustaceans (particularly krill, amphipods and decapods), cephalopods (notably arrow squid *Nototodarus sloanii*) fishes and salps (Kitson *et al.* 2000; Cruz *et al.* 2001; Newman and Kitson 2001) and return at the onset of dusk.

There is strong year to year variation in laying and hatching. Prey availability may have an important role in determining adult survival, breeding success and chick fledging weight (Kitson *et al.* 2000). *Tūtū* harvesters have noted large interannual fluctuations in the condition (fat levels) and abundance of chicks (Russell and Gaw

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1998; Lyver 2002). In *kiaka* (skinny chick) years many chicks fail to fledge and many harvesters believe this is because of a scarcity of food.

Tītī number in the millions and are among the most abundant seabirds in New Zealand. Recent declines in tītī numbers have been detected from counts off the USA coast and analysis of a harvester’s diary, and may have declined 47%-90% in the past 16 years (Veit *et al.* 1996, 1997; Lyver *et al.* 1999). Declines in the number of dead tītī washed ashore on Northland beaches suggests that declines have been ongoing since the early 1960s (Scofield and Christie 2002). New Zealand’s mainland breeding colonies have contracted or disappeared mainly due to predation by introduced mammals (Jackson 1957; Marchant and Higgins 1990; Hamilton and Moller 1993; Hamilton *et al.* 1996; Jones 2000; Lyver 2000a; Lyver *et al.* 2000; Jones *et al.* 2003). However these small mainland colonies represent a very small proportion (much less than 1%) of the New Zealand population, so predation by introduced predators is an insufficient explanation for more widespread decline. The diary showed that tītī are in some way affected by the precursor climate conditions that bring El Niño and La Niña weather conditions, because fluctuations in tītī harvest rate predict the weather pattern ensuing over the next year (Lyver *et al.* 1999). Adult survival appears to be greatly reduced when an intense El Niño is coming. Climate perturbations may affect food availability or impair feeding efficiency, or changes to predominate wind patterns make migration to the southern breeding colonies more difficult.

Tītī are culturally very important for Rakiura Māori and their harvest is one of the last large scale customary uses of native wildlife in New Zealand. Traditionally, tītī are an important food and trade source of Rakiura Māori (Dacker 1990; Beattie 1994; Dacker 1994). *Heke ano kai tītī* (the annual migration to the Tītī Islands) are social occasions, uniting families and reaffirming cultural identity, which acts to generate social cohesion and group identity amongst Rakiura Māori (Waitangi Tribunal 1991; Dacker 1994; Taiepa *et al.* 1997).

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2 Rakiura Māori refers to a person who is a member of the Ngāi Tahu or Ngāti Mamoe tribe and is a descendant of the original Māori owners of Rakiura (Department of Lands and Survey 1978).
Archaeological data show that titi were widely exploited in prehistoric New Zealand 600-800 BP, but there is little archaeological data that pinpoints the onset of large scale birding, which may have been a proto-historic phenomenon (Anderson 1997; 2001). Radiocarbon data dated a fire pit on a southern titi island off Rakiura at 1470 - 1660 AD (Hawke et al. 2003).

On the 29th June 1864, the Deed of Cession of Rakiura was signed between Rakiura Māori and the Crown. Certain islands were set aside for Rakiura Māori to take titi (Beneficial Islands) and the other islands (Crown Islands) were retained by the Crown for the use of Rakiura Māori who were not descended from the chiefs who signed the Deed. Regulations enacted in 1912 at the request of Rakiura Māori themselves permitted the harvest of titi on 36 Muttonbird/Titi Islands in Foveaux Strait and around Rakiura. Harvests of titi chicks was only allowed during a "birding season", from 1 April to 31 May (Department of Lands and Survey 1978). In 1998, the Crown Titi islands ownership was returned to Ngāi Tahu (Ngāi Tahu Settlement Act 1998) and they were renamed the Rakiura Titi Islands. However, the regulation of the harvest is largely unaltered.

The main periods of harvest, nanao and rama, are related to chick development stages. During the nanao, which occurs from 1 April until mid-to-late April, the chicks are extracted from the burrows during daylight, usually by use of a flexible wire bent into a hook at one end. During the rama (or "torching" period: from late April until mid May) the chicks are captured once a sufficient number have emerged from their burrows at night to make the hunt cost-effective. As fledging approaches, the chicks spend more time out of their burrows to flex their wing muscles and lose their down. The nanao and rama harvesting modes can overlap, and birders will switch from one to the other according to the behaviour and abundance of the birds.
Each island operates within its own system of birding. Some have a 'closed system' where each family has their own area or *manu* in which to take tītī. Other islands have an 'open system' where individuals have rights to take from anywhere on the island. Some islands have variations of these systems depending on whether it is nanao or rama.

A system of Traditional Ecological Knowledge and legislation governs this harvest (Department of Lands and Survey 1978; Wilson 1979). Traditional Ecological Knowledge (TEK) refers to "a cumulative body of knowledge, practice, and belief, evolving by adaptive processes and handed down through generations by cultural transmission, about the relationship of living beings (including humans) with one another and the environment" (Berkes 1999:8). TEK is a system of knowledge that guides indigenous peoples' customary uses of wildlife.

The tītī harvest provides an important case study of TEK management systems in action within New Zealand. This study is of more widespread conservation interest, because of calls for reinstatement of customary harvest rights round the world (Posey 1996, IUCN 1997) and ensuing debates about the environmental safety of indigenous people’s harvest management. Some commentators in New Zealand deny that Māori can adequately manage the New Zealand environment (Moller 1996; Taiepa et al. 1997). This belief is seen in their submissions to the Southland Conservation Board on the proposed return of the ownership of the Tītī Islands to Ngāi Tahu (Southland Conservation Board 1994) and their submissions to the New Zealand Conservation Board on Customary Use of Wildlife (NZCA 1997). These submissions have challenged whether adequate TEK still exists amongst Māori; whether it can ever be sufficient to ensure sustainable use; and whether it can guide within new ecological conditions prevailing in New Zealand, or where new technologies may have made current harvest rates unsustainable. The issues surrounding the tītī harvests by Rakiura Māori parallel those experienced by other indigenous peoples in the world. Prior to the current ārī research programme very little research had occurred on the sustainability of this culturally significant harvest.

3 “Birding” or harvesting ground.
The Kia Mau Te Tītī Mo Ake Tōnu Atu research programme

Rakiura Māori established the Kia Mau Te Tītī Mo Ake Tōnu Atu “Keep the tītī forever” research programme in 1994. This was done to examine the sustainability of the harvest and to ensure that the birds remain plentiful for their mokopuna (grandchildren) (Moller 1996; Taiepa et al. 1997; Moller et al. 1999). The science objectives sought by Rakiura Māori are:

1. Measure the current level of the tītī harvest and assess whether it is sustainable in the long-term.
2. Provide guidance on where and by how much harvest must be increased or decreased in order to ensure sustainability of the harvest and to maximise the harvest opportunity.
3. Determine what sets the limit of the past and present tītī harvest levels so that the impact of any future technologies or changed practices can be predicted.
4. Provide base-line measures of tītī abundance and establish monitoring methods (so that any future changes in tītī numbers can be detected).
5. Determine the diet of tītī so that future research on food species might identify threats to the well being of tītī.
6. Begin research on the impacts other than harvest on tītī populations, including potential impacts of climate change, food failure, fisheries bycatch, introduced predators and pollution.
7. Record and compare the understandings of tītī ecology, harvest impacts and management generated from Mātauranga Māori and kaitiakitanga with that from ecological science and wildlife management.

Rationale of my research

This thesis addresses Objective 3 (Chapter 2); Objective 4 (Chapter 3); and components of Objective 7 (Chapters 4 and 5) of the Kia Mau Te Tītī Mo Ake Tōnu

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Chapter 1

Atu research programme. The overall aim of this thesis is to examine Rakiura Māori tītī harvesting TEK and management system practices as they relate to sustainability.

The potential impact of technology on customary use on tītī is an important consideration. There is debate on whether use of technology makes previously sustainable customary uses unsustainable (Berkes 1999; Lyver and Moller 1999; Lyver 2000b). Chapter 2 examines what current activities limit the number of chicks harvested and the potential influence the use of technology in processing has on harvest offtake. Using time and motion studies of harvesting and processing, and analysing the daily activity of muttonbirders, I determine which activities limited harvest size on Putauhinu Island. This research should enable Rakiura Māori to predict future impacts of any new technologies or methods proposed for use during the harvest.

The ability to monitor population trends is important to ensure sustainability in any wildlife harvest. I examine in Chapter 3 the postulate proposed by Lyver (2000b) that nanao harvest rates could be used to monitor tītī population trends. I assess and verify preliminary findings from Poutama (Lyver 2000b) by using more intensive measures on another tītī island to examine the suitability of nanao harvest rates as a monitoring tool.

Consistent with other indigenous resource users, Rakiura Māori have no rules that dictate the numbers they can harvest (Wilson et al. 1994; Colding and Folke 2001). This makes it important to understand other resource practice and social mechanisms behind harvesting practices that have governed sustainable use. This theme is examined extensively in Chapters 4 and 5. Chapter 4 investigates whether Rakiura Māori harvesting practices constitute common property resource management and the ways that TEK are applied to advance the sustainability of the tītī harvests. It is also important to understand how social processes adapt to changing ecological and social pressures and whether they provide a sound basis for sustainable resource

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management. Chapter 5 investigates mechanisms for generation, accumulation and transmission of ecological knowledge; structure and dynamics of institutions; and worldview and cultural values associated with Rakiura Māori tītī harvest. How such social processes worked in the past, how they might be changing and implications for sustainable resource management is investigated.

**Thesis structure**

This thesis has been written as a collection of stand-alone papers in order to facilitate publication. However, this does lead to repetition of material particularly in the “Introduction” and “Methods” sections of each chapter. This general introduction provides an initial introduction to themes and interrelationships of the papers that make up the thesis and details the structure of the thesis.

An edited version of Chapter 2 has already been published, and Chapter 3 and Chapter 4 have been submitted for publication as sole-authored papers. Chapter 5 requires editing because of its length, and once editing has been completed will be submitted with my main supervisor as a co-author.

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**Chapter 3:** Kitson, J.C. (submitted). Harvest rate of sooty shearwaters (*Puffinus griseus*) by Rakiura Māori: a potential tool to monitor population trends? This paper is currently in review by *Wildlife Research*.

**Chapter 4:** Kitson, J.C. (submitted). Looking after your ground: resource management practice by Rakiura Māori tītī harvesters. *Conservation Biology*. 
Chapter 5: Kitson, J.C. and H. Moller. Social mechanisms for sustainable resource management: learning and change by traditional Māori seabird harvesters. This paper will be submitted to *Society and Natural Resources*.

Chapter 6: Discussion. This chapter summarises and links the findings within each of the chapters.

My research for this PhD also involved studies of tītī diet (Objective 5 of the Kia Mau Te Tītī Mo Ake Tōnu Atu research project) and research on the harvesters’ selectivity of heavier and better developed chicks. The latter is a potentially important part of the impact of harvests on tītī populations (Objectives 1 and 2) because the larger chicks are the ones most likely to recruit back into the breeding population. The Kia Mau Te Tītī Mo Ake Tōnu Atu research project is a team effort. Team funding contractual requirements forced the earlier publication of this material with several co-authors. The resulting publications (Hunter *et al.* 2000; Kitson *et al.* 2000; Cruz *et al.* 2001) have not been included in this thesis in recognition that my contribution was only one part of a team’s effort.

REFERENCES


Chapter 1


Proceedings of a hui, Murihiku Marae, August 2000. Online at:
http://www.otago.ac.nz/Zoology/hui/Main/default.htm


Chapter 1


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Chapter 1

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An edited version of Chapter 2 has already been published, and Chapter 3 and Chapter 4 have been submitted for publication as sole-authored papers. Chapter 5 requires editing because of its length, and once editing has been completed will be submitted with my main supervisor as a co-author.

The chapters and submission details are as follows:


**Chapter 3:** Kitson, J.C. (submitted). Harvest rate of sooty shearwaters (*Puffinus griseus*) by Rakiura Māori: a potential tool to monitor population trends? This paper is currently in review by *Wildlife Research*.

**Chapter 4:** Kitson, J.C. (submitted). Looking after your ground: resource management practice by Rakiura Māori tītī harvesters. *Conservation Biology*. 

Chapter 5: Kitson, J.C. and H. Moller. Social mechanisms for sustainable resource management: learning and change by traditional Māori seabird harvesters. This paper will be submitted to Society and Natural Resources.

Chapter 6: Discussion. This chapter summarises and links the findings within each of the chapters.

My research for this PhD also involved studies of tītī diet (Objective 5 of the Kia Mau Te Tītī Mo Ake Tōnū Atu research project) and research on the harvesters’ selectivity of heavier and better developed chicks. The latter is a potentially important part of the impact of harvests on tītī populations (Objectives 1 and 2) because the larger chicks are the ones most likely to recruit back into the breeding population. The Kia Mau Te Tītī Mo Ake Tōnū Atu research project is a team effort. Team funding contractual requirements forced the earlier publication of this material with several co-authors. The resulting publications (Hunter et al. 2000; Kitson et al. 2000; Cruz et al. 2001) have not been included in this thesis in recognition that my contribution was only one part of a team’s effort.

REFERENCES


Chapter 1


Chapter Two

What Limits the Number of Tītī (*Puffinus griseus*) Harvested by Rakiura Māori?
Chapter 2

ABSTRACT

Māori continue a centuries old harvest of tītī chicks (sooty shearwater, *Puffinus griseus*) on islands adjacent to Rakiura (Stewart Island). This study measured time limits on the number of tītī taken each day from Putauhinu Island. In the first period of the harvest (‘nanao’) the chicks are extracted from the breeding burrows during daytime. In the second period of harvest (‘rama’) the chicks are caught at night after they have emerged from their nesting burrows. Capture rate is much higher during the rama than the nanao. More time is spent processing (plucking, cutting-up, gutting and packing) chicks during rama than the nanao because of a 1.3 – 1.7 increase in the number of chicks caught. Processing is a more limiting factor during the rama than nanao. Future innovations that decrease the time to process each chick during rama could therefore greatly increase the total number of chicks harvested on Putauhinu. Recently introduced motorised plucking machines decrease the time required to pluck each chick and make plucking less physically demanding and less painful. However, motorised pluckers did not increase the number of chicks harvested on Putauhinu. Other social limits may control harvest intensity and influence sustainability of muttonbirding.
Chapter 2

INTRODUCTION

Indigenous people worldwide practice customary use of plants and animals for food, shelter and art (Bridgewater 1995; Posey 1996; IUCN 1997). This use is justified with claims of asserting and maintaining cultural identities, but has brought indigenous people into conflict with preservationists and eurocentric conservation lobby groups that wish to stop the use of native wildlife (Redford and Stearman 1993; Smith 1994; Moller 1996; IUCN 1997; New Zealand Conservation Authority 1997; Weaver 1997). Preservationists often assert that harvests pose unacceptable risks to wildlife, and that traditional management systems and Traditional Ecological Knowledge (TEK) are unable to safeguard harvested species facing modern day pressures on wildlife resources (Head 1990; Caughley et al. 1996). Commercial exploitation, introduced predators, global climatic change and new capture and processing technologies may all make previously sustainable customary uses unsustainable (Berkes 1999; Lyver and Moller 1999a; Lyver 2000a).

If harvest management practices remain ‘passive’ (i.e. by not putting limits on the number of animals harvested) new technology may increase overall offtake if it increases the rate of harvesting (Altman and Allen 1992; Bomford and Caughley 1996). This concern assumes that indigenous people take as much of a natural resource as they can, as fast as they can, until a depletion of the resource occurs. It implies that there are no existing social or cultural restrictions on levels of harvest. These assumptions have rarely been tested by detailed study of customary uses of wildlife.

One of the last large scale customary uses of native wildlife in New Zealand is the annual harvest of sooty shearwaters (Puffinus griseus, tītī, muttonbirds) by Rakiura Māori (New Zealand’s southern-most indigenous people). Rakiura Māori travel to islands around Rakiura¹ (Stewart Island) to harvest chicks in April and May (Fig. 1).

¹ Māori words are italicised at first mention. They are defined by Dacker 1990, Roberts et al. 1995, Ryan 1995 and Ashwell 1999.
‘Muttonbirding’ is the body of techniques whereby the sooty shearwater chicks and fledglings are caught, processed and preserved for food (Anderson 1996, 1997). A system of TEK, guardianship (*kaitiakitanga*), and legislation govern this harvest (Department of Lands and Survey 1978; Wilson 1979).

Rakiura Māori established the *Kia Mau Te Tītī Mo Ake Tōnu Atu* “Keep the tītī forever” research program in 1994 to ensure the continuation of a sustainable harvest for future generations (Moller 1996; Taiepa *et al.* 1997; Moller *et al.* 1999). This study is part of that project. It uses time and motion studies of current practices to enable Rakiura Māori to predict future impacts of any new technologies proposed for use during the harvest. This may also allow Rakiura Māori to predict when harvest becomes uneconomic should the resource become depleted.

A preliminary investigation of processing and catch rate limits (Lyver 1999; Lyver and Moller 1999a; Lyver 2000a) on the number of tītī harvested was conducted on Poutama (Evening) Island (Fig. 1) in the 1994 and 1995 seasons. Two new technological innovations (plucking machines and the use of wax to remove pin-feathers) did not make work substantially faster, although they did make the work less physically demanding and painful (Lyver and Moller 1999a). This research needs to be replicated before conclusions can be drawn about limits on harvesting on all 36 Tītī Islands. Only a small number of ‘muttonbirders’ were observed on Poutama and environmental and social organisation also varies between islands (Kitson pers. obs.).

Using time and motion studies of harvesting and processing, and analysing the daily activity of muttonbirders, I determined which activities limited harvest size on Putauhinu. Plucking took a third of processing time on Poutama (Lyver and Moller 1999a), so variation in plucking is potentially the most important determinant of variation in harvest levels. Therefore, this study also investigated the potential effect of technology and the seasonal development of chicks, on plucking rates for different families muttonbirding on Putauhinu Island.
METHODS

Study Site

The study was conducted over three consecutive muttonbirding seasons (1997-1999) on Putauhinu Island (47°12.5'S, 167°21.6'E) (Fig. 1). The island is approximately 140 hectares in size. Putauhinu operates under a ‘closed harvest’ system, where each individual Rakiura Māori family has their own manu (birding ground) within which to harvest. Detailed observations occurred on four manu in 1997 and 1998, but harvesting was observed on only one manu in 1999.

Activity periods of birders

The harvest season consists of two phases: the nanao is where chicks are extracted from burrows during the daytime between 1 April until about 20 April; the rama (‘torch’) is the period where chicks are caught at night on the surface as they emerge from burrows to fledge and takes place between 21 April and 20 May (Lyver and Moller 1999a,b). All analyses separate these two harvest periods because each period’s harvest determinants and patterns differ radically.

Birders were asked to record their daily activities in a diary, one or two times per week during the 1998 and 1999 season. Birders from two manu recorded the number of hours that they spent processing during the late rama in 1997. They recorded the amount of time spent: (i) catching chicks; (ii) processing chicks; and, (iii) other activities (e.g. eating, sleeping, and leisure activities). Processing was divided into time taken to pluck-dewax (time to pluck, clip wings and legs, wax and dewax), and gut-pack (time spent gutting, salting, and packing chicks for storage). See Lyver (2000a) for a detailed explanation of these processes.
FIGURE 1: Rakiura (Stewart Island) and adjacent Titi Islands showing Putauhinu and Poutama Islands.
Usually, more than one birder worked on each manu and not all the birders carried out all the activities, nor were they always conducted at the same time. Activities were therefore calculated as a percentage of the ‘total birder time’ available to each manu (total minutes available each day x number of birders on each manu). Occasionally, a birder would visit another manu and help with some of the processing. These processing times were recorded, and then the time the helper remained on the manu was added to the ‘total birder time’ for that manu on that day. Standard errors for the means of these percentages were calculated using Cochran’s (1977) method.

\[ SE = \sqrt{\frac{1-n}{N}} \times (SD) \times \sqrt{n} \]

Where,

- \( n \) = number of days harvested that were sampled
- \( N \) = Total number of days worked on all manu in the particular period of harvest.
- \( SD \) = standard deviation

Two-sample t-tests assuming unequal variances were used to examine differences in mean percent time spent on each activity.

Throughout the three seasons this study recorded the time individual birders spent harvesting chicks and the numbers of chicks harvested each day (Table 1). Harvest time consists of the total time spent collecting chicks, travelling between the house and the manu, and ‘down time’ (lunch and short breaks). Over the duration of this study, all birders were considered ‘experienced’ harvesters (> 3 years catching experience).

The relationship between manu processing times (time to pluck-dewax, time to gut-pack, and total processing time) and number of chicks caught per day was examined using multiple regression analysis. Harvesting during nanao, variations in birder and day of season (1= 1 April, 2= 2 April etc.) and year could affect the number of chicks caught. Due to the unbalanced nature of the data, the year could not be used as a predictor (Table 1). A general linear model was used to relate the number birds caught to time spent harvesting, day, and birder. Harvest during rama, rain and moon patterns affect the number of chicks emerging on a given night (Lyver 2002) and
therefore were included in a general linear model. For this analysis, moon fraction was categorised into ‘no moon’, ‘some moon’, and ‘full moon’. Moon rise and set times for Putauhinu (source: U.S. Naval Observatory) were compared to rama harvest start and finish times, so that the moon category could be adjusted to ‘no moon’ if the moon had not risen during harvesting. Residual diagnostics from a preliminary analysis indicated that five observations had very high influence on the results, because they were from days not sampled in the other two years. These observations were eliminated from the final model.

The least significant terms (p<0.10) were dropped from models and the models were re-run until only significant terms remained (Neter et al. 1996).

**Plucking**

In 1998, consecutive plucking times were measured once a week on three manu during the nanao, and one-two times weekly during the rama. In 1997, plucking times were only measured in the rama period. Plucking time was from the instant that a muttonbirder picked up the dead chick from a pile until the plucked chick was put down.

A plucking machine consists of two machine-driven rubber rollers rotating towards each other with a metal grid placed across the top of the rollers. The chick is brushed across the grid and the rollers pull the feathers out. On Putauhinu, machine-plucking involved one birder removing most of the feathers by machine and another birder then removing what was left by hand (‘hand tidy’). Machine-pluck time is the mean machine-pluck times added to the mean ‘hand tidy’ times from the same manu on the same day. All plucking times are in seconds.

All birders hand-plucked during the nanao period. Chicks are considered too soft to pluck with a plucking machine before the rama. Only one birder hand-plucked over the entire season in 1998, and other birders hand-plucked in rama only when their plucking machines broke down.
All plucking times were log transformed for statistical analyses because untransformed residuals showed signs of non-constant variance. The numbers of chicks observed or measured varied greatly between days, so the analyses were weighted by each day’s sample sizes (Neter et al. 1996).

**Effect of chick development on plucking times**

Freshly killed, individually marked chicks were measured for their percent down (judged to the nearest 10%; Lyver 1999), weight, and closed-wing (from the farthest anterior point on the anterior edge of the wrist joint to the tip of the longest primary feather; Baldwin et al. 1931; Pettingill 1985) as indicators of chick developmental stage. Eighty-six chicks were measured during the 1997 rama and then the time taken to hand-pluck (n = 43) or machine-pluck (n = 43) each chick was recorded. Another 100 chicks from the 1998 nanao were measured and the time taken to hand-pluck each was recorded. Weights, percent down and closed-wing length were recorded for 11 - 175 (1997) and 65 - 272 (1998) harvested chicks each week throughout the season.

Multiple linear regressions were carried out to examine the effect of chick weight, closed-wing, and percent down on machine and hand-plucking times of individual chicks. Initial analysis suggested that the error variances for hand-plucking measurements in 1998 and 1997 were different, so the two years were analysed separately. Regression analyses were also used to examine how the mean of these development factors changed throughout the season and to examine whether the mean pluck time changed throughout the season in the manner predicted by changes in chick development. Lagged residual plots, in which the residuals were plotted against the residuals for the previous day, were used to check for autocorrelation in the above two analyses.

