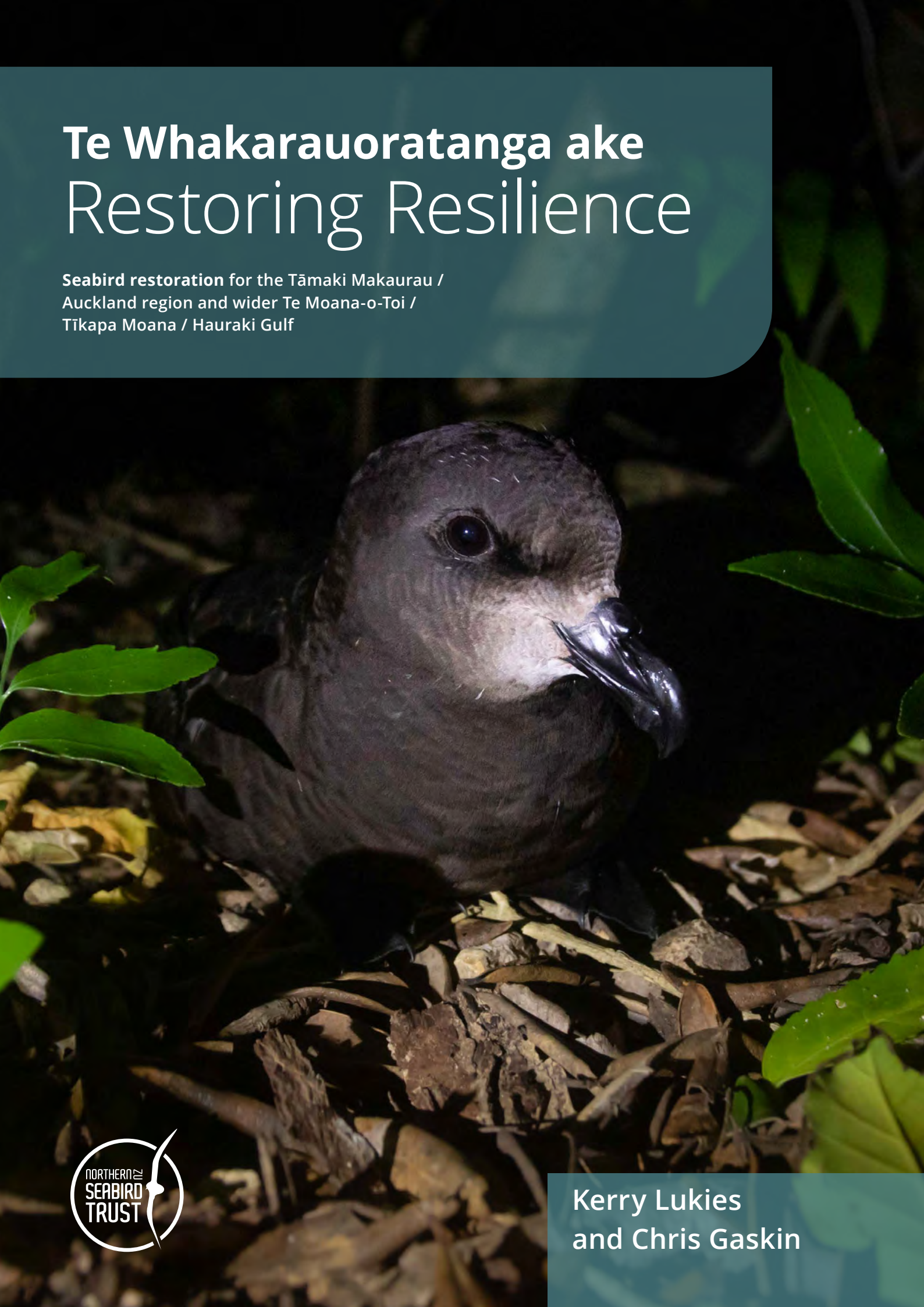
Te Whakarauoratanga ake
Restoring Resilience

Seabird restoration for the Tāmaki Makaurau / Auckland region and wider Te Moana-o-Toi / Tīkapa Moana / Hauraki Gulf



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NORTHERN NZ SEABIRD TRUST

A New Zealand fairy tern.
Image by Edin Whitehead

COVER: A grey-faced petrel marked as part of a mark-recapture study at Tāwharanui to determine the population size.
Image by Edin Whitehead

BACK COVER: A black petrel at sunset.
Image by Edin Whitehead.

This guide has been prepared by Kerry Lukies and Chris Gaskin (Northern New Zealand Seabird Trust)

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White-fronted tern courtship display.
Image by Edin Whitehead.

Ngā kōrero o roto

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He Whakarāpopoto

He nōhanga matua a Tāmaki Makaurau me te rohe whānui o Tīkapa Moana ki ngā manu moana. E rua tekau mā whitu ngā momo manu e whakawhānau pīpī ana ki konei, ā, i te ao whānui, koinei anake te wāhi whakawhānau pīpī o e rima o aua momo manu. He huhua tonu ngā nōhanga manu huri noa i Aotearoa, engari, nā te kawenga mai o ngā momo whakatumatuma e te tangata, kua whakawhāitihia te noho o ngā manu ki ngā motu me ngā ākau kāore e pāngia ana e te tangata. Kei te mārama tātou ki ngā pānga kino o ngā momo whāngote ū e kōkuhu ana i ngā kāinga o ngā manu māori, heoi, kātahi anō te motu ka tahuri ki te patu i ngā riha katoa hei whakamarumaru i ngā tipu me ngā kararehe māori. I te mea kei te piki ake te nui o ngā wāhi riha-kore i tēnei takiwā, kua wātea te hapori ki te whakatū i ētahi kaupapa whakarauora manu moana ki ngā motu iti me ngā ākau o Te Ika-a-Māui.

He nui tonu ngā painga o te kaupapa whakarauora manu moana – hei hāpai i te pūnaha hauropi, hei hāpai i ngā mahi a te tangata, hei hāpai anō i ngā tikanga ā-iwi. Kua whakatakotohia ēnei take ki roto i tēnei puka ārahi. Ki te whakarauoratia ngā manu moana, ka ora anō hoki te whenua me ōna pūnaha hauropi, otirā, ka whakapūmauhia ake anō ngā hononga a te iwi, ā, ka puare mai ngā tatau ki te ao mātauranga me ngā kaupapa tāpoi tautaiao. Ko te painga, he nui tonu ngā mahi whakarauora manu moana e taea ai e te hapori, i runga anō i te āwhina o ngā mātanga manu moana. Ko te patu riha tētahi o ngā tūmahi matua kua whakatakotohia ki konei hei whakamarumaru i ngā manu moana. Kei konei hoki tētahi kōrero mō te wāhi nui a te hapori whānui ki te aukati i te kōkuhunga atu o ā rātou mōkai ki ngā nōhanga o ngā manu moana kei te motu whānui me ngā motu iti. Mā ngā tūmahi ā-tinana – pērā i te kawenga atu o ngā manu ki wāhi kē me ngā tohu ā-pāpori – ka tere ake te putanga mai o ngā hua i ngā mahi māhaki noa, arā, ka rangona ngā painga e te pūnaha haupori, e ngā iwi me ngā pāpori.

Ko tētahi o ngā mahi matua o ngā kaupapa whakarauora manu moana, ko te aroturuki i ngā hua. Mā konā, ka kitea, kaua ko ngā hua o te kaupapa whakarauora anake, engari, ko ngā wāhi hei whakapai ake i te rautaki whakahaere. Waihoki, ka whakakipakipahia te hapori ki te kuhu mai ki te kaupapa, ka huraina mai hoki ngā kōrero mō te oranga o ngā manu moana, ā, ka puta mai ētahi kōrero hei tāpae atu ki ngā kaituku pūtea hei tautoko i ngā tono pūtea. He huhua tonu ngā momo ara mahi e tutuki ai ngā kaupapa whakarauora manu moana a ngā hapori, ā, he āwhina anō ngā tikanga a te ao pūtaiao me te ao Māori i roto i ngā mahi aroturuki.

Me kaha hoki tātou ki te whakamarumaru, ki te whakapai ake i te noho o ngā kāhui manu moana o tēnei rohe i roto i ā tātou mahi o ia rā. I te moana, me aukati te ekenga atu o ngā riha ki runga i ō tātou waka e ū pātata ana ki ngā motu riha-kore, ā, kia tika rawa te tuku atu i ngā manu e mau ana ki ā tātou rārangi hī ika. Ki tātahi me ngā ākau, me tūhono atu ki ngā rōpū hopuhopu riha, me hopu rānei ngā riha kei ō tātou kāinga, kaua hoki e tuku ngā mōkai ki te whakararuraru i ngā manu moana i runga i te whenua, ā, me kohikohi te kirihou e takoto ana ki runga i te onepū. Mā ēnei mahi iti noa, ka hikina ake, ka whakapūmautia te tatau o ngā manu moana, ā, ka whakarauoratia ngā āhuatanga katoa e whai pānga ana ki te noho o ngā manu moana ki te rohe o Tāmaki Makaurau.

Summary

The Tāmaki Makaurau Auckland and wider Te Moananui-o-Toi/Tīkapa Moana/Hauraki Gulf region is a world-renowned seabird hotspot with twenty-seven species breeding in the region, five of which breed nowhere else in the world. Seabird colonies were once abundant throughout mainland Aotearoa New Zealand, but due to many humanintroduced threats, they have been mainly restricted to offshore islands and inaccessible coastal areas. The negative impact invasive mammals have on our native species is well known, but only recently has there been a nationwide agenda to rid the country of these pests to protect our indigenous species. Given the increasing numbers of pest-free sites in the region, the opportunity arises for community-led seabird restoration projects at both island and mainland coastal locations.

Seabird restoration may be implemented for a variety of ecological, social, and cultural reasons which have been highlighted throughout this guide. Restoring seabird populations can not only reinvigorate terrestrial ecosystems but can also restore important cultural links and provide opportunities for education and ecotourism. Fortunately, many techniques exist for seabird restoration that can be easily implemented by communities with the guidance of seabird experts. The removal of invasive predators is discussed as the most important action to protect seabirds. Also discussed is how wider community support is crucial to prevent companion animals from accessing seabird colonies on the mainland and inhabited islands. Active measures such as translocation and the use of social cues can accelerate the restoration process to deliver the ecological, cultural, and social benefits of seabird populations sooner than passive management alone.

An integral part of any seabird restoration project is to monitor the outcome. This not only helps to determine the success of restoration project but can also indicate where improvements can be made to the management strategy. Moreover, monitoring can motivate continued community involvement, provide valuable information on seabird biology, and provide information for funders and support for further funding applications. A range of tools can be used in community-led seabird restoration projects and monitoring can incorporate both scientific methods and mātauranga Māori.

We also need to continue to protect and enhance our seabird populations in the region through our everyday actions. When at sea, we can ensure no pests have hitched a ride on our boats when we anchor near pest-free islands and ensure we correctly release any birds accidentally caught on our fishing lines. On our beaches and coastal areas, we can join a pest trapping group or trap pests on our own property, keep our pets from disturbing seabirds on land and pick up plastic on our beaches. These small actions can contribute to self-sustaining seabird populations and help restore seabird-driven resilience to the Auckland region.

Australasian gannets nesting at Muriwai on Auckland's west coast.
Image by Edin Whitehead

1. He Kupu Whakataki
Introduction

A New Zealand fairy tern in flight.
Image by Edin Whitehead

The purpose of this document is to act as a practical guide for community conservation groups, iwi and private landowners to restore seabird populations to the Tāmaki Makaurau Auckland region. The introduction focuses on why seabirds are important components of terrestrial ecosystems, the diversity of seabirds in northern Aotearoa New Zealand and the threats they face. Section two outlines why we should restore seabirds to the region, the requirements for a successful seabird restoration project and the methods available. The different types of restoration methods are highlighted in case studies of existing seabird restoration projects in Tāmaki Makaurau Auckland. The final section focuses on the importance of monitoring and other everyday actions that Aucklanders can do to help protect and enhance seabird populations.

He aha te manu moana?
What are seabirds?

Seabirds are a group of birds adapted to a life at sea, with many species only returning to land to breed. There are approximately 370 species of seabirds in the world, making up just a fraction of the 10,721 bird species [1]. What makes seabirds unique is the morphological and physiological adaptations that allow them to spend most of their lives in the marine environment. Excellent eyesight and sense of smell allow seabirds to find prey in often featureless oceans [2]. Waterproof feathers, webbed feet and strong wings or flippers are just some of their morphological adaptations that accommodate an aquatic lifestyle [3]. Additionally, different bill shapes allow seabirds to capture fish, cephalopods, crustaceans and plankton, and salt-excreting glands let them consume seawater [4, 5]. Some species can dive to great depths in pursuit of prey, while others dip at the surface of the ocean. Many seabirds forage in the open ocean far from land while others locate prey in shallow coastal waters, estuaries and harbours. Their aquatic adaptations and reliance on the ocean for food set seabirds apart from shorebirds that forage on sandy or rocky shorelines, mudflats and shallow waters [6].

An Australasian gannet and its chick. Gannets are an example of surface nesting seabirds.
Image by Edin Whitehead

New Zealand storm petrel on Hauturu. Procellariiformes, or tube-nosed seabirds, have an excellent sense of smell that allows them to detect prey in featureless oceans.
Image by Edin Whitehead

A pied shag in a tree-top nest.
Image by Edin Whitehead

Bird handled with a wildlife permit from the Department of Conservation

Seabirds differ in their life history strategies (age- and stage-specific patterns) to many other birds in that they are often long-lived, late to sexually mature, lay few eggs and chicks are slow to develop [4, 7]. The nesting strategies of seabirds typically fall into one of three categories: tree-nesters (e.g. shags), above-ground surface-nesters (e.g. gannets, gulls and terns) and below-ground burrow or crevice-nesters (e.g. petrels and shearwaters). Many species will breed in large colonies, and the density of nests depends on the type of nesting strategy employed. Typically, seabirds lay 1–2 eggs per year, except for shags that may lay up to five eggs [8]. Most species exhibit strong natal site fidelity, where they return to breed where they hatched and often return to the same nest and partner each year [4, 5, 8]. However, dispersal to other colonies [9, 10] and high gene flow [11] has been observed in grey-faced petrels (ōi, Pterodroma gouldi) suggesting that a small percentage of individuals disperse away from natal colonies, especially when aided by active conservation management [12]. Additionally, some gull and tern species have low natal site fidelity and colonies are highly mobile, with some colonies remaining consistent from year to year, while others are short-lived [13].

