NEW ZEALAND JOURNAL OF ECOLOGY

RESEARCH

Māori traditional harvest, knowledge and management of sooty shearwaters (*Puffinus griseus*) in the Marlborough Sounds, New Zealand

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Published online: 28 November 2019

Auheke: Kei roto tonu i te mātauranga taiao te oranga o nga mea katoa o te ao, ahakoa he kararehe, ahakoa he rākau, ahakoa he aha. Mo tēnei mahi rangahau i kōrero mātou ki ngā kaumātua e waru, no Te Atiawa me Ngāti Kuia, mo ngā tītī o tā rātou rohe o Te Tau Ihu o te Waka o Māui. Ko te nuinga o ngā kōrero he titiro ki te maha o te tītī ki taua takiwā, mehemea kei te mau pai tonu ngā kōhanga o te tītī, ki a rātou ake mahi hopu tītī, ā, ki a rātou tikanga mo te tiaki i te tītī. Te āhua nei kua iti haere te nuinga o te tītī, na te mea kua ngaro haere ngā tikanga tiaki tītī o ngā rā o mua. Ki ētahi, na ngā rāhui o te Kāwanatanga te hē, na te mea kua kore e āro ake ki te mātauranga o te Māori. Tuarua, kua iti haere te nuinga o te tītī mai te ao whānui, ina rā, kua tata mate katoa, e ai ki ētahi kōrero pēnei i te IUCN. Ko te mea kē, ka ngaro te rangatiratanga o te mātauranga taiao ka iti haere hoki te nuinga o te tītī. Nā kona e kī ai tēnei mahi rangahau, me kaha tonu te titiro ki nga mahi hopu tītī a te Māori. Me mau pono tonu ki ngā tikanga o te mātauranga taiao kia kore ai e iti haere te nuinga o ngā mea katoa o te taiao - koiana te kōrero.

Abstract: Traditional ecological knowledge (TEK) can provide valuable insights into historical abundance, ecology and conservation of species. In this study, we interviewed eight Maori kaumatua of Te Atiawa and Ngāti Kuia to document Maori traditional knowledge, or matauranga Maori, of sooty shearwaters (*Puffinus griseus*) of the Marlborough Sounds, New Zealand. Interview questions focused on shearwater abundance, breeding habitat, customary harvest, and traditional management. Matauranga Maori suggests high shearwater abundance historically, as well as traditional harvest protocols and traditional population management techniques no longer in use. Government imposed harvest bans reduced interaction with, and thus matauranga Maori of, sooty shearwaters followed by the species experiencing a worldwide decline in abundance and being classified as Near Threatened by the IUCN. Our study serves as an important reminder that TEK and species abundance often decline in tandem and that cultural harvest must be considered when designing conservation management strategies for species.

Keywords: Matauranga Maori; muttonbird; traditional ecological knowledge; sooty shearwater; *Puffinus griseus*; New Zealand

Introduction

Indigenous communities establish a cumulative body of knowledge through interaction with their environment (Berkes 2008). This knowledge, often referred to as traditional ecological knowledge (TEK), takes a holistic approach to understanding ecological processes, is passed between generations and is used to govern natural resource management in many communities throughout the world (Berkes 2008; Mistry & Berardi 2016; Schultz et al. 2018). For example, knowledge of Aboriginal elders of Northern Territory, Australia documented the widespread decline of native mammals, spurring ecological research and intensified management (Ziembicki et al. 2013). Similarly, traditional knowledge of Māori, or mātauranga Māori, revealed previously unknown historic distributions of tuatara (*Sphenodon punctatus*), suggesting sites for conservation translocations (Ramstad et al. 2007). In some cases, TEK has advanced Western science by resolving apparent contradictions in the scientific literature (Klein et al. 2014).