**Plucking technology and the role of experience**

Differences in mean plucking times between hand and machine-pluck were examined for each year during the rama, using a general linear model in which day of the season was a covariate. In 1997, one birder was an inexperienced machine-plucker (<3 years
machine-plucking experience). This birder's mean machine-plucking time was added to the 1997 model in order to compare the inexperienced machine-plucker's times with experienced machine-pluckers times and hand-plucking times.

RESULTS

Daily activities- how did Putauhinu muttonbirders spend their time?

The mean percentage of time spent processing and in other activities did not differ between the nanao and rama (Fig. 2). The time spent catching was less in the rama, compared to nanao, but time spent processing chicks rose during rama, so the total time worked during both harvest periods was equivalent (nanao = 37.6 ± 6.17% CI, rama = 36.6 ± 4.3%).

[Figure 2: Mean percent time spent on different activities during nanao (open bars) and rama (shaded bars) during 1997-1999 seasons on Putauhinu. Mean is for all manu and error bars are 95% confidence intervals. Significant differences (p < 0.05) between activities in nanao and rama are shown by stars.]
The mean duration of catching per birder was 4.94 (± 0.27 CI) hours per day during nanao and 2.38 (± 0.14) during rama (Table 1). The overall mean processing time per birder was 5.6 (± 1.94) hours (n = 19) during nanao and 6.18 (± 1.10) hours (n = 21) during rama.

Over twice as many days were taken off from harvest in nanao compared with rama (Table 1). During nanao, 76% of these were taken off due to wet weather. The majority of nights taken off during rama in 1997 occurred in the first week of this harvest period (50%) and/or when there was a full moon throughout the evening (83%). Only one birder took nights off in 1998, and this was to process chicks while another birder from the same manu harvested.

There was no significant difference in the number of chicks caught (in nanao and rama) and the total time taken to catch (nanao) between years (Table 1). However, during rama it took about 30-40 minutes longer to catch a similar number of chicks in 1998, compared with 1997 and 1999 (Fisher’s LSD test, significant at 5%).

**Variations in the number of chicks harvested and processing.**

A strong relationship exists between the number of chicks caught and the time spent harvesting each day in both nanao and rama (Table 2). The longer a birder harvested in a day the more chicks they caught.

Day of season and time spent catching were not correlated (nanao $r = -0.281$; rama $r = 0.237$).

The number of chicks harvested per day in the nanao varied greatly amongst individual birders (Table 2). The coefficient of variation of the captured chick numbers per day amongst birders ranged from 35.9% to 41.1% between 1997-1999. The actual day of harvest may have influenced the number of chicks caught (Table 1). No trend was apparent in the mean number of chicks caught with day of the season (Fig. 3a).
TABLE 1: Harvest effort and success during the nanao and rama, 1997-1999, on Putauhinu Island.

<table>
<thead>
<tr>
<th>Year</th>
<th>Manu n</th>
<th>Birder n</th>
<th>Days harvested</th>
<th>Days off</th>
<th>Mean chicks/ harvested day</th>
<th>95% CI chicks/day</th>
<th>Mean time catching (hours)</th>
<th>95% CI time catching (hours)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Nanao</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1997</td>
<td>3</td>
<td>5</td>
<td>67</td>
<td>22</td>
<td>66.9</td>
<td>6.2</td>
<td>4.92</td>
<td>0.41</td>
</tr>
<tr>
<td>1998</td>
<td>3</td>
<td>3</td>
<td>43</td>
<td>22</td>
<td>72.0</td>
<td>9.1</td>
<td>5.00</td>
<td>0.50</td>
</tr>
<tr>
<td>1999</td>
<td>1</td>
<td>2</td>
<td>33</td>
<td>1</td>
<td>79.1</td>
<td>10.6</td>
<td>4.87</td>
<td>0.58</td>
</tr>
<tr>
<td>1997-1999</td>
<td>4</td>
<td>6</td>
<td>143</td>
<td>45</td>
<td>71.4</td>
<td>4.7</td>
<td>4.94</td>
<td>0.27</td>
</tr>
<tr>
<td><strong>Rama</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1997</td>
<td>3</td>
<td>5</td>
<td>93</td>
<td>6</td>
<td>106.0</td>
<td>12.8</td>
<td>2.11</td>
<td>0.20</td>
</tr>
<tr>
<td>1998</td>
<td>2</td>
<td>3</td>
<td>53</td>
<td>13</td>
<td>130.5</td>
<td>20.2</td>
<td>2.81</td>
<td>0.24</td>
</tr>
<tr>
<td>1999</td>
<td>1</td>
<td>2</td>
<td>33</td>
<td>0</td>
<td>112.4</td>
<td>26.6</td>
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<td>0.25</td>
</tr>
<tr>
<td>1997-1999</td>
<td>3</td>
<td>7</td>
<td>179</td>
<td>19</td>
<td>115.2</td>
<td>10.2</td>
<td>2.38</td>
<td>0.14</td>
</tr>
</tbody>
</table>
TABLE 2: Results of general linear models predicting the number of chicks caught from the time spent harvesting on the same day, during nanao and rama in the 1997-1999 seasons on Putauhunu Island.

<table>
<thead>
<tr>
<th>Dependent variable</th>
<th>Predictor variables</th>
<th>Co-efficients</th>
<th>s.e.</th>
<th>d.f.</th>
<th>p-value</th>
<th>F-value</th>
<th>$r^2$</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Nanao</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of chicks</td>
<td>constant</td>
<td>-5.27</td>
<td>4.40</td>
<td>ns</td>
<td></td>
<td></td>
<td>83.4%</td>
<td>136</td>
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<td></td>
<td>time spent</td>
<td>0.25</td>
<td>0.01</td>
<td>1,108</td>
<td>&lt;0.0001</td>
<td>309.89</td>
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<tr>
<td></td>
<td>catching (minutes)</td>
<td></td>
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</tr>
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<td>day</td>
<td></td>
<td></td>
<td>21,108</td>
<td>0.012</td>
<td>1.98</td>
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<td></td>
<td></td>
<td>5,108</td>
<td>&lt;0.0001</td>
<td>11.98</td>
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<td></td>
</tr>
<tr>
<td><strong>Rama</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of chicks</td>
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<td>3.88</td>
<td>10.32</td>
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<td></td>
<td>time spent</td>
<td>0.87</td>
<td>0.08</td>
<td>1,116</td>
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<td>120.17</td>
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</tr>
<tr>
<td></td>
<td>day</td>
<td></td>
<td></td>
<td>23,116</td>
<td>&lt;0.0001</td>
<td>5.24</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>year</td>
<td></td>
<td></td>
<td>2,116</td>
<td>ns</td>
<td>1.03</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>birder</td>
<td></td>
<td></td>
<td>6,116</td>
<td>0.01</td>
<td>2.96</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>moon</td>
<td></td>
<td></td>
<td>2,116</td>
<td>ns</td>
<td>0.13</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>rain</td>
<td></td>
<td></td>
<td>1,116</td>
<td>&lt;0.0001</td>
<td>17.18</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>year*rain</td>
<td></td>
<td></td>
<td>2,116</td>
<td>&lt;0.0001</td>
<td>17.54</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>birder*time</td>
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<td></td>
<td>6,116</td>
<td>0.004</td>
<td>3.44</td>
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<td>2,116</td>
<td>0.004</td>
<td>5.79</td>
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<td></td>
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<td></td>
<td>(minutes)</td>
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</tr>
</tbody>
</table>
The day of season influences the number of chicks harvested each night during rama (Table 2). The coefficient of variation of number of chicks caught per day amongst birders ranged from 54.0% to 63.3% between 1997-1999. The mean number of chicks harvested each day of season stayed moderate, with little apparent trend in the last ten days of April, but then increased in early May (Fig. 3b). Approximately 1.5 times more chicks were harvested when it rained (mean_{rain} = 148.09 ± 19.23 CI, mean_{no\ rain} = 96.50 ± 13.56). An interaction between rain and moon phase was also significant. Birder harvested more chicks when it had rained and the moon had risen compared with clear moonlit nights (Table 2). The year and rain was also significant (Table 2) because there were more nights of rain during rama in 1998 (66%) than there was in 1997 (19%) and 1999 (29%).

Processing activities and day of harvest strongly predicted the number of chicks caught each day during rama (Table 3). Total time spent processing during nanao increased with the daily tally, unlike the time spent plucking-dewaxing and gutting-dewaxing (Table 3).

The number of chicks caught by machine-pluckers per night (mean = 109.7, se = 6.84, n_{days} = 107, n_{birders} = 5) was not significantly different than the number of chicks caught by hand-pluckers (mean = 125.4, se = 7.35, n_{days} = 55, n_{birders} = 3; two tailed t-test assuming unequal variances; p>0.05, d.f. = 136).

Changes in plucking times over the season.

Pooled mean hand-plucking times showed no evidence of change over the 1998 season (Fig. 4). However, in a regression of an individual birder’s hand-plucking times with day of season, birder ‘A’s’ time trend increased gradually over the whole 1998 season (Fig. 4). It took this birder 9 seconds (25%) longer to pluck a chick at the end compared with the start of the season.
This study found no evidence that machine-plucking times vary with day of season in both years (Fig. 4; $r^2_{1997} = 14.1\%$, $r^2_{1998} = 6.6\%$).

**FIGURE 3:** General Linear Model estimate of mean number of chicks caught by each birder on each day harvested during the a) Nanao and b) Rama (after the 20th of April) periods during 1997-1999 seasons on Putauhinu. Error bars are 95% confidence intervals.
TABLE 3: Results of multiple regression models predicting number of chicks caught each day from time spent processing on the same day, during nanao and rama in the 1997 and 1998 seasons on Putauhinu.

<table>
<thead>
<tr>
<th>Dependent variable</th>
<th>Predictor variables</th>
<th>Co-efficients</th>
<th>s.e.</th>
<th>d.f</th>
<th>p-value</th>
<th>F-value</th>
<th>$r^2$</th>
<th>n</th>
</tr>
</thead>
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<tr>
<td><strong>Nanao</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of chicks caught</td>
<td>intercept</td>
<td>58.99</td>
<td>2, 16</td>
<td>ns</td>
<td>2.25</td>
<td>24.0%</td>
<td>19</td>
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<tr>
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<tr>
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<td>2, 15</td>
<td>ns</td>
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<td>17.0%</td>
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<td>ns</td>
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<td>0.03</td>
<td></td>
<td>ns</td>
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<td>67.21</td>
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<td>ns</td>
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<td>ns</td>
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<td>Time spent gutting-packing (minutes)</td>
<td>0.14</td>
<td>0.13</td>
<td></td>
<td>ns</td>
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<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Number of chicks caught</td>
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<td>-91.62</td>
<td>2, 18</td>
<td>0.0001</td>
<td>31.55</td>
<td>77.8%</td>
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<tr>
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<td>0.03</td>
<td>0.0001</td>
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<td></td>
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<tr>
<td>Number of chicks caught</td>
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<td>2, 18</td>
<td>0.0001</td>
<td>28.22</td>
<td>75.8%</td>
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<tr>
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<td>day</td>
<td>5.47</td>
<td>1.39</td>
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<td>0.0009</td>
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<td>Time spent plucking- dewaxing (minutes)</td>
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<tr>
<td>Number of chicks caught</td>
<td>intercept</td>
<td>-65.04</td>
<td>2, 18</td>
<td>0.0001</td>
<td>16.97</td>
<td>65.3%</td>
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<td></td>
<td>day</td>
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<td>0.0175</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>Time spent gutting-packing (minutes)</td>
<td>0.45</td>
<td>0.12</td>
<td>0.0013</td>
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Figure 4: Individual birder mean hand-pluck times (open & crosses) and machine pluck times (solid) over the 1998 season on Putauhinu. A significant linear regression line for hand-plucker birder ‘A’ (crosses) is shown (p<0.001, F= 56.57, d.f. = 1,7, r²= 89%). Error bars are 95% confidence intervals. A multiple regression model (Table 4) predicted hand-plucking times using each day’s mean chick weight, wing length and % down during nanao and is shown by horizontal bars. Data points are back-transformed.
Effects of chick development on plucking time.

There was no evidence of a relationship between hand-pluck time and the three development variables in the 1997 rama (Table 4). However, in the 1998 nanao, it took more time to hand-pluck both the heavier and longer-winged chicks. No evidence was found that these chick development variables affected machine-plucking times.

Chick development changes.

Chicks were heavier in 1998 compared to 1997 (Fig. 5a; Hunter et al. 2000). No evidence was found that harvested chick weight changed over either the nanao and rama periods for both years (Fig. 5a). In both years closed-wing length increased significantly during the nanao (Fig. 5b), and then remained constant throughout the rama (Fig. 5b). The percentage of down cover decreased significantly in nanao and rama in 1998 and in 1997 during the rama (Fig. 5c). There were very slight differences in wing length between years whereas weight and percent down showed considerable variation.

Major changes in wing length and percent down were evident at the time of switching from nanao to rama. Weight stayed similar throughout the harvest. The chicks caught on the surface during the rama from 17–27 April were much more developed than chicks caught underground during nanao on 19 and 22 April (Fig. 5b). Projection of the nanao regression equations suggests that chicks underground (selected ‘blind’ by the nanao harvester) would not have reached the asymptotic wing length until around 26th or 27th April. This underscores how differential emergence behaviour at the beginning of the rama leads to more advanced (developed) chicks being harvested from amongst all those available.
Similarly, the fledgling chicks caught near the start of the rama had considerably less down than the more representative sample of chicks removed from burrows near the end of the nanao (Fig. 5c). This difference was particularly evident in 1998 compared to in 1997.

The hand-pluck times predicted by the regression model (Table 4), using the day’s mean chick weight, closed-wing length, and percent down, were very similar to the observed mean hand-pluck times during nanao (Fig. 4).
Figure 5a: Mean weight of chicks harvested during nanao (squares) and rāma (circles) over the 1997 (open) and 1998 (grey) seasons on Putauhinu. Error bars are 95% confidence intervals.
FIGURE 5b: Mean closed-wing length of chicks harvested during nanao (squares) and rama (circles) over the 1997 (open) and 1998 (grey) seasons on Putauhinu. Significant regression lines and equations are shown for:

Wing _nanao_ 1997 (grey) (p<0.0001, F=119.17, d.f. =1,4; r²=96.8%); Wing _nanao_ 1998 (black) (p<0.0001, F=446.45, d.f. =1,10; r²=97.8%).

Error bars are 95% confidence intervals.
FIGURE 5c: Mean % down of chicks harvested during nanao (squares) and rama (circles) over the 1997 (open) and 1998 (grey) seasons on Putauhinu. Significant regression lines and equations are shown for:

Down rama 1997 (grey) (p<0.0001, F=68.20, d.f. =1,11; r^2= 86.1%); Down nanao 1998 (dashed) (p=0.003, F=15.34, d.f. =1,10; r^2=60.5%);
Down rama 1998 (black) (p=0.001, F=16.43, d.f. =1,19; r^2=46.4%). Error bars are 95% confidence intervals.
### Table 4: Results of multiple regression models predicting time to hand or machine pluck a chick using percent down, weight, closed-wing length as predictor variables.

<table>
<thead>
<tr>
<th>year</th>
<th>method</th>
<th>harvest period</th>
<th>variables</th>
<th>coefficient</th>
<th>se</th>
<th>df</th>
<th>p-value</th>
<th>F</th>
<th>$r^2$</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td>1997</td>
<td>hand</td>
<td>rama</td>
<td>all</td>
<td>1.0273</td>
<td>0.8518</td>
<td>3, 39</td>
<td>ns</td>
<td>1.59</td>
<td>10.9%</td>
<td>43</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>intercept</td>
<td>1.0273</td>
<td>0.8518</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>weight (g)</td>
<td>0.0003</td>
<td>0.0003</td>
<td></td>
<td>ns</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>wing (mm)</td>
<td>0.0020</td>
<td>0.0033</td>
<td></td>
<td>ns</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>down (%)</td>
<td>-0.0003</td>
<td>0.0007</td>
<td></td>
<td>ns</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1997</td>
<td>machine</td>
<td>rama</td>
<td>all</td>
<td>1.1122</td>
<td>0.4352</td>
<td>3, 39</td>
<td>ns</td>
<td>0.39</td>
<td>2.9%</td>
<td>43</td>
</tr>
<tr>
<td></td>
<td></td>
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<td>intercept</td>
<td>1.1122</td>
<td>0.4352</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>weight (g)</td>
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<td>0.0002</td>
<td></td>
<td>ns</td>
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<td></td>
<td>wing (mm)</td>
<td>0.0011</td>
<td>0.0016</td>
<td></td>
<td>ns</td>
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<td></td>
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<td></td>
<td></td>
<td></td>
<td>down (%)</td>
<td>0.0004</td>
<td>0.0005</td>
<td></td>
<td>ns</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>1998</td>
<td>hand</td>
<td>nanao</td>
<td>all</td>
<td>1.2153</td>
<td>0.1191</td>
<td>3, 96</td>
<td>&lt;.0001</td>
<td>11.87</td>
<td>27.1%</td>
<td>100</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>intercept</td>
<td>1.2153</td>
<td>0.1191</td>
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<td></td>
<td></td>
<td></td>
<td>weight (g)</td>
<td>0.0002</td>
<td>0.0001</td>
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<td>0.004</td>
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<td></td>
<td>wing (mm)</td>
<td>0.0011</td>
<td>0.0004</td>
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<td></td>
<td></td>
<td></td>
<td>down (%)</td>
<td>0.0000</td>
<td>0.0005</td>
<td></td>
<td>ns</td>
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</tbody>
</table>
Hand-plucking compared with machine-plucking.

In 1997, the mean machine-pluck times and mean inexperienced machine-pluck times over rama were significantly lower than the mean hand-pluck times (Fisher’s PLSD, p<0.0001, Fig. 6). The experienced machine-pluckers were 33% more efficient. No evidence of significant time differences in the two plucking methods was found in 1998, and overall machine-plucking took 4 seconds longer (Fig. 6).

Hand-plucking took longer in 1997 than in 1998 (t-test assuming unequal variances; mean$_{1997} = 76.5$, mean$_{1998} = 54.5$, p = 0.030, d.f. = 7), and machine-plucking time was faster in 1997 than in 1998 (mean$_{1997} = 47.0$, mean$_{1998} = 58.3$, p = 0.001, d.f. = 16).

![Figure 6: Mean pluck times for hand (open), experienced machine (grey), and inexperienced machine (stripes) pluckers, during rama in 1997 and 1998, on Putauhinu Island. Results from the General Linear Model were p = 0.034, F = 4.12, d.f. = 1,18 in 1997, and p = ns, F = 0.20, d.f. = 1,15 in 1998. Error bars are 95% confidence intervals. Means are backtransformed.](image-url)
DISCUSSION

Variations in number of chicks harvested.

Individual birders varied in their harvest rate (chicks extracted per minute) each day during the nanao (CV ranged from 19.6 – 27.1% in the years 1997-1999). To extract chicks during the nanao requires a high degree of skill, and this varies amongst individuals. This was also observed in the Poutama study where the coefficient of variation of capture rates was much higher at 46.7% (Lyver 2000a). Birders also varied markedly in their nightly tallies of chicks during rama. The coefficient of variation in harvest rate of different birders ranged from 44.7 – 57.6%, higher than in the nanao. Although less skill is involved in the rama harvest compared with nanao (Lyver 2000a), the main reason for increased variation between nights is probably that chick emergence behaviour is an extremely variable determinant of success during the rama. However, spatial variation in chick abundance and distribution are probably also important. The speed of birders and access to areas where the chicks congregate may affect individual birders’ capture rates. For example, in 1997 two birders from one manu on Putauhinu were able to catch the same number of chicks as the rest of the birders in 30% less time. In some areas of the islands, certain manu were reportedly better sites to harvest, because they are more exposed to the prevailing winds which induce more birds to emerge from burrows (Lyver 2002).

There was no trend in the number of chicks caught per day throughout the nanao. In contrast, birders on Poutama were found to target areas of higher chick density before moving onto lower density areas so that the number of chicks harvested declined throughout the nanao (Lyver 2000a). Birders on Putauhinu may have enough high density areas on their manu to avoid having to use lower density areas as the end of nanao approaches.

During the rama, day of season had a strong effect on the nightly tallies, which corresponded with the emergence patterns of the fledgling chicks. The number of chicks remained moderate for the first week of rama but then increased at the
beginning of May when mass emergence and fledgling of chicks occurs. The same
effect was found on Poutama (Lyver 2002), where the harvest rates (chicks/minute)
increased as the rama progressed, then declined in its later stages.

Year did affect tally, but the total mean time spent harvesting was higher in 1998 than
the other years (Table 1). This emphasises the importance of a targeted tally. If
necessary, birders will work harder to get their expected numbers, even in a relatively
“poor” year.

Weather conditions during the season can also limit the number of days that can be
harvested in both harvest periods. Birders will rarely harvest on rainy days during the
nanao. During the rama, birders tend to target nights with wind, rain and lack of
moonlight because they produce higher catch rates (Lyver 2002; Kitson unpubl. data).
Other researchers have reported higher chick emergence during rain, and avoidance of
moon (Richdale 1946; Lyver 2000b, 2002). In this study, rain was a predicting factor
on the number of chicks harvested in a night. Moon phase was not shown to affect
tally, but the harvest timetable is usually arranged to avoid the moon by either
harvesting before it rises (‘night torching’) or after it has set (‘morning torch’). This
adjustment of harvest would have obscured moon effects. The interaction between
moon phase and rain affects tally, and harvesters will harvest on full moon nights in
conditions of heavy cloud cover.

The majority of harvest days were taken off during nanao, the period when harvest
rates are lowest anyway. Some of these days were spent visiting other manu, or in
leisure activities (particularly fishing) rather than being enforced because of wet
weather (Kitson pers. obs.). However, it was very rare for birders to take nights off
for leisure during the rama. The high number of chicks available and comparative
ease of catching them compensates for the discomfort of work during inclement
weather.
Processing limits on harvest.

On Putauhinu, the number of chicks harvested is strongly influenced by the total time spent processing. Processing takes a substantial proportion (53%) of total work time, and limits the time remaining to catch chicks.

During the 1998 nanao, hand-plucking times increased with weight and wing length of chicks. Heavier chicks are bigger and have more feathers to pluck. The wings themselves are not plucked, so the increased plucking times must relate to the more advanced chick development which is indirectly reflected by their increased wing length. There was no relationship with decreasing percent down. However, Lyver (1999) found that plucking time decreased with increase in percent down near the start of the rama. Low power from overall low sample size (n = 86 for both rama periods; Table 2) may explain the difference. However, it is also possible that my multiple regression underestimated the significance of this predictor in hand-plucking because it varied closely with other developmental features. Wing lengths reach a plateau soon after the start of rama (Fig. 3). It is possible that variations between other development stages of harvested chicks were not large enough to show differences in hand-plucking times. Differential emergence behaviour and birders’ selectivity of larger, more developed chicks (Lyver 2000b; Hunter et al. 2000) were evident from the way development stage of harvested chicks changed markedly from the end of nanao to early rama. This selection limited the range of variation of development between chicks sampled by my investigation (Table 4).

My study suggests that increased mechanisation from motorised plucking machines gave little relief from the overall constraint on harvest rate imposed by plucking time. Hand-plucking times increased over the duration of the 1998 season for one birder, which reflected increasing chick development over the whole season. Birder fatigue may also have been a factor. Hand-plucking is strenuous and painful on the birder’s hands. Increasing hand-plucking times over the season was also found for one birder on Poutama (Lyver and Moller 1999a). Birders have mentioned during formal
interviews that they adopted machine-plucking primarily to increase their comfort in plucking rather than to increase the speed of processing (Kitson unpubl. data).