A little penguin incubating eggs in an artificial nest box.
Image by Edin Whitehead

Buller's shearwaters in an underground burrow. Most of the seabird species in northern New Zealand are burrow-nesters.
Image by Edin Whitehead

Species name (English/Māori)	Taxonomic name	Threat Status (DOC/IUCN Red List)	Endemism Status
Northern little (blue) penguin / **Kororā**	*Eudyptula minor iredalei*	**At Risk — Declining** Least Concern	NZ endemic subspecies
Black petrel / **Takoketai, tāiko**	*Procellaria parkinsoni*	**Threatened — Nationally Vulnerable** Vulnerable	Region endemic
Cook's petrel / **Tītī**	*Pterodroma cookii*	**At Risk — Relict** Vulnerable	NZ endemic
Pycroft's petrel / **Tītī**	*Pterodroma pycrofti*	**At Risk — Recovering** Vulnerable	Region endemic
Black–winged petrel / **Tītī**	*Pterodroma nigripennis*	**Not Threatened** Least Concern	NZ native
Grey–faced petrel / **Ōi, tītī**	*Pterodroma gouldi*	**Not Threatened** Least Concern	NZ endemic
Buller's shearwater / **Rako**	*Ardenna (Puffinus) bulleri*	**At Risk — Naturally Uncommon** Vulnerable	Region endemic
Flesh–footed shearwater / **Toanui, tuanui**	*Ardenna (Puffinus) carneipes*	**Threatened — Nationally Vulnerable** Near Threatened	NZ native
Fluttering shearwater / **Pakahā**	*Puffinus gavia*	**At Risk — Relict** Least Concern	NZ endemic
Little shearwater	*Puffinus assimilis haurakiensis*	**At Risk — Recovering** Least Concern	NZ endemic subspecies
Sooty shearwater / **Tītī**	*Ardenna (Puffinus) grisea*	**At Risk — Declining** Near Threatened	NZ native
Fairy prion / **Tītī wainui**	*Pachyptila turtur*	**At Risk — Relict** Least Concern	NZ native
Northern common diving petrel / **Kuaka**	*Pelecanoides urinatrix urinatrix*	**At Risk — Relict** Least Concern	NZ native
White–faced storm petrel / **Takahikare–moana, takahikare**	*Pelagodroma marina maoriana*	**At Risk — Relict** Least Concern	NZ endemic subspecies
New Zealand storm petrel	*Fregetta maoriana*	**Threatened — Nationally Vulnerable** Critically Endangered	Region endemic
Australasian gannet / **Tākapu, tākupu**	*Morus serrator*	**Not Threatened** Least Concern	NZ native
Pied shag / **Kāruhiruhi, kawau**	*Phalacrocorax varius varius*	**At Risk — Recovering** Least Concern	NZ endemic subspecies
Little shag / **kawau paka**	*Phalacrocorax melanoleucos brevirostris*	**Not Threatened** Least Concern	NZ endemic subspecies
Black shag / **Kawau, tuawhenua**	*Phalacrocorax carbo novaehollandiae*	**At Risk — Naturally Uncommon** Least Concern	NZ native
Little black shag / **Kawau tuī**	*Phalacrocorax sulcirostris*	**At Risk — Naturally Uncommon** Least Concern	NZ native
Spotted shag / **Pārekaraeka, kawau tikitiki, pāteketeke**	*Stictocarbo punctatus punctatus*	**Not Threatened** Least Concern	NZ endemic
Southern black–backed gull / **Karoro**	*Larus dominicanus dominicanus*	**Not Threatened** Least Concern	NZ native
Red–billed gull / **Tarāpunga**	*Chroicocephalus (Larus) scopulinus*	**At Risk — Declining** Least Concern	NZ endemic
Black–billed gull / **Tarapuka**	*Chroicocephalus (Larus) bulleri*	**Threatened — Nationally Critical** Endangered	NZ endemic
White–fronted tern / **Tara**	*Sterna striata*	**At Risk — Declining** Near Threatened	NZ native
Caspian tern / **Taranui**	*Hydroprogne caspia*	**Threatened — Nationally Vulnerable** Least Concern	NZ native
New Zealand fairy tern / **Tara iti**	*Sterna nereis davisae*	**Threatened — Nationally Critical** Vulnerable	NZ and region endemic sub–species

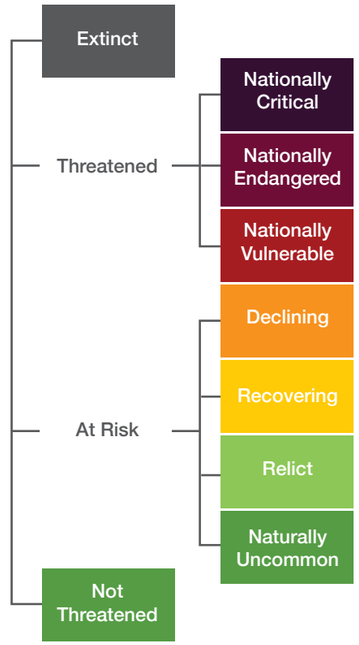


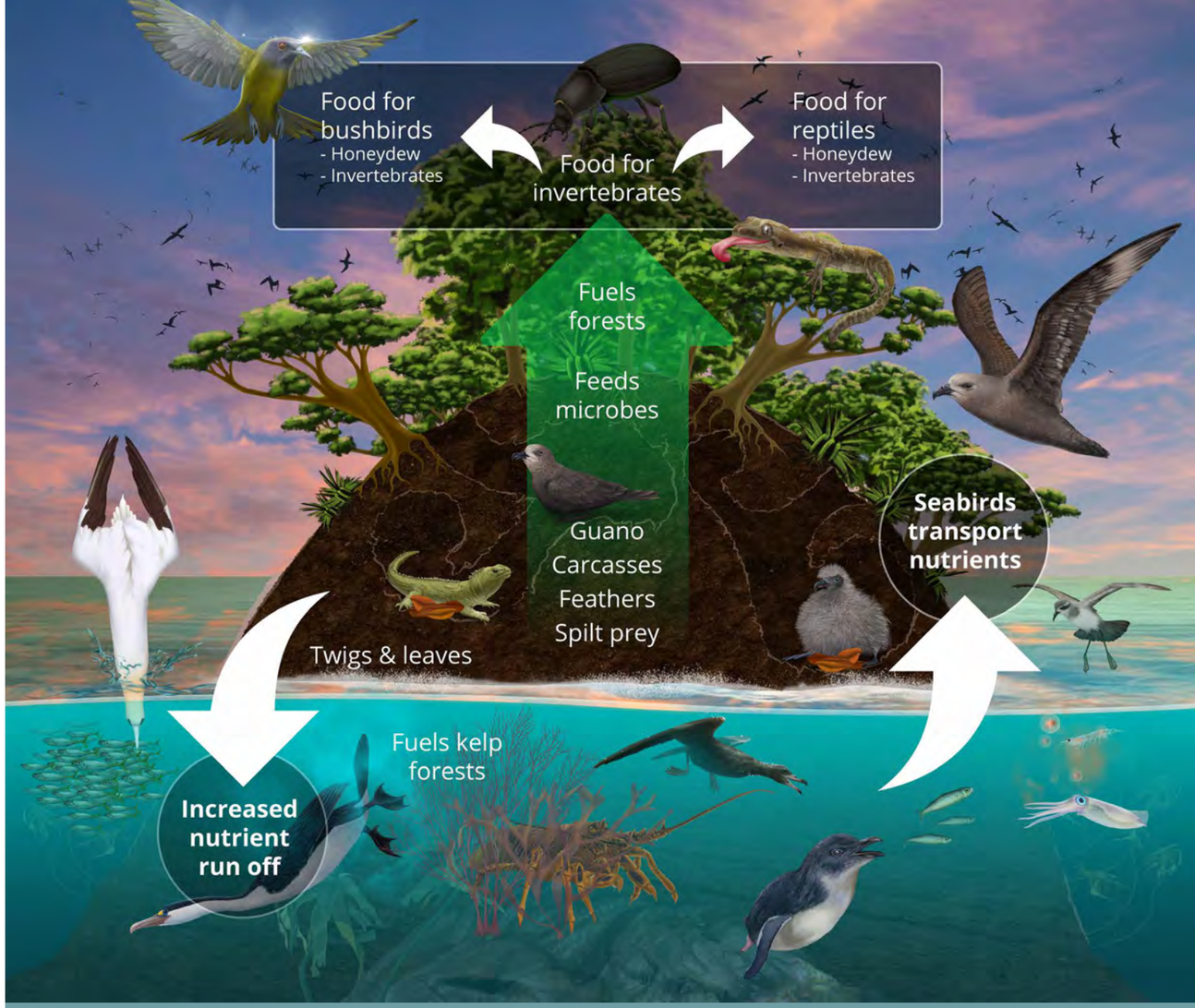
Table 1:
Seabird species breeding in the wider Te Moananui-o-Toi Tīkapa Moana Hauraki Gulf and their threat and endemism status. Both the New Zealand Threat Classification System (**NZTCS**), administered by the Department of Conservation, and International Conservation Status (IUCN Red List, viewed 5 August 2020) are listed for each species. The NZTCS complements the IUCN Red List but is 'focussed at the national level and provides a more sensitive classification for taxa with naturally restricted distributions and small numbers as a result of insular rarity' [14]. The hierarchy for the NZTCS [14] are illustrated on the left. NZ Endemic refers to species that only breed in New Zealand and Region Endemic refers to species that only breed in the northern New Zealand region.

Seabirds as marine ecosystem indicators

"As predators at the top of the food chain seabirds are crucial components of marine ecosystems and possess attributes that make them useful as indicators of change in the marine environment. Changes in lower trophic levels of marine food webs can be brought about by climatic or anthropogenic (human) impacts on marine resources, such as overfishing and/or pollution. Such changes are frequently reflected in seabird populations through shifts in population size, behaviour and/or the chemical signature of individuals' tissues [16-18]. Given that there is an increasing demand for relevant indicators for the marine environment, the conservation and study of seabird populations represents a viable and cost-effective 'canary in the coal mine' for the long-term assessment of marine ecosystems across broad spatial scales." [19]

Red-crowned Kākāriki on Tawhiti Rahi, Poor Knights islands. Nutrients from seabirds help to create food and habitat for forest birds.
Image by Edin Whitehead

A Grey-faced petrel chick in a natural burrow.
Image by Edin Whitehead



The ecological role performed by seabirds

Te mahi a ngā manu moana i te pūnaha hauropi
The role of seabirds in ecosystems

Seabirds as ecosystem engineers

Seabirds provide a vital link between land and sea by transporting marine-derived nutrients to terrestrial environments through regurgitated food, stomach oil, feathers, guano, corpses, eggs and shells [20, 21]. Guano (seabird excrement) provides the two elements that are the most limited to plants: nitrogen and phosphorus. Increased nutrient input from guano, in particular, combined with the burrowing behaviour of many seabirds can aerate and enrich the soil which encourages plant growth [20, 22]. This seabird-driven nutrient cycling helps to support many terrestrial plants, invertebrates [23], reptiles [24] and forest birds and has led to seabirds being labelled as ecosystem engineers [20, 25]. Additionally, seabird burrows provide thermal and humidity refugia for invertebrates and reptiles (cool stable temperatures, higher relative humidity) to prevent desiccation as well as providing places to shelter from avian predators [26]. Moreover, nutrient leaching enhances the shallow marine environment surrounding seabird islands and can increase the diversity and abundance of seaweeds and other algae which provide food and habitat for other marine species [27]. Accordingly, seabirds are a vital component of the ecosystems within which they reside.

A Pycroft's petrel on Red Mercury Island.
Image by John Stewart.

A Marbled skink, one of the many reptiles found in association with seabird burrows.
Image by Edin Whitehead

A common diving petrel outside its burrow.
Image by Edin Whitehead

A group of rangatahi/young people visiting Ōtata, Noises Islands to learn about the role of seabirds in island ecosystems.
Image by Kennedy Warne.

Te hora o ngā manu moana ki Aotearoa i mua, ināianei hoki

Historic and current distribution in Aotearoa New Zealand

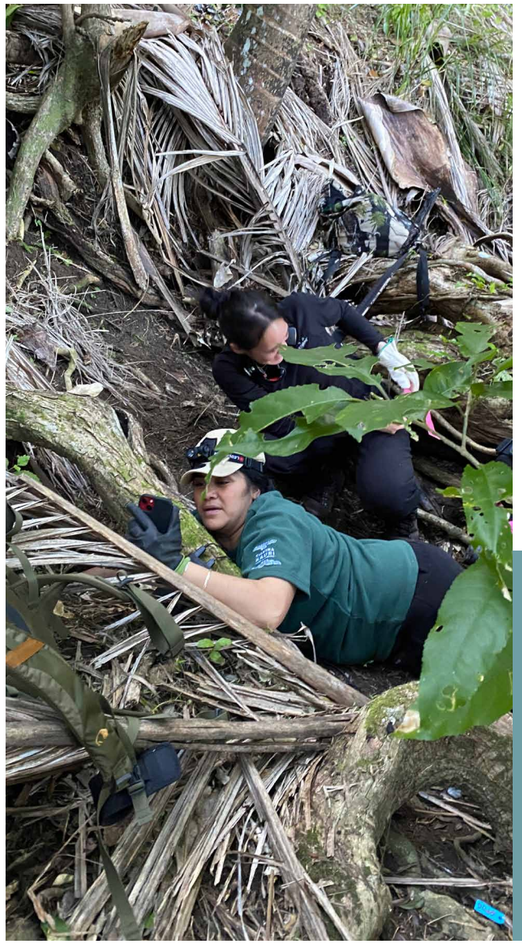
Aotearoa New Zealand is a seabird hotspot with 87 species breeding throughout the country [28], approximately one-quarter of the global seabird species. Included in these are penguins (Spheniscidae), albatrosses (Diomedeidae), fulmars, petrels, prions and shearwaters (Procellariidae), storm petrels (Hydrobatidae), diving petrels (Pelecanoididae), tropicbirds (Phaethontidae), gannets and boobies (Sulidae), cormorants and shags (Phalacrocoracidae), skuas (Stercorariidae), gulls (Laridae), and terns and noddies (Sternidae) [29]. This diversity is largely due to the productive oceans surrounding the country and the lack of mammalian predators throughout much of its history [8]. New Zealand encompasses a range of different seabird habitats, from the subtropical Kermadec Islands where red-tailed tropicbirds (amokura, Phaethon rubicauda) are found, to the sub-Antarctic where penguins and albatrosses form breeding colonies into their thousands [28]. So unique are the seabirds of New Zealand that almost half of them breed nowhere else in the world [7].

Historically, seabirds would have been found throughout coastal New Zealand and some inland mountain ranges [30, 31]. Habitat modification through burning, clearing for agricultural crops and livestock grazing, urbanisation, human harvest and introduced predators have caused the local extinctions of many seabird colonies [8]. Thirty-three of the 36 burrow and surface nesting petrel species in New Zealand have experienced a range-reduction due to human activities, primarily predation by introduced mammals and as such, few inland burrowing seabird colonies still exist [32]. The exceptions to this are the Westland petrels (tāiko, Procellaria westlandica) in Westland, Hutton's shearwaters (kaikōura tītī, Puffinus huttoni) in Kaikōura [22, 31] and mottled petrels (kōrure, Pterodroma inexpectata) at Lake Hauroko, Fiordland, which is the only burrowing seabird colony in the world within a freshwater ecosystem [26]. It is because of the vast reduction in the distribution and abundance of seabird colonies that seabird-driven ecosystem processes such as marine nutrient input and cycling have been lost from much of New Zealand's coastline, rendering them less productive than they were in pre-human times.

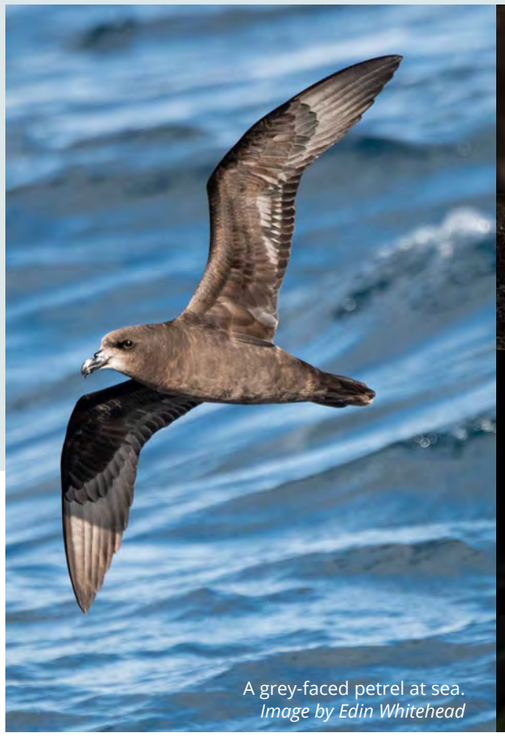
Fluttering and Buller's shearwaters, and fairy prions foraging in front of a backdrop of Hauturu.
Image by Edin Whitehead

Cultural value of seabirds

Seabirds are important for cultural reasons in addition to their role in ecosystem function. Tangata whenua have a special relationship with seabirds as many species are considered taonga (treasures). This relationship is recognised under both the Treaty of Waitangi and the Conservation Act 1987 and is reflected in species management plans with co-governance arrangements between the Department of Conservation (DOC) and iwi [24, 33]. The chicks of sooty shearwaters (tītī, Ardenna grisea) and grey-faced petrels, collectively known as tītī or muttonbird, are a traditional food source for some iwi [34]. Tītī harvesting can provide Māori with a connection to ancestors, culture and tribal identity and still occurs on some islands, especially those near Rakiura/Stewart Island and the Mokohinau and Ruamāhua/Aldermen Islands in northern Aotearoa New Zealand [19, 34]. Restrictions are in place to prevent overharvesting of tītī including a permit system, commercial trade conditions and seasonal and temporal constraints [8].



Ngātiwai staff burrow scoping for Ōi / grey-faced petrels on Taranga / Hen Island. *Image by Chris Gaskin*



A grey-faced petrel at sea.
Image by Edin Whitehead

A pair of Australasian gannets courting.
Image by Edin Whitehead

A fluttering shearwater held by a seabird researcher.
Image by Edin Whitehead

Bird handled with a wildlife permit from the Department of Conservation

A dog disturbing nesting Australasian gannets at Muriwai on Auckland's west coast. Dogs are prohibited from the gannet colony and surrounding area.
Image by Edin Whitehead

A global seabird hotspot

Twenty-seven seabird species breed within the wider Tīkapa Moana Hauraki Gulf region including petrels, shearwaters, shags, one penguin, one gannet, three terns and three gulls [19]. Four of those species are endemic to the region, breeding nowhere else in the world [19]. Given this, the northern New Zealand region is classified as an Important Bird Area (IBA) [28] and the high diversity of seabirds makes the region a global seabird hotspot.