DOI: https://dx.doi.org/10.20417/nzjecol.43.29

Reliance of indigenous people on native plant and wildlife harvest for survival requires they develop a close relationship with their environment. Māori harvest a diverse range of flora and fauna, governed by extensive spiritual and cultural protocols (Kirikiri & Nugent 1995; Roberts et al. 1995). Harvest regimes are based on mātauranga Māori (Paul-Burke et al. 2018), which, like knowledge systems of other indigenous peoples around the world, is a fluid body of knowledge built over generations (Cisternas et al. 2019). Assimilation of Māori into European culture has led to a breakdown in mātauranga Māori transmission (Tau 2001; Reihana et al. 2019). Breakdown in inter-generational mātauranga Māori transmission, as well as legislative barriers and environmental degradation, has led to concern among government agencies and the New Zealand public that Māori are no longer resourced to manage wildlife using their traditional knowledge and techniques (Moller et al. 2009). As a consequence, Māori have largely remained on the periphery of conservation management despite legislative recognition of their co-management rights and increasing efforts toward community management partnerships (Jacobson et al. 2016; Wright et al. 1995). However, Māori are becoming increasingly prominent in species research and conservation management, particularly as iwi (similar to tribes) settle historic grievances with the New Zealand government, and researchers and iwi find common ground in conservation (Cisternas et al. 2019; Collier-Robinson et al. 2019). For example, the Te Urewera Act 2014 facilitates management of what was once Te Urewera National Park by a board composed of both Crown and Tūhoe representatives. More recently, iwi have been involved in guiding the use of new genomic technologies and the use of te reo (Māori language) in formally naming taonga (culturally significant, treasured) species (Collier-Robinson et al. 2019; Veale et al. 2019).

Sooty shearwaters (*Puffinus griseus,* tītī, muttonbirds) are medium-sized seabirds that are a seasonal source of food for iwi (Anderson 1997). This trans-equatorial migrant breeds on islands off South America, Australia and New Zealand, with > 98% of New Zealand sooty shearwaters breeding in The Snares and Rakiura Tītī (Muttonbird) Islands at the southern end of the South Island (Fig. 1a; Newman et al. 2009). A small number of New Zealand sooty shearwaters (c. 7000 birds or < 0.01%) breed in the Marlborough Sounds (Newman et al. 2009), an area of sea-drowned valleys and easily accessible islands located at the northern end of the South Island of New Zealand (Fig. 1b). Despite a recent estimate of over 21 million birds (Newman et al. 2009), the species was classified as Near Threatened by the IUCN in 2004 due to population declines (Clucas 2011; Birdlife International 2018).

Traditional harvest of sooty shearwaters (a practice known as muttonbirding) occurred historically throughout the Marlborough Sounds. In this study, we conducted interviews with kaumātua (elders) from two iwi, Te Atiawa Manawhenua ki te Tau Ihu (Te Atiawa) and Ngāti Kuia. Te Atiawa moved from the North Island of New Zealand to Arapawa Island and

