Establishing a Seabird Monitoring and Research Programme for Tāmaki Makaurau

Programme Overview and Initial Findings as of 2024

State of the Environment Reporting

Gaia Dell'Ariccia, Maíra Fessardi and Todd J. Landers

September 2025 Technical Report 2025/16

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Front cover image credit: Black petrel chick, Te Hauturu-o-toi / Little Barrier Island. Photograph by Todd J. Landers
Page 2 image credit: Australasian gannets, Muriwai. Photograph by Gaia Dell'Ariccia
Back cover image credit: Cook's petrel, Hauraki Gulf. Photograph by Gaia Dell'Ariccia

Executive summary

The Tāmaki Makaurau / Auckland region is an internationally recognised hotspot for seabird diversity. Remarkably, 25 seabird species are known to breed in this region, of which 15 (60%) are Aotearoa New Zealand endemic species or subspecies. However, most of these birds are 'Threatened' or 'At Risk', requiring urgent protection, management and restoration. This led Auckland Council to establish the first local government-led regional Seabird Monitoring and Research Programme. This long-term (>10 years) programme aims to increase our knowledge on the presence, health and trends of seabird populations in the Auckland region and the factors affecting their population distributions and trends so to advise and develop restoration actions to improve their conservation statuses.

This report outlines the development of the programme, explains the rationale behind the prioritisation and choices of species and areas to monitor and research, and presents the activities carried out so far and the first results.

Using a prioritisation process, nine species were identified as having major knowledge gaps (black petrel / tākoketai/tāiko, Cook's petrel / tītī, New Zealand white-faced storm petrel / takahikare, sooty shearwater / tītī, little penguin / kororā, pied shag / kāruhiruhi, black shag / māpunga, little black shag / kawau tūī, Caspian tern / taranui) and six with a partial knowledge gap (black-winged petrel / karetai kapa mangu, fluttering shearwater / pakahā, little shag / kawaupaka, spotted shag / kawau tikitiki). Two other species were recognised as having specific interest for mana whenua, stakeholders, education, and/or research purposes (Australasian gannet / tākapu, grey-faced petrel / ōi). The study areas were selected based on their importance for seabirds and for the presence of prioritised species.

With a focus on these species and sites, several projects were initiated. While long-term monitoring and research is needed, data gathered so far are still informative. The main findings so far are listed below.

Species projects:

- The black petrel population on Hauturu is small despite high protection, showing yearly fluctuations in number of breeding birds. This population vulnerable and highly impacted by extreme weather events.
- Cook's petrels on Hauturu are showing positive numbers of breeding birds and good breeding success, also in 2023, showing a potentially higher resilience than other species. A small part of the colony was impacted by weather events because of slips and fallen trees that destroyed it.
- A first population estimate of white-faced storm petrel breeding on Maria Island, The Noises was calculated. Despite the high level of uncertainty due to low number of repetitions, it shows that several thousands of birds are probably breeding on this island. Interannual variability in both nest occupancy and breeding success is high and the species is heavily impacted and vulnerable to extreme weather events.

- A map of shag colonies in the region was compiled. This work is not yet complete, but present findings show that pied shags are the most abundant species. However, colonies have a different distribution than past reported data. Little shag colonies are more abundant than what was previously reported. Black and little black shags are rare, but previously unreported colonies of these species are being found.
- Population counts of spotted shag reveal large variation year to year, with signs of continued decline over time. A tracking study of foraging birds is ongoing.

Site-based projects:

- Ōtata Island (The Noises) is an important seabird site. Monitoring of grey-faced petrel showed a relatively stable population, whereas little penguin were present in low numbers and only a small number of them were breeding. Trials for restoration of spotted shag, fluttering shearwater and little penguin are ongoing.
- The restoration research projects in the Waitākere ranges highlighted that grey-faced petrel can have relatively high breeding success despite the presence of introduced mammalian predators as long as these are below a certain threshold level. The most vulnerable time identified is the early chick-rearing phase. The Waitākere Ranges community are generally supportive of increased predator control and other habitat management approaches to support the restoration of grey-faced petrel.
- The pilot trial for seabird monitoring feasibility at Glenfern Sanctuary on Aotea / Great Barrier Island was successful even if first findings evidenced low numbers of occupied burrows. The employment of a seabird detector dog located more active burrows for both black and Cook's petrel, as well as some little penguin burrow. Regular, long-term monitoring is feasible and relevant.
- The access to Pokohinu / Burgess Island was inconsistent preventing the collection of reliable data. Amongst the other seabird species that breed there, only very few burrows of black-winged petrel and only one of sooty shearwater have been found, highlighting the need for further monitoring to identify trends. Monitoring is needed for all seabird species on Pokohinu.