Differences between speeds of plucking technologies were dependent on year, or on differences between individual pluckers. In 1997 the hand-pluckers took 24 seconds more than machine-pluckers, but also took 16 seconds longer than an inexperienced machine-plucker. Although an inexperienced birder using a machine takes 7 seconds longer than experienced birders using a machine, it was still quicker than hand-plucking. The results from 1998 show no difference between machine and hand-plucking. The differences between years may be because individual pluckers in each category were not the same in both years. Lyver and Moller (1999a) found no difference between machine and hand-plucking. This suggests that difference between machine and hand-plucking may relate strongly to differences amongst individual birders, especially their experience level and thoroughness. These factors can outweigh the marginally increased efficiency in plucking rate achieved by using a machine. As Lyver (1999) found, significant year-to-year differences between mean hand-plucking and machine-plucking from the same birders, so differences between the years cannot be ruled out.

It is harder to gain efficiency when learning to hand-pluck than when using a machine. On Poutama, experienced hand-pluckers were significantly faster than (34%) inexperienced hand-pluckers (Lyver and Moller 1999a). My study suggests an increase in efficiency of about 13% for experienced machine-pluckers compared to inexperienced machine-pluckers occurred on Putauhinu.

The lack of any strong influence of plucking machines on tally is also corroborated by the absence of a significant difference in total number of chicks taken by families with or without a plucking machine.
Chapter 2

**Limits on harvest levels**

Twelve birders from nine different islands stated in oral interviews that their daily chick harvest limit (‘tally’) is set by how long it takes them to catch and process the chicks (Kitson unpubl. data).

Overall the limits on the harvest on Putauhinu and Poutama are passive, with the numbers of chicks taken determined by the time spent harvesting and processing the chicks. The time saved from reduced time spent harvesting during the rama as compared with nanao is spent on processing the increased catch. Between 1.3-1.7 times more chicks are caught in the rama compared to the nanao, so processing is more of a limiting factor during the rama than nanao (Table 2). Future innovations that decrease the time to process each chick during rama could therefore greatly increase the total number of chicks caught each night.

On Poutama, the mean time spent harvesting chicks was higher than on Putauhinu in both harvest periods. Birders on Poutama spent a mean of 6.95 hours (se = 0.23, n_birder_days = 72) catching during nanao and 3.75 hr (se = 0.23, n_birder_days = 330) during rama (Lyver 2000a), for a mean tally of 77 and 97 chicks per day respectively (Lyver and Moller 1999a). On Putauhinu 28.9% and 36.5% less time was spent catching in the nanao and rama for similar daily tallies.

The density of chicks is an indirect determinant of the number of chicks that can be harvested on Poutama (Lyver 2000a). Harvest (chicks/minute) and strike rate (proportion of chicks caught per attempted burrow entrance) increased with increased chick density in different places and years on Poutama (Lyver 2000a). It is possible that an overall higher density of chicks on Putauhinu drives the faster harvest rate there, but more replication on several different islands is needed to test this hypothesis.
Innovations in traditional wildlife harvests.

The involvement of modern technology in traditional harvesting will not always increase exploitation. In this study, machine-plucking did not result in more chicks harvested in a day, even though in one year it allowed slighter faster plucking. Oral testimonies of birders suggest that the main motivation for technological innovations are to ease the burden of work rather than add to the number harvested (Kitson unpubl. data).

The introduction of new technology is often criticised for not being ‘traditional’ and interpreted to mean the people have lost their culture (Chase 1981; New Zealand Conservation Authority 1997). However, technologies can save physical effort without infringing upon the social and culturally important outcomes or rendering tradition unauthentic. Tools involved in a traditional harvest are less important than the social components surrounding it (Chase 1981). New technologies need not alter the amount of prey captured (Riddington 1982). The harvest of tītī by Rakiura Māori is not solely about catching the maximum number of chicks possible: many birders have commented that they go to the island to be with family, connect with the land and to escape from the pressures of modern life (Kitson unpubl. data). It is important to understand these social and cultural constraints and their implications for the number of chicks being harvested.

Culture is dynamic and not static, in other words culture is always in flux and responding to needs and circumstances. As a major feature of indigenous culture, Traditional Ecological Knowledge contains the capacity to respond and adapt to suit changing environmental conditions (Berkes 1999; Lyver 2002). Rakiura Māori have shown that by initiating and continuing a partnership in research with an ecological research team, they are able to use ‘modern’ ecological science methods alongside their own TEK and tikanga (customs). Using ecological science as a tool does not alter the relationship between Rakiura Māori and the tītī, just as the introduction of motorised pluckers and technological innovations need not threaten the continuation of culturally important harvests for future generations.
ACKNOWLEDGMENTS

I would like to thank the Rakiura Tiiti Islands Committee for their support and guidance as well as the birding community on Putauhinu Island. Thanks to Detta Russell and Christine Hunter for field support and the collection of data in the 1999 season. Dr Phil Lyver provided some logistical information. Drs Henrik Moller, Jamie Newman, David Fletcher and Mr Chris Jones reviewed the written manuscript. David Fletcher also provided statistical support. This research was primarily funded by the Foundation for Research, Science and Technology who also granted me a Tuapapa Puitaiao Mdoi Fellowship. Further financial assistance was received from a New Zealand Lotteries Board, the University of Otago, Te Riianga O Ngai Tahu, New Zealand Aluminium Smelters Ltd., New Zealand Department of Conservation, the Southland Licensing Trust, and the Pacific Development and Conservation Trust. Southwest Helicopters Ltd. have also provided logistic support.

REFERENCES


Chapter 2


Chapter Three

Harvest rate of sooty shearwaters (*Puffinus griseus*) by Rakiura Maori: a potential tool to monitor population trends?
ABSTRACT

Sooty shearwaters (tītī, muttonbird, *Puffinus griseus*) are highly abundant migratory seabird, which return to breeding colonies in New Zealand. The Rakiura Māori annual chick harvest on islands adjacent to Rakiura (Stewart Island), is one of the last large-scale customary uses of native wildlife in New Zealand. This study aims to establish whether the rate at which muttonbirders can extract chicks from their breeding burrows indicates population trends of sooty shearwaters. Harvest rates increased slightly with increasing chick densities on Putauhinu Island. Birders’ harvest rates vary in their sensitivities to changing chick density. Therefore a monitoring panel requires careful screening to ensure harvest rates of the birders selected are sensitive to chick density, and represents a cross section of different islands. Though harvest rates can only provide a general index of population change, it can provide an inexpensive and feasible way to measure population trend. Detecting trend is the first step to assessing the long-term sustainability of the harvest.
Chapter 3

INTRODUCTION

Indigenous people worldwide practice customary uses of wildlife (Bridgewater 1995; Posey 1996; IUCN 1997). These practices allow for the cultural survival of these people by the continuation of cultural values, group adhesion, and transmission of knowledge to younger generations (NZCA 1997).

The term Traditional Ecological Knowledge (TEK) describes the adaptive and dynamic body of knowledge that guides such customary uses of wildlife. It is acquired through direct experience and observation and is handed down through the generations (Stevenson 1996; Huntington 1998; Berkes 1999; Wenzel 1999; Usher 2000). Some scientists and resource managers have recognised the importance of TEK for its ability to provide valuable information on species ecology, distribution and management (Gunn et al. 1988; Freeman 1992; Ferguson and Messier 1997; Ferguson et al. 1998; Foale 1999; Wenzel 1999).

An important component of TEK is knowledge about past and current use of the environment, and in particular, an understanding of variation in harvest rates and prey abundance (Usher 2000). Statistics from harvest levels can be useful for both socio-economic and biological research purposes (Usher and Wenzel 1987), and as a way of monitoring resource abundance and the long-term sustainability of the current harvest.

Catch per unit effort is a common index of relative population density (Caughley 1977). Despite its widespread use as a population-monitoring tool, the relationship between harvest rate and prey density has seldom been studied in detail. Theoretically, if targeting only one species, hunting rate declines as density declines because it takes longer to find an animal at lower densities (Bomford and Caughley 1996). Catch per unit effort, as an index to population change, assumes that: (a) conditions of catch and catching efficiency are standardised; (b) the catching of one animal does not interfere with the catching of another; and (c) animals do not court or avoid capture (Caughley 1977). Caution needs to be exercised when interpreting harvest rate changes as relative measures of animal abundance, especially if the harvesters are only exploiting spatial and temporal periods of high abundance (Hunter
The annual harvest of sooty shearwaters by Rakiura Māori (New Zealand’s southernmost indigenous people) is one of the last large-scale customary uses of native wildlife in New Zealand. Rakiura Māori travel to islands around Rakiura¹ (Stewart Island) to harvest chicks in April and May (Figure 1). ‘Muttonbirding’ refers to the harvesting, processing and preserving techniques for sooty shearwater chicks and fledglings (Anderson 1996, 1997). A system of TEK, guardianship (kaitiakitanga) and legislation (Department of Lands and Survey 1978; Wilson 1979) govern this harvest.

Sooty shearwaters (tītī, muttonbird, Puffinus griseus) are a migratory seabird, which return to breeding colonies on the coastal islands and shorelines of New Zealand between September and May each year (Marchant and Higgins 1990). These birds nest in burrows and only lay one egg each breeding season. Strong year-to-year variation occurs in laying and hatching.

Sooty shearwaters number in the millions and are among the most abundant seabirds in New Zealand. Recent declines in sooty shearwaters have been detected (Veit et al. 1997; Lyver et al. 1999), but the long-term prospects for the population are unknown.

In 1994, the Kia Mau Te Tītī Mo Ake Tōnu Atu ‘Keep the Tītī Forever’ research program was established and co-managed by Rakiura Māori and researchers at the University of Otago (Moller 1996; Taiepa et al. 1997; Moller et al. 1999). One of the main research aims is to provide muttonbirders with cost effective and accurate methods to monitor sooty shearwater population trends (Moller 1996; Taiepa et al. 1997; Moller et al. 1999). Harvest rate fluctuations are an important part of TEK and the birders’ understanding of the resource wellbeing (Lyver 2002). Although catch per unit effort can provide a cheap and socially acceptable indexing method, it makes several assumptions. The main need is for a directly proportional change in harvest rate to be triggered by change in density. If the index is to have utility, the relationship must also be relatively constant between harvesters, places and years.

¹ Maori words are italicised at first mention, defined by Dacker 1990, Roberts et al. 1995, Ryan 1995 and Ashwell 1999.
The behaviour changes of developing chicks divide the harvest into two phases. The first phase is the nanao (April 1 to ~ April 20) when chicks are still in the nest and are extracted from burrows during the daytime, usually by use of a flexible wire bent into a hook at one end. The rama (torch) period (April 21 – mid May) begins when the chicks emerge at night from their burrows to fledge, and the ‘muttonbirders’ harvest them from the surface. This paper only investigates the relationship between harvest rate and chick density in the nanao.

On Poutama Island, the nanao harvest rates of chicks increased in both areas and years of higher chick density (Lyver 2000a). This suggested that monitoring harvest rates could monitor sooty shearwater population trends. However, measurements of chick densities were sometimes 30m from areas where muttonbirder harvest rates were recorded in the Poutama study (Lyver 2000a). My study gives a tighter spatial match between observed harvest rates and local chick density on Putauhinu Island. The Poutama study must be replicated on other islands to ensure that the relationship between harvest rates and chick densities was not an island-specific effect. Harvest rate may vary with density within the same island but not predict relative density amongst different islands. Islands with different ranges of chick densities may detect little change in harvest rate as density either reduces or increases. My study seeks to replicate and check the preliminary findings on Poutama by intensive measures on another Tītī Island. My main aim is to establish whether nanao harvest rates could indicate population trends of tītī, and whether an increase or decrease in harvest rate indicated the same proportionate increase or decrease in actual chick density.
FIGURE 1: Rakiura (Stewart Island) and adjacent Titi Islands showing Putauhinu and Poutama Islands.
Chapter 3

METHODS

Study Site

The study occurred over three consecutive muttonbirding seasons (1997-1999) on Putauhinu Island (47°12.5'S, 167°21.6'E) (Figure 1). The island is approximately 140 hectares in size. Putauhinu operates under a ‘closed harvest’ system, where each individual Rakiura Māori family has their own manu (birding ground) within which to harvest.

Catch per unit effort

Harvest rate equals the number of chicks per minute of gathering on the breeding grounds. Rejection of some chicks occurs because they are deemed too small (Ashwell 1999; Lyver 1999; Lyver 2000b; Hunter et al. 2000). My catch per unit calculation includes the time taken to extract rejected chicks.

Researchers monitored three to eight days of harvest during the nanao of six different birders from four manu in the 1997, 1998 and 1999 seasons (Table 1). The number of co-operative harvesters available dictated the number of harvesters observed each year on Putauhinu Island. We observed their harvest at least every week and at regular intervals to ensure that the sample was representative of nanao for each season. Harvest monitoring occurred for periods between 40 and 210 minutes in 1997 & 1998, and between 20 and 105 minutes in 1999. During this period, we recorded the number of chicks harvested and time taken to harvest them, in order to calculate a harvest rate for a harvest ‘session.’

Chick density measures

We marked a sample of consecutive prospected burrow entrances and any passed over (‘ignored’) burrow entrances among them in the area where we observed the harvest session for that day. We marked 20 and 10 prospected burrow entrances per session in 1998 and 1997, respectively. In 1999 the 20 burrow entrances marked included the
ignored burrows. We recorded whether a chick was procured, or rejected (*a kiaka*, a chick that is too thin to take as food (Ashwell 1999)) and put back from these burrow entrances. Burrow entrances where the birder found no chick were ‘burrowscoped’ 0 to 4 days after the day of harvesting. The burrowscope has an infra-red lit camera at the end of a three metre length of hose that can be pushed down a burrow to project a picture of the burrow contents on a video monitor at the burrow entrance (Lyver et al. 1998). We designated the burrow entrance as ‘occupied’ when a birder or a burrowscope found a chick, ‘unoccupied’ if we burrowscoped the entire burrow and found no chick, or ‘unknown’ when obstructions or inaccessibility prevented searching the entire burrow with the burrowscope.

We counted the number of useable burrow entrance numbers within a 12.56 m² plot (2 m radius) in the sampled area to calculate burrow entrance density per m². I define a useable burrow entrance as any burrow ≥ 20 cm long; the shortest burrow found occupied (Hamilton *et al.* 1996).

I calculated the density of chicks under ground in the area traversed by the muttonbirder during the observed harvest session using:

Chick density = burrow entrance density * burrow entrance occupancy.

Where:

Burrow entrance occupancy was the proportion of burrow entrances occupied by a chick.

Lyver (2000a) calculated chick density using:

Chick density = Burrow density * burrow occupancy

and,

Burrow density = burrow entrance density * b * c

where:

b = ratio of the burrows per usable entrance measured on the transects;

c = number of entrance holes per burrow measured on the transects;

burrow occupancy = the proportion of known burrows that had a chick.
In order to compare chick densities from the Poutama and Putauhinu surveys, I recalculated the raw data from Poutama using my equation.

I performed a chi-square test for independence to examine the methodological effect of the addition of birder strike rate (the number of chicks taken from burrows) and burrowscope data to give overall occupancy for the harvested area. This test compared the proportion chicks found or not found using a burrowscope, in burrows ignored by the birder and in burrows prospected by a birder.

**Effect of chick density on harvest rates**

To extract chicks during the nanao requires a high degree of skill, and this varies amongst individuals (Lyver 2000a; Kitson 2002). I used a general linear model to relate harvest rates, individual birder, and the interaction between harvest rate and individual birder on Putauhinu, to the density of chicks in harvested areas. Residual diagnostics from a preliminary analysis indicated that one birder’s observations had a very high influence on the results (Table 2). This birder was observed only three times in one year after about a six years absence from harvesting. In the final model the observations from this birder were eliminated (Table 2).

**Differences in catch rates among birders**

I performed a chi-square test for independence to examine whether the numbers of burrow entrances ignored and the number of prospected burrow entrances. The number of chicks caught (i.e. successful strikes) and the number of chicks missed (i.e. the number of chicks found only using the burrowscope) were different among the individual birders.

Simple regression analysis examined the relationship between each birder’s average harvest rate and the proportion of burrows prospected, and each birder’s average harvest rate and their successful strike rate.
RESULTS

Burrows prospected by birders had a higher proportion of chicks found (62%, \( n = 753 \)) than ignored burrows searched with a burrowscope (27%, \( n = 57 \)) (Chi-squared test \( \chi^2 = 79.6, p < 0.01, \text{d.f.} = 1 \)).

There is no evidence that average chick densities (Anova \( F = 0.36, p = 0.70, \text{d.f.} = 2, 42 \)) and birder harvest rates (Anova \( F = 0.11, p = 0.89, \text{d.f.} = 2, 42 \)) differed between years (Table 1). Monitored harvest rates of individual birders that harvested in more than one year varied considerably with CV ranging from 30.4% to 32.8% between different years.

The general linear model found a significant relationship between chick densities and harvest rates, and a near significant relationship between chick densities and the interaction of birder and harvest rates on Putauhinu (Table 2). However, the individual birder’s harvest rates did not vary significantly with different chick densities, although birders J and T showed signs of increased harvest rate at higher chick density. Birder T had a nearly significant increase of harvest rates to increasing chick densities of \((p < 0.1; \text{Figure 2})\). Other factors have lead to high variation in harvest rates between sessions even where density of chicks was similar. The increased sample size in the combined GLM using birder and birder density interactions is therefore the most reliable indicator of the relationships.

Three birders (with cell frequencies > 5) varied in the proportion of total burrow entrances they ignored and total burrow entrances they prospected (Chi-squared test \( \chi^2 = 9.53, p < 0.01, \text{d.f.} = 2 \)). Birders M, R and T prospected, respectively, 92%, 94% and 86% of the burrows they encountered (\( n = 561 \)).

Five birders (with cell frequencies > 5) varied in the number of chicks caught and the number of chicks they missed (Chi-squared test \( \chi^2 = 10.44, p < 0.05, \text{d.f.} = 4 \)). Birders I, J, M, R and T caught, respectively, 71%, 75%, 53%, 66% and 56% of the chicks available (\( n = 444 \)).
The proportion of burrows prospected and the successful strike rate was strongly correlated for each birder \((r_{xy} = 0.84, r^2 = 70.5\%, p = 0.04, n = 6)\). The two simple regression models using the proportion of burrows prospected \((y = 0.2x + 0.03, r^2 = 2.7\%, p = ns, n = 6)\) and the proportion of successful strikes \((y = 0.1x + 0.15, r^2 = 2.6\%, p = ns, n = 6)\) as the predictors of average harvest rate for each birder were not significant.

Putauhinu had mean chick densities in harvested areas nearly two times higher than those measured on Poutama (two-tailed t-test assuming unequal variances, \(p < 0.001\), d.f. =81; Table 3). However, both islands had similar mean harvest rates (two-tailed t-test assuming unequal variances, \(p > 0.05\), d.f. =7, Table 3).
TABLE 1: Mean chick and burrow entrance densities in harvested areas and harvest rates with 95% CI limits on Putauhinu in 1997-1999. Range in brackets.

<table>
<thead>
<tr>
<th>year</th>
<th>Number of manu</th>
<th>Number of birders</th>
<th>Number of days measured</th>
<th>Number of burrow entrances</th>
<th>Mean chick densities (m$^2$)</th>
<th>Mean harvest rate (chick/min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1997</td>
<td>2</td>
<td>4</td>
<td>12</td>
<td>128</td>
<td>0.35±0.07</td>
<td>0.23±0.05</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>[0.17-0.56]</td>
<td>[0.08-0.43]</td>
</tr>
<tr>
<td>1998</td>
<td>3</td>
<td>3</td>
<td>18</td>
<td>380</td>
<td>0.32±0.06</td>
<td>0.22±0.04</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>[0.17-0.60]</td>
<td>[0.13-0.35]</td>
</tr>
<tr>
<td>1999</td>
<td>3</td>
<td>4</td>
<td>15</td>
<td>300</td>
<td>0.33±0.05</td>
<td>0.24±0.06</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>[0.18-0.54]</td>
<td>[0.09-0.45]</td>
</tr>
</tbody>
</table>
TABLE 2: Results of general linear model predicting chick density from harvest rates, individual birder, and the interaction between birder and harvest rates on Putauhinu in 1997-1999. Results are shown for observations from all birders and when data from birder L with a high influence on the model were removed.

<table>
<thead>
<tr>
<th>Predictors of chick density</th>
<th>d.f.</th>
<th>F-value</th>
<th>p-value</th>
<th>$r^2$</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td>All birders observations</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>included</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Harvest rate</td>
<td>1, 44</td>
<td>6.99</td>
<td>0.012</td>
<td>37.2%</td>
<td>46</td>
</tr>
<tr>
<td>Birder</td>
<td>5, 44</td>
<td>1.75</td>
<td>0.151</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Harvest rate * Birder</td>
<td>5, 44</td>
<td>1.75</td>
<td>0.054</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Constant</td>
<td></td>
<td></td>
<td>0.194</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Birder L observations removed</td>
<td></td>
<td></td>
<td></td>
<td>34.7%</td>
<td>43</td>
</tr>
<tr>
<td>Harvest rate</td>
<td>1, 41</td>
<td>5.34</td>
<td>0.027</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Birder</td>
<td>4, 41</td>
<td>1.96</td>
<td>0.125</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Harvest rate * Birder</td>
<td>4, 41</td>
<td>2.50</td>
<td>0.062</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Constant</td>
<td></td>
<td></td>
<td>0.211</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
FIGURE 2: Putauhinu Birder J (circle), birder R (square) and birder T (diamond), and Poutama (crosses, from Lyver 2000a) harvest rates over different chick densities. Regression lines are shown for:

Birder R (dotted) $y = 0.07x + 0.3$, $r^2 = 0.4\%$, $p = \text{ns}$; birder J (dashed) $y = 0.10x + 0.12$, $r^2 = 61.3\%$, $p = \text{ns}$; Birder T (solid) $y = 0.27x + 0.09$, $r^2 = 27.4\%$, $p < 0.1$; Poutama (grey) from Lyver 2000a.
TABLE 3: Mean chick density of harvested areas and harvest rates on Putauhinu between 1997-1999 and Poutama 1995 with 95% CI and range in brackets.

<table>
<thead>
<tr>
<th>Island</th>
<th>Chick density (per m$^2$)</th>
<th>Harvest rate (chick per minute)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Putauhinu</td>
<td>0.33±0.03</td>
<td>0.23±0.03</td>
</tr>
<tr>
<td></td>
<td>[0.17-0.60]</td>
<td>[0.08-0.45]</td>
</tr>
<tr>
<td>Poutama$^a$</td>
<td>0.17±0.03</td>
<td>0.25±0.1</td>
</tr>
<tr>
<td></td>
<td>[0.06-0.45]$^b$</td>
<td>[0.14-0.45]$^c$</td>
</tr>
</tbody>
</table>

$^a$ from P. Lyver unpublished data.
$^b$ N=38
$^c$ N=7
DISCUSSION

Precision of occupancy measures

Birders found over twice as many chicks in prospected burrow entrances than the burrowscope in ignored burrow entrances. Muttonbirders may have chosen not to harvest a burrow entrance because the entrance showed no ‘signs’ of occupancy (J. Kitson unpubl. data). Ignored burrow entrances may represent a sample with lower occupancy rates than those attempted by birders. However, chick densities measured by the addition of chicks found by the burrowscope and birders, are more likely to be higher than from burrowscoping alone (i.e. burrowscoping prior to harvesting). This is because the birder plus the burrowscope searched for chick occupancy.

Inter-island variability

On Poutama, Lyver (2000a) found a strong relationship between harvest rates with chick density, even when the measures of chick density occurred up to 30m away from the monitored harvesting. On Putauhinu, I found a similar relationship for the pooled data using the GLM but the relationship varied significantly between individual birders. Furthermore, the increase in harvest rate was only slight compared to increases in chick density (Figure 2). For example, even for birder T who showed the strongest effects of density, a doubling of chick density (100% increase) from 0.3 to 0.6 chicks per m² only resulted in increases in harvest rate from 0.17 to 0.23 chicks per minute (a 35% increase).

Detection of interannual variation in harvest rate, not in chick density, indicates further cause for concern about using harvest rate to index abundance. Presumably differing rejection rates, weather, patchiness in chick density, and harvest success explains why the average harvest rates rather than chick density varied between years.