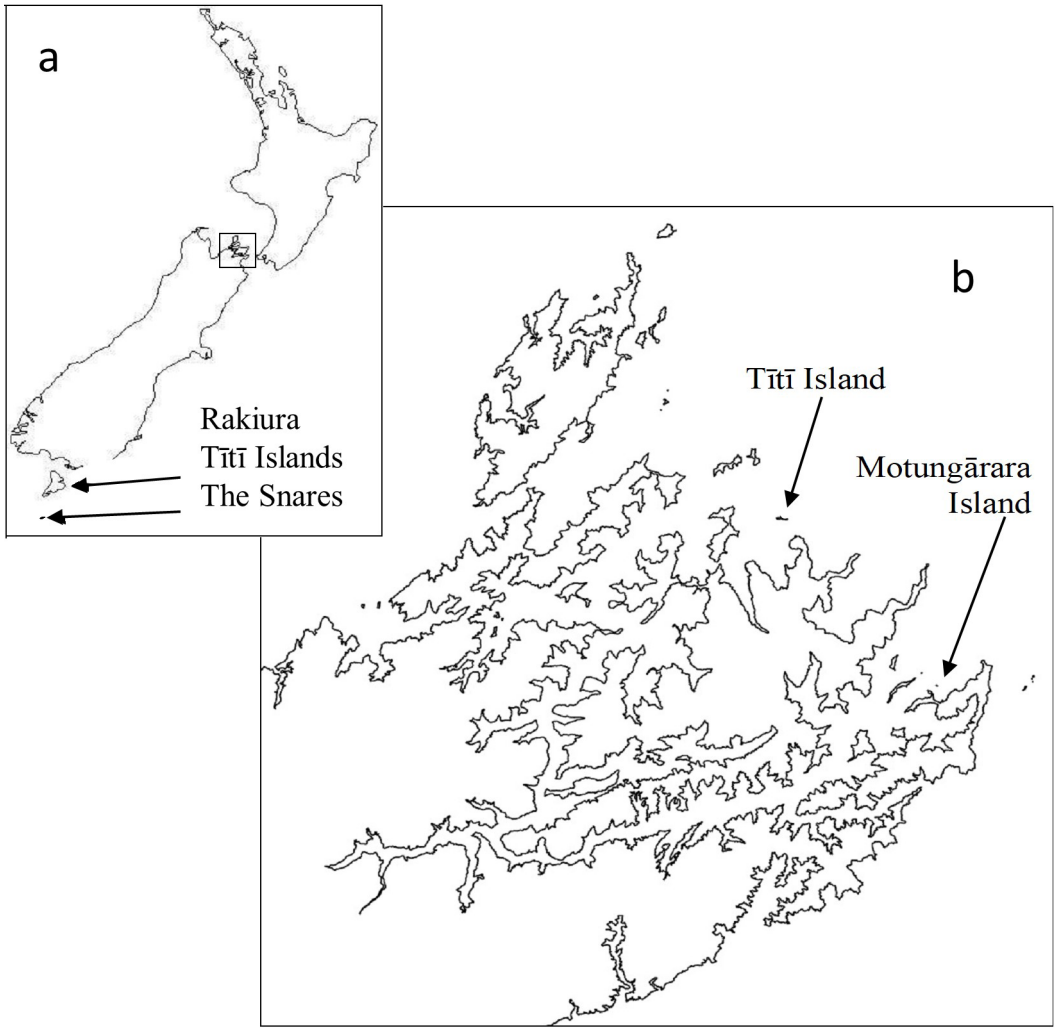

Figure 1. (a) Location of the Marlborough Sounds (boxed) in relation to the primary sooty shearwater breeding areas in New Zealand on The Snares and Raikiura Tītī Islands, (b) Location of Tītī and Motungārara Islands in the Marlborough Sounds.

Queen Charlotte Sound in the 1820s (Mitchell & Mitchell 2007). Ngā Takiwā o Te Atiawa whānau (Ngā Takiwā), a group of families from within Te Atiawa, began harvesting seabirds on Motungārara Island (Fig. 1b) soon after arrival. Ngāti Kuia has occupied the Marlborough Sounds area since Māori arrived in New Zealand in the thirteenth century (Mitchell & Mitchell 2007) and traditionally harvested seabirds on three islands in outer Pelorous Sound (Meihana 2018), including Tītī Island (Fig. 1b). In the 1800s, many seabird islands in the region were acquired by the New Zealand Government, which consequently considered the iwi to have absolved their rights to harvest seabirds but permitted muttonbirding 'at the indulgence of the Crown' until the 1950s (MacLachlan; unpublished report to the Lands and Survey Department, New Zealand, File AAAC W3179). As part of an effort to establish and protect nature reserves, the New Zealand government banned muttonbirding on Motungārara Island in 1963 (Douglas; unpublished report to the Lands and Survey Department, New Zealand, File AAAC W3179) and on Tītī Island in 1960 (Gaze 2000). Nearly 50 years on, small scale harvest was again allowed on Tītī Island in 2007 (Gaze & Smith 2009).

This study was initiated by Ngā Takiwā to determine if traditional muttonbirding islands could sustain resumed harvest and to record mātauranga Māori before it was lost with the passing of elderly kaumātua. Specifically, we aimed to (1) determine the nature and scale of the historic muttonbird harvest on Motungārara (< 1 ha) and Tītī (32 ha) Islands; (2) assess historical abundance of sooty shearwaters in the Marlborough Sounds; and (3) describe traditional management strategies for tītī.

Methods

This study was conducted using a kaupapa Māori approach, where principles and ideas of the participating iwi formed the basis for the research. From the inception of this study through the publication of this paper, and all steps in between, the project was guided by the iwi themselves to ensure adherence to tikanga (culture, custom, ethics). We interviewed eight members of Ngā Takiwā and Ngāti Kuia identified by their iwi as having knowledge of sooty shearwater harvest. Mātauranga Māori was recorded through semi-directed interviews in English because the many of the kaumātua interviewed came from an era where speaking Māori was actively discouraged and thus were not fluent in te reo (Māori language). Kaumātua that spoke te reo were discretely asked what language they would like to use and they all preferred to use English. We used semi-directed interviews because this technique has been effective in collecting specific information in similar studies (Ramstad et al 2007).