Tāmaki Makaurau Auckland is New Zealand's largest city with a population of 1.57 million people [35]. The city has a considerable coastline due to its isthmus landform. To the east of the isthmus is the Tīkapa Moana Hauraki Gulf which encompasses both inshore waters and the continental shelf edge covering 1.2 million hectares [36]. Within the Hauraki Gulf are thirty major island groups and 400 small islands and islets, many of which are free of introduced mammals (pest-free) and the waters around the islands provide ample foraging opportunities for seabirds [36, 37]. (For more information, see 'Seabirds of the Hauraki Gulf' [19]. A link to the full text is in Appendix 2). On Auckland's turbulent west coast, small pockets of seabird breeding sites are dotted along the coastline [38] including little blue penguins (kororā, Eudyptula minor iredalei), gulls, terns and grey-faced petrels, among others, in addition to one of few mainland Australasian gannet (tākapu, Morus serrator) colonies.

Te tūnga whāomoomo o ngā manu moana me ngā mahi whakatumatuma

Conservation status and threats

Seabirds are the most threatened group of birds in the world [7] with one-third of all seabirds categorised by the IUCN Red List of Threatened Species as Critically Endangered, Endangered or Vulnerable [39]. Globally, islands provide refuge for species that have been eliminated from mainland breeding sites through a range of land-based threats. This is seen in New Zealand where many seabird colonies are restricted to inaccessible coastlines or island refuges where threats are less prevalent [22]. Seabirds face a variety of threats both on land and at sea: from direct disturbance by humans and invasive predators at breeding sites to being caught as bycatch, marine pollution and the effects of climate change at sea [40].

The remainder of this section will focus on the threat that invasive predators pose to seabirds but for a full review of the threats facing seabirds in the region refer to 'Threats to seabirds of Northern Aotearoa New Zealand' [40] (A link to the full text is in Appendix 2).

The impact of invasive mammalian predators

Introduced mammalian predators (invasive predators) are the primary threat to island biodiversity and have caused the extinction of numerous seabird species globally [37, 41]. Invasive predators present a considerable risk to many native species in Aotearoa New Zealand who have evolved without mammalian predators and often lack predator response strategies [42], which is the case for many seabirds. Additionally, the nesting strategies of many seabird species on or below ground makes them easily accessible to invasive predators [32] such as rats (Rattus spp.), cats (Felis catus), mustelids (stoats, weasels and ferrets, Mustela spp.), mice (Mus spp.) and pigs (Sus scrofa). These invasive predators prey on at least sixteen seabird species in Aotearoa New Zealand and can reduce or eliminate entire populations [22]. Seabirds can be killed and eaten at every life stage (eggs, chicks and adults) and even the smallest introduced mammal can cause mortality (for example, mice on Gough Island in the Atlantic Ocean attack live Tristan albatross (Diomedea dabbenena) chicks and have reduced the fledgling population by 60% [43]).

As seabirds are ecosystem engineers (see Section 1.2.2), the predation of seabirds, eggs and chicks can alter the functioning of entire ecosystems, more than just being a threat for the birds themselves [12, 44]. As marine-derived nutrient input declines alongside seabird populations, islands invaded by rats have an altered nutrient profile of carbon, nitrogen and phosphorus [44], the key nutrients required for plant growth. This modified nutrient profile can weaken plant growth and alter the availability of

Cats, both feral and companion, can kill seabird chicks and adults.
Image by Edin Whitehead

A rat killed by a GoodNature rat trap.
Image by Edin Whitehead

Rat traps in wooden tunnels help protect seabird colonies and prevent non-target species from getting caught.
Image by Kerry Lukies

A stoat caught by a DOC200 trap.
Image by Kerry Lukies

food and habitat for species on land [20, 22]. Moreover, nutrient runoff into the shallow marine environment surrounding seabird islands declines if seabird populations are removed, reducing the diversity and abundance of marine species [27, 45]. Given this, the negative impact of invasive predators on seabirds and seabird-driven ecosystems makes predator removal the most effective seabird conservation measure [41, 46, 47].

Removing invasive predators

Islands have been targeted for ecological restoration globally as they are often refuges for species lost from the mainland and because their aquatic boundaries have made pest removal and native species reintroductions more feasible [41]. Twenty-five invasive species had been removed from 900 islands globally by 2011, with rodents, goats (Capra spp.) and feral cats the most common targets [41, 48].

Trapping and aerial or ground poisoning are the techniques that are often used to eradicate invasive predators from smaller, uninhabited areas such as offshore islands [22]. These techniques can also be used on large and inhabited areas but must take into account social, economic or cultural interactions [41] such as potential community disapproval of poisons. Eradicating invasive predators on large islands or areas of the mainland can benefit numerous species and ecosystems that may be absent on smaller islands [24]. In some cases, the complete removal of invasive predators may not be feasible and in these situations, they can be controlled or excluded with predator-proof fences or intensive trapping networks, sometimes in addition to ground poison.

Aotearoa New Zealand has led the way in predator eradication on islands and one of the world's first rodent eradications was on Maria Island/Ruapuke in the Hauraki Gulf in 1960 [49, 50]. More than 100 islands in Aotearoa New Zealand are now pest-free [24] and at least 35,000 ha on islands are now available as safe breeding sites for seabirds and other native species [33]. Until now, the majority of islands cleared of invasive predators have been uninhabited islands managed by DOC [33]. This is changing, however, as a growing number of predator eradication and restoration projects throughout Aotearoa New Zealand are carried out by community groups, local residents and iwi as an interest in hands-on conservation management has grown [24, 51, 52].

A predator-proof fence can help to create safe nesting habitat for seabirds and other native species.
Image by Edin Whitehead

It is not only wild introduced mammals that need to be controlled near seabird breeding, feeding and foraging areas but also companion cats and dogs (Canis familiaris). An example of the impact of cat predation is on Rangitāuha/Raoul Island, where entire populations of petrels and shearwaters (millions of birds) were wiped out by cats and rats [53]. Uncontrolled dogs can kill and maim seabirds on land or disturb roosting and nesting birds in coastal areas [40]. Penguins are particularly vulnerable as dogs can dig nesting or moulting birds out of burrows [54]. A review of little blue penguin mortality in Otago found that dogs contributed to 14% of the mortality events investigated [55]. Likely, many penguin deaths are not reported by, or even known to dog owners. Companion cats and dogs can be restricted from important seabird areas through predator-proof fencing, local bylaws and social policing.

How invasive predator removal affects seabird populations

Removing invasive predators from an area, especially islands, can result in the recovery, recolonisation or colonisation of the area by native species, including seabirds [22, 41]. It is thought that between 50–100% of the Critically Endangered and Endangered seabird species globally benefit from the eradication of invasive predators on islands [41]. Populations may increase due to enhanced hatching or fledging (chicks leaving the nest) success [56, 57] or improved adult survival rates following the removal of invasive predators [58, 59]. However, the positive impact of eradications on seabird population demography can be slow due to the long generation times of most seabirds [12] and population increases may not become apparent for decades. Many other factors also influence whether seabirds recover or recolonise newly available habitat, most of which are discussed in Section 2.2.

Population recovery following eradication — the example of New Zealand Storm Petrel

The New Zealand Storm Petrel (Fregetta maoriana, NZSP) is an exceptional example of population recovery following the removal of invasive predators. Presumed extinct for 170 years and known only from three museum specimens collected during the 1800s, an unidentified bird was seen near the Mercury Islands in January 2003 [60], followed by at least ten individuals seen later that same year about two kilometres north of Te Hauturu-o-Toi/Little Barrier Island (Hauturu) [61]. Assumed to be the similar-looking black-bellied storm petrels (Fregetta tropica), later analysis of photographs and a published description suggested they were a different species [60, 61]. Further at-sea sightings of these black and white storm petrels occurred in the wider Hauraki Gulf and Far North regions from November 2003 to June 2005 [62]. Measurements from birds captured at sea in 2005 and 2006 were compared to museum specimens, confirming that they were the presumed extinct NZSP [63].

A New Zealand storm petrel foraging at sea.
Image by Edin Whitehead

A NZSP photographed at sea in 2011 had vegetation attached to its leg that suggested the species breeding grounds may have been somewhere in northern New Zealand [64]. In 2013, eleven NZSP radio-tagged at sea were detected at night near Hauturu [65] and tracked to a small colony (four burrows) on the island [65]. Hauturu is pest-free, with cats removed in 1980, followed by rats in 2004 [57]. The NZSP colony that was discovered was potentially a remnant population that survived predation by rats and cats. Given its location on the island and the lack of detection by DOC rangers and many researchers that had visited the island over the years, the colony was more likely the expansion of a relict population from refugia in steep-sided valleys and on ridges that began to recover following the eradication of rats and cats [22, 65]. The current estimate for the NZSP population is 1,630 (range 624–3,758) individuals based on resightings of banded birds at sea [66]. As of today, Hauturu remains the only known breeding site [19].

Members of the Leigh Penguin Group waiting for nightfall to detect little penguins coming ashore at Ti Point.
Image by Karen Baird

Ngā mahi whakarauora manu moana e arahina ana e te hapori

Community-led seabird restoration

An increasing number of New Zealanders are involved in eradication and restoration activities throughout the country as the adverse effects of invasive predators on native species are widely known [52, 67]. Community efforts have contributed to the pest-free status of many islands and an increasing number of mainland locations in Auckland where seabird colonies have re-established [19, 68]. Many of these islands and mainland sanctuaries are in public ownership and are managed by community groups in collaboration with Auckland Council (e.g. Tāwharanui Regional Park, Shakespear Regional Park) or DOC (e.g. the islands of Motuihe, Tiritiri Matangi and Motuora) [33, 52]. Not all islands are publicly owned, however, with more than half of the islands in northeast Aotearoa New Zealand in private or Māori ownership [33]. Additionally, one-quarter of the 600 community environmental groups in Aotearoa New Zealand work to restore private, rather than public land [52]. Given this, as more pest-free sites are established on privately owned or Māori land, the opportunity arises for more community-led seabird restoration projects on islands and the mainland.

Active seabird restoration methods (detailed below) are more achievable on islands and mainland sanctuaries where the threat of invasive predators has been eliminated or reduced significantly. For community groups, local residents and iwi looking to restore seabirds, intensive pest control and habitat restoration may be a great first step to protect remnant seabird colonies with a goal to become pest-free [50]. In addition to removing rats, feral cats, pigs and mustelids from restoration sites, pet cats and dogs also need to be excluded to protect seabird colonies. Preventing companion animals from accessing seabird sites requires community support especially on the mainland and on inhabited islands (e.g. Aotea/Great Barrier Island and Waiheke) for seabird populations to flourish [33].

The first field crew of what will become 14 workers on the project.
Photo by Tim Higham

Bringing back what should be here
A mana whenua lead approach on Aotea

Opo and Elaine Ngawaka literally live among seabirds.

Their family are the only residents of Māhuki, one of Broken Islands south of Port Fitzroy on Aotea Great Barrier Island, and the largest tākapu or gannet colony in the Hauraki Gulf.

The island is Māori owned and Opo is Chair of a Project Steering Group that oversees the Ngāti Rehua Ngātiwai ki Aotea-led Tū Mai Taonga project, set up with the support of the Jobs for Nature - Mahi mō te Taiao programme to remove feral cats and rats from Aotea.

He sees the presence of introduced predators as part of the process of colonisation. “They are part of the story of loss that Ngāti Rehua Ngātiwai ki Aotea has suffered; of land, language, knowledge, mana and the company of once abundant native wildlife.”

“There have been many tragedies. This is one of them. We must be involved; it is in our interest.”

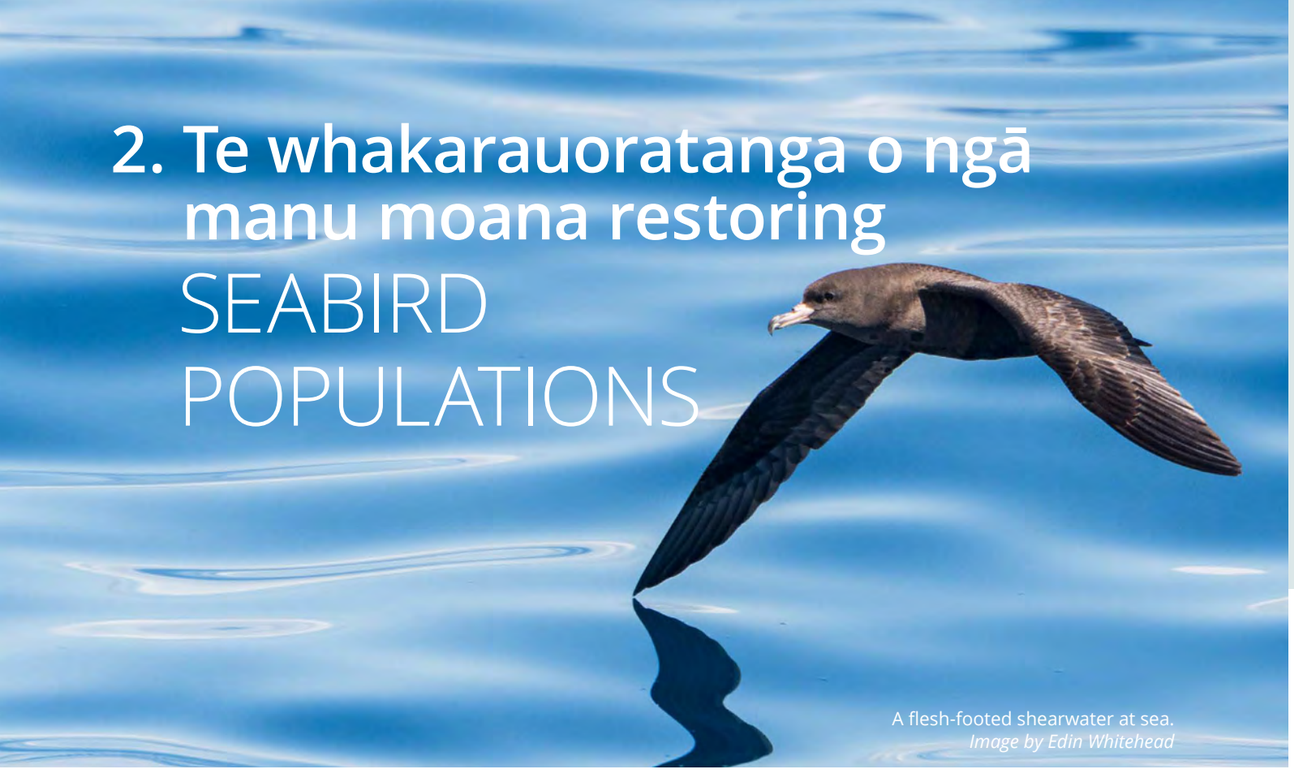
Work has started in the Te Paparahi block in the island’s north to create a network of feral cat traps and trail cameras over 4,500 ha, to help protect seabirds like tākoketai (black petrel), Ōi (grey- faced petrel) and tītī (Cook’s petrel).

For ship rats and kiore, the project has defined a pathway to eradication approach of the back of a feasibility study, using islands like Māhuki to trial new combinations of eradication tools and detection equipment to prevent reinvasion. With growing capacity and proof of concept Tū Mai Taonga aims to unite community and agency effort in stages across the island, backed by the tikanga of mana whenua.