On Putauhinu, birders harvested areas with average chick densities nearly double of that on Poutama (Table 3). The presence of a strong relationship with density on Poutama but not on Putauhinu may relate to lower density on Poutama. The two
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3.17 islands may be showing different parts of a curvilinear relationship in which harvest rate can not increase any more with further increases in chick density once a point of inflection is reached. Poutama could then be showing increasing harvest rates with increasing chick densities, whereas on Putauhinu the harvest rates may be close to the maximum irrespective of encountering higher density. However, low statistical power of the Poutama data hampered the ability to compare the two data sets and test this hypothesis. More study on the effects of low chick density areas on harvest rates is needed.

If non-linear, the relationship between harvest rates and chick density means that at high densities, changes in harvest rate will not indicate proportional changes in density. On islands with high chick density, such as Putauhinu, harvest rates could be slow to indicate changes in chick density if a long-term trend in tītī abundance occurs.

Harvest rates as a monitoring tool

Basic assumptions for using harvest rate to index population change are not met with the nanao harvest of sooty shearwaters. Putauhinu birders varied in the proportion of prospected burrows and successful strikes. Harvest rates from individual birders also varied in their ability to change with changing chick densities. Only birder T showed an increase in harvest rates with an increase of chick densities. The Poutama data was predominately from only one birder. Nevertheless, other broader correlations suggest that harvest rates are able to give broad-brush measures of chick abundance. A diary donated from a birder showed that harvest rates have declined in the last twenty years (Lyver et al. 1999), which is corroborated by a decline of chick abundance over the last decade on an unharvested island (Hamilton et al. 1996; Cooper 1996).

My observations of particularly high variation in harvest rates between birders, and the interaction effect between chick density and birder, signal potential problems in using a panel to adequately monitor changes in sooty shearwater abundance. Firstly, proportionate monitoring would necessitate a large panel of birders from many different islands. Moreover, the individual birders constituting a monitoring panel would require careful selection and screening to ensure that their harvest rates are
sensitive to changes in chick density. These same panel members should be used as much as possible. Finally, inexperienced nanao harvesters could not be used on the panel because they take twice the time to catch chicks as experienced harvesters (Lyver and Moller 1999).

Currently, researchers use a ‘burrowscope’ to monitor sooty shearwater population abundance. This method is highly expensive, time consuming and requires highly skilled field staff (Hamilton et al. 1997, 1998; Lyver et al. 1998; Moller et al. 1999), which makes it impracticable for muttonbirders to use. Though harvest rates can only provide a general index of population change, it can provide an inexpensive and feasible way for muttonbirders to measure population trend. Harvest rates are a traditional monitoring method used to monitor trends in resource abundance. Harvest itself is of paramount importance for the birders and the practice of Rakiura Māori TEK. It is accepted as the main clue they use to monitor trends in resource abundance. Traditional monitoring methods are also valuable because they are based on the accumulation of knowledge over a long time, incorporate large sample sizes and can be evaluated by the harvesters (Moller et al. subm.). This study is dedicated to exploring harvest rate for its monitoring utility. Detecting trend is a first step to assessing the long-term sustainability of the harvest.

ACKNOWLEDGMENTS

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Conservation Trust. Southwest Helicopters Ltd. have also provided logistic support.

REFERENCES


Chapter 3


Chapter Four

Looking after your ground: resource management practice by Rakiura Māori tītī harvesters.

“...we’ve always been told you respect the island and look after it.” Birder P
ABSTRACT

The annual harvest of tītī (*Puffinus griseus*) on islands adjacent to Rakiura (Stewart Island) by Rakiura Māori is one of the last large-scale customary uses of native wildlife in New Zealand. This study investigates whether Rakiura Māori harvesting practice constitutes common property resource management and how these practices apply to the sustainability of tītī harvests. Semi-directive interviews were conducted with twenty experienced tītī harvesters and elders to record the Rakiura Māori Traditional Ecological Knowledge that governs this harvest. Access to the resource is shared and controlled by birthright. Informal and formal sanctions enforce the rules that apply to harvest. An important component of Rakiura Māori Traditional Ecological Knowledge is the system of rules used to assist sustainable use by protecting island habitat and adult birds, and temporal restrictions on harvest. These rules and other aspects of tītī harvesting practice conform to common property resource management theory. While adhering to the main resource rules, localised flexibility in management provides harvesters with the ability to adapt to changing circumstances.
INTRODUCTION

The term Traditional Ecological Knowledge (TEK) refers to “a cumulative body of knowledge, practice, and belief, evolving by adaptive processes and handed down through generations by cultural transmission, about the relationship of living beings (including humans) with one another and the environment” (Berkes 1999:8). TEK is a system of knowledge that guides indigenous peoples' customary uses of wildlife. It is an attribute of societies with a long-term continuity of resource use on a particular land (Johnson 1992; Gadgil et al. 1993; Berkes 1999). TEK is cumulative and dynamic, building on experience and adapting to socio-economic and environmental changes and incorporating useful aspects of modern technological innovation (Johnson 1992; Gadgil et al. 1993; Stevenson 1996; Berkes 1999; Lyver and Moller 1999a, b; Lyver 2002).

Sustainable customary use of wildlife by indigenous people often involves an added challenge because the resource may be owned by an entire tribal group or harvested from communally owned land. Such communal access to a customary resource can be defined by common property theory.

Common property theory applies to resources that share two characteristics:
1. The exclusion of potential users is difficult
2. The activity of each user subtracts from the welfare of all the others (Berkes 1989; Feeney et al. 1990).

Achieving sustainable common property resource management requires the group to control access of all potential users and to have common property institutions. The latter include decision-making arrangements where rules for resource harvesting and sharing are made and enforced among the users themselves (Berkes 1986, 1999). Once access and resource use rules are in place, both the cost and benefits of any management action will be borne by the same individual or group, thus providing an incentive to conserve. The alternative has been characterised by Hardin (1968) as “the tragedy of the commons”.

Constructed by a trial and error process over a long period, resource use rules can be quite complex. Their implementation may involve an intimate belief system (Gadgil et al. 1993; Berkes 1999). Compliance with these rules can occur through religious beliefs, cultural rituals and other social mechanisms (Gadgil et al. 1993; Colding and Folke 1997; Colding 1998; Folke et al. 1998; Berkes et al. 2000; Colding and Folke 2001).

This paper describes in detail how Rakiura Māori, New Zealand’s most southern group of Indigenous people, manage one of the last large-scale customary use of native wildlife in New Zealand - their annual harvest of tītī (*Puffinus griseus*, sooty shearwaters, muttonbirds).

The tītī harvest provides an important case study of TEK and common property theory in action within New Zealand. However, calls for reinstatement of customary harvest rights round the world (Posey 1996; IUCN 1997) and ensuing debates about the environmental safety of indigenous people’s harvest management, make this study of more widespread conservation interest. Some Pākehā (non-Māori people) deny that Māori can adequately manage the New Zealand environment (Moller 1996; Taiepa et al. 1997). This belief is seen in their submissions to the Southland Conservation Board on the proposed return of the ownership of the Tītī Islands to Ngāi Tahu ownership (Southland Conservation Board 1994) and their submissions to the New Zealand Conservation Board on Customary Use of Wildlife (NZCA 1997). These submissions have challenged whether adequate TEK still exists amongst Māori; whether it can ever be sufficient to ensure sustainable use; and whether it can guide within new ecological conditions prevailing in New Zealand, or where new technologies may have made current harvest rates unsustainable.

Rakiura Māori established the *Kia Mau Te Tītī Mo Ake Tōnu Atu* “Keep the tītī forever” research program in 1994. This was done to examine the sustainability of the harvest and to ensure that the birds remain plentiful for their mokopuna (grandchildren) (Moller 1996; Taiepa et al. 1997; Moller et al. 1999). A major facet of the program’s research is to record the TEK of the Rakiura Māori tītī harvesters. This study is part of that project.
The objective of this paper is to investigate whether Rakiura Māori harvesting practices constitute common property resource management, as well as the ways that TEK is applied to promote the sustainability of the tītī harvests.

**BACKGROUND**

Tītī is probably the most ecologically important seabird in New Zealand (Warham and Wilson 1982). Adults spend April to August in the northern Pacific, before migrating in September and October to breed on New Zealand's offshore islands with a small number still attempting to nest on the mainland.

The centre of breeding abundance is in Foveaux Strait and on the islands around Rakiura (Stewart Island). Tītī nest in burrows dug by the adults (Figure 1). The prodigious density of the birds, their burrowing, and deposition of large quantities of nutrient rich guano have an over arching influence on the plant and animal ecology of the "bird islands" (Campbell 1967; Towns et al. 1990; Hawke and Newman 2001). These islands are internationally significant conservation areas.

Culturally, tītī are very important for Rakiura Māori. Archaeological data shows that sooty shearwaters were widely exploited in prehistoric New Zealand, but their present large-scale use may have been a proto-historic phenomenon (Anderson 1997). "Muttonbirding" is a collective term for techniques and practices, in which chicks of various Procellaridae are captured, processed and preserved for food (Anderson 1996, 1997). Traditional harvests are known from the north Atlantic, Australia, Raoul and Norfolk Islands, and several places within New Zealand (Anderson 1996).

Traditionally, tītī are an important food and trade source of Rakiura Māori (Beattie 1994; Dacker 1990; Dacker 1994). The harvest is a defining cultural activity, which acts to generate social cohesion and group identity amongst Rakiura Māori (Waitangi Tribunal 1991; Dacker 1994; Taiepa et al. 1997).
The harvest of titi can occur on 36 Muttonbird/Titi Islands in Foveaux Strait and around Rakiura (Figure 3). The median island size is 15 hectares, with Taukihepa being the largest island at 929 hectares, and Putauhinu the second largest at 141 hectares (Southland Conservation Board 1994). Rakiura Māori have rights to harvest titi chicks each "birding season", from 1st April to 31st May (Department of Lands and Survey 1978).

On the 29th June 1864, the Deed of Cession of Rakiura was signed between Rakiura Māori and the Crown. Certain islands were set aside for Rakiura Māori to take titi (Beneficial Islands) and the other islands (Crown Islands) were retained by the Crown for the use of Rakiura Māori who were not descended from the chiefs who signed the Deed. In 1998, the Crown Titi islands ownership was returned to Ngāi Tahu (Ngāi Tahu Settlement Act 1998) and were renamed the Rakiura Titi Islands.

The main periods of harvest are nanao and rama. During the nanao, which occurs from April 1st until mid-to-late April, the chicks are extracted from the burrows during daylight. At the later phase of nanao, the chicks start to emerge from their burrows at night, but not in large numbers to warrant harvesting them at night. The manu (birding ground; Figure 1) can be harvested again, with birders concentrating their effort on burrow entrances marked with down, which signals chick burrow occupancy. This is called pahure. During the rama (or ‘torching’ period, from late April until mid May) the chicks are captured once a sufficient number have emerged from their burrows at night to make the hunt cost-effective. As fledging approaches, the chicks spend more time out of their burrows to flex their wing muscles and lose their down (Figure 2).
FIGURE 1: Typical area of 'manu', birding ground, with burrow entrances evident. 
(Photo: Darren Scott)

FIGURE 2: Titi chick exercising wing muscles during nanao. Note various stages of 
feather development. (Photo: Jamie Newman)
I interviewed twenty experienced muttonbirders, elders and kaumātua (respected and wise elder, Garven et al. 1997). The selection of participants was non-random because I targeted older people who are more likely to have retained traditional management strategies. In many indigenous communities, elders play a key harvest management role – they are often the keepers, transmitters and interpreters of TEK (Berkes 1999; Berkes and Folke 2002). The interviewees had to be over fifty years old, still actively muttonbirding, and living in the Southland area. This project had a dual role, in that it was requested that the oral history from the elders and kaumātua of the Rakiura Māori community be recorded before the information was lost. Because of this, two kaumātua were interviewed even though they had not been birding since they were teenagers.

I started with being introduced to two possible interviewees by a Rakiura Māori kaumātua, who in turn suggested other elders to approach. The interviewee’s ages ranged 55 to 85 years (mean = 69), and the sample consisted of 7 females and 13 males. The sample represented approximately 30% of the possible candidates that fitted the selection criteria at that time. The heterogeneity of practices and traditions on different islands was addressed by interviewing representatives of various families from 11 different islands and 17 manu (Figure 3).

Four people approached for interviews refused. Two of them felt uncomfortable with the idea of being interviewed and audio-taped and one refused because she apparently distrusted science. The fourth person distrusted researchers because a previous and unethical researcher had taped their conversation without her consent. However, the relatively high proportion of older birders interviewed and the low level of non-participation suggests that my information will be an unbiased representation of the views and knowledge of the older tītī harvesters in the community.

1 Two of the birders were a couple, and were interviewed together.
FIGURE 3: Rakiura (Stewart Island) and adjacent Titi Islands. Interviewee’s birding islands are shaded and named. Specific birding areas (manu) are also named for Taukihepa.
Before the ‘official’ interview took place, I visited the kaumātua or elder and spent time building up trust. In some cases I visited them several times. In these pre-interview periods, I also asked them general personal information, but during the majority of this period the questions came from the prospective interviewee. As I am of Rakiura Māori descent, it was important for the interviewees to find out how I related back to them, and to share accounts of my family members.

The interviews were semi-directed (Huntington 1998, 2000) or unstructured (Lofland and Lofland 1995), where participants are guided in the discussions by the interviewer, but direction and scope of the interview followed the interviewee’s train of thought. There was no fixed questionnaire, though I did have an interview guide that I referred to for prompting further discussion if there was a lull in conversation.

The interviews were audio-taped and transcribed and took place between November 1997 to early March 2000. All interviewees received a copy of the interview and transcript. If the interviewee was willing, a copy of the interview/s was lodged at the Southland Museum and Art Gallery, sometimes with restrictions placed on access and future use. Seventeen interviewees granted that their interviews could be lodged at the archive.

Although many of the interviewees have been going to their island since they were very young children, they were very concerned about being singled out as ‘authorities’ on muttonbirding. Because of this modesty, confidentiality was assured to them in any publication, hence this manuscript refers to the participants as Birder A, B, C etc.

Spoken language can appear quite ungainly when typed on a page. To aid readability, quotations from the transcripts have been edited to remove fillers (such as ‘um’, ‘ah’ and ‘you know’ etc); repeated phrases; false starts; pauses; laughs; and the occasional grammatical error. Occasionally, changes were also made to ensure confidentiality. Square brackets indicate where I have added text to aid understanding. Three reviewers compared the original transcript quotations with the edited quotes in this text to ensure that any changes made were to aid understanding and keep the original meaning intact.
All written work resulting from the *Kia Mau Te Tītī Mo Ake Tōnu Atu* “Keep the tītī forever” research program is reviewed and commented on by the Rakiura Tītī Island Administering Body (representatives elected by the Rakiura Māori community). Although the scientific data are jointly owned, a cultural safety agreement between Rakiura Māori and the University of Otago research team ensures the Traditional Ecological Knowledge remains the intellectual property of Rakiura Māori (Moller 1996; Taiepa *et al.* 1997). Before submission the Administering Body validated this paper.

**RESULTS**

**ACCESS**

Access to both the Rakiura Tītī (ex-crown) Islands and Beneficial Tītī Islands is through Rakiura Māori hereditary rights. Only Rakiura Māori, and with them their spouses, are allowed access. Access is controlled in two ways depending whether the island is a Rakiura Tītī Island or a Beneficial Island.

All birders who wish to bird on Rakiura Tītī islands need to apply for an annual permit. These permits are applied to a group of Rakiura Māori birders who are elected by the Rakiura Māori birder community (‘Rakiura Tītī Island Administering Body’). Before the tītī season at an annual gathering of the birding community (‘Permit Day’), permits for Rakiura Māori and their spouses are read out. If disputes arise from permits, the individuals have to prove their *whakapapa* (genealogy) in front of the gathering. Any Rakiura Māori can apply for a permit for any of the Rakiura Tītī Islands.

On Beneficial Islands Rakiura Māori must prove that they descend from one of the original owners of that island or, in the case of Taukihepa, the specific manu where they propose to harvest. To become a ‘beneficiary owner’ they must succeed their beneficiary rights from their parent when they die. The younger generations in those families are called potential owners and are allowed to bird with the permission of the family member who has the beneficial right. Historically, the beneficiary owners are those who make the decisions on that island or manu:
“...my old people when they were going to the islands we had no say whatsoever. You did as you were told, and it worked out all right. We weren’t the beneficiaries at that stage, they were the beneficiaries, [and] we were only potential [beneficiaries]. Whatever my Dad said went, that was it.” Birder E

**Territoriality within islands**

Territoriality is often an aspect of the control of access within Common Property management system (Berkes 1986). The forms of territory systems found on the Tītī islands can be broadly described as ‘closed’ and ‘open.’ A closed system is where an area is allocated to each adult Rakiura Māori birder or each family on the island. An open system is where all the birders on the island can harvest anywhere on the island. The type of system and variations depend on the how they ‘worked’ (organised the allocation of the resource) that particular island, as the following quote from Birder C highlights;

“... Now we have our main manu [birding area] that is ours, and then if there’s any left over, you share it per family. That’s the way we work ours. The working rule[s] on all islands are different. I mean we work ours different from say likes of Pohowaitai. They work strips nanaoing but they don’t [in] torching. It’s an open island for torching. But it all depends on the island. [The] likes of Putauhinu, they have their family manu regardless of how many on each manu. It’s the workings of the island and the people on the island make their own working rules.” Birder C

On some islands the type of territory system varies according to the development of the chicks. During nanao, some islands work in ‘strips’, where all the birders work side by side working from one boundary to another on a predetermined width of manu. For individuals these strips could vary from year to year or remain constant. During pahure, where birders can go over the ground again before the rama period, access is generally open. Once rama begins the islands become either open or closed systems.

During torch in some open systems, families allocate different times to harvest for different family members so that they do not deplete the number of emerged chicks
available for capture. Some harvesters go out in the morning, others at night, or they can take turns to harvest (Birder H; Moller 2002).

Allocation management of territories occurs prior to the start of the season and is determined by the birders from that island. Historically, the elders of the island determined territories, and boundaries can be tracks, creeks or other natural markers. Horomaemae and historically Big Island allocated separate areas for men and women to work during the nanao.

On Pohowaitai the allocation of areas to groups of birders to work in strips during nanao is determined by one member from each group drawing a playing card; the person who draws the highest card has the first choice of area. This allocation method requires that all the birders work together. If a day is to be taken off during nanao then all the birders need to take that day off.

The territory systems are dynamic and systems have changed on islands over time. Some islands that had ‘closed’ systems now have open ones, and Big Island has changed from a closed to open, and then back to a closed system over a lifetime. Birders have observed changes in the numbers of tītī as natural successional changes in vegetation make the habitat more (or less) suitable for the birds. On Big Island this resulted in an increase in the number of birders wanting to work the area as numbers of tītī increased. The island’s closed system was opened as there was not sufficient land area to allocate individual manu, and the open system enabled the increased resource to be shared among a larger number of birders. However, as the vegetation pattern continued to change² numbers of tītī declined to a level where less birders wanted to work the area, once again allowing the allocation of individual manu and a return to a closed system.

² The vegetation successional change made the ground cover sparse, which in turn meant the chicks were harder to catch during the rama.
"THE RULES"

Certain traditional rules or *tikanga*¹ apply to this harvest (Wilson 1979). Using the framework set out in Folke *et al.* (1998), I explored ‘rules’ or the ways birders’ “look after” the manu/island fitted under three categories: protection of habitat, protection of vulnerable life-history stages, and temporal restrictions of harvest.

**Protection of habitat**

The interviewees placed a strong emphasis on rules for protection of habitat, by protecting the island vegetation, keeping the manu tidy and protecting *tītī* breeding burrows.

**Protection of vegetation**

Discouragement of unnecessary cutting down of live wood was strongly emphasised in nearly three-quarters of the interviews. In the past firewood was a sought-after resource because of the reliance on open fires for domestic purposes and for cleaning and cooking the chicks. Despite this high demand, the birders were only allowed to collect dead wood for firewood. Collecting firewood was something that the majority of the interviewees participated in as a child. Birder C recalls branding the dead trees in order to claim them as firewood, because there was such a demand for wood.

“...through the season you didn’t take trees that were standing and with all the houses on the island [with] open fires you’d have to go a long way [to collect wood], but [when] everybody would land [on the island] they’d rush and put their brand on the fallen trees that were closest, so if you were there early you got the closest trees.”

Birder C

The use of helicopters for transportation and lifting gear off boats means that the majority of birders now use coal and gas as their main fuel instead of dead wood from

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¹Tikanga; custom, the correct way of doing something, lore.
the islands. Without helicopters the physical effort required to transport either coal or gas was prohibitive.

Fires are not allowed to be lit indiscriminately, because a) the risk of the fire spreading, and b) before modern communications, lighting a fire on the landings was the only way to signal that someone was ill and needed evacuation.

“You were not allowed to light fires indiscriminately anywhere because fires were used as a medium of communication from island to island. And fire[s] had to be lit in a certain place, because of the composition of the soil on the island being peaty it could burn on for years and years if it got into the ground.” Birder D

The cutting of tracks is necessary for access to manu, to transport harvested chicks, aid navigation and demarcate manu. Tracks need to be clear enough for the birders’ safety (i.e. avoid scratching themselves, poking an eye out, or hitting their head on a low hanging limb etc) but not too wide to cause unnecessary damage to vegetation. Birders try to use old established tracks rather than establishing new tracks. By using the same tracks birders are also avoiding damage to breeding burrows, as can be seen from this extract:

“... you’re taught from when you’re old enough to use a slasher that you mustn’t cut your track too wide and too far back[.] [It’s] got to be clear so that you’re not going to run into sticks or that in the night, but you’re taught how to cut your tracks so that you’re just trimming it back each year and you’re not going to damage your trees[.] So that you’re sort of weaving your way through the trees, more than opening up big tracks because you’re relying on those, the roots of those trees to bind all those holes [tītī burrows] together and keep everything intact[.] If there's a tree that's in the way you'll have to sacrifice it if it grows up [so] that it's in the way because you shouldn't deviate your tracks, because if you do, you're tramping a different part of the ground. What happens over the years is that the stuff that you’re cutting builds up on that ground it gives more humus and everything and then the roots come through that and so where you’re walking, is solid earth and you don’t go through [collapsing a tītī breeding burrow].” Birder K
Tracks that are too wide and clear can be difficult to catch chicks on during the torch. Chicks will sit in fern and low scrub just off the tracks, and move from cover to the track, where the birder can harvest them, but if the track is too wide the chicks will move off them faster in order to find cover (Birder Q).

An exception to the prohibition to cut down live wood is when a tree is about to die, as evidenced by leaves curling and letting sunlight through the canopy (Birder K). One of the main canopy species Tūpare (Olearia colensoi) has about a 30-50 year cycle on the muttonbird islands (Birders A, C, L; Hawke et al. in press). If the tree will fall and damage the manu, it will be removed rather than allowing it to fall naturally (Birders C, K, R). However, some dead trees have an important purpose. In order to initiate flight, tītī require a high point from which to jump, such as a cliff. In some cases they use trees as take-off points. If a take-off tree has died, Birder K will try and retain that take-off tree, and in some cases has propped up individual trees if they are in danger of falling. Birder K has linked the presence of these ‘airports’ to the number of birds in the area.

“A muttonbird is a pretty lazy sort of a guy, he won't walk any distance, if he can help it, so they'll use trees and that to climb up [and] to take off from rather than go to the cliff [.] If one of those [trees] died you do everything that you can to preserve that take off, because if those birds haven't got that tree to take off from, they won't bother nesting there. Near the centre of the island there was a big easy manu, which the women used to work [.] That was a women's manu because it was a nice easy ground to work because there was a nice big tree there for them to take off [from]. [It] was good birding in that area, there was a lot of birds there, and then the whole clump of trees got that old that the whole lot fell down, and all the leaves went in to those holes and you wouldn't even know that a muttonbird had ever nested there. It was just not a bird or a hole anywhere. Then over the years more trees grew up but they still never nested there[.] The trees that grew up there was just a thick canopy – tētēaweke [Olearia oporina] just blocks the sun right out, and it wasn't until a big storm broke a big branch off and made a gap, and then they could come up that tree and out through the gap. And then all those birds came back and opened that area up and nested there again. So you never cut or damage, one of the airports.” Birder K
Birders L and Q mentioned planting of young trees in areas where the old trees died off. Birder P planted young *pūnui* (būnui, *Stilbocarpa lyalli*) in response to damage caused by rats. The *pūnui* is useful in keeping the breeding burrow entrances free of leaves (Birder P).