Five kaumātua (three men from Ngā Takiwā and two men from Ngāti Kuia) had participated in muttonbird harvests for varying periods at ages between seven and twenty years. One kaumātua (male) had harvest knowledge passed on from his father and another (female) processed birds following harvest. The eighth interviewee (female) was employed by Te Rūnanganui o Te Tau Ihu o Te Waka a Maui, an iwi authority, at a time when muttonbird harvest was debated. Ages of interviewees ranged from 50 to 85, the low number of those interviewed reflects the few people still living that have knowledge of the sooty shearwater harvest.

Interview questions were developed by conservation ecologists and Ngā Takiwā representatives. Questions were asked about sooty shearwater abundance and harvest, and about the islands themselves. All interviews were conducted by both AFG and DLD, and in the presence of an iwi member.

Interviews were conducted between February and April 2009 and lasted between 45 and 120 minutes. All interviews were recorded digitally with a Panasonic HVX200 video camera and transcribed using the programme WAVpedal® v5.05. Interviewees provided informed consent to protect their intellectual property rights, and reviewed their interview transcripts for correction and confidentiality. Information from the transcripts was summarized in spreadsheet form to compare responses. Final transcripts and video records were returned to each interviewee for their personal records and to their iwi for archiving; iwi members were involved in preparation of the manuscript.

Results

Muttonbirding on Motungārara and Tītī Islands

On Motungārara, all three harvesters described landing on the island before sunrise. Early morning was considered the best time to harvest chicks as they were close to the entrance of their burrows after being fed by their parent. Harvesters from Ngā Takiwā indicated that birds preferred to nest in areas where the soil was friable for digging. Two harvesters thought most burrows were found at the highest elevations of Motungārara, and another suggested burrows were only found above the flax line that skirts the island. He described this as being a boundary, below which only little blue penguins (*Eudyptula minor*) were present. Two harvesters suggested the same birds returned to the island each year to breed, and one further suggested that chicks born on Motungārara come back to breed on Motungārara.

All five harvesters indicated the birds produce only one chick each season and that the primary method of chick extraction involved extending an arm down the full length of the burrow. In some cases, a stick was first extended into the burrow to determine the occupant. Ngā Takiwā harvesters used the type of peck on the stick to identify the species, whereas harvesters from Ngāti Kuia used the sound or call of the disturbed bird inside. One harvester from each iwi described fraying the end of a stick and rotating it in the burrow to extract down and feathers and, thus, confirm the presence of a shearwater chick.

All harvesters identified tītī or muttonbird chicks as the sole target of harvest. Despite fluttering shearwaters (*P. gavia)* also present on both islands, and flesh-footed shearwaters (*P. carneipes*) being present on Tītī Island, only sooty shearwaters were identified as the target species. Interviewees indicated that men harvested and prepared the birds, while cooking was primarily undertaken by women. Women landed on Tītī Island during harvest but generally fished or gathered seafood rather than participate in the capture of tītī. Birds were typically eaten fresh but were also preserved in their own fat, either in kerosene tins or wooden fish boxes, to help families through the winter months.

On both islands, interviewees reported harvest occurring in either late March or April (austral autumn). Tītī were not harvested every year. When harvest was undertaken, the dates were timed to coincide with abundant numbers of chicks in optimal condition. A harvester from each of Ngā Takiwā and Ngāti Kuia said they never saw 'skinny' chicks. However,

interviewees defined poor seasons as years when chicks were 'skinny'. Such seasons were attributed to irregular feeding by parent birds due to lengthy fishing trips or to parents abandoning chicks too early. Criteria for determining when chicks were in peak condition and appropriate for harvesting were the lack of adult feathers and high fat content. Small or undersized birds were returned to their burrows. One harvester from Ngā Takiwā described pulling a bird from a burrow and if it was not bigger or of equal size to the one before, it was put back. This was reinforced by the female kaumātua from Ngā Takiwā who described the birds she processed as all being large and uniform in size, comparable to the size of a bantam chicken.