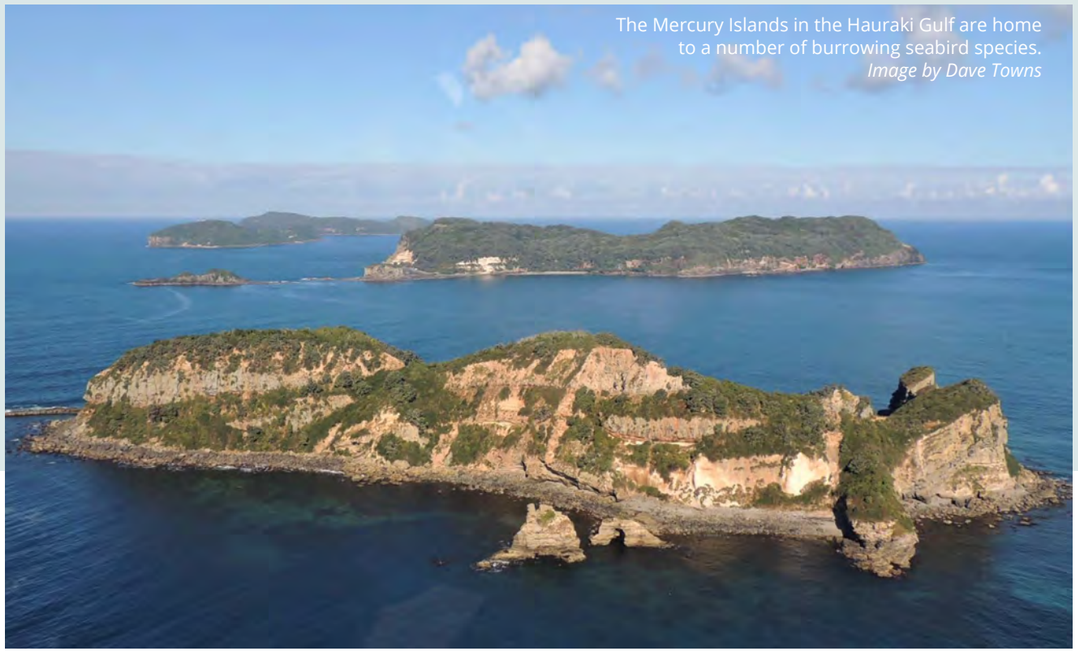
Photo by Saskia Koerner

“Māori understand how everything is connected and important. The priority is to have those birds, plants, reptiles and insects that should be here, back among us.”
– Opo Ngawaka

2. Te whakarauoratanga o ngā manu moana restoring SEABIRD POPULATIONS



A flesh-footed shearwater at sea.
Image by Edin Whitehead



The Mercury Islands in the Hauraki Gulf are home to a number of burrowing seabird species.
Image by Dave Towns

He aha te take me whakarauora ngā manu moana?

Why restore seabird populations?

Seabird restoration may occur for a variety of reasons: to re-establish populations to historic breeding sites, encourage breeding at locations recently cleared of pests, establish multiple breeding colonies [46], prevent extinction, restore ecosystem function and resilience [32] or to reinstate sustainable harvest [33]. The poor conservation status and great diversity of seabirds in Auckland make their conservation a priority in the region [19]. Fortunately many practical, cost-effective techniques exist for seabird restoration [69].

The role of seabird-driven ecosystem functioning has become better understood over the last fifty years, inducing a shift from species-specific restoration to a holistic ecosystem-based approach [32, 70]. Seabird restoration can strengthen ecosystem resilience by re-establishing marine-derived nutrient input which is crucial when restoring islands and some mainland areas to fully functioning ecosystems [46]. The restoration process can take time but ultimately results in long-term ecological benefits for both the seabirds themselves and terrestrial ecosystems [71].

While most restoration projects will have an ecological focus, seabird restoration can present additional cultural, social and economic benefits to communities. Accessible seabird colonies can provide opportunities for education, community engagement and a connection to nature [37, 72]. Seabird restoration can benefit communities through ecotourism opportunities, for example, the tours to the Cape Kidnappers Australasian gannet colony (https://gannetsafaris.co.nz/) or visits to the only mainland colony of northern royal albatross (toroa, Diomedia sanfordi) at Taiaroa Head (https://albatross.org.nz/). Some iwi would like to see seabird populations return to a level that sustainable harvest could be reinstated, a practice that creates cultural cohesion and restores cultural traditions [34].

Seabird restoration can be complex due to social, practical, financial and ecological factors. These complexities need to be considered early in the process when planning a seabird restoration project and will vary depending on what species are being restored, where, how, and when restoration will occur and who needs to be involved. Here, we present several available methods to successfully restore seabird populations. Before any active restoration is carried out, the first steps are to ensure that threats have been removed, the correct permissions have been obtained and that life-histories of seabirds have been considered.

Ngā āhuatanga e whai pānga ana ki te whakarauoratanga o ngā manu moana

Factors influencing seabird restoration

For successful restoration projects, several factors need to be considered, more than just space and time. These include species-specific behaviours, habitat requirements and life-history traits, as they influence seabird population recovery and recolonisation of newly available habitat [68, 73].

Space and Time

Space and time are important considerations influencing seabird restoration. For example, the proximity of a restoration site to a potential source population will influence how long the restoration of seabird populations may take. Source populations are existing and often large colonies of birds where individuals may disperse from and form new colonies. Research has shown that restoration sites within 25 km of a source population are more likely to attract birds looking for available breeding habitat than those further away [12], however young birds of some species (e.g. grey-faced petrels) who are wide-ranging have been shown to be attracted to new sites further afield [11]. The distance of a site from foraging grounds and human activities also influences the chances of successful seabird restoration [68]. The life histories of most seabirds (slow to mature, raise few young each year) mean generation times are long and restoration efforts may not become apparent for decades following predator eradication [12, 74, 75] but once established, colonies are likely to persist.

Behaviour

Most seabirds are colonial and are more likely to colonise a site where birds of the same species or a species with similar ecological requirements are already present [46], as available social cues indicate suitable breeding or foraging habitat [12, 37, 76]. The diversity of species present appears to be important, as recolonisation rates are higher at locations where two or more species are already resident [12]. At the same time, competition for nest sites between species may cause one species to become more dominant than the other [37] and such competitive exclusion should be taken into account when restoring species with similar nesting habits.

Size and habitat

The size and quality of habitat present is a key factor in seabird recolonisation [46]. Tree nesters

Bird handled with a wildlife permit from the Department of Conservation

A Fluttering shearwater chick at Tāwharanui.
Image by Edin Whitehead

Aotea Great Barrier Island is home to a remnant population of black petrels.
Image by Kerry Lukies

Checking a trail camera for images of little penguins visiting their nest.
Image by Karen Baird

(e.g. shags), surface nesters (e.g. gannets, gulls and terns) and crevice and burrow nesters (e.g. little blue penguins, prions, petrels and shearwaters) have different habitat requirements which should be taken into account when planning a restoration project [46]. Vegetation type, soil depth and quality (burrow nesters), slope, aspect and the presence of launch sites can determine whether a site is suitable [73, 77]. Species such as grey-faced petrels, fluttering shearwaters (pakahā, Puffinus gavia) and common diving petrels (kuaka, Pelecanoides urinatrix urinatrix) are much more generalist in their habitat requirements and are more likely to colonise new sites than species with specialist habitat requirements like, for example, New Zealand fairy terns (tara iti, Sterna nereis davisae) that nest only on low-lying sand-spit, beach and dune habitats [19, 37]. Island size can be important as relict populations of seabirds can be found on larger islands where invasive predators are present [68], for example, the population of black petrels (takoketai, Procellaria parkinsoni) on Aotea in the presence of rats, feral cats and pigs.

Age of first breeding

Species that reach sexual maturity at a younger age are typically quicker to colonise new sites than species that mature later. For example, common diving petrels and white-faced storm petrels (takahikare, Pelagodroma marina maoriana) reach sexual maturity at 2-3 years and recolonised Burgess Island (Pokohinu) within two decades following rat eradication [78]. Species such as black and Pycroft's petrels (tītī, Pterodroma pycrofti) only start breeding at 5-10 years so recolonisation by these species would be more gradual [Reviewed in 68].

Ngā tirohanga whenua
Site surveys

Before embarking on seabird restoration, it is important to determine which species are already present, if any, and the type of habitat available at each site.

Detecting seabird presence

The ease of seabird detection varies among species with surface or tree nesting species more visible than nocturnal burrow nesters that may have small, undiscovered remnant colonies at some locations [41]. While survey methods for surface or tree nesters may include aerial photography or visual nest counts, survey methods for more cryptic species may involve ground searches, acoustic monitoring, trail camera monitoring, thermal imaging or employing a seabird detection dog [19]. While several of these methods require specialist knowledge of seabird biology, both trail cameras and acoustic monitoring are easy and cost-effective initial detection methods that can be utilised by community groups with supervision and training. It is important that birds are not disturbed when nesting or when moving to and from nest sites. Appendix 2 lists available seabird detection equipment and how to obtain it.

Seabird researchers manually checking seabird burrows on Red Mercury Island.
Image by John Stewart

Once seabird presence is confirmed in an area by methods such as acoustic recorders, trail cameras or thermal imaging cameras, then ground searches or specially trained seabird detection dogs can be used to pinpoint nest locations. Section 3 describes the steps to be taken to aid the recovery of existing populations or to encourage the colonisation.

Replanting coastal species can help to restore habitat for seabirds.
Image by Edin Whitehead

A milktree forest on Middle Island, Mercury Island group, where burrowing seabirds are found.
Image by Dave Towns

Habitat assessment

Habitat quality should be considered when attracting seabirds to breed in new or restored areas. Areas must be pest-free with suitable habitat, for example, forest, scrub or open habitat, the requirements of which vary among species. Seabirds are less likely to colonise highly-modified habitat like, for example, land that has been previously farmed, when given a choice [12, 74, 75]. The likelihood of colonisation can be enhanced by improving the habitat quality and suitability, e.g. replanting native vegetation, before seabird restoration [37, 46].

Many coastal areas in the Auckland region have a history of agricultural use. Tiritiri Matangi, Motuora and Tāwharanui and Shakespear Regional Parks are all examples of previously farmed areas where seabird restoration has occurred. Tiritiri Matangi, in particular, provides an excellent example of how the revegetation of a previously deforested island provides habitat for many species, including numerous seabirds [22]. Burrow-nesters generally prefer habitat with deep soils and a closed canopy of taller coastal vegetation [79], but some of the more generalist species (e.g. grey-faced petrels, fluttering shearwaters, common diving petrels and little blue

Pūkeko are opportunistic predators that prey on seabirds.
Image by Edin Whitehead

penguins) are able to nest in a wider range of habitat types [79]. Areas of dense vines should be avoided as they can cause seabird deaths through entanglement [26].

Kauparehia ngā take whakatumatuma

Remove the threats

It is important to address any land-based threats that have contributed to seabird population decline or may hinder restoration efforts before embarking on them [46]. For example, seabird restoration should only be encouraged at pest-free sites where invasive predators (including cats and dogs) have been either eradicated, controlled, prohibited or excluded with predator-proof fencing. Invasive predators are the biggest threat to seabirds and birds should not be encouraged to nest where they will likely be predated. Following predator removal, constant vigilance is required to prevent and detect re-invasion by invasive predators as even a single pest can decimate an entire seabird colony. Biosecurity and the need for continued pest-monitoring are discussed further in Sections 5.3 and 5.4. Similarly, avian predators such as weka (Gallirallus australis) and pūkeko (Porphyrio melanotus) can prevent small seabird species from establishing and their control or exclusion should be considered in seabird restoration plans.

Direct human disturbance, overgrown vegetation and artificial lights are other threats on land that should be taken into account and eliminated or reduced as much as possible [40]. Seabird restoration sites at publicly accessible locations should be situated in areas where birds will not be frequently disturbed, nests trampled by human activities, or restoration equipment vandalised. The risk of disturbance can be minimised by cordoning off restoration sites while simultaneously promoting the project through educational signage. Overgrown vegetation can prevent some species from locating nests or chicks [21] and ongoing management may be required at restoration sites. The timing of weed management should avoid seabird breeding seasons to prevent accidental trampling of occupied nests or the adverse effects of chemical sprays on birds [19]. Artificial lighting should be reduced or eliminated at existing colonies or proposed restoration sites as it can attract and disorient young seabirds, causing injury or mortality through light-induced collisions or leaving birds unable to get airborne again [80]. Groups aiming to establish a colony inland from brightly lit cities or towns need to assess the risk of light attraction on birds and whether the project would be viable. The risk of light attraction would not have been a factor for birds nesting inland 200 years ago [26].

Removing weeds on Ōtata Island, Noises Island group.
Image by Sue Neureuter.

Ngā raihana

Permitting

Approval and permits from local authorities may be required depending on the method and location of seabird restoration. Handling, direct movement (e.g. translocation) or manipulating the movement (e.g. social attraction) of native species requires a wildlife permit from DOC and permission is required for any activity carried out on DOC land in consultation with tangata whenua. Many coastal locations in the Auckland region are significant to tangata whenua, so iwi must be consulted at the start of the planning process, especially if restoration methods could involve earthworks (e.g. installing artificial nest boxes or speaker systems). Known archaeological sites must be avoided and any site disturbance caused by restoration activity ceased if unknown archaeological sites or artefacts discovered. Similarly, any activity carried out on Auckland Council land will require discussion with Council staff and iwi. Animal ethics approval may also be required to assess the impact of the restoration project on seabird welfare. The Department of Conservation, Auckland Council and the Northern New Zealand Seabird Trust can assist with the permitting process (see details in Appendix 2).

An acoustic recorder used to detect seabird calls.
Image by Edin Whitehead

3. TE WHAKAHOKINGA MAI O NGĀ MANU MOANA
METHODS FOR ATTRACTING SEABIRDS

White-faced storm petrels are one of nine species that breed on Burgess Island in the Mokohinau Group. *Image by Edin Whitehead.*

Following the removal or exclusion of invasive predators, the restoration of seabird populations can be achieved through passive or active management; both methods are outlined below. Passive restoration is based on the principle of removing the threat and letting the natural system restore itself [37], which in the context of seabirds means leaving populations to recover or recolonise an area without further human intervention. This differs from active restoration, where recovery is manipulated to encourage settlement [46]. There has been a shift toward active management over the last few decades as the understanding of how seabird species respond to different management techniques has grown [46]. Additionally, passive restoration may not sufficiently restore seabird-driven ecosystem function to the extent achieved through active restoration [71]. Deciding which management technique to use can be difficult and must take into account the ecological, social, economic and cultural factors involved in seabird restoration [37].

Ngā mahinga māhaki
Passive restoration

Passive restoration involves removing or controlling invasive predators and allowing seabird populations to recover or recolonise sites naturally [81]. This has been the most common management strategy for seabird restoration in the past [82] but is highly dependent on the proximity of the restoration site to source populations, therefore is best suited for sites within 25 km of a source population, with similar seabird species already present and at less disturbed sites [12]. The habitat requirements, life history traits and social breeding structure of seabirds can mean passive restoration can take a long time or may be unsuitable for some restoration projects depending on the location (i.e. proximity to source populations and foraging grounds) and seabirds targeted [12, 83]. [12]. Additionally, if the ultimate goal of seabird restoration is to restore ecosystem function then active restoration should be considered to accelerate the process [71, 83, 84].

An example of successful passive restoration is on uninhabited Burgess Island in the Mokohinau Group, following the eradication of rats in 1990. Four seabird species were confirmed breeding on the island before the eradication which more than doubled to nine species by 2011. These are: grey-faced petrel, fluttering shearwater, sooty shearwater, little shearwater (Puffinus assimilis haurakiensis), common diving petrel, white-faced storm petrel, black-winged petrel (tītī, Pterodroma nigripennis), little blue penguin and red-billed gull (tarāpunga, Chroicocephalus scopulinus) [78]. Suggested source colonies for the recolonising species may have come from nearby pest-free rock stacks near the island [26],

Bird handled with a wildlife permit from the Department of Conservation

A seabird researcher checking on a grey-faced petrel chick on Burgess Island in the Mokohinau Group. *Image by Edin Whitehead.*

A common diving petrel at sea. This species is common throughout the Hauraki Gulf. *Image by Edin Whitehead.*

Fanal Island (Motukino, ~5 km away), Hauturu (29 km) or the Hen and Chickens Island group (Marotere, 30 km) [78], all of which had predators in 1990. A handful of small islands and stacks however remained free of rats, e.g. Tatapihi (Groper) and Lizard Islands, and would have held suitable source populations.

Several examples exist where passive restoration of seabirds has not occurred as expected. On Mana Island, for example, common diving petrels had not returned to a historical breeding site ten years after the eradication of mice [32], nor had seabirds recolonised Cuvier Island (Repanga) from neighbouring islands in the Mercury group twenty-two years after the eradication of rats [Reviewed in 73]. In these examples, other factors are likely preventing the passive recolonisation of seabird populations.

Ngā tūmahi ā-tinana
Active restoration

Active restoration techniques manipulate the demography and movement of seabirds, requiring an understanding of species-specific behaviour and population dynamics to be successful [46, 85]. Methods such as social attraction or translocation can accelerate the recovery or recolonisation process or can be used where passive restoration has failed to regenerate populations [71]. Due to the factors influencing seabird population recovery and recolonisation of newly available habitat, active restoration would benefit sites that lack remnant colonies or have declining populations, have no source colony nearby or highly modified sites with shallow soil and slope [37].

Based on the above principles, nine islands in the Hauraki Gulf region have been identified where active seabird management could be prioritised [73]. These are Hauturu, Rakitu (Arid Island), Tiritiri Matangi, Rangitoto, Ōtata (Noises Islands), Motutapu, Motuihe and Rotoroa Island. Of these, three (Hauturu, Ōtata and Motuihe) have active restoration projects as of June 2021 and one (Rotoroa) had a programme in place that has now ceased.