Unnecessary disturbance to other birds or vegetation is frowned upon (Birder E, F, L, P, O).

“...they wouldn’t allow you to cut down any trees - you could cut up all the trees that had fallen down, cut those up for wood - but they wouldn’t allow you unless it was really urgent to cut down a living thing, because if you did the cycle would just finish. All the plants and that, they wouldn’t allow you to kill off anything that you weren’t supposed to. That includes the muttonbirds and all the bird life on the island, you couldn’t touch them. You got chastised if you did harm any of the birds or bird life. The only thing bird life we were allowed to do anything with was wekas\(^4\) and muttonbirds because they were things that we had to take to eat and to help with our diet.” Birder E

**Keeping the manu tidy**

Another method of looking after your manu is to clear wood and debris from the manu (Birders D, F, G, I, L, M, R). In the past, a large amount of wood was removed from the manu to be used for domestic purposes and stacked for easy access (Ashwell 1999). Some birders still cut up dead trees and stack that and other dead wood in piles. Birder R recalls his grandparents ‘cleaning the manu’. For some this practice was important in order to make the manu looked cared for (Birder R and L) and it aided access for harvesting and it was believed to aid access for the birds (Birder G and L). Not all islands carry out this practice (Birder O).

“...most people seem to try and keep the manu [tidy], you know stack old stuff that falls over and keep it sort of a bit tidy so that there’s some open spaces rather than pushing your way through everything. It’s [for] ease of access but I think it’s

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\(^4\) Herbaceous bush up to 1m with large leaves up to 30cm.

\(^5\) *Gallirallus australis*, a native Rail similar in size to a domestic chicken.
probably better for the birds too ‘cause they do struggle in the thick and I think they like the open manu too ‘cause that’s where they seem have their burrows.’ Birder L

A practice that could also be considered ‘cleaning the manu’ is clearing the burrow entrances of leaves. Birders I, M and P cleared out all burrow entrances of leaves and sticks during nanao regardless of whether they thought a chick was in the burrow or not. By doing this it is thought that it might encourage a bird to use it the next year and the burrow will not be lost. In 1942 the season was very poor. Richdale (1944) reported that birders believed this was because the burrows had not been cleared out, and the oil pollution from the high number of ships sunk during the war caused a high adult bird mortality.6

An important ‘cleanliness’ issue is the effective disposal of the entrails and waste products from processing chicks, such as wings and tails. Such waste products are mostly disposed of in the sea. Some islands with beaches can have this waste washed up on to them. Birders O and P harvest on such an island and they stressed the importance that people did not disturb the gulls that helped clean the beach.

Protection of the breeding burrows

The protection of burrows was the most frequent management practice mentioned. Eighty percent of the interviewees said this was very important. Out of the four birders that didn’t mention this, three did not nanao or had not been to the islands since childhood. During nanao, if the chick cannot be reached, a hole is dug over where it is estimated to be to enable the chick to be extracted (This act is called whakaputa; Ashwell 1999). It is then important to plug or ‘puru’ the hole to ensure the nest will remain dry and the adult bird will nest there again in the next season. It was also important to puru the ground if you accidentally broke through the ground.

“They [the old people] have always been pretty conscious of looking after their grounds especially the burrows.] If you dig down a puru for to get a bird out you’ve got to plug that up properly or otherwise you ruin the hole, ruin the nest and the bird

6 Birder A also mentioned oil pollution from the war decreased iff numbers.
is not going to nest there next year.] They were very fussy on that one. Don’t destroy the holes that’s the whole concept you know of not going on the island in the off season and everything else, don’t disturb the breeding in any way and don’t destroy the holes. And we’ve always been very conscious of that.” Birder F

Rat management

Some islands have introduced rats (Kiore, *Rattus exulans*; Ship or Black Rat, *R. rattus*; and Norway Rat, *R. norvegicus*). On these islands, a more modern day method of habitat protection is controlling rodents by regularly laying rat poison. Birders from Putauhinu have worked with the Department of Conservation to eradicate Kiore, and enabled transfers of threatened bird species such as Codfish Island Fern-birds. South East Islands, which have been re-infested by rats from Rakiura, combine efforts and resources in attempt to control rat numbers (Birders P and H).

*Temporal restrictions of harvest – a disturbance reduction strategy*

Centuries old, off-season rāhui (ban) applies to the islands (Department of Lands and Survey 1978; Wilson 1979; Taiepa *et al.* 1997; Lyver and Moller 1999b; Moller *et al.* 1999). The rāhui serves to prevent disturbance of the ground as well as the breeding adults while they are mating, incubating and, initially, rearing the chicks. As one birder relates,

“...we were always taught [that] when a bird is nesting, you never go near it. Because that mother may leave the eggs, but once that the bird is hatched, the mother instinct then takes over and it will never leave it. It’ll always keep looking after that bird”

Birder K

Scientists have found that tītī are susceptible to disturbance in the egg phase (Warham and Wilson 1982). This is believed to be a common phenomenon in Procellariids (Serventy and Curry 1984; Warham 1996).
Historically, Rakiura Māori would have followed a resource gathering (*mahinga kai*) cycle. Their movements to different locations were according to the seasons; they followed the life cycles of the animals and plants that they depended on for survival and cultural continuation (Dacker 1990). During the period outside the tītī season, they would have been busy gathering other types of materials in different locations, leaving little opportunity to visit the islands outside the season. The only other abundant food source on the island outside the season were seals and sea-lions, which would have been far more easily obtainable from more accessible mainland coasts (Hawke *et al.* in press).

Rāhui can also be used to place a temporary ban on harvesting for harvest sustainability reasons. Historically, Rakiura Māori have harvested other petrels on the muttonbird islands, such as *korure* (mottled petrel, *Pterodroma inexpectata*) and *parara* ('paras', broad billed prion, *Pachyptila vittata*). Birder L’s mother placed a still existing ban on korure for her family’s manu in about 1949 after detecting a decline in numbers.

In earlier times, temporal restrictions were also used, to minimise the disturbance of the chick’s normal emergence behaviour. *Pahure* is viewed as important because it delayed the start of the rama harvest period (Birder D, F, Q). These interviewees believed that if the rama begins too early then the chicks will fledge and leave the island earlier, thereby decreasing harvest opportunities. As Birder Q explains:

“...the earlier you go out catching your birds and chasing them, the earlier they are going to jump over the cliff. They are like sheep. If you go out and chase the bloody things every night, they are going to run away as soon as they see you. So if you go out there on the 21st [April] you are starting the ball rolling. So after that when they see your light coming they are off. I say leave it till later on and go about things quietly.”

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7 *Mahinga kai*; food resources and associated places and activities.
Chapter 4

Days off; A conservation measure?

Historically, Sundays were always a day taken off from harvesting. In fact, it was stated in the regulations that applied to the taking of tītī (Land Act Regulations 1912; Department of Lands and Survey 1978): *No work in connection with the taking or preserving of the muttonbirds shall be done before 6pm on any Sunday.* This legislated day off applied until 1962 (Land Act Regulations 1949, amendment No.3 (1962)). In some places, part of Saturday was taken off as well (Birder E, I, J). Sunday was a time for social interaction, passing on traditional knowledge, and community assessment of the harvest (Kitson and Moller subm.), as well as religious observance:

"... we would work from Monday through till Saturday lunch time and my old tāua [grandmother⁸] she wouldn’t let them work after 12 o’clock on Saturday. That was the time that they had for themselves. It was free time and our uncles used to knock off work on Saturday lunchtime, have lunch, have a wash and change their clothing and they’d be away from one end from Pūwai at one end of the island right away to the other end of the island and they’d be away, spend the weekend away and come home again on the Sunday night. Yeah and those at the other end of the island they’d do the same thing, back down come back to our end of the island so yeah they would have a constant change of visitors and they would come and stay the night or just come and visit and go away[.] In the weekend there was always new faces around, around the house. There would be the old ones, the young ones and there’s the young carrying younger ones..." Birder E

As another birder relates,

"...you couldn’t catch a bird on a Sunday and you couldn’t go out torching on a Sunday night till after twelve. You weren’t allowed to catch birds on a Sunday then. It was religious reasons they used to have bible readings, when we were small, every Sunday in the morning." Birder C

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⁸ Also can refer to an old female relative (Dacker 1994).
When the chicks were stored using Pōhā (kelp bags) taking days off from harvesting was also necessary for curing, preserving and storing chicks (Birders C, D, I, M, Q). However, plastic 10-litre pails with lids are now the common modern method of storage and days off for preparation are not required.

"... when I was a kid people down there used to have Sundays off and they would have another day off to cut up and they'd have another day off to pack the birds. Today there's no days off. She's all go. So bit of a lost part of the island, you know."

Birder M

Families no longer collectively take Sundays off. However, they do set aside occasional days for socialising and fishing. These days are usually between the nanao and torch period, when the birders have to wait until the chicks come out of the burrows at night in sufficiently large numbers. On Big Island, Good Friday is a scheduled day off from harvesting and is spent socialising and sharing a meal.

During nanao, birders are unlikely to harvest chicks on rainy days (Birders C, N, Q, R, S). The main reason for not harvesting in the rain is to avoid getting ill, and thereby miss torch which is more productive (Kitson 2002). Birder C stated another reason: the protection of breeding burrows.

"...you couldn't go out in the rain, because the old people used to say it softens the ground too much and you can't plug the holes properly. So that was the why they wouldn't let them go in the rain."

Birder C

At the beginning of nanao, harvest can be delayed for several days if the chicks are deemed too young or small to harvest (Birders C, F, M, N, P, Q, R). The harvest begins when the chicks grow to a suitable size. This decision is made as a group, or by the 'supervisor' elected by the group.

Birders F, K and M considered taking days off a conservation measure, because a number of chicks were spared because no harvest took place on that day:

"And working Sundays, that was a sort of self imposed conservation, because that was one day, one extra day you didn't work birds so that was so many birds saved sort of thing."

Birder F
Protection of life history stages

Harvesting is solely restricted to the chicks. The adult birds kaiaka (also referred to as kaiaki, ‘mother birds,’ ‘parent birds,’ and ‘old birds’) are protected because they are the breeders. Killing an adult is considered the ultimate transgression: “There is the odd time where your foot will go through the ground and make a hole, [and] if anyone walked on and left that unplugged, that’s one of the ultimate sins. That’s probably the second worst thing you can do. The worst crime on an island is to kill a kaiaki [adult bird].” Birder K

Seabirds are long-lived, with low productivity, so the demographic impacts of harvesting chicks is much less than if adults are taken (Lyver and Moller 1999b; Hunter et al. 2000a; Moller in press).

Tapu areas

Everything designated as ‘tapu’ must either be avoided or handled with care according to prescribed rules (Metge 1976). Tapu is normally understood as prohibition (Irwin 1984), but its function in resource management is for protection (Irwin 1984; Puia 1990). Tapu is a central concept in the Māori culture and is described in more detail in other publications (Metge 1976; Marsden 1981; Irwin 1984; Patterson 1994).

Designating areas as tapu can be used as a way of preventing access to protect areas sensitive to habitat damage:

“...there’s some areas of the island that are tapu you never ever work them because ground is so soft and the hole[s] are so near to the surface that if you did walk in there those holes would just collapse. ... you didn't go near there, you just left it for the birds to breed in that area, because if you went in there the holes would collapse. ...on a little island like ours whether you like it or not we've got to try and find birds because every hole matters. And then of course the tracks are worked out so that they sort of go round the perimeter of those sort of areas [tapu areas] so that you have a fair chance of picking those birds up at torching time.” Birder K
Designating areas as tapu can also prevent access to sacred sites associated with their ancestors (tūpuna) (Birder C, J, P):

“...there’s a woman and a baby buried there. And mind long before my time, but it’s never nanaoed, [and] it’s in the middle of my manu. And I’ve never nanaoed it. I’ve only known one person to nanao it, that was my brother-in-law, [a] Pākehā and did he get told off. And it’s got all sorts of dry wood on it but nobody goes in to get the dry wood, and even [in] torching time if there’s birds on that side, and there always is, I never ever go on to it, no. [I] Wait till they come off.” Birder C

“...we don’t go where the old houses have been where the old people have lived. You will see rings of burnt rocks and you don’t get wood there or anything like that. It’s always sort of tapu to us. We just leave them. There are plenty of places you can go and you don’t bird there. You don’t go and nanao there. I know near where we are there’s a two big rings of old burnt black rocks where there have been houses and over further there’s a patch and it’s got all sorts of dry wood but you never ever go in there.” Birder P

Waste minimisation

An important concept for some of the interviewees was not wasting tūtū or resources on the islands. Kiaka (a chick that is too thin to take as food; Ashwell 1999) are avoided (Birders A, D, E, F, I, J, L, M, N, O, R; Hunter et al. 2000b; Lyver 2000a). Only suitable chicks are killed, and this is done instantaneously so as to avoid unnecessary suffering. However, Birders J and P said that if they found a very weak kiaka they would kill it out of mercy rather than allow the rats to do so.

Birders F, G, O, S, and Q stated that it is important to harvest only as many chicks as they process. With the current technology, the amount of time it takes to process the chicks limits the number of chicks that can be harvested without wastage (Lyver and Moller 1999a and b, Kitson 2002).

The way the chick is handled through the catching, processing and storage stages is important in order not to ruin the bird (Birder K). Chicks that become ripped, bruised
or deemed unsuitable for sale, barter or gifting become ‘home’ or ‘tucker’ birds and are retained by the birders for their own food (Birder R, G, F, I, Kitson unpubl. data).

Sanctions, compliance and enforcement

Both legal and social mechanisms that function to guide compliance and enforcement exist. In particular, social sanctions function as guides for human conduct toward the natural environment (Colding and Folke 2001). While the harvest had been governed by traditional rules, in 1910 Rakiura Māori petitioned the New Zealand government (Taiepa et al. 1997) to recognise most of these rules as legal regulations (Land Act Regulations 1912, Department of Lands and Survey 1978). This legal recognition was seen as a way to negate any changes to island land use and open access to others, for example leaseholds and farming (Wilson 1979, Birder L). The past or current regulations do not cover protection of vegetation, yet the majority of interviewees stressed the importance of this. This indicates the presence of social sanctions still guiding behaviour of ōtī harvester.

In addition, localised sanctions on islands can occur. A prohibition of ‘clubbing’ is proposed for new bylaws for the Rakiura ōtī islands and changes to the existing regulations, and this practice has already been banned on some islands and manu (Birder F and M). ‘Clubbing’ involves the use of a small club to kill the chicks during rama. The main objection to this method is concerned with the possibility of wastage; it is unnecessary to handle chicks before killing them, so small chicks and adults could be accidentally killed. Bruising the meat can occur, which makes it less suitable for sale. ‘Fencing’, where ōtī are trapped during rama when they make their way to cliff take-off points, is another method proposed for prohibition because of the risk of wastage and harming adult birds.

Access to the muttonbird islands is strongly protected. At permit day permission for access goes through close community scrutiny and sometimes heated debate. In the past, trespass has been penalised by confiscation of harvest and public notification of the offence. Pākehā have also been prosecuted and penalised for trespass on the
islands (Southland Times 3/7/1913). Historically, blood has been spilt in fights between island owners and trespassers on the islands (Wilson 1979).

In the late 1960s, one interviewee was stopped at the wharf just before embarking to the island because he had not gone through the Māori Court and gained a succession order to allow him to go to the island. In 2003, at the request of Rakiura Māori beneficial owners, the Department of Conservation removed non-beneficiaries from two manu (S. Owen, pers. comm.).

Beneficial owners have removed potential owners from the island or prevented them from taking part in the harvest if they damaged the island or misbehaved (Wilson 1979, Birder E and P). As one birder recounts:

"...one year some [of] my cousins came down, [and] they didn’t know anything about muttonbirding and they were just starting at the mouth of the hole and digging their way back until they found a bird. ‘Cause they’d never been told and I remember they were told if they couldn’t do it properly, [then] stay out of the bush. They weren’t allowed to go out and that then. If you don’t respect the island and things down there, well they always get told off and if you don’t do it, the owners will get together and tell you to keep off the island." Birder P

The rules that protect the islands are viewed as the one thing that the birders have direct control over:

“I think the habitat and how we look after it is really important for the returning birds when they come back, because no matter what happens out there we’re the only ones who have got control of the habitat ‘cause there’s no control in the ocean. There’s so many things happening out there that we have got absolutely [no] control unless we can convince Governments to stop pouring out pollution and all the things that have adverse effects in the ocean. So you know we should do everything we can on the land to make sure that the ones that do come back have the very best habitat there is for them.” Birder L

For common property resource management to work, it is important for the resource users to believe that abiding by the rules will bring benefits to them as individuals.
Birders believe that if they look after the manu, the birds will keep coming back and will continue the harvests for the generations to come:

"I think how you look after an island dictates as to what will be on that island because, those birds keep coming back to that island. I know that the mothers do. Once they’ve nested, they will keep coming and nesting there again..." Birder K

In some of the interviews, the kaumātua and elders mentioned a responsibility they had to look after the islands for the next generations and it was important to pass on the knowledge and the resource to the next generations. This concept relates to kaitiakitanga and kaitiaki. Kaitiakitanga has been defined as the act of guardianship, and kaitiaki as a guardian (noun) and to protect or to guard (verb; Roberts et al. 1995). This responsibility was given to them by their ancestors. This knowledge had been passed down to them from their parents or (in many cases) grandparents. Looking after the land is also looking after your people:

"I think kaitiakitanga is really looking after what is here, now and making it improve and grow. I see kaitiaki as being what we have done on [our island]. I see it all being part of the lifestyle of the people on the island but I see it ‘cause that’s kaitiaki too is how we look after our families. We are kaitiaki of those children and young people. Then it transfers on to the land and I see what we have done down there how the island’s starting to blossom I see that being kaitiaki.” Birder L

Another birder relates:

“...most of the people I know down there [on the tītī islands] look after the muttonbirds. There’s the odd one in every situation that don’t - that are grabbers and don’t care about the holes or the way the ground’s left or anything. I have seen it myself, but the majority of them, thank god, are good conservationists and as long as that happens and you teach the young ones properly so that they come along to be good conservationists and look after that what you got, you got no problem and I don’t [see that] the [Forest and] Bird Society and that, should have to worry about it. Because, if you have got to be told by somebody else how you should run something that you have had for generations, you’re at the end of your tether, so you might as well stop.” Birder M
As many of the birders stated, it is important for the next generations to be taught properly to look after the islands for the sustainability of the tītī and the cultural heritage of Rākiura Māori (Birders J, K, L, M, N, S).

**DISCUSSION**

This study confirms that Rākiura Māori tītī harvesting practice is an example of common property resource management. Access is shared and controlled by birthright, and rules apply to the harvest and are enforced by legislation and cultural and social sanctions (Kitson and Moller subm.). Through abiding by the rules, it is believed that the birds will return, therefore individuals have an incentive to comply.

It is important that Rākiura Māori retain the control of tītī harvesting, both for the tītī *per se* and for the cultural wellbeing of Rākiura Māori. Societies do not establish conservation rules and ethics for the benefit of outsiders (Berkes 1999). Incursions of outsiders and the inability of a group to defend an important resource have been shown to cause the lifting of rules and the decline of conservation ethics (Feit 1986; Berkes 1986; Berkes et al. 1989).

Rākiura Māori rules dictate the behaviour of tītī harvesters in relation to the resource. For example, rules ensure adult birds are not disturbed, only suitable sized chicks are harvested, and wastage is minimised. However, the majority of rules focus on the protection of the habitat of the island, such as burrow integrity, care of vegetation and maintenance of manu areas.

Overall, the limits on the harvest of tītī are passive, with the numbers of chicks taken being set by time spent harvesting and processing the chicks (Lyver and Moller 1999a; Lyver 2000b; Kitson 2002). There are no rules that dictate the number of tītī they can harvest. This finding is consistent with other studies of indigenous resource users (Wilson *et al.* 1994; Colding and Folke 2001).

The rules used by Rākiura Māori to promote sustainability fit into the categories established for other cultures' sustainable use of a common resource: protection of
habitat, protection of vulnerable life-history stages, and temporal restrictions of harvest (Folke et al. 1998). The potential threat to adult birds and possible wastage has prompted the development of rules banning certain techniques for harvesting tītī. These rules would then fit under the method taboo category of Colding and Folke (2001).

Many indigenous societies’ resource and habitat protection rules have functions similar to ‘westernised’ conservation management (Colding and Folke 2001). For example, habitat protection is a large part of westernised resource management and Rākiura Māori harvesting rules. One of the most important harvest rules is the protection of breeding adult birds, which has also been highlighted as the most vulnerable life stage to harvest for long-lived seabirds (Hunter et al. 2000a; Moller in press).

Rākiura Māori have both informal and formal institutions⁹ to govern their behaviour. Social mechanisms (informal institutions) can be far more effective and are less costly as compliance and enforcement mechanisms (Colding and Folke 2001) because of their self-regulatory nature. Rāhui and tapu are central cultural and social mechanisms for tītī harvest management.

This study has shown that rules, sanctions and harvest organisation can be different on different islands. This gives harvesters the ability to reorganise and adapt to new situations and circumstances while still keeping within the generally defined bounds of acceptable social behaviour (i.e. tikanga or customary lore; Hviding 1998). The experience and wisdom of TEK holders provides the context for this flexibility in rules (Berkes and Folke 2002).

An important aspect for enduring cultural and ecological sustainability is the mechanisms by which TEK is received, accumulated and the transmitted to the next generation (Ohmagari and Berkes 1997; Folke et al. 1998). Elders and other wise

⁹ Institutions provide the rules for management systems. They set rules and norms that structure human interactions (North 1994).
people play a key role as the keepers of TEK, transmitting knowledge and providing wisdom to interpret novel observations (Berkes 1999). The importance of kaumātua and elders and the transfer of TEK as well as possible obstacles to such transfer, warrants further study for the harvest of tītī by Rakiura Māori.

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Chapter Five

Social mechanisms for sustainable resource management: learning and change by traditional Māori seabird harvesters.

Te Ao Hurihuri
**te ao huri ai ki tōna tauranga:**
**te ao rapu;**
**ko te huripoki e huri nei**
**i runga I te taumata o te kaha**

Te Ao Hurihuri
Is a world revolving:
A world that moves forward
To the place it came from;
A wheel that turns on
an axle of strength
ABSTRACT

Social mechanisms behind harvesting practice influence harvester behaviour in the creation and maintenance of conservation ethics, thus creating potential for adaptation in the face of global ecological change. This study investigates the social mechanisms behind the last large-scale customary use of a seabird in New Zealand: the harvest of tītī (*Puffinus griseus*) by Rakiura Māori. Semi-directive interviews were conducted with twenty experienced tītī harvesting elders in order to investigate mechanisms for transmission of ecological knowledge; structure and dynamics of Rakiura Māori institutions; and worldview and cultural values associated with harvesting. Rakiura Māori learn ecological knowledge through observation, hands-on experience and storytelling. The fact that younger Māori spend less time harvesting nowadays in order to meet employment and educational needs puts pressure on the transmission of knowledge. However, use of modern technology for harvesting facilitates the transfer of essential processing skills. Rather than reducing the integrity of traditional harvest, technological advances thereby contribute to cultural sustainability and continuance of the tradition of harvesting tītī. Awareness of ancestors (*tūpuna*) and taboo improve compliance to correct harvesting practices and reinforce Rakiura Māori’ connection to the harvesting islands and foster a strong conservation ethic. When the negative influence of colonising was viewed as a risk to the traditional rules that govern this harvest, Rakiura Māori used law to strengthen lore. Global climate change is probably causing tītī population decline and reduced predicability of harvest seasons using traditional knowledge. This has led Rakiura Māori to add ecological science as a tool to complement traditional knowledge for monitoring harvest sustainability. Science cannot be used without traditional ecological knowledge and needs to be compatible with existing social institutions.
INTRODUCTION

Sustainable use of the environment depends on interactions between social and ecological systems (Berkes and Folke 2002). ‘Sustainable development’ is commonly defined as “development that meets the needs of the present without compromising the ability of future generations to meet their own needs” (WCED 1987:43). The model of sustainability supported by the New Zealand Parliamentary Commissioner of the Environment (PCE 2002) recognises that human society and economic activity are constrained by the natural systems of our planet, and considers society a subset of the environment. It is therefore fundamentally important to understand how societies learn and transmit knowledge about their environment and customary use, how they adapt to new ecological changes, and what social institutions and mechanisms influence harvesting behaviour. The worldview, belief and values of harvesters are likely to influence the responsiveness of a society of traditional harvesters to changing ecological conditions.