A single trip was taken to Motungārara in harvest years, and the harvest was always shared among all Ngā Takiwā families, regardless of each family's participation in the harvest that season. Thirty to 80 birds were taken and shared between three to four families. On Tītī Island, multiple trips were made during a harvesting year with family groups harvesting on different days to minimise the number of people on the island at one time. One Tītī Island harvester thought an average of twelve birds per family was harvested by up to twelve families.

Historic abundance of sooty shearwaters in Marlborough Sounds

None of the kaumātua could say how many birds were present in the past on Tītī Island. Two, however, referred to a nearby area known as Tītīrangi (tītī = muttonbird; rangi = sky) which they explained meant that large flocks of birds would have once filled the skies. Two kaumātua also suggested that the habitat of these birds would have also included mainland New Zealand, not just the offshore islands they are restricted to now, which would have contributed to a greater historical abundance of birds. One kaumātua that harvested from the 1950s to the 1970s on Motungārara stated 'From memory, there was close to 800 pairs [nesting] on there. Could be more I'm not sure but…it's quite a racket when the adult birds are coming back.' Interviewees indicated that the government ban on harvesting in the 1960s did not stop the gathering of muttonbirds and, in fact, may have increased harvesting. One Ngāti Kuia harvester suggested as many as 500 birds could have been taken in any one season following the closure of Tītī Island.

Traditional sooty shearwater management strategies

Five kaumātua indicated that harvest and respect for the environment while harvesting are the key methods for managing the sooty shearwater populations and their island habitat. One Ngā Takiwā kaumātua described the harvest as a 'responsibility' which was guided by a number of protection strategies (Table 1). Digging chicks out was prohibited as it was believed that breeding tītī would not return to or use a damaged burrow the following year. As one kaumātua put it: '… [the harvesters] used to look after the [island] so next season the next whānau might be able to get there and there would be no damage and management would be right. Take the right ones and don't destroy the holes – that was the main thing.'

The number of birds harvested fluctuated between years. Kaumātua stated that short trips were made to both Tītī and Motungārara Islands prior to the harvest season to determine whether the population could sustain harvest that year. One Motungārara harvester commented that the number of chicks available could fluctuate dramatically between years. He remembered occasionally harvesting barely enough for a meal but the following year there being an abundance of chicks. Three of the five harvesters stated that the number of birds collected reflected the number of birds available. According to all three Motungārara harvesters, harvester experience was required to make a good judgement as to the number of sooty shearwaters to take.

The kaumātua expressed concern that Māori currently have little involvement with the management of the islands and the birds. Harvest was banned due to an apparent decline in bird numbers, yet one kaumātua from each iwi suggested that populations were declining because iwi were not muttonbirding. An interviewee from each iwi identified poaching as an issue since harvest cessation. Another kaumātua expressed a dichotomy between the western conservationists who oversaw the island and local Māori: 'The reason why we stopped… government took over, conservationists came in, but we were already [conserving the population], by harvesting every second bird, so the birdlife kept going'. Thus, mātauranga Māori of the kaumātua interviewed suggests harvest and management of sooty shearwaters as complementary and reciprocal.

Table 1. Harvest strategies used by Ngā Takiwā and Ngāti Kuia to manage Motungārara and Tītī Islands' sooty shearwater populations, Marlborough Sounds, New Zealand.

Concept	Strategy
Harvest regulation	Annual pre-harvest stock assessment to determine whether a harvest could occur
	Annual adjustment of the number of chicks to be harvested based the number of chicks available
	Only chicks harvested, never adults
	Only harvesting every second chick
	Use arms only to extract a chick, no use of a hook or stick for extraction purposes
	Only harvested chicks of uniform or minimum size; small or undersized chicks returned to their burrow
	Harvest conducted over one day on Motungārara and one day per family group on Tītī
Habitat protection	Movement within colonies restricted to minimise damage, all damaged burrows restored as best possible
	No digging into burrows to access chicks
	Only minimal clearing of undergrowth allowed to enable easier access to burrows by returning adult birds
Access control	Rights to harvest restricted to families with ancestral ties to the islands
	No settlement or long-term occupation of the islands