Active restoration techniques for smaller seabird species (e.g. petrels and shearwaters) should only be used on pest-free islands or mainland sanctuaries with predator-proof fencing, otherwise, seabirds attracted to the site will likely be eliminated by invasive predators. Even with trapping programs in place, invasive predators have decimated restored populations of common diving petrels at Te Henga (Bethell's Beach), Hutton's shearwaters at Kaikoura before the predator-proof fence installation, and sooty shearwaters at Banks Peninsula and Otago Peninsula [26].

Social attraction

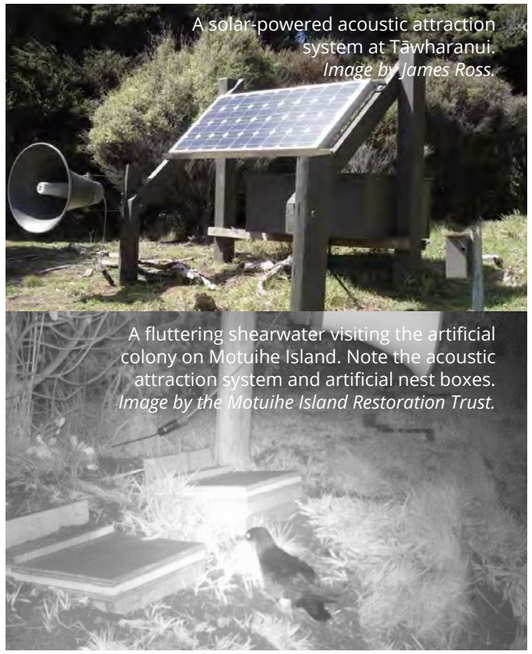
The majority (> 95%) of seabird species are colonial and are attracted to the social cues present at established colonies [46]. Social cues indicating an active colony may be visual, acoustic or olfactory [69]. When colonies are eliminated from a location, intrinsic social cues that advertise suitable habitat are lost [86]. Therefore, sound recordings, decoys, imitation guano, mirrors, scent, and artificial burrows are all artificial cues that may function as social attraction methods to mimic an established colony [46, 87]. Mimicking an established breeding colony can be used to lure passing individuals or to anchor existing birds to a site, hopefully keeping them around long enough for other individuals to arrive, thus increasing the chances of forming a breeding colony [71, 86].

Social cues may encourage prospecting individuals, often juveniles, to colonise sites beyond their natal colony [68, 76]. Juveniles of some species such as grey-faced petrels can be highly mobile and colonise sites far from their natal colony [11 and references therein] especially when encouraged by social attraction methods [13]. Additionally, some species of gulls and terns have highly mobile colonies and can be attracted to new sites through social attraction. The key determinant for social attraction is whether birds are frequently within range of the systems installed. This means that if they are foraging offshore or flying overhead they must detect the social attraction methods and be attracted sufficiently to check the site out.

The benefits of using social attraction methods over translocation include the cost, logistics and time. Social attraction is more cost-effective and less logistically challenging than translocation as it requires little hands-on management following the initial set up [46]. Also, social attraction may restore populations faster than translocation which involves a time lag (usually 2-5 years) before the translocated chicks return to breed [46]. However, as social attraction is most likely to attract young birds, which are often first time and inexperienced breeders, they could take two or more years to start breeding.

Acoustic playback

Acoustic playback can mimic the sound of an active colony by playing typical vocalisations of the target species through a speaker system, encouraging passing birds to land at the site [46]. Acoustic attraction is appropriate for both diurnal and nocturnal species by playing calls by day or at night respectively, although it is more effective with burrow nesting species as they rely more on acoustic social cues [69, 88, 89], whereas diurnal species rely more on visual cues. This method is commonly used in conjunction with other social attraction tools depending on the species targeted. For burrow-nesting nocturnal species, acoustic attraction is commonly paired with artificial nest boxes which increase available nesting sites. Species such as grey-faced petrels, fluttering shearwaters and common diving petrels are ideal candidates for acoustic playback and will readily settle at restoration sites with acoustic attraction systems [10, 13, 71, 86]. Other species, such as Buller's, flesh-footed and sooty shearwaters, Cook's, Pycroft's and black-winged petrels, and white-faced storm petrels are also likely to be suitable candidates for this method.



A solar-powered acoustic attraction system at Tāwharanui. *Image by James Ross.*

A fluttering shearwater visiting the artificial colony on Motuihe Island. Note the acoustic attraction system and artificial nest boxes. *Image by the Motuihe Island Restoration Trust.*

Other benefits of acoustic playback are the ability to attract multiple species, ability to play different calls according to the birds' breeding stage and the cost-effectiveness. Acoustic playback systems can play the calls of assorted seabird species at the same time which can attract multiple species to the location. Some species can be attracted to the calls of other species with similar ecological requirements as this can indicate suitable breeding or foraging habitat. This was first observed on Raoul Island, where black-winged petrels were attracted to sound recordings used to lure in white-naped petrels (Pterodroma cervicalis). Multi-track recordings made through different times of the year can be used to follow the breeding cycles of multiple species through complete seasons [13], further creating a live-colony effect. Acoustic playback systems are low cost (<NZ$4,000) and following the initial investment, are cost-effective, require little maintenance and can be powered through solar panels.

Decoys and mirrors

Surface-nesting species such as gannets, gulls and terns strongly rely on visual cues to indicate suitable nesting habitat and, for this reason, the use of decoys and mirrors are particularly effective with these species. Decoy adults, nests, chicks and eggs of the target species can be fashioned from a range of materials including 3D-printed plastic, wood, ceramic, polystyrene, fibreglass and plasticine and set up on site to imitate an active colony. Furthermore, partnering artificial nesting material or painted 'guano' with decoys can provide additional visual cues. When used in conjunction with acoustic

Decoy Australasian gannets at Tutukaka. *Image by Edin Whitehead.*

playback, decoys can mimic both the sight and sound of a colony, further encouraging passing birds to land at the site [90]. The active colony aspect can be enhanced by installing mirrors at decoy colonies to give the appearance of larger numbers of birds and reflecting the movement of any live birds [87]. Initial setup costs are low and decoy colonies require little maintenance (mainly weeding).

The experimental use of New Zealand fairy tern decoys at Papakanui Spit in the Kaipara Harbour is an example of how active restoration could be utilised in threatened species management. A study investigated whether fairy terns were attracted to decoys on a sandspit separated from the main beach and therefore less accessible to predators and less likely to be disturbed. The results showed that most (80%) fairy tern landings were in areas where painted polystyrene decoys were present in conjunction with acoustic playback of tern calls [91], indicating they were attracted to the decoy birds and acoustic recordings. This shows how social attraction methods can be used to relocate colonies and encourage nesting in safe areas such as pest-free sanctuaries or islands. Another example was the use of decoys to establish a new breeding colony of Australasian gannets: eighteen gannet decoys were installed at Te Kuri o Pāoa/ Young Nicks Head within a pest-free enclosure in 2008, approximately 145km from the nearest source colony at Te Kauwae-a-Māui/Cape Kidnappers. By the following year, 200 gannets had settled at the artificial colony and within four years 38 chicks had fledged [90]. Elsewhere, such as on Mana and Rotoroa Islands, and Tāwharanui Regional Park, decoys have so far failed to encourage sufficient gannets to form a breeding colony [13, 92].

Australasian gannet decoys being installed at Tāwharanui by volunteers. *Image by James Ross.*

Nest boxes

Existing natural burrows may be limited, are energetically expensive for birds to excavate and are prone to flooding and collapse, hence artificial nest boxes can offer a quality alternative [93]. Nest boxes increase nest site availability and are a good conservation management tool for burrow-nesters,

A recently hatched grey-faced petrel chick inside an artificial nest box at Tāwharanui.
Image by Edin Whitehead

especially in modified habitat where the ground may be compacted and difficult for birds to excavate [71]. In fact, nest boxes can lead to higher survival rates and breeding success than natural nests in some burrow-nesting species [93, 94]. They come in a range of species-specific designs (the links to some nest box designs can be found in Appendix 2) and usually consist of a flexible drainage pipe as the burrow entry and a wooden or plastic box as the nest chamber. Boxes are dug into the ground with the entry pipe exposed to mimic a natural burrow entrance and fine gravel may be used as the chamber floor for drainage followed by a leaf litter lining [95]. Sandbags may be placed on top of nest boxes to prevent overheating, especially on north-facing sites [95]. This method is commonly used in conjunction with acoustic playback to encourage passing birds to land at the site [46]. Nest boxes also facilitate monitoring which is key to determining the success of a restoration project.

Little penguin nest boxes painted by students at Leigh Primary School.
Image by Kerry Lukies

A grey-faced petrel artificial nest box. Note the plastic pipe that makes up the burrow entrance is not pictured.
Image by James Ross

Scent

Scent, or odour, is another social cue that can indicate an active colony and act as a lure for prospecting individuals [86]. Petrels and shearwaters use their exquisite sense of smell to locate foraging grounds at sea and breeding colonies [4, 89, 96]. The birds also have a distinctive petrel smell, an odour that comes from the oil preened onto their feathers which keeps their plumage waterproof. Adding a species' natural scent to artificial nest boxes may increase visitation rates or encourage use [69].

White-faced storm petrel chicks being translocated.
Image by Edin Whitehead

The use of olfactory cues for seabird restoration appears an underutilised method with only two examples found in the scientific literature. First, scented nesting material was moved with translocated Chatham Island tāiko (Pterodroma magentae), Chatham petrel (ranguru, Pterodroma axillaris) and Pycroft's petrel chicks to anchor them to a new nesting location as part of their species recovery plan [95]. The second example involved experimentally introducing the scent of different storm petrel species to a maze to examine which direction the birds travelled. Fork-tailed storm petrels (Oceanodroma furcata) were attracted to the scent of individuals of the same species whereas Leach's storm petrels (Oceanodroma leucorhoa) were not, possibly because the smell of another Leach's storm petrel may indicate a nest is already occupied [86]. Scent may be incorporated into burrow-nesting species restoration plans but should be used in conjunction with other methods such as nest boxes and acoustic playback [86].

Translocation

Translocating seabirds to pest-free islands is a conservation method that has been commonly used since the 1980s [22]. This technique involves moving chicks from their original site to a new site, which may be to re-establish populations to historic breeding sites, to establish multiple populations or to move a population to safe breeding habitat, for example, within a pest-free sanctuary. Translocation can only be used for species with an easily replicated diet and where chicks are independent once fledged

School students installing fluttering shearwater nest boxes on Motuihe Island.
Image by the Motuihe Island Restoration Trust

Fluttering shearwater nest boxes installed on Korapuki Island, Mercury Island group. *Image by Chris Gaskin.*

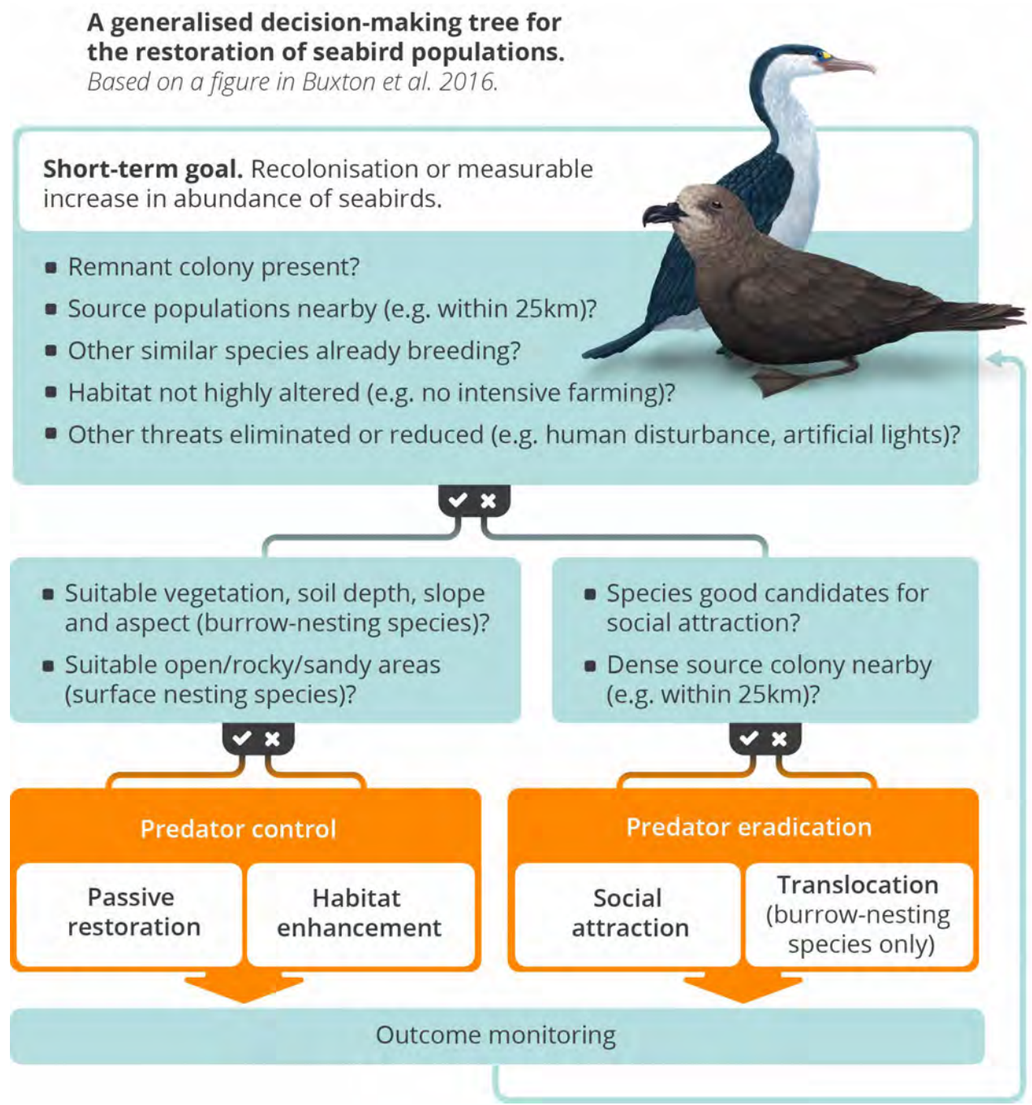
i.e. are not taught to forage by their parents [46, 71]. For example, this trait makes terns unsuitable as juveniles are reliant on parents after fledging [46]. On the contrary, most burrow-nesters make excellent candidates for translocation and this method has been used for eleven species of prions, petrels and shearwaters in Aotearoa New Zealand [97-99].

As seabirds generally exhibit high natal site philopatry, meaning that breeding adults will return to their natal colonies [100], chicks must be translocated to the new site before their homing instincts develop [46]. This instinct is thought to develop when chicks start emerging from their burrows before fledging. Therefore translocation must occur before burrow emergence which varies among species from days to weeks before fledging [32]. At the time of sexual maturity, translocated chicks should return to the new site and establish a new breeding colony, although not all do. Seabirds become sexually mature when they are at least two years old, but this may be up to ten years for some species. Once they return to the colony it may take more time to find a partner and start breeding, causing a time lag. The time elapsed between when chicks fledge and when they reach breeding age means establishing a breeding colony through translocation can take many years, resulting in a slow return on resources invested [95]. Immigration of non-translocated individuals is uncommon due to the philopatry of many species but does occur as illustrated below in Section 4.3.

Translocation is an energy-intensive and costly process as translocated chicks must be frequently hand-fed by qualified people until they are ready to fledge [71, 81]. This involves tube-feeding each chick with a blended mixture of tinned fish, water and vitamin powder that has been heated to a specific temperature. All equipment used when feeding chicks must be cleaned thoroughly between feeds and kept sterile Translocation must, therefore, be carried out by experienced people due to the highly technical processes of chick retrieval, transport and feeding required [101].