This study focuses on the transmission of knowledge and sustainable harvest practices amongst Rakiura Māori, New Zealand’s southernmost group of indigenous people, who harvest the chicks of a seabird, the sooty shearwater (tītī, Puffinus griseus). Tītī numbers are declining, probably because of climate change (Veit et al. 1997; Lyver et al. 1999; Scofield and Christie 2002). Investigation of the social mechanisms behind sustainable harvest management may predict whether Rakiura Māori can ensure that the birds remain sufficiently plentiful to enable their grandchildren to harvest and thereby continue their cultural connection to the birds, their breeding islands and associated issues of cultural identity.

Tītī harvesting is guided mainly by Traditional Ecological Knowledge (TEK), a system of knowledge that guides indigenous peoples’ customary uses of wildlife. TEK refers to “a cumulative body of knowledge, practice, and belief, evolving by adaptive processes and handed down through generations by cultural transmission, about the relationship of living beings (including humans) with one another and the environment” (Berkes 1999:8). It is an attribute of societies with a long-term continuity of resource use on a particular land (Johnson 1992; Gadgil et al. 1993;
A commonly expressed belief amongst some commentators in New Zealand is that TEK is an inadequate knowledge system to guide safe harvesting. This is partly because they consider it dated and unable to adapt quickly to rapid global ecological change (Moller 1996; NZCA 1997; Taiepa et al. 1997; Newman and Moller subm.).

Titiri harvesting, along with nearly all other traditional harvest management by Indigenous peoples, does not institute formal limits to the actual harvest extraction rates (Wilson et al. 1994; Colding and Folke 2001; Kitson 2002, subm.a). Nevertheless, social institutions are often active in traditional harvest management in more subtle but potentially also more powerful ways. Institutions represent the arrangements or "rules-in-use" (Ostrom 1992) which people set up to control the use of the environment. Institutions include behavioural constraints and their enforcement, which structures human interaction with the environment (North 1994). Constraints can be formal (i.e. written rules, laws, constitutions) or informal (i.e. local social norms, conventions, codes of conduct).

An important factor of institutions is the ability to monitor and punish those who violate the rules-in-use (Acheson et al. 1998). Indigenous peoples’ rules-in-use tend to be informal institutions and compliance can occur through religious beliefs, cultural rituals and other social mechanisms (Gadgil et al. 1993; Colding and Folke 1997; Colding 1998; Folke et al. 1998; Berkes et al. 2000; Colding and Folke 2001). The structure and dynamics of institutions are therefore potentially crucial for sustainable resource management practices (Hanna et al. 1996; Berkes 1998) and can have similar functions to formal ‘westernised’ resource management legislation (Colding and Folke 2001).

This case study investigates mechanisms for generation, accumulation and transmission of ecological knowledge; structure and dynamics of institutions; and worldview and cultural values associated with Rakiura Māori’s Titiri harvest. Folke et al. (1998) and Berkes et al. (2000) emphasise the importance of these social mechanisms, but there have been few in-depth case studies of their importance in New Zealand. I wanted to learn how such social processes worked in the past, how they might be changing, and whether the world-view and connection of Rakiura
Māori to the birds and the birds’ breeding islands provides a sound basis for sustainable resource management.

BACKGROUND: TĪTĪ AND TRADITIONAL HARVESTING

Tītī are considered the most ecologically important seabird in New Zealand (Warham and Wilson 1982). Tītī are probably “keystone” species (Paine 1966, 1994) on the islands at the centre of breeding abundance in Foveaux Strait and around Rakiura (Stewart Island). This is because of the high density of birds, digging of nest burrows, and deposition of large quantities of nutrient rich guano have an over arching influence on the plant and animal ecology of the "bird islands" (Campbell 1967; Towns et al. 1990; Hawke and Newman 2001).

Adults spend April to August in the northern Pacific, before migrating in September and October to breeding colonies in New Zealand.

Culturally, tītī are very important for Rakiura Māori. They are an important food and trade source of Rakiura Māori (Beattie 1994; Dacker 1990; Dacker 1994). The harvest itself acts to generate social cohesion and group identity amongst Rakiura Māori (Waitangi Tribunal 1991; Dacker 1994; Taiepa et al. 1997).

Archaeological evidence shows that sooty shearwaters were widely exploited in prehistoric New Zealand, but their present large-scale use may have been a proto-historic phenomenon (Anderson 1997). The term "Muttonbirding" refers collectively to the techniques and practices, in which chicks of various Procellarridae are captured, processed and preserved for food (Anderson 1996, 1997).

The harvest of tītī can occur on 36 Muttonbird/Tītī Islands in Foveaux Strait and around Rakiura (Figure 1). Tītī chicks are harvested each "birding season", from the 1st April until the 31st of May (Department of Lands and Survey 1978). Resource access is controlled by birthright and there is a system of rules used to assist sustainable use by protecting island habitat and adult birds, and temporal restrictions on harvest (Kitson subm.a).
The main periods of harvest are nanao and rama. During the nanao, which occurs from the first of April until mid-to-late April, the chicks are extracted from the burrows during daylight. During the “torching” (or rama period, from late April until mid May) the chicks are captured at night once a sufficient number have emerged from their burrows to make the hunt cost-effective. As fledging approaches, the chicks spend more time out of their burrows to flex their wing muscles and lose their down, enabling tītī harvesters to quickly gather them.

Processing techniques have adapted to incorporate modern technologies. Motorised plucking machines and wax are commonly used to remove feathers and down, whereas in the past, harvesters used hand-plucking and rubbing the chick after immersion in near boiling water (‘water-cleaning’). These new technologies were adopted mainly for convenience and to ease labour (Lyver and Moller 1999; Kitson 2002). Plastic 10 litre buckets are used to store chicks, rather than the traditional pōhā (kelp bags made from Durvillea antarctica) that are placed in flax baskets (kete) and protected with tōtara bark (kiri tōtara\(^2\)), or if bark was unavailable raupo\(^3\) or dried flax (kuka\(^4\)).

Rakiura Māori established the Kia Mau Te Tītī Mo Ake Tōnū Atu “Keep the tītī forever” research program in 1994. This was done to examine the sustainability of the harvest and to ensure that the birds remain plentiful for their mokopuna (grandchildren) (Moller 1996; Taiepa et al. 1997; Moller et al. 1999). A major facet of the program’s research is to record the TEK of the Rakiura Māori tītī harvesters. This study is part of that project.

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1 The colloquial term “torching” was used by the interviewees instead of the Māori equivalent of rama. Therefore, to remain consistent with the quotes from the interviews I have used the term torching in this manuscript.
2 *Podocarpus hallii*; Hall’s totara.
3 *Typha orientalis*.
4 *Phormium tenax*. Kuka refer to the dead dried flax leaves still attached to the plant (Ashwell 1999).
METHODS

I interviewed twenty experienced muttonbirders, elders and kaumātua (respected and wise elder; Garven et al. 1997). The interviewees had to be over fifty years old, still actively muttonbirding, and living in the Southland area. The interviewee’s ages ranged 55 to 85 years (mean = 69), and the sample consisted of seven females and thirteen males. The sample represented approximately 30% of the possible candidates within the entire community that fitted the selection criteria at that time. The heterogeneity of practices and traditions on different islands was addressed by interviewing representatives of various families from 11 different islands and 17 manu (Figure 1).

The selection of participants was non-random because I targeted older people. However, in many indigenous communities, elders play a key harvest management role – they are often the keepers, transmitters and interpreters of TEK (Berkes 1998; Pinkerton 1998; Berkes 1999; Berkes and Folke 2002). In recognition of this, it was requested that this project had a dual role, to record oral history from the kaumātua and elders of the Rakiura Māori community before the information was lost. Because of this, two kaumātua were interviewed even though they had not been birding since they were teenagers.

5 Two of the birders were a couple, and were interviewed together.
6 “Birding” or harvesting ground, often refers to a specific family’s area.
FIGURE 1: Rakiura (Stewart Island) and adjacent Titi Islands. Interviewee’s birding islands are shaded and named. Specific birding areas (manu) are also named for Taukihepa.
Initially I was introduced to two possible interviewees by a Rakiura Māori kaumātua, they in turn suggested other elders to approach. The interviews were semi-directed (Huntington 1998, 2000) or unstructured (Lofland and Lofland 1995). Participants are guided in the discussions by the interviewer, but direction and scope of the interview followed the interviewee's train of thought.

Before the 'official' interview took place, I visited the kaumātua or elder and spent time building up trust. In some cases I visited them several times. In these pre-interview periods, I also asked them general personal information, but during the majority of this period the questions came from the prospective interviewee. As I am of Rakiura Māori descent, it was important for the interviewees to find out how I related back to them, and to share accounts of my family members.

Four people approached for interviews refused. Two felt uncomfortable with the idea of being interviewed and audio-taped, and one refused because she apparently distrusted science. The fourth person previously encountered an unethical researcher who taped her conversation without her consent and consequently distrusted researchers. However, the relatively high proportion of older birders interviewed and the low level of non-participation suggests that my information will be an unbiased representation of the views and knowledge of the older tītī harvesters in the community.

The interviews occurred between November 1997 to early March 2000. They were audio-taped and transcribed. All interviewees received a copy of the interview and transcript. With interviewee consent a copy of the interview/s was lodged at the Southland Museum and Art Gallery, sometimes with restrictions placed on access and future use. Seventeen interviewees granted that their interviews could be lodged at the archive.

Many of the interviewees had harvested on their island since they were very young children, however they were very concerned about being singled out as 'authorities' on muttonbirding. Accordingly confidentiality was assured in publications. This manuscript therefore refers to the interviewees as Birder A, B, C etc.
Chapter 5

Spoken language can appear quite ungainly when typed on a page. Therefore quotations from the transcripts have been edited to assist reading. Editing removed fillers (such as ‘um’, ‘ah’ and ‘you know’ etc.); repeated phrases; false starts; pauses; laughs; and the occasional grammatical error. Occasional changes were made to ensure confidentiality. Square brackets indicate where I added text to aid understanding. Two reviewers compared the original transcript quotations with the edited quotes in this text to ensure that any changes made were to aid understanding and keep the original meaning intact.

All written work resulting from the Kia Mau Te Tūī Mo Ake Tōmu Atu “Keep the tūī forever” research programme is reviewed and commented on by the Rakiura Tūī Island Administering Body (representatives elected by the Rakiura Māori community to administer the requirements of the Ngāi Tahu Settlement Act 1998). A cultural safety agreement between Rakiura Māori and the University of Otago research team ensures the traditional ecological knowledge remains the intellectual property of Rakiura Māori and scientific data is jointly owned (Moller 1996; Taiepa et al. 1997). Before submission, the Administering Body validated this paper.

TRANSMISSION OF ECOLOGICAL KNOWLEDGE

Previous knowledge holders and learning

Rakiura Māori have a holistic view of who holds reliable and trusted ecological and cultural knowledge (Newman and Moller subm.). Part of the assessment of a Rakiura Māori knowledge holder is that they: had a good teacher; come from a cohesive family with a good transmission of knowledge through the generations; are experienced harvesters, with current knowledge; and are trustworthy in other aspects of life (Newman and Moller subm.). In general, family elders are key knowledge holders in Rakiura Māori society.
The majority of the kaumātua and elders interviewed (16 out of 20) were taught about muttonbirding by their parents, grandparents and/or older relatives. Two were taught by a parent-in-law and spouse, because they both married into a birding family. The couple started birding when they were in their early thirties and were taught by the other birding families on the island. Birder E’s excerpt discusses his teachers and his assessment of why they were good knowledge holders and how he was taught:

“I had some good teachers in my Tāua [grandmother] and Pōua [grandfather], because they were of the old people and they just carried out what they had been taught, and they handed down to me the same things ... When I say they taught me I just learned by watching how they caught the muttonbirds, how they prepared the muttonbirds, how they looked after the whole environment of the island - as to conservation, I suppose, although they didn’t know it by that name.” Birder E

Detailed knowledge and skills are essential to harvest and process tītī effectively. Learning involved a mixture of observation and hands-on experience (Birder C, E, G, I, J, M; Figure 2).
Harvesting muttonbirds is a family activity where members of the family contribute to the workload, whether this is harvesting, processing, domestic work or looking after small children (Birder C, F, L). By watching their parents and older family members as young children, the interviewees first identified the skills that need to be learned. This learning by watching is illustrated in these quotes from Birder E and G.

"We would crawl around under the trees after Dad and Mum and uncles and observe what they were doing to catch the birds, how they caught them. And Dad would teach us by saying "Come here and have a look at this", this is the way you do this, and all this sort of thing, you know, and it was quite interesting." Birder E

"Just watching Dad and then going out with him, behind him, and you know watching Mum cut-up, and pluck, and clean. You just pick it up naturally - see what they are doing and you try it and you’re doing it." Birder G

The majority (12) of the kaumatua and elders first went to the islands as babies or young children. Some mentioned that they could not remember a time before they ‘worked’ the birds (Birder J, K, R).
"...I suppose we just gradually worked in, when I was old enough. I don’t actually remember starting, but I don’t remember not working them put it that way.” Birder R

Children were given some chores that involved helping in simple tasks or steps of tasks. As children the majority of the interviewees first helped with the collection of wood. In the past, firewood was a sought-after resource because of the reliance on open fires for domestic purposes and for cleaning and cooking. However, Rakiura Māori resource management practice prohibits cutting down of live wood (Kitson subm.a.). Participating in the collection of dead firewood as young children helps reinforce this habitat protection practice. This is illustrated in this statement from Birder C:

“Oh it’s a wonderful place for children to learn. When I was small - [and] my kids were the same - they had their jobs. They had to get in the lala”, the morning wood. And when we were getting wood, they had their wood to carry, even [if] it was only a couple of sticks. But then when we were small we had the open fire, and we would have two or three days getting wood and it was always trees that had come down through the season, you didn’t take trees that were standing ...” Birder C

Part of the learning complex was being taught the certain steps for harvesting and taken on as an apprentice or ‘helper’, as illustrated in this extract from the interview with Birder K.

“...there are many things that you’re taught right from [when] you’re a child. When you’re young on our island you’re always taken with someone else. [The child’s] job as the helper is to gather up the birds as the catcher catches when you are nanaoing. And you are taught [that] whether a bird is easy and can be plucked and cleaned and worked efficiently, depends what you do with that bird from the instant you put your hand on it the first time. So, you’re taught to catch it and even extract it from the hole a certain way...”

The interviewees would learn and practise the easier skills first and then graduate to harder tasks (like plucking the front of chicks) and ones too dangerous for children,

Twigs and small sticks used as kindling wood. Also referred to as rara.
like ‘splitting’ (which involves using a knife to cut open the chick prior to gutting it). Play also appeared to be important to learn about their island.

“...getting the morning wood [lala] was good fun. We had a dinghy and we would go round the cliffs getting dry morning wood [lala], and we played and we didn’t do much work when we were children. We played on the rocks, we fished and we got pāua\(^10\) and kina\(^11\) and things like that and you got to know all the birds and watch things and made basket[s]. Some kids had to work but we didn’t do a heck of a lot of work and then when you get older you learn to pluck the backs of the birds. You weren’t to pluck the fronts because if you pulled - gave a yank, you ripped the flesh off the bird and got told off. Practising, you know, and things like that.” Birder P

“Yes we had to work them when we were young, we had to do everything. I think that’s how we have learnt. We would have to pluck and we had to water-clean ... And then we had to learn to split\(^12\) but we weren’t allowed to split till we were a bit bigger. But [we] learnt\(^13\) to gut when we were smaller and then whawahao\(^14\) put them into the kelp bags [pōhā], and tā\(^14\) - put the bark and that around them. But we didn’t have to do it all the time, we still had our play time - wonderful place for kids.” Birder C

Eventually the interviewees learnt all the skills and became an integral part of the working family unit in their teens.

“My parents learnt us. Even as a girl you learnt to catch a bird and then you caught the bird and you were made to pluck it and you worked it right through as they told you, and as you got older you just automatically went right through. As a child we had a good life ‘cause we had good parents and they didn’t slave you into anything. You just wandered along and did what you like but as long as you did your wee share nobody worried about it. And you see I had to learn to make scones\(^15\) when they were out working and I more or less kept the food going. I learnt that when I was only young you see, and see this goes on and on and that’s how I hope I was teaching my

\(^{10}\) Haliotis iris; abalone.
\(^{11}\) Eucheirius chloroticus; sea urchin.
\(^{12}\) To cut open a chick with a knife in order to gut it.
\(^{13}\) The act of filling pickled fish into the kelp bag (pōhā; Ashwell 1999).
\(^{14}\) Placing the bark, ruāpū or dried flax around the pōhā with an open network of twine or flax (Ashwell 1999).
\(^{15}\) Colloquial name for a plain dough bun.
children to do the same thing. Do your work. Everybody help[s] each other and that’s all that matters.” Birder J

Some skills like nanao, hand-plucking and water-cleaning take some time to learn. Using water-cleaning required the chicks to be handled in a certain way in order for the chick not to become greasy from over handling and leaking stomach oils (Birder K, P, S).

“It all involves the whole family when they are down there. They get to know their jobs, as they get older they do a wee bit more and someone specialises in some things. Some are good at nanao, some are good pluckers, [and] some are good cleaners ... This nanao business, it takes a while to get used to that, to get the feel of that. You see people go down there and they will poke down the hole there and can’t find anything, and another person will come along and put their hand down and out the birds pop. Very frustrating if you’re nanaoing. One person’s catching [chicks] and another one’s not... But it’s all time, [it is the] same with plucking, it all takes time to feel it. Know the shape of your bird, [and] how to handle it.” Birder F

“...oh different ones try water-cleaning but unless you sort of been brought up to it and shown it, it can be quite fiddly because if you haven’t got the water boiling\textsuperscript{16}, it just sort of cooks, [and] makes the birds greasy and the down won’t come off or anything.” Birder P

“ Took me sort of [a] few years to learn how to water-clean, you used to bust the birds a lot. The fatty birds. You’d run your hand over them you’d bust the skin.” Birder R

\textit{Story telling: an important mechanism for transmission of knowledge}

Story telling was also used as a way to pass on traditional knowledge such as history, legends, and whakapapa\textsuperscript{17}. Harvest rates and seasons were discussed and compared when birders gathered during or prior to the season. Historically, Sundays were taken

\textsuperscript{16} The accepted temperature is actually below boiling. One of the skills in water-cleaning is judging correct temperature.

\textsuperscript{17} Genealogy, family tree.
off from harvesting and in some places part of Saturday was taken off as well (Kitson subm.a.) and this day was usually spent socialising with other birders. Birder M remembered visiting people on his day off on Sunday when he was young:

"...all these people had different places around and they would come to your place or you'd go to their place and have a yarn and a cup of tea and a good old chat. Yeah that used to be quite good. Those days you learnt that lots of things had happened and talked about years ago and history was passed on. It was marvellous how much history was actually passed on in them days - if you were prepared to sit and listen. It was quite nice. It was history about the islands, about catching birds and about how many they got [harvested] this day and what you have [got] and what somebody did and what somebody didn't and it was general things. The knowledge that you learnt and you remember and as you get older you pass it on perhaps to your kids to talk about. You know, what they used to do when you were young and I find sometimes now you haven't got time to do [that] - when your birding starts, you haven't got time to do a lot of things. Well I have noticed with a lot of people [that] it's all go. You can't go and visit for very long through the nanao time because everybody's working. Everybody's gotta go and I feel sorry that part of it is finished."

Birder M

Birder D also recalled story telling to be common in his youth:

"... on the island when we were young there were no distractions such as radios or TV or anything like that. We never had those things, but we would all get into one house, and build up a good fire and sit round and talk. We as kids of course had to be quiet but we could listen and we did and we learnt quite a lot of things from the old people. They spoke of everything from adventures, coming and going to the island, how places got their names all that sort of thing. There wasn't a subject that they didn't touch on. There was always somebody who knew something about the history of the place or and as for whakapapa everybody knew everybody else. You mention a name and 'oh yes she was so and so' or 'he was so and so' and all that sort of thing."

Birder D

Transport was by communal boat to many of the islands. The 'Old' and 'New' Wairua boat transported many of the birders to the South-West Island group (where the majority of birders go). The journey could last from a few days to two weeks, depending on the weather conditions. During this time the birders would share stories
and information. As Birder F recalls: "...all the people were altogether then [when] they were all travelling together and you knew everybody. The way it is now with them flying down and going down in fishing boats some people you never see from year to year, but in those days you saw everybody, worked all the landings and it was quite good. Hear all the old stories and they would talk about what used to happen, and who went where, talked about the hākuai, mostly about the season, how the season went and all that kind of thing.” Birder F

Transmission of knowledge to today’s generations.

Today’s children and grandchildren are being taught in a similar yet subtly different manner as the elders were. Teaching is still a mixture of observation and hands-on experience. Teaching and learning is treated as a gradual process and Birder K mentioned that there are techniques that make it easier for children to learn about birding.

“...kids haven’t got a big hand to hang onto the necks of five birds, so if they are trying to hang onto that and then a noose around their heads its difficult. So you teach them to put the noose onto their wrists and they get the birds in and then they move it down round. So [there are] all sorts of easy little things like that for little ones that we teach - little short cuts like that.”

Many of the interviewees stated it was important that the next generation come to the islands, because it was their heritage. It was also important for the practice of muttonbirding to continue in the family. In some cases the interviewees take their grandchildren in order to teach them about birding, because employment prevents the parents from harvesting. Also, some birders feel it is the responsibility of the grandparents to teach their grandchildren rather than the parents (Metzger in press).

18 On the ‘Wairua’.
19 In helicopters.
20 Helped with loading and unloading other birders’ gear at less rugged sites around the islands.
21 A legendary bird.
22 This is done to hui the chicks. This is where chicks are gathered together in bunches of five at either end of twine or flax string in order to be slung across the shoulder for carrying.
Some of those interviewed stated that it was an important duty to ensure children are taught properly. This is illustrated by this quote from Birder M:

"The main thing, you know, is to teach the kids. You don’t do that, and you don’t do these things, you do this, because you are not going to be here forever. So what you are taught as a kid, there’s a way you go through life, I don’t care whose child it is. If he’s taught to grab something some way and do it there, that’s the way he does it for most of his life and that’s the way he’s been brought up. That’s the way I have been brought up. You get out of life what your parents have put into it for you. So it’s the same with the heritage, you go muttonbirding, if you teach them how to do it properly and enjoy it and make them understand that’s how bloody nice it is - well he’s on his way to becoming you again."

Interviewees believed that they needed to teach the current generation properly with a framework of tikanga\textsuperscript{23} (customary lore) and kaitiakitanga\textsuperscript{24} (the act of guardianship), so they can pass this knowledge to the next generation, even if there is a break between generations from muttonbirding. This quote from Birder O encompasses a typical sentiment:

"It is important that my grandchildren are taught about muttonbirding. Even if they never ever go back for a tītī season to actually harvest tītī. Their children might want to. Now if they can tell them, how to go about it, it’s a step in the right direction and if they can tell them what their duty is - by duty I mean in the tikanga and the kaitiakitanga. That’s three steps in the right direction, so it’s very important to me and to them too I think." Birder O

Contemporary opportunities for story telling have decreased with few days being taken off during the harvest and more individual family transport arrangements such as charting fishing vessels and helicopters. The use of television and other electronic devices for entertainment is more common, so some families may have become unaccustomed to story telling.