Discussion

Reduced sooty shearwater abundance and agents of decline

Mātauranga Māori of Ngā Takiwā and Ngāti Kuia kaumātua suggests sooty shearwaters were once far more abundant in the Marlborough Sounds and that their colonies extended beyond the island refuges on which they now occur. The reference to Tītīrangi by Ngāti Kuia kaumātua, and its interpretation as large flocks of birds filling the skies, supports this assertion, as does the estimated 800–1000 chicks per season that were harvested on Tītī Island by Ngāti Kuia between 1918 and 1933 (Gaze & Smith 2009). Motungārara and Tītī Islands now support approximately 100 (Newman et al. 2009) and 1300 (Geary 2010) breeding pairs respectively. Using the 800 pair estimate presented by a Ngā Takiwā harvester, we suggest it is possible that the Motungārara breeding population of sooty shearwaters has declined by approximately 4% per annum over a 50 year period. This is corroborated by abundant evidence that New Zealand sooty shearwater numbers overall have declined dramatically (between 64 to 78%; Scofield & Christie 2002) over at least the past 30 years (Clucas 2011; Scofield & Christie 2002; Scott et al. 2008; Veit et al. 1997).

When the Marlborough Sounds harvest was ceased by the Crown in the 1960s, sooty shearwater colonies were already beginning to disappear from headlands on the South Island (Jackson 1957) and many small island populations had also started to disappear (Scott et al. 2008). Most mainland colonies now only survive in the presence of intense pest control (Jones 2000) but there has also been a marked decline in sooty shearwater populations on pest free islands. For example, surveys on the non-harvested Snares Islands in 1969-1971 and 1996-2001 showed a cumulative 37.0% decline in burrow abundance representing an annual decline of 1.7% (1.4–2.1%; 95% CI) over 27 years (Scott et al. 2008). Clucas (2011) used eight muttonbirders' diaries to show a nearly identical trend in populations harvested by Rakiura Māori; sooty shearwater harvest tallies declined by 39.2% over the same period, an annual decline of 1.9% (1.1–2.7%; 95% CI).

Ngā Takiwā and Ngāti Kuia kaumātua attributed the long-term decline of the sooty shearwater populations to their no longer being allowed to harvest and manage the populations with traditional methods. This reflects a view held among many indigenous cultures that harvest of a resource is a responsibility and ultimately enhances population persistence. For example, traditional harvest practices have been shown to help maintain *Agave* spp., bonefish (*Albula* spp.) and reindeer (*Rangifer tarandus)* populations (Johannes & Yeeting 2000; Peters 2018; Sandström et al. 2003). As well, many indigenous cultures view the hunt as being controlled by the prey, which only make themselves available to harvesters if respect, and appropriate harvest protocols are applied (Berkes 2008; Krupnik & Vakhtin 1997; Lyver et al. 2008a). When such respect is retracted, so too is the resource. For example, the long-term decline of kererū in Te Urewera and particular small mammal species in Arnhem Land, Australia has been attributed by some Tūhoe and Aboriginal elders to the decline in traditional harvest rituals (Lyver et al. 2008a; Ziembicki et al. 2013). Thus, the ban on muttonbirding would have also been a ban on traditional management that may have further exacerbated the decline in numbers of sooty shearwaters.

The causes of seabird decline are complex. Mātauranga Māori of Rakiura Māori, who traditionally and currently harvest shearwaters from the Rakiura Tītī Islands at the southern end of the South Island (Fig. 1a), holds that good body condition of chicks is correlated with greater chick abundance. However, they have also observed increasing incidences of years in which chicks were fat but fewer birds were available than expected (Lyver 2002). This led harvesters to conclude that factors outside of the breeding grounds were likely influencing the populations (Moller et al. 2004). Growth trajectories of sooty shearwater populations are highly sensitive to changes in adult mortality rates (Hamilton & Moller 1995; Hunter et al. 2000). Such changes could be brought about by increased rates of fisheries by-catch, as has been implicated in the decline of flesh-footed shearwaters on Lord Howe Island (Barry & Wise 2005). Climate perturbations also impact sooty shearwater distributions, productivity and, potentially, survival at sea (Clucas 2011; Lyver et al. 1999; Shaffer et al. 2006; Veit et al. 1997) and are a more likely cause of the broad decline observed in the species across its range (Bond & Lavers 2014).