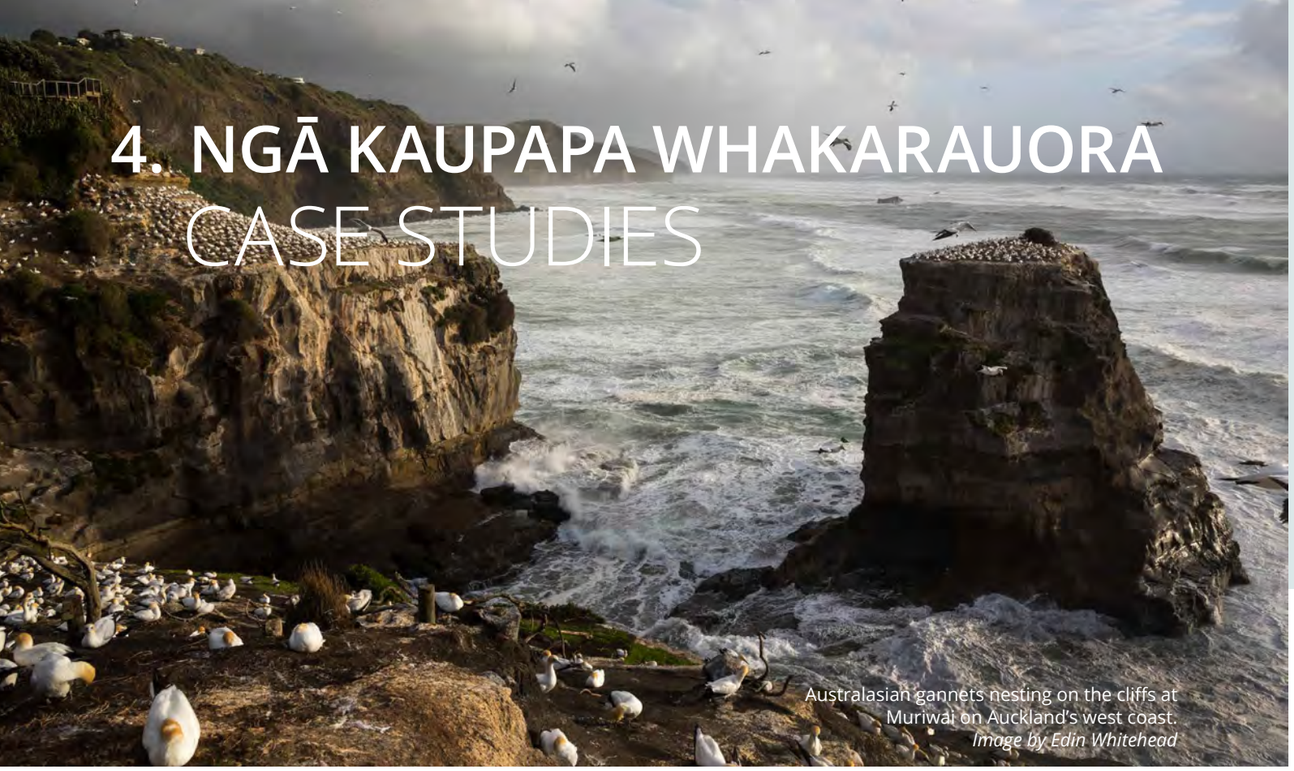
Translocation is more costly and labour intensive than passive management or social attraction but can overcome impediments to population recovery such as the distance to source populations [46, 81]. Given this, species suitable for translocation are those that would not reach the restoration site unaided or would not occur within range to see or hear social attraction methods [32, 37, 71]. Translocation is also used when trying to prevent the extinction of highly threatened species by moving individuals to safe areas such as pest-free islands [37].

A generalised decision-making tree for the restoration of seabird populations.
Based on a figure in Buxton et al. 2016.



A translocated Pycroft's petrel chick in an artificial nest box on Motuora Island. *Image by John Stewart*

4. NGĀ KAUPAPA WHAKARAUORA CASE STUDIES



Australasian gannets nesting on the cliffs at Muriwai on Auckland's west coast.
Image by Edin Whitehead

A Cook's petrel at sea.
Image by Edin Whitehead

E karanga ana ki ngā manu moana
Acoustic attraction of petrels and shearwaters — Tāwharanui

Tāwharanui Regional Park is a 588ha pest-free mainland sanctuary located 90 km north of central Auckland on the Tāwharanui Peninsula. The regional park encompasses a range of diverse landscapes including rocky coastlines, sandy beaches, old-growth forests, regenerating forest and pasture. It is managed by Auckland Council in collaboration with Tāwharanui Open Sanctuary Society Incorporated (TOSSI). A 2.7 km predator-proof fence was built in 2004 to separate the park from the rest of the peninsula and seven invasive mammals were eradicated within the park, creating a sanctuary for native biodiversity [102]. Ongoing pest control measures within and around the park by rangers and volunteers help to maintain its pest-free status.

Five species of seabirds were already breeding at Tāwharanui when seabird restoration began in 2012. These included grey-faced petrels, little blue penguins, southern black-backed gulls (karoro, Larus dominicanus dominicanus), red-billed gulls and white-fronted terns (tara, Sterna striata). It is unclear whether a remnant population of grey-faced petrels remained or whether a few individuals recolonised the park following the eradication of rats, stoats and possums [77]. Pied shags (kāruhiruhi, Phalacrocorax varius varius) and Caspian terns (taranui, Hydroprogne caspia) were also present in the park but not breeding. Additionally, many other species frequent the waters around the coast of Tāwharanui including Buller's shearwater (rako, Ardenna bulleri), flesh-footed shearwater (toanui, Ardenna carneipes), fluttering shearwater, Cook's petrel (tītī, Pterodroma cookii), fairy prion (tītī Wainui, Pachyptila turtur), common diving petrel, white-faced storm petrel and the Australasian gannet. The presence of these birds so close offshore makes them good candidates for social attraction at Tāwharanui.

The installation of artificial nest boxes at Tāwharanui.
Image by James Ross

Members of TOSSI and the Northern NZ Seabird Trust installing an acoustic attraction system for grey-faced petrels at Tāwharanui.
Image by James Ross

A survey carried out in 2009 found the first known grey-faced petrel burrow containing a chick. Further surveys (acoustic recorders and ground searches) were carried out to determine where petrels were present. More seabird burrows were found, and these were regularly monitored. Three acoustic attraction systems were installed in 2011, broadcasting grey-faced petrel, common diving petrel and fluttering shearwater calls out to sea. All three species were attracted to the broadcast calls within the first six months of operation and common diving petrels were confirmed breeding within 8 months [13]. Later, Cook's petrel and white-faced storm petrel calls were added to two systems, at the Ngaio Bay and Marine Triangle sites respectively.

From 2013-2015, forty-one nest boxes were installed at two of the acoustic attraction sites near where the first burrows were found. Several boxes were quickly occupied by grey-faced petrels and fluttering shearwaters and in 2014 the first chicks fledged. In 2016 grey-faced petrels had started breeding at a new site within the park without an acoustic attraction system in place, indicating the colony was expanding beyond the sites where they were being actively lured by recordings. In 2019, fifteen more nest boxes were installed, and the first grey-faced petrel chick known to have fledged from Tāwharanui was found back at the colony as an adult. In the same year, a Cook's petrel burrow was discovered on the southern coast. In 2020, the Cook's petrel pair laid an egg and successfully fledged a chick in March 2021. This is likely the first Cook's petrel chick to fledge from mainland New Zealand in more than a century.

The seabird restoration project at Tāwharanui is the first project to actively restore seabirds to mainland Auckland. Eighty-seven grey-faced petrel chicks have fledged since 2009, twenty-seven fluttering shearwaters chicks since 2014 and four common diving petrel chicks are known to have fledged since 2012. It is likely more birds of all these species are nesting in inaccessible places on steep slopes. This restoration project demonstrates the benefits of removing introduced predators and maintaining

Spotted shag in mussel farm.
Image by Shaun Lee

high levels of pest control for seabird restoration. Ongoing pest control measures within and around the park by rangers and volunteers help to maintain its pest-free status. However, as with all mainland sanctuaries, there is a high risk of pests re-invading from vehicles, boats or around the ends of the pest-proof fence. Rats, stoats and cats can, and do, enter the sanctuary. In 2019, most of the grey-faced petrel chicks were killed by an unidentified predator. This highlights why constant vigilance and evolving pest control strategies are required to protect seabird colonies on mainland sites.

The restoration of seabird colonies to Tāwharanui is seen as vital to restoring fertility and biodiversity to this coastal ecosystem. Ongoing monitoring of the seabird populations at Tāwharanui is carried out and is discussed in the "Monitoring" section below.

Ngā manu taupunga

Decoy spotted shag colony — Noises Islands

The Noises Islands are a privately-owned group of islands, 24 km northeast of central Auckland with no permanent inhabitants. The largest of the four main islands is Ōtata (21.8ha). The island group has evidence of historical Māori occupation and is now managed by The Noises Islands Family Trust. The Noises have been free of invasive predators since 2002 and support at least nine species of seabirds alongside many forest birds, reptiles and invertebrates [103].

Spotted shags (pārekareka, Stictocarbo punctatus punctatus) used to breed on the islands, a species now threatened with extinction in the Auckland region. They are restricted to just three breeding sites, two on Waiheke Island, and one small island in the Firth of Thames. Approximately 300 breeding pairs remain in the area [104]. Their population decline is attributed to dramatic reductions in forage fish prey, historic shooting by humans to limit supposed competition for fish and mammalian predation [105, 106].

Spotted shag decoys getting painted at Auckland Museum by volunteers.
Image by Carol, 2018

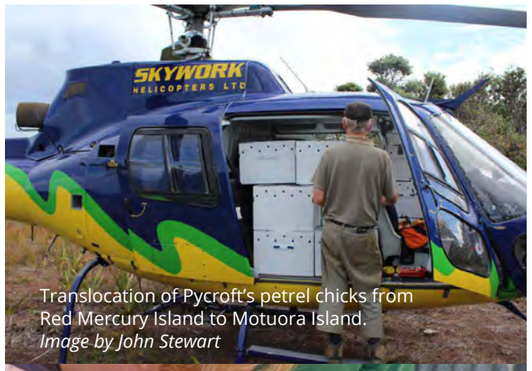
In early 2019 a spotted shag decoy colony was installed on a rock stack on the northern side of Ōtata Island in a collaborative effort between the Auckland War Memorial Museum, Auckland Council and The Noises Islands Family Trust to establish a new breeding colony. Nine decoys were 3D-printed from museum mounts and hand-painted in full plumage by museum volunteers. Decoys were attached to the rock with two-pot epoxy mortar and screwed into place. Decoys were either standing or positioned on nesting material and white house paint was spread around the rocks to imitate the guano present at a real colony. A solar-powered acoustic attraction system was installed at the site on the nearby main island and during the day plays recordings of spotted shag breeding colonies. At night, a separate speaker located in the forest further inland plays calls from various nocturnal burrowing seabird species (grey-faced petrel, common diving petrel, fluttering shearwater and white-faced storm petrel) to enhance existing populations, or to lure birds from established colonies on nearby Ruapuke/Maria Island.

At least one spotted shag was observed roosting at the artificial colony in the summer of 2019/2020 [107]. Photographs of the individual taken on different days appear to present different plumage indicating that possibly more than one spotted shag was attracted to the site. In April 2021, 19 spotted shags were observed roosting at the artificial colony on one occasion [108], indicating that those individuals may have been attracted to the decoy birds and acoustic recordings. Additionally, a Cook's petrel chick was discovered in a burrow on the island in November 2020 [109]. This discovery, along with the Cook's petrel burrow discovered at Tāwharanui (Section 4.1) suggests that Cook's petrels may be expanding into new pest-free sites in the Hauraki Gulf.

Te ikiiki manu moana

Translocation of Pycroft's petrels — Motuora

Motuora is an 80ha island south of Kawau Island and 5 km east of the Mahurangi River estuary. Like many other islands in the Hauraki Gulf, Motuora was farmed for many years and was largely dominated by pasture. Since 1995 the island has been managed by volunteers from the Motuora Restoration Society (MRS), in collaboration with DOC, and has had an active native vegetation planting programme. Revegetation efforts have focussed on planting coastal-broadleaf forest, several native conifers and other native vegetation including harakeke (Phormium tenax), nīkau palm (Rhopalostylis sapida), kiekie (Freycinetia banksii) and pukatea (Laurelia novae-zelandiae) from eco-sourced seeds [110]. Remarkably, Motuora has never been invaded by invasive predators despite it once having been farmed.



Translocation of Pycroft's petrel chicks from Red Mercury Island to Motuora Island.
Image by John Stewart

Translocated Pycroft's petrel chick being hand-fed on Motuora Island.
Image by John Stewart

Bird handled with a wildlife permit from the Department of Conservation

The restoration strategy for Motuora was forward-thinking in its objectives with a focus on restoring ecosystem services, for example, the nutrient input provided by seabirds, to support further flora and fauna restoration efforts. The first 'Working Plan' for the Island was written in 1997. It was subsequently replaced by the current Restoration Plan in 2007. Several species of seabird were already present on the island when the restoration work began, including 280 breeding pairs of grey-faced petrels in 2005/2006 [111] and little blue penguins. Red-billed gulls and white-fronted terns visit but breeding has not been recorded recently [112]. Historically many other species may have been present on the island in high numbers including sooty, flesh-footed and fluttering shearwaters, common diving petrel, Cook's petrel, Pycroft's petrel and white-faced storm petrel [110].

An active seabird restoration project was planned for the island to accelerate the ecological restoration of the entire island. Firstly, common diving petrel chicks were translocated to artificial nest boxes on the island. These fledged and, while a few pairs did return to breed on Motuora, they adopted sites on a

Ihumoana Island on Auckland's west coast is an example of an island dominated by burrowing seabirds. Intensive pest control occurs on the island and adjacent mainland by volunteers. *Image by Edin Whitehead*

cliff face which were difficult to monitor. Since then, common diving petrels have not yet established in significant numbers [112]. Secondly, Pycroft's petrels were selected for translocation to Motuora because they are an endemic and rare species that would not necessarily recolonise the island unaided. The details of this translocation are outlined below.

Two hundred and sixty-two Pycroft's petrel chicks were translocated to Motuora from Red Mercury Island (Whakau) between 2013 - 2015 following the DOC burrowing petrel translocation protocol [101]. Chicks were transferred to artificial nest boxes where they were hand-fed until they fledged. The first chicks translocated to the island in 2013 returned to the island in the 2015/2016 season, and more returned the following season when the first egg was laid [112]. The chick hatched but died before fledging. During the 2017/2018 breeding season, 17 Pycroft's petrels were recorded on the island, of which six breeding pairs were in nest boxes, and three chicks fledged at the end of the season. Thirty-seven Pycroft's petrels were recorded on the island during the 2018/19 breeding season and thirteen nest boxes were occupied. Four chicks fledged that year. Additionally, two unbanded Pycroft's petrels (birds that were not translocated to the island nor hatched there) also arrived on the island in 2019. These were individuals from other breeding colonies that may have followed the translocated birds back to the island, an unexpected and welcome addition to the new colony. In the 2019/2020 season 38 Pycroft's petrels were recorded and 10 chicks fledged, and in 2020/21 there were 36 Pycroft's petrels recorded and 15 chicks fledged. By the end of the 2020/21 season, 54 individual birds had been recorded. Again, two previously unrecorded birds were detected in 2020/21 that were not from the island. Return rates of the three translocated cohorts are 31%, 20% and 11% [112]. It is anticipated that further growth will depend on the return of the offspring of the translocated birds which became possible from September 2020 onwards.

Additional seabird restoration on Motuora includes acoustic attraction for Australasian gannets and fluttering shearwaters. Both species have been successfully attracted to the island with the latter species is breeding in small numbers. Artificial nest boxes for little blue penguins have been taken up by multiple breeding pairs and many chicks have fledged successfully. Other species that have been suggested for future translocation to Motuora include little, flesh-footed and sooty shearwaters and white-faced storm petrels.

Ngā mahinga māhaki ki te whakarauora manu moana ki te tai hauāuru o Tāmaki Makaurau

Passive restoration of seabirds on Auckland's west coast

Pest control efforts have increased in Auckland over recent years, in line with the Pest Free Auckland 2050 and Predator Free New Zealand 2050 initiatives. In addition to Auckland Council, community conservation groups, iwi and private landowners trap rats, mustelids, possums and feral cats along the west coast, often with a specific objective to protect breeding seabirds (e.g., Muriwai, Cornwallis and Te Henga). Auckland's west coast has large areas of intact coastal forest, providing ample habitat for burrowing seabirds. However, invasive predators are abundant in mainland Auckland and have contributed to the decline of many native species, including seabirds [8]. Despite these introduced predators, several seabird species are known to breed on Auckland's west coast including little blue penguins, grey-faced petrels, sooty shearwaters, flesh-footed shearwaters, common diving petrels, Australasian gannets, pied shags, white-fronted terns, red-billed gulls and southern black-backed gulls [19, 38].