\textsuperscript{23} Custom, the correct way of doing something, lore or law (Dacker 1994, Garven et al. 1997).
\textsuperscript{24} Kaitiakitanga has been defined as the act of guardianship, and kaitiaki as a guardian (noun) and to protect or to guard (verb; Roberts et al. 1995).
However, passing on stories to younger generations still appears to be important for some birders. Birder M used stories to connect his mokopuna with their heritage and to engage them to learn about the island by making it interesting to them.

“You teach them all the ways that you were taught, if you make a hole in the manu you purie25 it. All the ways that you were taught, and how you should never make a mess of the holes. You should never smash the holes and all this. You should always look after it because the birds come back again next year. There’s always a next year. And how you use the flax, how you use everything [that’s] there on the island - for the purpose of catching your muttonbirds, catching the tītī. And you can only pass on what you have been taught and you tell them the stories - like I was telling you about when we were children, and how they used to have the Sundays off and all the old people used to be telling stories and talking. That was if you were really interested, it was great. You know it was lovely to hear. Well now you can pass it on to your kids. It’s a heritage. And a lot of the grandchildren, they sit down there and you tell them about everything. We used to on bad nights and it was really blowing, and it’s raining and cold and [I am] especially talking about my wee mokopuna. He used to go out torching for a couple of trips and when it got too rough you would stop home, and then we would be sitting inside and he’d come up for a cuddle and I would say to him you know, ‘remember the night that the wind blew, and we went away out and we got lost and we saw a big muttonbird hole and we climbed down [into it] so it was nice and warm and there were leaves’, you know about spinning a yard to him...and you could just see him, he was there - It was happening to him. Lots of little things like that, just folk stories and that.” Birder M

25 Make a plug so the burrow is water tight to ensure the nest will remain dry and the adult bird will nest there again in the next season (Ashwell 1999).
Many of the interviewee’s (Birders A, C, G, I, M) mentioned that employment pressures on the mainland now prevent people from muttonbirding. Many potential birders either cannot afford to take time off work, or employers are not agreeing to re-employ them after their 8-10 weeks on the island. Those birders that do manage to take some limited time off target the torch period of the harvest, where offtake is the highest (Kitson 2002). Three interviewees only go to their island for the torch period - two (the couple) have not learnt to nanao and the other goes with her son who can only take enough time off work for the torch. Interviewees from nearly half of the islands and manu mentioned that more people now attend torch compared with nanao. On Kaihuka no harvest occurs during nanao, and on Tīā and Puawai26 usually only one or two people harvest during nanao. Some interviewees believe that the skill of nanao is being lost (Birders C, J, S).

The majority of those interviewed had come down for the whole season since they were babies. However, the time constraints of formal schooling only allow their grandchildren to go to the islands at times that correspond to school holidays, generally two weeks around the Easter period (Birder J, M; Kitson unpubl. data). Some children may only experience muttonbirding a few times, because they live in other parts of the country or the world. This limited time on the islands is perceived as a problem because tasks like nanao, hand-plucking, and water-cleaning are hard to master and it was considered important to start to learn these skills when young (Birder F, J, S).

However, modern techniques make it easier for children to master skills, for example using wax to remove down feathers is much easier to learn than water-cleaning. Wax can minimise the possibility of handling errors affecting the removal of down and therefore far easier to pick up by children compared to water-cleaning, as can be seen in the following quotes from Birder K and S. These techniques mean that essential processing skills can be transferred in a shorter period

“I just can’t see the advantage whatsoever in using wax. I think maybe that the only reason they don’t water-clean is probably because they’ve never done it. And possibly

26 A manu on Taukihepa.
with some of them, from just talking to them, the reason is that they've never been taught how to handle that bird and keep it in good condition, because it sort of doesn't matter too much how you handle a bird for using wax. It still cleans, so they can grab it by the foot or the wing or any old way and drag it out of the hole and not be too fussy with it. Whereas, [with] water-cleaning you've got to be careful how you handle it and do everything right, and then it's easy. But if you don't, well, you're better to go the wax then because it's taken you too long to clean it because you're going to be counting away over 30 to get the down off it if you haven't treated it right you see. It takes longer with water-cleaning if you've done something [wrong] with that bird - if you've got just a speck of oil\textsuperscript{27} on it or something or maybe torn the flesh a wee bit or any little thing like.” Birder K

“I know how to water clean. We used to do that in the old days before the wax come in. Different ball-game that. You have got to keep the bird warm and try not to rip them when you pluck them and it's hard. That's why you are better off to have wax because it gives you more chance - you don't have to look after the bird to keep him warm before you water clean him. It's hard yakka\textsuperscript{28} doing that all right.” Birder S.

There is indication that some information has not fully transferred to the current elders and kaumatua. Birder F and O mentioned that their own teachers did not always give explanations for some practices. This makes it difficult to explain and transfer this information to their grandchildren.

Another factor that may increase the difficulty of traditional knowledge transfer methods is highlighted in an extract from the interview with Birder F. The Birder notes that in formal education children are now taught in a different manner and this may interfere with traditional methods of knowledge transfer.

“... when we were young, if we questioned our grandparents, Pōua and Tāua, or Mum and Dad, we'd say why should we do that for? They'd say because you don't do those things, and we took that for word [because] the old people said don't do it. But today

\textsuperscript{27} Stomach oils regurgitated by chick.

\textsuperscript{28} "Yakka" is a colloquialism for work.
the kids say but why not? You know, they need to be have some explanation of why they shouldn’t do these things and sometimes it’s a bit hard, because when the old people said don’t do it, we didn’t do it and we haven’t had an explanation. Now its law and into the scientific reason they are looking at, you don’t do it because blah blah blah, but we were taught you don’t do it because our elders told us - without a reason. I think that happens in every family though, kids question everything now don’t they?” Birder F

Some of the interviewees expressed it was important for children to have continued experience of muttonbirding from a young age, because they felt that would be the only way for them to learn to respect and value the islands and make them want to become muttonbirders. This extract from Birder F’s interview describes this.

“Well you can tell the difference with the kids, you know with the ones that are used to going. They get all excited. The part of the family that doesn’t go, it [the harvest time] just goes by and they don’t take any notice. Two different outlooks on the life - like my great-grandson, he loves it [and] he has been there since a baby and he will always be a birder I think. Yet there are other branches of the family which haven’t gone as kids or anything, and they might get out for a season and you don’t see them again and so those are the kinds of things you see coming out in the young ones.

When asked whether it was important for children to go to the islands, Birder F replied:

“Oh its [going to the island] part of their education I feel. Something that they know that nobody else knows, and they get to appreciate the conservation side of it, they gradually learn to look after the place and protect the birds and one thing and another, so you know its all part of their learning.”

There is a fear that the younger generation are losing the respect and feeling for the manu and islands, partly because young people are spending less time on the island. A kaumātua recently expressed this fear in an article: “By not staying right through the season, the young ones are missing out on the feelings that come from birding as a whole” (Moller 2003).
In order for tītī harvest management to be effective and sustainable, tītī harvesters require appropriate institutions. This requires social organisation of tītī harvesters for coordination, cooperation, resource management rule-making and rule-enforcement.

**Role of elders and wise people in the past compared to now**

Historically, family elders upheld the spiritual components of the harvest from when the birders first arrived with ceremony to remember their ancestors, and *karakia* (prayer, incantation) when the harvest began and finished, as Birder E recalls: “the old tāua she used to have her karakia before we started work and karakia when we finished work. Yeah. And on the weekends there would generally be karakia too.”

Family elders also had (and in some cases still have) a strong role in the decision-making and harvest practice on their particular island or, in the case of Taukihepa, the specific manu (Kitson subm.a). They could remove younger family members from the island or prevent them from taking part in the harvest if they damaged the island or misbehaved (Wilson 1979; Kitson subm.a). They could also set rules that the family had to abide by, such as rāhui (temporary ban on harvesting; Kitson subm.a). In recent times, method bans have occurred in some families and islands before they have been legislated (Kitson subm.a) and some families have banned the use of mechanised plucking.

Since the first muttonbirding regulations (Land Act Regulations 1912) a ‘supervisor’ has been elected by those who bird on the same island or manu. In many cases those who are elected are respected elders or people who are recognised for their wisdom and appear to have the same role as elders traditionally had. With the regulations, law was used to strengthen lore at a time when negative colonising influences could jeopardise the tikanga that traditionally govern this harvest (Wilson 1979; Taiepa et al. 1997; Birder L). Supervisors are “responsible for ensuring a fair and equitable distribution of the privileges, opportunities, and rights under the regulations of all persons authorised to enter the island or parts of the island” (Department of lands and Survey 1978). The supervisor can also call meetings of other birders on the island to
allot birding areas (manu) and approve sites for proposed building. It is the supervisor’s job to ensure that harvest practice is carried out correctly, as Birder M states:

“Well I think supervisor’s job all depends on the amount of people there. If you do your job properly, you see that the grounds are worked properly. That it is not all dug away and smashed holes and things like that. See that if you have a dog that he’s not digging. And make sure that the ground’s getting worked properly. If it’s going to be dug and purued, that it’s purued properly. The holes are not dug open from the mouth so they can reach [the chick]. If they have boundaries and their own bit of ground, see that everybody does their own bit of ground, not somebody else’s.”

Historically, the supervisor enforced when the nanao and rama was to start and when harvest could not take place. Birder C recalls:

“...it was a easier pace in those days, ‘cause if it rained you couldn’t go out and nanao in the rain. The supervisor would come and say “no”. And you couldn’t start torching until he said torching. He’d go out and he’d come back and say “no they’re not ready yet” or, he’d go out and say right you can go out tonight torching ... And you couldn’t go torching so you might have had even a week or fortnight off before you started torching, but as soon as he was out and he could get a hui quick enough he’d come back and say right you can go torching now.”

If the supervisor cannot settle a dispute that occurs on the island then he/she reports it to the Department of Conservation’s Southland Conservator and the matter is usually referred on to a Committee of 10 Rakiura Māori which has been elected by the Rakiura Māori community. Traditionally, those elected are usually well respected and recognised experts on muttonbirding. This committee ensures that access is controlled and helps settle disputes that could not be settled by the birders on the island during the harvest season.

Elders’ wisdom provides institutional memory and can be called upon to settle such things as boundary disputes, as can be seen from this extract from an interview with Birder J:

“I was home and one of the kids rang me to say would I go to the meeting [permit day meeting]. They wanted me and I said “What for, [you] don’t need me”. They said,
“Oh yes you have got to come to the meeting”, so I went to the meeting and it was about the boundary. And I just said “my parents had told me that’s where the boundary was when I was a kid and that’s where it’s going to stay” and that was all there was to it and they just let it stay there... The meeting was settled just like that because the ones that wanted it [changed] were just new to the place. They had only been down there about a couple of years or so, so what would they know about it?”

Four interviewees stated that elders are no longer treated as the authorities, decision-makers and reinforcers of traditional rules on the islands (Birders E, G, J and Q). Two of these interviewees birded on the same island, which might indicate a particular issue for that island. Another interviewee had not been to the island since his childhood, so may not have met the community’s criteria of a knowledge holder, needing to be an experienced harvester (Newman and Moller subm.). Nonetheless, this may indicate that some of the important roles that the elders have traditionally held have now been diminished. Further research is needed to elucidate whether rule making and enforcement has become externalised in law, and, if so how are laws enforced during harvest if the elders do not reinforce them? If the role of elders has been diminished by legalisation of lore into law, then this could have created problems with knowledge transfer and created tension between the older and younger generations.

Community assessments

Rakiura Māori monitor the long-term well being of tītī primarily from catch per unit effort (Lyver et al. 1999; Birders A, I, Q; Kitson subm.b.; Kitson unpubl. data). They also sense their environment through ‘touch, feel and sight’ (Moller and Sunseri 2003) and ‘smell and sound’ (Heaslip 2002; Birder C, N).

Historically, social gathering on Sundays would involve discussion and assessment of the season compared with previous seasons by the community on the island. In the past communal travel arrangements would also be a time to swap information and develop community assessment for island geographical groups. Presently, VHF radio provides a vehicle for inter-island assessment, where birders compare the current
season’s harvest rates and conditions between each other (Birders A, D, K, N, P, R; Kitson unpubl. data).

Catch per unit effort information (CPUE) would be passed from one generation to the next and would relate to a specific area. Studies on tītī have shown a potential curvilinear relationship between chick density and CPUE (Lyver 2000; Kitson subm.b). Harvesting areas with high chick density would show little change in harvest rates over the past decades despite a declining population, whereas other harvesting areas with lower chick density would show decline in harvest rate. This may become problematic for a community wide assessment because individual birders may not have experienced the same observations. Moller et al. (subm.) notes that an unexpected bonus from studies of tītī CPUE has been increased consensus amongst harvesters in different harvesting territories about what is happening to the resources.

Are taboos and social regulations still at work?

Taboos and other regulations on social conduct are recognised as important mechanisms for resource conservation (Colding and Folke 1997, Colding 1998; Folke et al. 1998; Colding and Folke 2001).

For Rakiura Māori the connections with their ancestors (tūpuna) play a strong regulatory role. Ancestors have the power to discipline those who do not uphold the correct practices (Birder O). This was reinforced through storytelling. Many of the interviewees recalled being told ghost stories as children (Birder B, C, D, J, P, Q, R). These stories would help regulate behaviour, as shown by Birder R’s statement: "Ghosts. They were all over the place when I was a kid. My tāua and that, they used to always tell stories - don’t do this or a ghost will get you. Taipo [ghosts] will get you. Terrified me."

The interviewees did not consider it unusual to see a ghost. In some cases they were not malevolent, but just reminders that their ancestors are watching over them, as can be seen by this excerpt:
“I did see an old lady on the island. I can remember we were out torching and my brother had gone down to the cliff face to have a look and I shone the torch and there was an old lady standing under the tree watching me and she had a scarf around her head. I said to Dad and he said it’s only granny, she’s only looking after you. That was the old Granny who we got our muttonbirding rights from. And then two of my cousins saw the same old lady years later. They described her and it was the same old lady that I’d seen when I was a child.” Birder P

White (albino) tītī are treated with respect and fear. They are not harvested and some interviewees would not even touch one, because they are believed to bring bad luck. Birder Q’s elders had told him that a white bird was an ancestor that had come back to check up on the practices of the current generation. Morepork\(^{29}\) (a small native owl) also represented the ancestors (Birder R). Schwimmer (1963) notes that for Ngati Wai\(^{30}\) morepork can act as a messenger from the world of the dead.

Sites and objects associated with ancestors, such as burial sites and artefacts are treated with great respect and reverence (Kitson subm.a.). Not respecting such things can result in great misfortune. Wilson (1979:98) documented an account of two fishermen drowning after attempting to remove of a tapu (sacred) stone. Three interviewees mentioned that if they found anything that “belonged to the island”, such as adzes or other artefacts they bury them or leave them alone. Areas associated with burials and old houses are also avoided and are therefore a refuge from harvesting (Birders C, J, P; Kitson subm.a).

The hākuai\(^{31}\) is a legendary bird that has been described as a kaitiaki or guardian of the tītī (Garven \textit{et al.} 1997; Ngai Tahu Settlement Act 1998) by Ngāi Tahu. In legends, the hākuai is the father of the muttonbirds and its call in the night was said to foretell the end of the season of harvesting tītī (Birder E, K; Garven \textit{et al.} 1997). The hākuai has a fearsome reputation, a supernatural being with wings with multiple joints

\(^{29}\) Ruru; \textit{Ninox novaeseelandiae}.
\(^{30}\) An māori tribe (\textit{iwi}) from the far north of New Zealand.
\(^{31}\) There are different legends of this mysterious bird held by other iwi. This mysterious bird is also known as Hakuwai, Hokioi, Hokio, Break Sea Devil (Hurley 2000).
and reputation as a giant eagle, but has never been seen (Smith 1913; Miskelly 1987; Ngāi Tahu Claims Settlement Act 1998; Hurley 2000). Traditionally, stories of the hākuai were shared when birders gathered. People who have heard the hākuai recount its call as distinctive and spine chilling. Birder E recalls hearing it on Taukihepa:

“They had some fun tales to tell you [of] what went on during the weekend and they talked about the hākuai a lot. They heard it or they didn’t hear it and they’d try to give you a description of what they heard and all this. I only heard it once, and it is different. We were at visiting on the Sunday - Rahui [a manu on Taukihepa] is just near the pakihi32. When we came out on to the pakihi, Dad was walking in front, there was Dad and his two brothers and then there was my two brothers and myself, ‘cause being the smallest I was last. And we didn’t walk very fast but we were wandering along the track to get to across the pakihi and heard this sound way in the distance. All you could hear is it sounded like ‘hākuai hākuai’ and all of a sudden you hear ‘whooooosh’ over the top of your head and as I said I was at the back and by the time this thing went past, whatever it was, I was suddenly right behind Dad. Yeah, hanging onto his trousers and right behind him. It was an unearthly sound. There has been lots of people [who] have sat on a fine night and winds been out and they’ve listened and tried to figure out what it was and nobody seems to know what it is yet. And that is what they called the hākuai. My grandmother, my tāua, used to say that the hākuai was a male bird, because with the tītī have you ever noticed there’s no male birds in amongst the tītī they’re all females. So my tāua used to say that the hākuai was the male bird, because it was after you heard it that the birds started to leave the island. It was the hākuai - the male bird calling to the females to leave the island. So whether it’s true or not I don’t know. You know these things are what our old people believed and we were bought up that way.” Birder E

Ornithologists believe that the call associated with the hākuai was that of the extinct Stewart Island Snipe (Coenocorypha aucklandica iredalei), which were present on Jacky Lee, Herekopare, Ruapuke, Green, Taukihepa, Pukeweka, Solomon, and Poutama Islands until the introductions of either ship rats33, or weka34 and/or cats35.

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32 A name for the open country above the bush line on Taukihepa, Putauhinu, and Big Moggy.
33 Rattus ratus.
34 Gallirallus australis.
Two of the interviewees who had birded on Taukihepa have heard the hākuai. The supernatural nature of this kaitiaki and its legend was therefore reinforced by the fact that some heard its call and this legend was then spread to other islands.

It is likely that the hākuai legend is linked to the extinct Haast’s eagle (*Harpagornis moorei*) which at 13.5 kg was large enough to prey on moa, co-existed with earliest Māori settlement in New Zealand and could possibly have killed humans (Anderson 1989; Worthy and Holdaway 2002). Eagles feature in Māori rock paintings (Worthy and Holdaway 2002) and are likely to have featured in stories and legends.

Studies of other iwi describe kaitiaki (guardian spirits) that manifest themselves in the form of animals, birds or other natural objects as a warning against transgression, or to punish transgressors (Schwimmer 1963; Mardsen 1981). White tūī, morepork and the legendary hākuai held similar roles. These guardians illustrate the blurred boundaries between the supernatural and natural world for Rakiura Māori.

Ancestors (tūpuna) and their manifestations played a key role in the adherence to resource management rules. The resource rules contain access restrictions, protection of habitat, burrows and adults, and waste minimisation (Kitson subm.a). Rāhui (harvest ban) and tapu (sacred, forbidden, taboo) are mechanisms that are used to maintain these rules (Kitson subm.a). Compliance with these rules, based on respect and reciprocity, are enforced primarily by fear of divine retribution. Enforcement is also formal, with most of the resource rules now found in legislation (Department of Lands and Survey 1978) and enforced with prosecution, fines and confiscation of harvest. However, social mechanisms can be far more effective and are less costly than legal compliance and enforcement mechanisms (Colding and Folke 2001) because of their self-regulatory nature. These social mechanisms are certainly still in the minds of the interviewees, but this research cannot ascertain how strong a role they play in contemporary tūī harvesting, and whether they are effective in the younger generation of harvesters.

35 *Felis catus.*
WORLDVIEW AND CULTURAL VALUES: IS THERE A CONSERVATION ETHIC AT WORK?

Values and beliefs are an important part of how a group of people perceive and relate to the environment they live in (Berkes et al. 2000). In the Māori world all natural things are connected by mauri36 (Kirikiri and Nugent 1995; Ngai Tahu Settlement Act 1998). Mauri represents the essence that binds the physical and spiritual elements of all things together (Ngai Tahu Settlement Act 1998; Patterson 1994). In this holistic view of the environment, all forms of life are related and Māori see themselves as an intrinsic part of that environment (James 1993; Roberts et al. 1995; Figure 3). The realms of animals, humans, supernatural and natural are all connected (Marsden 1981; Roberts et al. 1995). This kin-centric world view, in which humans and nature are not separate entities, shows itself in Rakiura Māori harvest practice in the respect shown to nature by minimising waste and the reciprocal belief that by adhering to correct resource practice the birds will return (Kitson subm.a).

There are certain values associated with the islands and harvesting titi. Some of these values are identity and heritage, strengthening family ties and in some cases financial security. Some of the values are expressed in the following interview excerpts from Birder L and M:

“...there’s physical values, there are the conservation values but I think there’s something else that [is] more [a] spiritual part of who we are. There’s a definite feeling when you’re there, of a time before now, when other people were there before you - there’s definitely that feeling. It’s a pretty spiritual place.” Birder L

“There’s something about the smell of the land, something about muttonbirding. There’s just something about it and you think back about your whole family being there. It’s just a way of life. It’s just feeling so contented and yes, it’s just a great time of the year.” Birder M

36 Life force.
Many of the interviewees said that muttonbirding becomes part of them. In fact several of the interviewees expressed distress when they had to miss a harvest season. When asked what makes her keep going back to the island Birder J replied:

"I think it's just because it's like being bred and born on the place. Every time the season comes round there's just something there - that just tells you it's time for birding again. I often think well you could give it up, I suppose forever, but I feel I couldn't. I just had to be there. I suppose [being] brought up as a kid down there, it gets in the blood stream. It must get in your blood stream."

When asked what the island meant to him, one interviewee’s eyes welled up with tears. He could not find the words to express the strength of feeling he felt for his island and the connection he felt to it.

**FIGURE 3:** Adult tītī return at dusk to provision chicks. Rakiura Māori believe that by adhering to correct resource practice ‘the birds will return’. *(Photo: Jamie Newman)*
Many of the interviews reflected that much of the connection of Rakiura Māori to their islands and tītī is also through the heart and reminds me of the statement made by Marsden (1981: 143) “...it is important to remember that Māoritanga” is a thing of the heart rather than the head”.

Rakiura Māori elders expressed a strong responsibility to act as kaitiaki (guardians) of the islands for the next generations (Kitson subm.a). This responsibility has been handed down from their tūpuna (ancestors) and is part of their connection with them and the future generations. This responsibility is expressed in the following extract from Birder O:

“My tāua taught me mainly how to look after the island. She taught me that I was only there as caretaker for the generations yet to come. I didn’t understand what she was trying to teach me then. It was quite some time later that I realised what she was teaching me, but I was only there for my lifetime and, and for those afterwards and I got to leave that island in no worse condition than I found it. If possible improve it.”

Birder O

Interviewee’s expressed a strong conservation ethic to ensure that tītī remain plentiful for the generations of Rakiura Māori to come. Continuation of Rakiura Māori identity and cultural practice is strongly linked with the sustainability of tītī harvests.

**DISCUSSION:**

**Reliability of the sample**

The non-random selection of elders and kaumātua participants in this study will create some bias in these results. My sample represented interviewees from all the different island groups and captured information from a high proportion of older birders in the selection criteria. Overall, the study is likely to be accurate and representative of elders and kaumātua in the Rakiura Māori tītī harvesting community. However,

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37 Māori culture, Māori perspective.
random sampling is required to corroborate and further investigate social mechanisms occurring in the contemporary muttonbirding community.

This study had a dual role of not only investigating TEK, but also recording the oral history from the older generations before the information was lost. Unfortunately, at the time of writing, five of those interviewed have since passed away. Rakiura Māori are not the only indigenous people that fear the loss of their TEK. This sentiment is echoed by many other cultural and ethnic groups (Cox 2000).