Can traditional harvest conserve TEK and species?

The ability to produce local food at formal gatherings is a source of pride for many iwi and provides cultural incentive to manage the resource sustainably (Lyver et al.2008a,b; Taiepa et al. 1997). In some cases, return of a resource to tribal management has proven successful in preventing overharvest. For example, the return of management of kiekie (*Freycinetia baueriana*) harvest to Ngāti Rakaipaaka prevented potential overharvest of the plants by another iwi (Coombes 2007). Resource management will only succeed when supported and enforced by those with access to the resource (Johannes 1978; Kitson & Moller 2008) and when the management comes from the harvesters' cultural perspective (Berkes & Turner 2006; Moller et al. 2009). Therefore, if poaching is to cease, harvest authority will need to come from the kaumātua or kaitiaki (guardians) of Motungārara and Tītī Islands.

The mātauranga Māori presented by our interviewees includes detailed information on sooty shearwaters breeding on Motungārara and Tītī Islands. For example, sooty shearwaters preferentially select elevated and therefore windier sites to nest because they have high wing loadings and struggle to take flight in calm conditions (Warham 1977). High elevation breeding colonies, as observed by Ngā Takiwā harvesters, gain important benefits such as air currents and exposed launching sites. Sooty shearwaters spend the majority of their lives at sea and only come to land to breed (Shaffer et al. 2006; Warham 1990). The significant knowledge of tītī breeding ecology possessed by the kaumātua reflects the amount of contact they had with the birds during this critical time.

Maintaining mātauranga Māori and traditional conservation management strategies for sooty shearwater populations in the Marlborough Sounds will require the resumption of cultural harvest. Traditional harvest, even of very few birds, is crucial to maintaining connections between iwi, sooty shearwaters and mātauranga Māori, and to Māori reasserting mana (prestige) and rangatiratanga (chieftainship) over the resource (Gaze & Smith 2009; Lyver et al. 2008b). Ngāti Kuia have already resumed such a harvest for sooty shearwaters on Tītī Island (Gaze & Smith 2009), as have Ngāti Awa for the grey-faced petrel (*Pterodroma gouldi*) in New Zealand's Bay of Plenty (Jones et al. 2015). The inclusion of mātauranga Māori in the management of these and other petrel customary harvests (Lyver et al. 2008b; Moller et al. 2004) will enable the persistence of important cultural practices, reduce poaching, and provide a means for monitoring populations of this culturally important seabird.

Conclusions

Mātauranga Māori has increased our understanding of historic sooty shearwater harvest, abundance and management in the Marlborough Sounds. However, harvest restrictions limit exposure of harvesters to the sooty shearwaters and mātauranga Māori of the species. Our study provides another line of evidence that sooty shearwater numbers in the Marlborough Sounds were much greater previously. The now smaller populations are in danger of local extinction, as is mātauranga Māori of these populations. It is timely and urgent that all available knowledge be brought to bear on designing a long-term conservation management strategy that involves all stakeholders and reinforces the relationships between Māori and sooty shearwaters of the Marlborough Sounds.

Acknowledgements

Many thanks to Ngā Takiwā o Te Atiawa Whānau, Ngāti Kuia and all the people that agreed to be interviewed. Ngā mihi maioha ki a koutou katoa. Many thanks to those that have been instrumental in keeping the tītī story alive, including Miriama Watson, James and George Aldridge, Neville Watson Tahuaroa, Diana Fife, Raymond Smith, Tom Wilson, Lyle Walker, Peter Meihana, Waihaere Mason and Mark Moses. Thanks also to the New Zealand Department of Conservation staff at Sounds Area and Marlborough Conservancy offices. This study was made possible by a Te Tipu Pūtaiao grant from the New Zealand Foundation for Research Science and Technology (grant VUWX0801). Additional support was provided by a Fulbright US Graduate Fellowship and Fulbright New Zealand. Research was conducted under New Zealand Department of Conservation permits NM-25084 and NM-225556-RES and approved by the Victoria University of Wellington Human Ethics Committee.

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Received 30 August 2019; accepted 16 September 2019
Editorial board member: Shaun Ogilvie