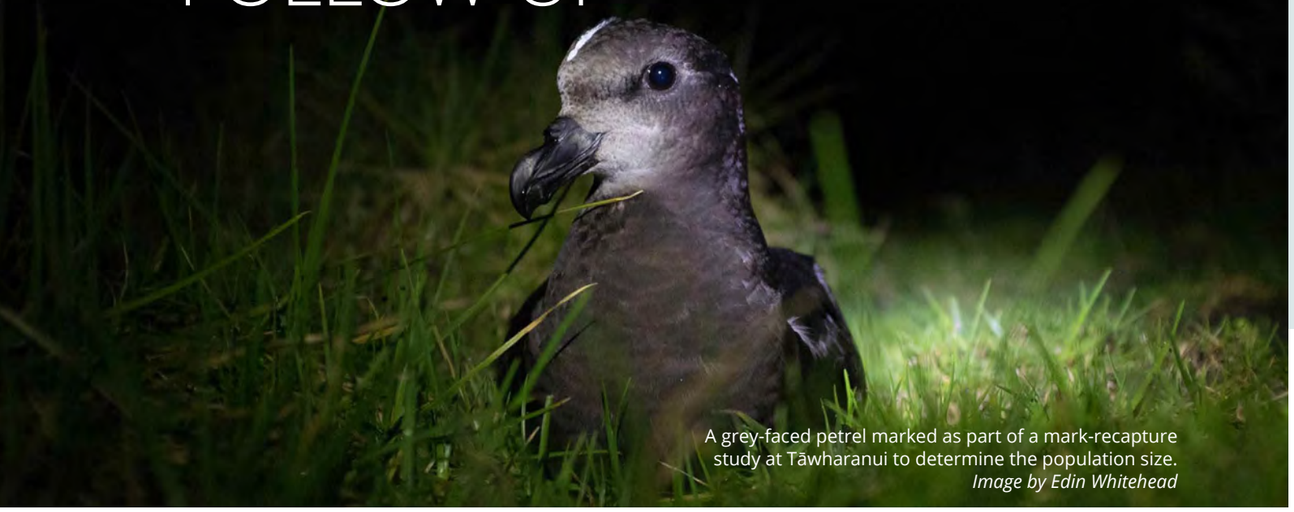
Grey-faced petrels, together with little blue penguins, are the most widely distributed of all the west coast seabirds. Small to medium colonies of grey-faced petrels (10 – 60 burrows per site) are located at Muriwai, Te Henga, Piha, Karekare, Whatipu and Cornwallis, in addition to larger colonies on Ihumoana and Kauwahaia Islands, adjacent to Te Henga [113]. Three decades of monitoring at these islands have shown an increase in the grey-faced petrel population from 40 pairs in 1989 to 120 pairs in 2012 (Ihumoana) and from 200 pairs in 1990 to 320 pairs in 2012 (Kauwahaia) [113 and references therein]. These large colonies may act as a source population for other sites on the west coast where pest control has minimised the threat of predators. A seabird survey by Auckland Council in 2016 found 51 grey-faced petrel burrows showing signs of activity (feathers, digging, guano etc.) between Muriwai and Te Henga, most of which were in the northern and southern reaches of the surveyed area [38]. Fewer than 1,000 grey-faced petrel burrows had been recorded at twenty mainland sites in the northern North Island by 2015 [113], which shows the value of these small colonies in Auckland.

Populations have been fluctuating of other seabird species on the west coast, but they have generally increased since monitoring began. One of Aotearoa New Zealand's largest Australasian gannet colonies is located at Muriwai, both on the mainland and nearby offshore islands and rock stacks. The population of gannets at this colony increased from 28 pairs in 1975 to 1,393 pairs in 1998 [114], 1,608 pairs in 2015 [115] and the most recent count was 1,931 pairs in 2017 [116]. Alongside the gannets there are three colonies of white-fronted terns, on Oaia Island, Motutara and the Muriwai mainland. With 709 pairs, these colonies are the stronghold for this species in the northern North Island [116]. Little blue penguins have been observed at many locations along the coast, with breeding confirmed at Piha, Karekare, Cornwallis and Whatipu [38]. A 2016 survey found fourteen little blue penguin nests between Muriwai and Te Henga but breeding was not confirmed [38]. Little blue penguin monitoring has been sporadic throughout the Auckland region, thus the overall local population is unknown.

Sooty shearwater, flesh-footed shearwater and common diving petrel populations at Kauwahaia Island, Te Henga had different population trends despite their location on the same island. The sooty shearwater population decreased from 45 pairs in 1990 to 20 pairs in 2012, suggesting that other causes are at the source of these trends on land, whereas flesh-footed shearwaters increased from eight to 23 pairs over the same period [117]. However, incursions by stoats and rats are a threat to these remnant populations highlighting the need for intense predator control over the adjacent mainland areas [13]. Other species observed during the 2016 grey-faced petrel survey by Auckland Council were pied shag, Caspian tern, southern black-backed gull and red-billed gull [38].

Community effort will be crucial in continuing to restore seabirds to Auckland's west coast, by intensifying pest control and prohibiting companion animals from areas where seabirds breed. While it appears some seabird populations on Auckland's west coast may have increased as pest-control efforts have intensified, we cannot discount that some are remnant seabird populations discovered due to increased survey effort. Regardless, removing invasive predators likely benefits seabird populations along with many other native species on Auckland's west coast. Additionally, local bylaws prohibit dogs from some areas where seabird breeding occurs, such as was implemented at Muriwai when grey-faced petrels were found to breed in areas commonly used by dog walkers [118]. But such measures have to be complied with by the local community and visitors to be effective.

5 Ā MURI ATU
FOLLOW UP



A grey-faced petrel marked as part of a mark-recapture study at Tāwharanui to determine the population size.
Image by Edin Whitehead

He aha te hua o te aroturuki?
Why monitor?

An integral part of any conservation management programme is monitoring. Monitoring will help assess the success of a restoration project, can improve our understanding of seabird recolonisation and recovery following the removal of introduced predators, and motivate continued community involvement.

Measure success of the restoration method

Aotearoa New Zealand leads the way in predator eradication internationally but how these eradications benefit native species and ecosystems are rarely monitored [71]. Therefore, monitoring seabird recovery and recolonisation following the removal of invasive predators informs us how native species and ecosystem processes recover. Additionally, monitoring can help us understand the population dynamics of our native seabirds such as the size and age composition, and the biological and environmental processes that drive them (such as birth and death rates, and by immigration and emigration), which we know little about [19]. Seabird restoration can take a long time and is still a process we don't fully comprehend, especially across a range of habitats. Therefore, monitoring seabird populations on pest-free island and mainland sites in Auckland can determine how effective certain conservation interventions are and how they differ among species and locations [12, 41, 68].

Monitoring seabird populations following predator control may be all that is required for passive management [37] and this technique is commonly used for little blue penguin, white-fronted tern, red-billed gull and shag populations in the Auckland region [77]. Monitoring can also determine whether current management is effective or whether management techniques should be adapted. For example, translocated chicks returning to breed, or adults prospecting around newly-installed acoustic attraction systems and observed through trail camera footage would indicate the restoration method is proving successful [46]. Conversely, if no seabird activity is detected in several years of regularly checking artificial nest boxes, the method of seabird attraction should be reviewed. However, patience is sometimes required: fluttering shearwaters visited a restoration site at Motuihe Island for eight years before a chick finally hatched and fledged in early 2020. The ultimate measure of a successful seabird restoration project is when a restored population becomes self-sustaining [46], a measure that can only be determined through regular monitoring.

The first fluttering shearwater chick to hatch at the artificial colony on Motuihe Island.
Image by the Motuihe Island Restoration Trust

Fairy prions and fluttering shearwaters foraging in association with a trevally school in the Hauraki Gulf.
Image by Edin Whitehead

Stormy seas can flood low-lying seabird nests and create difficult foraging conditions. Events such as this are likely to increase with climate change.
Image by Rod Neureuter

Detect changes in marine ecosystem health

Seabirds can reflect the health of marine ecosystems due to their position at the top of the marine food web. Changes in the abundance or distribution of lower trophic levels in the marine food web (e.g., plankton or fish) caused by human-induced or climatic impacts as, for example, overfishing, pollution or climate change, can be reflected in the populations of seabirds. A decrease in seabird population size can indicate declining prey abundance or a shift beyond the birds foraging range, whereas a population increase might suggest the opposite. Monitoring seabird populations on

Little penguin chicks in a nest box on Motuihe Island.
Image by Kerry Lukies

A seabird researcher checking a little penguin burrow with a burrowscope on Motuihe Island.
Image by Edin Whitehead

A photo taken by a trail camera of an Australasian gannet visiting a decoy colony at Tutukaka.
Image by Ward, 2019

Two little penguins detected by a trail camera.
Image by Karen Trickleback

land is much easier than assessing fish-stocks, therefore using seabirds as marine ecosystem indicators represents a viable and cost-effective means of monitoring ocean health across broad spatial scales [19].

Other reasons for monitoring

Maintaining a close watch on the progress of seabird restoration projects can have social, cultural and economic aspects in addition to the ecological benefits listed above. Monitoring by community groups can motivate continued project involvement as volunteers see tangible results from their efforts [67], while also facilitating outreach and education about conservation and increasing the capacity for further active restoration [51]. Additionally, monitoring records provide tangible results for funders (i.e., proof of a return on their investment). The information garnered through regular monitoring is useful when applying for funding to increase restoration efforts as it provides evidence of a project's achievements. However, it is important to remember the timescale involved in seabird restoration likely extends beyond the schedules required by funders (often 1 - 2 years) [59].

Me pēhea te aroturuki manu moana? How to monitor seabirds

Monitoring techniques

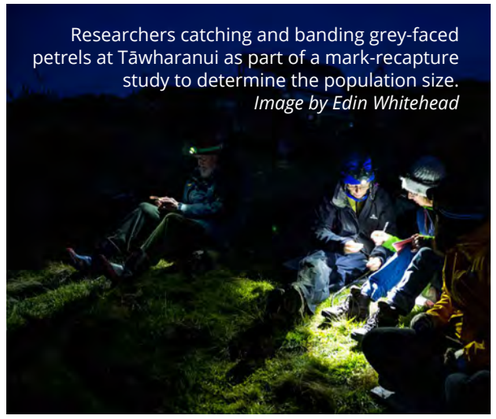
Seabirds in northern Aotearoa New Zealand can be difficult to monitor as most are located on offshore islands that can be expensive and logistically challenging to reach. The nocturnality and cryptic nesting behaviour of many species can also make them difficult to detect using conventional survey methods like aerial photography or visual nest counts [4, 28]. Many of the techniques used to monitor seabirds are those initially used to determine their presence, as mentioned in Section 2.3.1. Some of these methods (e.g., ground surveys, thermal camera monitoring, seabird detection dog, mark-recapture study) must be carried out by specially trained individuals such as seabird scientists from Auckland Council or the Northern New Zealand Seabird Trust [Reviewed in 119], whereas others such as nest box monitoring, trail cameras, photo-counts and acoustic monitoring can be undertaken by community groups to determine seabird visitation. Monitoring should be carried out during the breeding season as this is when seabirds are active on land, and this is variable according to species (For more information, see 'Seabirds of the Hauraki Gulf' [19]. A link to the full text is in Appendix 2).

Mātauranga Māori (Māori traditional knowledge) can provide baseline information of historic seabird population trends at locations where traditional tītī harvest occurs [34] and is used to monitor some contemporary seabird populations [120, 121]. For example, at the Alderman Islands (Ruamaahua) where tītī are harvested, a combination of scientific and mātauranga Māori techniques are used to monitor the population, promoting a knowledge transfer between scientists and tangata whenua [34].

An example of ongoing monitoring of a restored seabird population is the programme in place at Tāwharanui. Grey-faced petrels are monitored using a mark-recapture method which involves 'calling in' grey-faced petrels with acoustic attraction throughout the breeding season and capturing those that land. Each bird is banded with a metal ring with a unique identification number by certified banders (see the DOC bird banding scheme in Appendix 2) to enable easy identification in the future. Please note, banding must be carried out by certified banders. Birds are also weighed and visually inspected to determine their breeding status. This method provides an estimate of the colony size and helps researchers to understand the population dynamics and trends of a re-established seabird population on the mainland. Since 2011, 480 grey-faced petrels have been banded at Tāwharanui and 202 of these birds have been recaptured, as determined through their band numbers [77]. Additionally, natural burrows and nest boxes are checked monthly throughout the breeding season for grey-faced petrels, fluttering shearwaters and common diving petrels and any activity noted. Any chicks found are banded to enable easy identification in the future. The park is also visited by a seabird detection dog on an annual basis to locate new seabird burrows.

Record keeping

Record keeping of how a seabird restoration project is progressing is an integral part of monitoring and can help document seabird population trends over years or decades [19]. Records can be kept in a variety of ways, from hard copies in notebooks, with data entered into excel spreadsheets or online monitoring software. Digitising records is useful for large populations, where multiple species are present, when monitoring over long periods or when sharing monitoring information with other groups or organisations.



Researchers catching and banding grey-faced petrels at Tāwharanui as part of a mark-recapture study to determine the population size.
Image by Edin Whitehead

Summary of the seabird restoration project at Tāwharanui as recorded on SeabirdIT (CatchIT modified for seabird monitoring).
Image by James Ross

Monitoring software is an online tool that can be used to visualise seabird nest success and therefore population trends over time and can identify hotspots of seabird nesting activity. Such information can be useful in determining where to focus additional restoration efforts such as artificial nest box placement. Online monitoring tools such

Rubbish in the nest of an Australasian gannet at Muriwai.
Image by Edin Whitehead

A cat inspecting a little blue penguin burrow.
Image by Karen Trickleback

as CatchIT or Trap.NZ are often already in use by community groups to record the removal of invasive mammals in an area and can be adapted to monitor seabird restoration. Some monitoring software allows individuals or groups involved in seabird restoration to add seabird nests to an aerial map of their site and add comments each time the nests are checked. Examples of seabird monitoring software are outlined in Appendix 2.

Te hiranga o ngā mahi patu riha
Importance of continued pest control

The importance of mammalian predator control at seabird restoration sites cannot be stressed enough. Where feasible, sites should have invasive predators eradicated to eliminate the threat to seabirds.

A tracking tunnel used to monitor pests.
Image by Kerry Lukies

Eradication may be easier on small, uninhabited islands whereas larger islands and the mainland may consider a combination of intensive trapping networks and predator-proof fencing to exclude invasive predators from specific areas. In saying that, several islands >2000 ha in the Hauraki Gulf are now pest-free, including those with farms and small settlements [92] which highlights the advances in pest eradication techniques over time.

Cost-effective pest monitoring devices such as chew cards, tracking tunnels, wax tags and trail cameras can be used to detect incursions on pest-free islands and mainland sanctuaries or to ensure pest densities remain low at locations reliant on trap networks. Technological advances such as the capability of some trail cameras and thermal imaging cameras allow for the remote detection of pest presence with images automatically uploaded to the internet or forwarded to cellphones and email. It is important to note that some rats and stoats have been shown to avoid traps and detection devices [122] thus multiple monitoring techniques should be used at the same time. Pest control guidelines are listed in Appendix 2 along with where to purchase traps and monitoring tools.

He mahi mā te katoa
How everyone can help

Aucklanders spend a lot of time out on the water and exploring the abundant beaches, rocky coasts and islands this region has to offer. Everyone that frequents these areas can play a role in protecting our seabirds: from boaties and tourists visiting pest-free islands and mainland sanctuaries to recreational fishers, coastal residents and beach users.

Boaties and tourists — maintaining pest-free islands and mainland sanctuaries

"The major components of island biosecurity are prevention, detection and response to incursions. Since islands differ in their attributes, such as topography and forest cover, and individual predator species differ in their behaviours, multiple methods need to be used to detect and prevent the invasion of islands, including poisons, traps, passive detection devices and trained dogs. Detecting incursions early is crucial to managing them, as response operations are costly and the potential for damage to sensitive populations by a single individual can be catastrophic, especially in the case of mustelids and cats.

An example of the response required if a rat or rats are detected ashore is as follows: in January 2009, rat prints were recorded in tracking cards set for routine checks on neighbouring rat-free Whatupuke and Lady Alice Islands (Marotere Chickens Islands). One ship rat was subsequently caught in a live trap and another (dead) in a snap trap on the two islands, respectively. Total monitoring response to the incursion involved 26,395 tracking nights and 12,086 trap nights on Lady Alice Island plus 23,506 tracking nights and 16,751 trap nights on Whatupuke Island. The cost of the operation was approximately $100,000 [123].

Developing ways to prevent rats and other invasive predators invading an island in the first place is vitally important given the costs of a response and the potential, in some cases, to undertake the entire eradication process over again. As all vessels are a potential vector for rat invasions, biosecurity measures (permanent predator control devices) should be undertaken on-board all vessels approaching predator-free islands to minimise the risk of transporting mammalian predators. If there are no effective biosecurity procedures to prevent reinvasions or new arrivals undertaken, the investment in the eradication or control of problem species can be wasted.