**Te Ao Hurihuri: the changing world**

Rakiura Māori elders play a key role in the traditional knowledge system and social institutions. They provide the link between the past, current, and future generations and the natural system of which they are a part. Transmission of Rakiura Māori ecological knowledge is a mixture of observation and hands-on experience. Children become familiar with tasks through observation and are taught simple tasks, and as they grow older, more complicated tasks. This is consistent with findings in other studies (Ruddle and Chesterfield 1977; Hewlett and Cavalli-Sforza 1986; Ohmagari and Berkes 1997).

Transmission of Rakiura Māori knowledge may be challenged by diminished time available for birding because of formal schooling and wage employment. Many skills are relevant only to the islands and can only be learned through hands-on experience. Less time spent on the islands means that children lose the opportunity and ability to observe, practise and learn these skills. This also lessens the opportunities for knowledge transfer through communal story telling and may lessen the perceived trustworthiness as knowledge recipients in the eyes of the elders. However, new technology, such as using wax and plucking machines, and concentration of harvest effort during the rana period, means that children can pick up essential harvesting and processing skills more quickly. Some critics of traditional wildlife harvests consider modern technology a threat to the sustainability of traditional wildlife harvests (Berkes 1999; Lyver and Moller 1999; Lyver 2000; Kitson 2002) and interpret its use to mean the people have “lost” their culture (Chase 1981; New Zealand Conservation
Authority 1997). However, technological innovations do not always increase harvest rates (Lyver and Moller 1999; Kitson 2002). In fact, innovations may contribute to the successful transfer of essential harvesting skills, thereby contributing to cultural sustainability by continuing the tradition of harvesting tītī. Ohmagari and Berkes (1997) also attributed loss of, or incomplete transmission of, certain skills to diminished time in the bush, due to formal schooling and wage employment. That study also associated transmission problems with learning skills at later ages, changes in value systems, and changes in the education environment.

Learning, and reinforcement of social mechanisms and cultural values that are relevant to sustainable harvest, is a passive process and could be affected by diminished time spent on the islands. This may result in heavier reliance on legal mechanisms, which are more costly because they require stronger enforcement, as they are less likely to be accepted by the community than alternate solutions.

Some elders fear the younger generation are losing respect and feeling for the birding islands, because young people are harvesting only part of the season. This perceived lack of ‘feeling’ for the islands may also result in limited transfer of knowledge, because for some elders there is less faith in the next generation to respect the knowledge (Birder J; Kitson unpubl. data). For Māori, knowledge is regarded as tapu38 and as such needs to be handed down to those who will respect and look after it. Suitable candidates need to prove themselves worthy of the knowledge (Pewhairangi 1992). Some of the concerns about the protection of knowledge echoes concerns expressed by other Māori iwi elsewhere in New Zealand. For example, in some cases there is a belief that the knowledge is protected if it is not discussed, even if this means the knowledge dies with its holder (Manihera 1992; Pewhairangi 1992; Rangihau 199239; Kitson unpubl. data). This has immense consequences for transmission of knowledge, especially if the gap widens between the older knowledge holding generations and the younger generation. Contemporary New Zealand society puts pressures on younger people to be in full time employment and the job market

38 Everything designated as ‘apu’ must either be avoided or handled with care according to prescribed rules (Metge 1976).
39 These authors are Tainui, Ngati Porou, and Tuhoe tribes respectively.
requires higher education qualifications, which adds different pressures than the older generation faced and can also create different values and lifestyle perspectives. This appears to be creating tensions between generations and exacerbating issues with knowledge transfer.

Wage employment has caused concentration of harvest effort on the rama. During rama, harvesters concentrate their efforts where and when chicks are aggregated (Moller et al. subm.), and this reduces harvester’s ability to monitor long term population trends. Nanao catch rate has a stronger ability to indicate population trends (Kitson subm.a) and is comparable between different generations of birders on the same area. The loss of the skill to nanao may reduce the efficacy of TEK to monitor population changes.

With no rules dictating the number of chicks (Lyver and Moller 1999; Lyver 2000; Kitson 2002), the passive nature of the limits to harvest requires social mechanisms, such as conservation ethic and knowledge transfer, to remain strong.

Climate change is an added challenge for sustainability. Climate change is a probable cause for the declining tūtū population (Lyver et al. 1999; Scofield and Christie 2002, Scofield et al. in press). If the tūtū population continues to decline current harvest levels may become unsustainable. Rakiura Māori TEK management systems have shown they are capable of adaptation. In the past, aspects of tikanga governing the harvests have been recognised as law (Taiepa et al. 1997). Will additional legislation become necessary? If so, then Rakiura Māori need to determine whether legislation can be used to strengthen a fundamental construct in a cultures’ belief system, or whether reliance on legislation may impair the social and cultural mechanisms that traditionally upholds belief. If designed by customary users, it might be possible that law and lore can complement each other to ensure both cultural and ecological sustainability.

Climate change is also a threat to the continued acceptance of TEK. In the past, there has been a recognised cycle that every five-to-seven years there is a thin chick year
However, this cycle is becoming less predictable (Metzger in press). The effects of climate change on the predictability of TEK is a concern to other indigenous people (Berkes and Jolly 2001) as it impacts on hunting, fishing and other culturally defining activities as well as causing doubt on the reliability of their institutional memory for understanding ecosystem change. The Invuialiut, in Berkes and Jolly (2001) minimised impacts of changes in predictability of TEK by short-term strategies of switching species and adjusting the when, where and how of hunting, and linkages to other institutions and government agencies. Climate change could also impact on social mechanisms that govern traditional harvesting because of the perceived loss of authority of TEK and knowledge holders.

Rakiura Māori TEK and science can complement each other for ecological monitoring (Kitson subm.b; Moller et al. subm.). TEK collects data over long time periods in localised areas (such as on one island or manu), involves the harvesters as researchers and includes cultural and spiritual values. In contrast, science usually collects data over short time periods over a large area and data collection is objective and often involves highly skilled researchers (Moller 1996; Moller et al. subm.). By using the two types of knowledge systems together, a more complete picture of tītī ecology can occur in temporal and spatial scales. But while science can help inform what might be happening in the face of global ecological perturbations, it cannot be used without TEK and must be compatible with existing social institutions. Science is often too expensive for the remote harvest sites and poorly financed customary harvest management. Nor is science always trusted or welcomed by traditional harvesters, as demonstrated by one elder who refused an interview citing a distrust of science. Science needs to be congruent with traditional management and thereby acceptable to traditional resource users.

For complex or “wicked” environmental problems (Ludwig 2001:758) such as climate change, there is growing recognition that a singular reliance on conventional scientific approaches is insufficient (Kinzig 2001; Ludwig 2001). Such problems cannot be separated from social issues and values and require a combination of academic

\(^{40}\) A chick that is too thin to take as food; Ashwell 1999.
disciplines and knowledge systems and values (Ludwig 2001). Rakiura Māori conservation ethic is still strong and even with some mistrust towards science (Moller and Russell, in press) they have seen science as a possible tool to help explain changes in tūtī numbers and unpredictable seasons, in order to ensure harvests of tūtī continue for future generations.

The need to build Rakiura Māori science capacity has been identified and initial discussions have taken place in order to set up a Rakiura Māori taiao41 unit. The unit would have a dual aim of training young Rakiura Māori in science as well as strengthening the social mechanisms involved with tūtī harvesting (unpubl. minutes of subcommittee to investigate formation of a Rakiura Māori Taiao Unit). Elders will mentor the students and perhaps by doing so will enhance their traditional roles that may have diminished in contemporary times.

Irwin (1984) wrote of the whakatauki (proverb) Te Ao Hurihuri that the axle of strength is cultural identity found in belonging through the use of whakapapa. For Rakiura Māori, belonging is associated with their holistic connection to the environment and their connection and responsibility to their tūpuna (ancestors) and the future generations to ensure that the birds remain plentiful for their mokopuna (grandchildren). Te Ao Hurihuri (the changing world) does not need to leave the past behind (Irwin 1984). In the case of Rakiura Māori, social mechanisms are based on the foundation of tikanga and kaitiakitanga but are showing adaptation to incorporate different ways of learning and science, thereby building resilience and social-ecological sustainability of this culturally fundamental harvest.

This study highlighted the importance to elders of social mechanisms, such as belief in maintenance of resource rules and compliance mechanisms, and transmission of Rakiura Māori TEK for tūtī harvesting. There are indications that current cultural transmission may be deteriorating. Further study with a random sample of birders is needed before definite conclusions can be made on the acceptance and effectiveness of these social mechanisms in the contemporary muttonbirding community.

41 Environment, science.
Chapter 5

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Chapter Six

Discussion
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DISCUSSION

This thesis has been undertaken as part of the *Kia Mau Te Titi Mo Ake Tōnu Atu* research program, that has the overall aim to determine whether the current Rakiura Māori harvests of tūī are sustainable.

The main aims of my studies were to:

(i) Determine what activities may limit the number of chicks harvested;
(ii) Evaluate the potential influence of technology on the sustainability of harvesting;
(iii) Evaluate harvest rates as a potential monitoring method for population trends;
(iv) Examine and describe TEK resource management practices and social mechanisms with regard to sustainability.

*Limits on harvest levels*

Chapter 2 sought to determine what activities set the limits on the present number of chicks harvested, so that Rakiura Māori could predict the impact of any future technology or altered practice. The current limits on the harvest are passive rather than imposition of some fixed limit on the number of chicks taken. Harvest intensity is mainly determined by the time spent harvesting in harvested areas\(^1\), which is limited by the time required to subsequently process the chicks. There is potential to harvest greater numbers during rama, therefore processing chicks is most limiting during this period. Future innovations that may decrease the time to process each chick could therefore greatly increase offtake during rama and has the potential to lead to an unsustainable harvest rate.

The involvement of modern technology in traditional harvesting will not always increase exploitation. Machine-plucking did not result in more chicks being harvested

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\(^1\) Some areas are not harvested because they are inaccessible e.g. cliffs or areas that have thick and fallen vegetation (Lyver 2000b), or they have been designated as tapu (Chapter 4).
in a day, even though in one year it allowed slighter faster plucking on Putauhinu Island (Chapter 2). This was because the time saved was spent with family, visiting other manu and in leisure activities such as fishing. This highlights the social limitations that result from elders’ appreciation of the islands (Chapter 5).

Modern technology can make it easier for inexperienced birders to master essential harvest skills in a shorter period (Chapter 5). It appears that it is easier to become skilled with machine plucking than hand-plucking. Experienced machine-pluckers were just 13% more efficient than an inexperienced machine-plucker (Chapter 2). In contrast, Lyver and Moller (1999) found experienced hand-pluckers were 34% faster than inexperienced hand-pluckers.

Some critics consider modern technology a threat to the sustainability of traditional wildlife harvests (Berkes 1999; Lyver and Moller 1999; Lyver 2000a; Chapter 2) and interpret its use to mean the people have “lost” their culture (Chase 1981; New Zealand Conservation Authority 1997). However, technological innovations can save physical effort without necessarily increasing harvest rates (Lyver and Moller 1999; Chapter 2). Technological innovations may contribute to the successful transfer of essential harvesting skills without infringing upon the social and culturally important outcomes. Technologies can contribute to cultural sustainability, allowing new generations of harvesters to continue the tradition of harvesting tītī, despite modern time constraints (Chapter 5).

Additional technology could also be a threat if contemporary social mechanisms are not able to limit unsustainable take. Elders identified changing values between the generations and fear that young Rakiura Māori are losing sight of the islands’ values and are less able to spend time on the islands because of employment and education commitments (Chapter 5). Elders’ appreciation of the islands may result in some social limitations to harvest. Therefore, if these values are reduced for younger generations there is a possibility that technological advances that reduce or remove processing time will lead to unsustainable harvest, if no additional limitation mechanisms are in force.
Chapter 6

Nanao harvest rates as a monitoring tool?

I examined the hypothesis proposed by Lyver (2000a) that nanao harvest rates could monitor tītī population trends (Chapter 3). My study addressed the preliminary findings from the Poutama study (Lyver 2000a), using more intensive measures on another tītī island, Putauhinu.

Harvest rates on Poutama showed a strong relationship to chick densities (Lyver 2000a). However, Putauhinu harvest rates only increased slightly with increasing chick densities. Putauhinu birders harvested areas with average chick densities nearly double of that on Poutama (Lyver 2000a), however both islands had similar harvest rates.

The presence of a strong relationship between harvest rate and density on Poutama, but not on Putauhinu, may relate to lower chick density on Poutama. This suggests that the relationship between harvest rate and chick density may be curvilinear, where harvest rate can not continue to increase with further increases of an already high chick density. However, this hypothesis was unable to be tested because low statistical power of the Poutama data hampered the ability to compare the data sets from the two islands. Therefore, more study on the effects of low chick density areas on harvest rates is needed.

The basic assumptions in using simple catch per unit effort as an index of population change are not met with the nanao harvest of tītī. Harvest rates were highly variable and sensitive to changing chick density between birders and/or manu. Potential differences between islands and possible interannual variations in harvest rate, independent of chick density, were also identified. Despite these problems other correlations suggest that harvest rates could be used to give broad-brush measures of population trends. A diary donated from a birder showed that harvest rates have declined in the last twenty years (Lyver et al. 1999), which is corroborated by a decline of chick abundance over the last decade on an unharvested island (Hamilton et al. 1996; Cooper 1996).
The current method of “burrowscoping” that scientists employed to monitor *tíí* population abundance is highly expensive, time consuming and requires highly skilled field staff (Hamilton *et al.* 1997, 1998; Lyver *et al.* 1998; Moller *et al.* 1999). This makes it impracticable for muttonbirders to use. Monitoring also needs to be congruent with traditional management and thereby acceptable to traditional resource users (Moller *et al.* subm.). Many experienced birders currently assume that harvest is an indicator of resource abundance (Kitson unpubl. data) therefore use of harvest rate as an index should be acceptable to the birding community. Therefore, although harvest rates may only provide a general index of population change, it may be the most feasible method for muttonbirders to assess trend, which is necessary as a first step in assessing the long-term sustainability of the harvest. However, additional research is required to elucidate the relationship of harvest rate with varying bird density and various experienced birders, on a representative sample of islands.

If additional research answers these questions, a panel could be established to use nanao harvest rates to monitor changes in *tíí* abundance. Such a panel would need to:
(a) consist of many experienced harvesters from many different islands;
(b) consist of individual birders that have harvest rates that are sensitive to changes in chick density; and
(c) use the same panel members from year to year, as far as practicable.

However, the number of potential participants may be declining as a result of concentration of effort in the rama because pressures for continuous employment on the mainland prevents attendance in the nanao (Chapter 5). Therefore, birders concentrate their harvest effort on the rama because offtake is highest in this harvest period (Chapter 2). A possible loss of the skill to nanao has been highlighted (Chapter 5) and may mean that any potential panel will be aging and not able to replace members. Therefore, the efficacy of TEK to monitor population changes may be relatively short-lived unless the emphasis on the nanao phase of harvest and transmission of this skill can be revived.

My results are now being used by other researchers to simulate the minimum and optimal number of observers needed for a panel to monitor population change from harvest rate. My research, in addition to that of Lyver (2000a) provides the necessary
estimates of variability needed to prescribe the size of a panel that has sufficient statistical power to enable detection of, say, a 5, 10, or 20% change in tītī abundance.

**Practices and mechanisms for sustainability**

I sought to examine the TEK resource management practices that apply to the harvest and how they may promote sustainability (Chapter 4). Rakiura Māori tītī harvesting practice is an example of common property resource management whereby access is shared and controlled by birthright, and a system of rules and beliefs apply to the harvest.

The rules and beliefs dictate the behaviour of tītī harvesters in relation to the resource. The rules ensure adult birds are not disturbed, only suitable sized chicks are harvested, and wastage is minimised. However, the majority of rules focus on the protection of the habitat of the island, such as burrow integrity, care of vegetation and maintenance of manu areas. Also, harvest rules are flexible to adapt to changing harvest conditions. For example, method bans have occurred to halt potential threats to adult birds, the harvest of which is tapu.

Sustainable resource management requires social institutions and decision-making arrangements for rules about resource harvesting, sharing the resource and enforcement of compliance by the users. Rakiura Māori have both informal and formal institutions to govern their harvesting behaviour (Chapter 4 and 5). Rāhui and tapu are central cultural and social mechanisms for tītī harvest management (Chapter 4). Traditionally, divine retribution from ancestors (tūpuna) and their manifestations and taboo enforced compliance to the rules (Chapter 5). Also through abiding by the rules, it is believed that the birds will return, therefore individuals have an incentive to comply.

An important aspect for enduring cultural and ecological sustainability is retention of mechanisms by which TEK is received, accumulated and the transmitted to the next generation (Ohmagari and Berkes 1997; Folke *et al.* 1998). Rakiura Māori elders play a key role in transmission of TEK, which is learnt through observation, hands-on
experience and storytelling (Chapter 5). Diminished time spent harvesting on the islands by young Māori, due to contemporary education and employment needs, is challenging the transmission of knowledge. This puts particular pressure on the transfer of knowledge that relates to the reinforcement of social mechanisms and cultural values that are crucial for sustainable harvesting in a system with passive harvest limits (Chapter 2). Knowledge is considered tapu, and is only imparted when the recipient is trusted as a guardian. Therefore a widening gap between younger generations and elders may be a threat to the complete transfer of TEK.

This preliminary identified strong belief in TEK and conservation ethic among elders', which leads to their adherence to traditional harvesting lore (Chapter 5). However, the study was necessarily biased by only having interviewed, the known holders of TEK. This was a necessary first step to examine what TEK rules may apply to resource management. The crucial question of whether the same resource rules and ethics are more widely accepted by the contemporary Rakiura Māori harvesting community is therefore left unanswered. Indeed, some of the elders in this study believe there are threats to, and a break down of, traditional social mechanisms that limit harvests, and protect the birds and their habitat. Therefore additional study is needed, with random selection of birders, to elucidate the acceptance and efficacy of these social mechanisms in contemporary Rakiura Māori society. Such research is potentially crucial for Rakiura Māori to assess sustainability of their tītī harvests.

**Science and TEK**

Rakiura Māori have recognised challenges to TEK and the sustainability of their harvests of tītī. Declining tītī numbers, and the effects of climate change on the predicability of TEK (Lyver *et al.* 1999; Scofield and Christie 2002; Metzger in press; Scofield *et al.* in press) is of particular concern. However, Rakiura Māori conservation ethic is strong (Chapter 5) and despite some mistrust of science (Chapter 5; Moller and Russell, in press) many perceive science as a possible tool to help ensure harvests of tītī continue for future generations. My research has shown that despite some challenges to TEK transfer, there is a sound basis for Rakiura Māori
TEK and science to complement each other and provide a more complete picture of tītī ecology in temporal and spatial scales (Chapter 3; Moller et al. subm.).

Science cannot be used without TEK and needs to be compatible with existing social institutions in order to be accepted by the community. Science is often too expensive for the remote harvest sites and poorly financed customary harvest management. However, by using science together with TEK it is possible to make results testable, while remaining acceptable to traditional resource users. There is also growing recognition that problems like impacts of climate change cannot be solved by science alone, because such problems impact on social issues and values, which are intertwined with sustainability (WCED 1987; Kinzig 2001; Ludwig 2001; PCE 2002).

Rakiura Māori social mechanisms and worldview are fundamental to the cultural and ecological sustainability of tītī harvesting. Therefore, it is crucial to understand the adaptive nature and possible challenges to such mechanisms. One challenge is the need to increase science capacity in Rakiura Māori community, at the same time as continuing and strengthening TEK and cultural connections. Rakiura Māori have addressed this by initiating discussions on establishing a unit to train young Māori in science, with kaumātua teaching tikanga\(^2\) and TEK. This thesis has identified that TEK is best learnt through hands-on experience, which with contemporary time constraints is an increasing obstruction to TEK transfer. Therefore, such a unit will first have to identify and address these obstructions to TEK transfer, and recognise the needs and pressures on young Rakiura Māori in contemporary New Zealand society.

**Potential challenges to social institutions**

This thesis provides a baseline of the passive limits of tītī offtake with the current technology (Chapter 2). However, these limits require social mechanisms, such as TEK knowledge transfer and worldview, to remain strong and there is some indication that these might be deteriorating (Chapter 5). Tītī stomach oils are currently being investigated for industrial uses, such as high margin niche products in cosmetics, skin

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\(^2\) custom, the correct way of doing something, lore or law (Dacker 1994, Garven et al. 1997)
aids and nutritional health supplements and aquaculture foods (FRST 2002; Mackenzie 2002). Stomach oil is expelled from a harvested chick immediately after it is killed by using pressure on the abdomen to forcefully eject stomach contents to eliminate the likelihood of regurgitation as the carcass is processed (Ashwell 1999; Lyver and Moller 1999). If there is market potential for a more profitable product than flesh, which has negligible processing limits, then strong social mechanisms would be needed to enforce tikanga and the belief system of respect shown to nature by minimising waste. This could represent a huge challenge to the structure and dynamics of tītī harvesting institutions.

Legislation has been used by Rakiura Māori to strengthen lore at a time of perceived threat of negative colonising influences on tikanga that traditionally governs this harvest (Chapter 5; Wilson 1979, Taiepa et al. 1997). However, currently no legislation exists that would restrict wastage of chick carcasses, despite tikanga. Can legislation be used to strengthen a fundamental construct in a cultures’ belief system, and would that then weaken the social and cultural processes that traditionally upheld this belief? More research is required to examine if law and lore can complement each other to ensure both cultural and ecological sustainability.

Declining tītī numbers may put pressure on harvest sustainability. The current passive limits may be insufficient and there may be a need to incorporate limitation on harvested numbers. However, the immediate westernised response, namely the imposition of a numerical limit, may not be best solution. There is debate on whether ‘quota’ systems are effective in managing fisheries (Wilson et al. 1994; Acheson et al. 1998). Because tītī is an apex marine predator and therefore also subject to fluctuations in the marine system, as evidenced by food failure or kiaka (skinny chick) years (Russell and Gaw 1998; Lyver 2002), it may not be prudent to impose such a system on this species. Fortunately, there are various options that could be employed. Wilson et al. (1994) showed that rules and practices limiting ‘how’ people fish, rather than regulating ‘how many’ could be taken, dominated traditional fishery systems. Therefore method and/or temporal or additional access controls, may be more acceptable to tītī harvesters and more effective than controls on number of chicks harvested.
If passive limits are found insufficient, and the need arises to impose formal limitations, the limits would need to culturally congruent and put in place by the harvesting community itself. Outside interference and prescriptive systems may actually exacerbate cultural and harvest sustainability problems because of the consequent alienation of the harvesters from the resource and external resource managers, which would erode conservation ethic and cultural connection to the breeding islands and tītī.

The relationship between Rakiura Māori and tītī is a good example of the linkage between social and ecological systems (Berkes and Folke 1998). There are large potential challenges facing this system, such as global climate change, declining tītī numbers and potential changes in technology or markets. In light of these changes the key issue is not how the system can remain the same, but instead how the system can build adaptive capacity for sustainability out of changing ecological and social circumstances. This focuses on the concept of 'resilience', the capacity for social-ecological systems to absorb or buffer disturbance without undergoing fundamental changes in functional characteristics (Folke et al. 1998; Resilience Alliance 2002; Berkes et al. 2003). Folke et al. (1998) stressed the importance of using management practices based on local ecological knowledge, and enhancing social mechanisms that facilitate sustainability in order to build social-ecological resilience. Transfer of TEK and social mechanisms behind harvest practice are therefore fundamentally important for the sustainability of tītī harvests. Rakiura Māori have shown the ability to adapt to changing circumstances by using formal legal constraints and examining science as a tool that is complementary to TEK. However, it is extremely important to understand how much this system is capable of change and how the resilience of this system can be enhanced. The goal is to retain diversity and flexibility of future management options so that Rakiura Māori can keep the tītī for ever - Kia Mau Te Titi Mo Ake Tōnu Atu.
REFERENCES