The Seabird Monitoring and Research Programme involved collaboration with other institutions and universities. The results from these supporting projects are provided in a specific section of this report. These include studies on stress hormones, a socio-ecological study on the perceptions of pigs and black petrels on Aotea / Great Barrier Island and the search for juvenile black petrels at sea.

New research projects are also being initiated. The Programme will integrate data from population monitoring with research on threats. This includes a study of heavy metals and other contaminants and how they affect the health status of seabird populations. Another study on the effects of temperature on breeding aims to understand potential impacts on populations in a scenario of global climate warming.

The data collected from the Programme will form the baseline for long-term studies, which are essential if we want to identify population trends or patterns, to better understand species restoration requirements and to evaluate the impact of conservation efforts and environmental issues.

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List of acronyms and abbreviations

Aotea	Aotea / Great Barrier Island
BWPE	Black-winged petrel
CMS	Convention on Migratory Species
CORT	Corticosterone. A stress hormone in seabirds.
DOC	Department of Conservation Te Papa Atawhai
EEMU	Environmental Evaluation and Monitoring Unit at Auckland Council
Glenfern	Glenfern Sanctuary
Hauturu	Te Hauturu-o-Toi / Little Barrier Island
Hirakimata	Hirakimata / Mount Hobson on Aotea / Great Barrier Island
HPA	High Protection Area as per Hauraki Gulf / Tīkapa Moana Marine Protection Bill (August 2023)
HPAI	Highly Pathogenic Avian Influenza
IBA	Important Bird Area
IUCN	International Union for the Conservation of Nature
MEACT	Muriwai Environmental Action Community Trust
NETR	Natural Environment Targeted Rate
Pokohinu	Pokohinu / Burgess Island, Mokohīnau (Pokohinau) Island group
Ruapuke	Ruapuke / Maria Island, The Noises Islands
Te Henga	Te Henga / Bethells Beach
WFSP	White-faced storm petrel
WMIL	Wildlife Management International Ltd.

Glossary

Breeding season	The period when birds are mating, incubating the egg and chick rearing, until fledging.
Conservation physiology	The study of physiological responses of organisms to environmental change and stressors including human alteration of the environment that might cause or contribute to population declines.
Endemic	A species that is found exclusively in one specific geographic area and nowhere else in the world.
Eulittoral	The eulittoral zone is the intertidal zone, known also as the foreshore. It extends from the spring high tide line, which is rarely inundated, to the spring low tide line, which is rarely not inundated. It is alternately exposed and submerged once or twice daily.
High trophic level	A high trophic level refers to the position of an organism in a food chain or web, indicating its feeding relationship with other organisms. Higher trophic levels typically involve organisms that consume other organisms at lower trophic levels and occupying the apex of the food chain.
Mahinga kai	A food resource, a food gathering place.
Mesopredator	A predator that occupies a mid-ranking trophic level in a food web.
Native	A species that naturally occurs and has evolved within a specific geographic area or ecosystem.
Pelagic	Anything living in or relating to the open sea or ocean, away from the coast or seabed.
Philopatry	In seabirds, it is the tendency of an individual to return to its natal colony to breed.
Procellariform	Order of seabirds, also known as tubenoses or petrels, that includes albatrosses, petrels, shearwaters, and storm petrels.
Rāhui	A temporary prohibition, often used to restrict access to or use of an area, resource, or activity. It serves as a mechanism for conservation, protection, and to allow for the dissipation of tapu (sacredness) associated with a significant event like a death.
Taonga	Treasure, prized, of particular value. A valuable resource.

1 Introduction

Aotearoa New Zealand is internationally recognised as the seabird capital of the world with approximately one quarter of all existing seabird species breeding here and 10% endemic to New Zealand breeding grounds, meaning that they breed nowhere else in the world. Within New Zealand, the Tāmaki Makaurau / Auckland region is a hotspot for seabird diversity. There are 25 seabird species known to breed in this region, of which 15 (60%) are New Zealand endemic species or subspecies. These include 11 petrels and shearwaters, one penguin, one gannet, five shags, three gulls and three terns. Of these species, the black petrel / tāiko / tākoketai (*Procellaria parkinsoni*) and New Zealand storm petrel / takahikare-raro (*Fregetta maoriana*) are regionally endemic (breeding nowhere else in New Zealand or the world). This last species was re-discovered breeding on Te Hauturu-o-toi / Little Barrier Island in 2013 after being thought extinct. In addition, over 70 species of seabird, (around 20% of the world's seabird species), have been recorded within the Tīkapa moana / Moananui-a-toi / Hauraki Gulf region (e.g. Gaskin and Rayner 2013). This diversity has been recognised by Birdlife International through its New Zealand affiliate Forest and Bird, officially identifying the greater Hauraki Gulf region as an Important Bird Area (IBA) for seabirds at the international level (Forest & Bird 2014, 2015). A significant recognition given its proximity to the country's largest city – Auckland.