Currently, only commercial charter boats moving people and cargo to predator-free islands in the wider Hauraki Gulf region are required to be checked and have biosecurity measures in place. The benefits of these good conservation measures can be undermined by commercial fishing vessels and the many recreational vessels that anchor overnight close to predator-free island sanctuaries having no such requirements. For example, rats have been observed swimming to anchored vessels close to Aotea, or boarding vessels while tied to jetties at Port Fitzroy and Kaikoura Island [124]. If any of these vessels made one of the predator-free islands their next port of call, the hitchhiking rats could swim ashore.

Rats are found at most marina, wharf, jetty and slipway areas. Extra measures, such as maintaining traps and poison stations, should be considered around wharves and marinas to minimise the risk of rats embarking, disembarking, and moving between vessels. The approximate cost per annum for boat owners to maintain a rat free vessel would be: $40 (small boat, one bait station), $55 (medium cruiser, two bait stations) and $140 (larger vessel requiring three). By way of comparison, the cost of initially eradicating pests from Rangitoto and Motutapu Islands in 2009 (a single operation) was $4.2 million (or $3.5 million if indirect costs are excluded)." [40].

Vessels can cause injury or mortality when travelling at speed through seabirds resting at sea.
Image by Edin Whitehead.

5.4.2 Fishers - avoiding seabird bycatch

This guide has primarily discussed threats to seabirds on land such as invasive predators, companion animals and direct human disturbance, however, seabirds also face many threats at sea. One of those threats is where seabirds are accidentally caught by fishers as birds dive for baited hooks or become tangled in set nets or fishing line [125]. Seabird bycatch is not only a concern for commercial fishers but recreational fishers as well. Auckland has a high population of recreational fishers and seabird interactions with fishing gear are common. Gulls, shags and even gannets are likely to be caught by coastal fishers from rocks and jetties whereas petrels and shearwaters are more often caught by fishers from boats as they chase baits underwater [125]. Fishers may cut the fishing line with no attempt to remove the hook or line from the bird which can ultimately result in injury or death. If fishing tackle is not removed correctly, birds can become entangled in the line which can inhibit foraging, get snagged on vegetation at their breeding site or even strangled by the line itself [40 and references therein]. Being mindful of seabirds while fishing and adopting correct release measures can help to protect the many species that breed in the Auckland region. Resources that highlight ways to avoid seabird bycatch and safely release caught birds are listed in Appendix 2.

Coastal residents and beach users

Coastal residents and beach users can protect seabirds on land in a variety of ways, the most important being the removal of invasive predators. Removing rats, mustelids, possums and feral cats and pigs from coastal properties can significantly reduce the predation risk for seabirds on land. Pet owners can also reduce seabird predation by keeping cats indoors, especially at night, and keeping their dog on the leash when walking in areas utilised by seabirds. Encouraging other beach users to do the same and advocating for dog-free coastal areas will help protect seabirds, especially during the breeding season.

Human visitation to seabird breeding sites can lead to disturbance, nest trampling, and cause birds to abandon their eggs or chicks. Off-road driving is common throughout Aotearoa New Zealand and can cause injury or death to ground-nesting birds in coastal areas. Often these birds are well camouflaged, with nests that are an undetectable scrape in the sand. Cordoning off known breeding areas and restricting off-road driving on beaches during seabird breeding can help minimise the disturbance and mortality caused by direct human impacts [40].

Flesh-footed shearwaters entangled in fishing line on Pakiri Beach.
Image by Chris Gaskin

A dog disturbing nesting Australasian gannets at Muriwai on Auckland's west coast.
Image by Edin Whitehead

NGĀ ĀPITIHANGA
APPENDICES

Āpitihanga 1 — Ngā kaupapa whakarauora manu moana o nāianei
Appendix 1 — Existing seabird restoration projects

Table 2. Current seabird restoration projects in the Auckland and neighbouring regions (*).

Location	Group involved	Pest status	Seabird species	Restoration method	Project status
Aotea/Great Barrier Island	Glenfern Sanctuary	Predator-proof fence. Ongoing	Black petrels	Remnant population	Breeding confirmed
			Cook's petrels	Active — acoustic attraction	Breeding confirmed
			Little blue penguins	Passive	Breeding confirmed
	Windy Hill Rosalie Bay Catchment Trust	Ongoing pest control	Grey-faced petrels	Remnant population — with acoustic attraction added	Breeding confirmed
			Black petrels	Remnant population	Breeding confirmed
Auckland CBD	Auckland Council and consultants	Ongoing pest control	Red-billed gulls	Active — decoys	Breeding confirmed
Auckland — Hobson Bay	Auckland Council	Ongoing pest control	Shags	Active — artificial roost	Ongoing — breeding not yet established
Auckland's west coast	Auckland Council, DOC and various community groups and iwi	Ongoing pest control	Grey-faced petrels	Passive — pest control	Breeding confirmed
			Common diving petrels		
			Sooty shearwaters		
			Flesh-footed shearwaters		
			Little blue penguins		
			Australasian gannets		
			White-fronted terns		
			Pied shags		
			Red-billed gulls		
			Southern black-backed gulls		
Motukorea/ Brown's Island	Auckland Council	Pest-free since 2000	Little Blue Penguin	Active — nest boxes	Ongoing — breeding not yet established
Hauturu/Little Barrier Island	NNZST	Pest-free since 2004	New Zealand storm petrel	Active — acoustic attraction and nest boxes	Ongoing — breeding not yet established
				Remnant population	Breeding confirmed
			Black petrel	Remnant population and Active — translocation	Breeding confirmed
			Cook's petrel	Remnant population	
			Grey-faced petrels	Passive or remnant population	
			Little blue penguin	Remnant population	
Leigh and surrounding areas	Leigh Penguin Group and Pest-free Leigh	Ongoing pest control	Little blue penguins	Passive or remnant populations	Breeding confirmed
			Grey-faced petrels		
			Red-billed gulls		
			Southern black-backed gulls		
			Pied shags		
			Little shags		
Kaipara Harbour	Forest & Bird	Ongoing pest control	New Zealand Fairy Tern	Habitat restoration (shell), decoys and acoustic attraction	Ongoing — breeding not yet established

Location	Group involved	Pest status	Seabird species	Restoration method	Project status
Motuihe Island (Te Motu-a-Ihenga)	Motuihe Island Restoration Trust and DOC	Pest-free since 2005	Fluttering shearwaters	Active — acoustic attraction and nest boxes	Ongoing — breeding established
			Little blue penguins	Active — nest boxes	
Motuora Island	Motuora Restoration Society (MRS) and DOC	Never invaded	Pycroft's petrels	Active — translocation, acoustic attraction and nest boxes	Ongoing — breeding established
			Common diving petrels	Active — translocation, acoustic attraction and nest boxes	
			Australasian gannets	Active — acoustic attraction and decoys	
			Fluttering shearwaters	Active — acoustic attraction and nest boxes	
			Little blue penguins	Active — nest boxes	
			Grey-faced petrels	Passive or remnant population	Breeding confirmed
Mokohinau Islands	NNZST, DOC, Auckland Council, University of Auckland, Auckland War Memorial Museum	Pest-free since 1990	Fluttering shearwaters	Passive or remnant populations — nest boxes added to facilitate research	Breeding confirmed
			Common diving petrels		
			Grey-faced petrels		
			Little blue penguins		
			White-faced storm petrels	Passive or remnant population	Breeding confirmed
			Black-winged petrels		
			Sooty shearwater		
			Little shearwater		
			Red-billed gull		
Ōtata, Noises Islands	Auckland War Memorial Museum, Auckland Council and the Noises Islands Family Trust	Pest-free since 2002	Spotted shags	Active — acoustic attraction and decoys	Recently established
			Grey-faced petrels	Remnant populations plus active — acoustic attraction	Breeding confirmed
			Common diving petrels		
			Fluttering shearwaters		
			White-faced storm petrels		
			Little blue penguins	Passive or remnant population	Breeding confirmed
			Cook's petrels	Passive	Breeding confirmed
Pakihi	McCallum Family	Pest-free since 2018	Fluttering shearwaters	Active — acoustic attraction and artificial burrows	Recently established
			Grey-faced petrels	Passive or remnant population	Breeding confirmed
Rotoroa	Rotoroa Island Trust and Auckland Zoo	Pest-free since 2013	Australasian gannets	Active — acoustic attraction and decoys	Ceased — breeding not established and equipment removed
			Grey-faced petrels	Remnant population and active — acoustic attraction and nest boxes.	Attraction ceased — breeding established and remnant population ongoing
Shakespear Regional Park	Shakespear Open Sanctuary Society Incorporated (SOSSI) and Auckland Council	Predator-proof fence built 2011, ongoing trapping	Grey-faced petrels	Active — acoustic attraction and nest boxes	Ongoing — breeding established
			Fluttering shearwaters		Ongoing — breeding established
			Little blue penguins	Passive, some nest boxes installed	Breeding confirmed

Location	Group involved	Pest status	Seabird species	Restoration method	Project status
Tāwharanui Regional Park	Tāwharanui Open Sanctuary Society Incorporated (TOSSI) and Auckland Council	Predator-proof fence built 2004, ongoing trapping	Grey-faced petrels	Active — acoustic attraction and nest boxes	Ongoing — breeding established
			Fluttering shearwaters		
			Common diving petrels	Active — acoustic attraction	Ongoing — breeding established
			Australasian gannets	Active — acoustic attraction and decoys	Failed
			Little blue penguins	Passive, some nest boxes installed	Breeding confirmed
			Cook's petrels	Passive	Breeding confirmed
Tiritiri Matangi	Supporters of Tiritiri Matangi and DOC	Pest-free since 1993	Cook's petrels	Active — acoustic attraction and nest boxes	Ongoing — no birds detected since project began in 2017
			Grey-faced petrels	Remnant population	Breeding confirmed
			Common diving petrels	Remnant population	
			Fluttering shearwaters	Passive	
			Little blue penguins	Passive or remnant population	
Ahuahu/Great Mercury Island*	GMI Project Manager Peter Corson and Island Advisor Rob Chappell	Pest-free since 1993	Grey-faced petrels	Remnant population	Breeding confirmed
			Little blue penguins	Remnant population	Breeding confirmed
			Pycroft's petrels	Active — acoustic attraction project planned	Present, Breeding confirmed
Bream Head*	Bream Head Conservation Trust	Ongoing pest control	Grey-faced petrels	Passive	Breeding confirmed
			Little blue penguins		
Bream Tail*	Local landowners	Ongoing pest control	Grey-faced petrels	Passive	Breeding confirmed
			Little blue penguins		
Kaipara Head*		Ongoing pest control	Grey-faced petrels	Remnant	Breeding confirmed
Korapuki Island*	DOC and the Northern NZ Seabird Trust	Pest-free since 1987	Fluttering shearwaters	Remnant population plus Active — nest boxes	Breeding confirmed
			Little blue penguins		
			Pycroft's petrels	Passive or remnant population	
			Common diving petrels		
			Grey-faced petrels		
			Little shearwater		
			Sooty shearwaters		
Matakohe/ Limestone Island*	Friends of Matakohe-Limestone Island	Ongoing pest control	Grey-faced petrels	Active — translocation	Translocation complete
Repanga/Cuvier Island*	Department of Conservation	Pest-free since 1993	Pycroft's petrels	Active— translocation, acoustic attraction and nest boxes	Attraction ceased — breeding established
			Grey-faced petrels	Passive or remnant population	Breeding confirmed
			Fluttering shearwaters		
			Common diving petrels		
			Little blue penguins		
Raglan*	Karioi and Department of Conservation	Ongoing pest control	Grey-faced petrels	Passive	Breeding confirmed
Taurawhata, Tutukaka*	Local volunteers on private land	Ongoing pest control	Australasian gannets	Active — acoustic attraction and decoys	Ongoing
			Grey-faced petrels	Passive	Ongoing

Āpitihanga 2 — Ngā rauemi | Appendix 2 — Resources

When reviewing the resources listed below it is important to note that advice should be sought at an early stage from DOC, Auckland Council or the Northern New Zealand Seabird Trust for any planned seabird restoration project. This is to ensure that the correct processes are carried out and any relevant iwi have been consulted, in addition to confirming that wildlife permits and animal ethics approvals are in place.

Table 3. A resource list for useful tools in seabird restoration.

Recommended use	Tool	Approximate cost	Where to acquire
General information on seabirds in the region	Book — *Seabirds of the Hauraki Gulf*	Free download	Northern New Zealand Seabird Trust — https://www.aucklandcouncil.govt.nz/about-auckland-council/how-auckland-council-works/harbour-forums/Documents/seabirds-hauraki-gulf.pdf
		–	Advice provided by Auckland Councils biodiversity team — biodiversity@aucklandcouncil.govt.nz
		–	Advice provided by DOC — auckland@doc.govt.nz
General information on threats to seabirds in the region	Book — *Threats to Seabirds of Northern Aotearoa New Zealand*	Free download	Northern New Zealand Seabird Trust — https://www.aucklandcouncil.govt.nz/about-auckland-council/how-auckland-council-works/harbour-forums/Documents/threats-to-seabirds-northern-aotearoa.pdf
Information on conservation in Auckland	Website — Conservation Auckland	–	https://www.tiakitamakimakaurau.nz/ General conservation advice in the Auckland region including pest animal and plant control and maps of community groups involved in conservation
Detection and monitoring of seabirds (and pests — trail cameras)	Acoustic recorders	–	Advice provided by the Northern New Zealand Seabird Trust — chris@nzseabirds.com
		–	Advice provided by Auckland Councils biodiversity team — biodiversity@aucklandcouncil.govt.nz
		–	Purchased through DOC's Electronics Team — electronics@doc.govt.nz
			Purchased through the Cacophony Project
		$300 – $420	https://www.2040.co.nz/collections/cacophonometer-bird-monitoring
	Ground searches or seabird detection dog	–	Advice provided by the Northern New Zealand Seabird Trust — chris@nzseabirds.com
			Advice provided by Auckland Councils biodiversity team — biodiversity@aucklandcouncil.govt.nz
	Trail cameras	$200 – $600	Rubber Monkey — https://www.rubbermonkey.co.nz/Outdoor-Lifestyle/Wildlife-Trail-Cameras
			Hunting supply stores — https://www.huntingandfishing.co.nz/hunting-gear/optics/trail-cameras.html
Monitoring seabirds	Monitoring Software	Free to use	CatchIT - https://www.stat.auckland.ac.nz/~fewster/CatchIT/
		Project-specific	Eagle Technology - https://www.eagle.co.nz/
	Monitoring software for little blue penguins	Free to use	NZ Penguin Initiative — app to be made publicly available in future but for now contact Richard@nzpi.net
	DOC bird banding scheme	Protocol	DOC - https://www.doc.govt.nz/our-work/bird-banding/
	Information of other seabird monitoring techniques	Species and project-specific	Advice provided by the Northern New Zealand Seabird Trust — chris@nzseabirds.com
			Advice provided by Auckland Councils biodiversity team - biodiversity@aucklandcouncil.govt.nz
Artificial nest boxes	Design for little blue penguin nest box	Free download	DOC - https://www.doc.govt.nz/globalassets/documents/conservation/native-animals/birds/nest-box-design.pdf
	Design for petrel and shearwater nest boxes	–	Detailed nest box design information contained in 'Gummer et al. 2014' report listed in references
			Contact Northern New Zealand Seabird Trust — chris@nzseabirds.com
Reducing seabird bycatch	Guidelines	Free download	Southern Seabirds Solutions Trust - https://www.catchfishnotbirds.nz/post/how-to-handle-a-seabird
			Forest and Bird - https://www.forestandbird.org.nz/sites/default/files/2018-05/SeabirdIDGuide2016.pdf
Pest control	Auckland Council pest control guidelines	Free download	Auckland Council https://www.bionet.nz/assets/Uploads/pest-animal-control-guide-Auckland-Council-2016.pdf
	Traps and bait for rats, mustelids, possums	$20 – $200	Predator Free NZ - https://shop.predatorfreenz.org/
			Hardware or farm supply stores - https://clickandcollect.farmlands.co.nz/nz/en/products/infrastructure/pest_control.html, https://www.mitre10.co.nz/shop/garden-centre/plant-health-pest-control/household-pest-control/c/RF5427
	Predator-proof fencing	Project-specific	Xcluder - https://www.xcluder.co.nz/xcluder-fences/fence-designs/
Pest monitoring	Auckland Council pest monitoring guidelines	Free download	Auckland Council - https://knowledgeauckland.org.nz/media/1418/auckland-community-ecological-monitoring-guide-sept-2018-6mb.pdf
	Monitoring tools – chewcards, wax tags etc.	$5 - $20	Predator Free NZ - https://shop.predatorfreenz.org/
			Key Industries - https://keyindustries.co.nz/

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