Significance of seabirds

Seabirds are defined as birds that rely on the marine environment for at least part of the year, feeding at sea either in inshore or offshore waters; these include penguins, storm petrels, shearwaters, petrels, gannets, terns, gulls and shags (Croxall et al. 2012, Gaskin and Rayner 2013). Seabirds are a diverse group of organisms of high trophic level at the frontier between sea and land, occupying a wide range of habitats (pelagic, eulittoral, semiterrestrial and terrestrial habitats) and depending on a range of environmental resources to thrive. They are highly specialised, with physiological and morphological adaptations that enables them to live between the marine and terrestrial environment, foraging from the ocean and nesting on land (Warham 1990).

Seabirds play a key role in marine and terrestrial ecosystems. They are often regarded as ecosystem engineers for the important modification they contribute to the terrestrial environment where they breed. They are responsible for inputting marine-derived nutrients from their guano, prey items, dead tissues, or abandoned eggs into the soil, supporting otherwise nutrient-poor terrestrial environments. This nutritional link between the marine and terrestrial environments is crucial for the maintenance of nitrogen and phosphorus cycles in island and coastal ecosystems, enriching soils and supporting plant and animal life cycles. These nutrients are then returned to the sea through runoff, fertilising the nearshore environment (Şekercioğlu et al. 2004, Mulder et al. (eds.) 2011, Gaskin and Rayner 2013). The historical seabird populations of New Zealand significantly enriched the soil, making them a key factor in the country's current soil fertility.

Seabirds are considered sentinels of marine ecosystem productivity and general health. Unexpected changes in their numbers, health or breeding success provide a warning that may indicate unknown pollution issues or food supply problems. (Cairns 1987, Monteiro and Furness 1995, Furness and Camphuysen 1997, Gaskin and Rayner 2013). As all animal populations at high trophic level, they are largely controlled by bottom-up processes; they rely on the availability and quality of resources from the ocean, and they are sensitive to variations in ocean conditions such as primary productivity, fish stocks and environmental change. They are visible animals that can be counted in an environment in which most other animals and plants are hidden under the water; and they breed in colonies on land where they can be studied for a variety of demographic, behavioural and physiological parameters (Furness and Camphuysen 1997, Piatt et al. 2007b). Thus, regular monitoring of their populations may reveal wider trends in marine ecosystems. Monitoring the ocean is crucial under scenarios of global change but is challenging and expensive. With the collection of precise annual data on long-term time-series, seabirds can offer precious insights into the effects of climate change on marine ecosystems across broad spatial scales (Montevecchi and Myers 1997, Piatt et al. 2007b).

Threats

The extreme mobility and reliance on a wide range of habitat resources make this group of birds very sensitive to environmental changes and threats caused by different sources (Croxall et al. 2012, Dias et al. 2019, Whitehead et al. 2019). Seabirds are the most threatened group of birds in the world; according to the International Union for Conservation of Nature (IUCN), 42% of seabird species are considered Threatened or Near Threatened, and 47% are declining (BirdLife International 2018). Current threats are mostly due to anthropogenic sources affecting both terrestrial and marine environments. At sea, human activities such as fisheries and pollutants impact food availability and quality, and bycatch is a direct cause of mortality. On land, ongoing urban development and the spread of invasive exotic species threaten their breeding grounds (Croxall et al. 2012, Dias et al. 2019, Whitehead et al. 2019). This scenario is worsened by climate change accelerating broad-scale alterations in marine ecosystems (Doney et al. 2012, Poloczanska et al. 2013, Dias et al. 2019). Climate change can drive temperatures to levels beyond natural ranges and has started to impact the composition, abundance, and quality of seabird foraging conditions (Satterthwaite et al. 2012, Harding et al. 2013, Bishop and Landers 2019, Piatt et al. 2020).

In New Zealand, seabirds are most vulnerable to threats on land where species are not adapted to introduced mammalian predators (Whitehead et al. 2019). Seabird bycatch, pollution caused by artificial lights and contaminants (e.g. plastic) have been identified as the other main threats to northern island populations (Whitehead et al. 2019). However, more research is needed to better understand specific local threats, identify emerging threats and understand the relative effects of these threats on our Auckland populations. Although different threats impact species differently and will require different strategies, a holistic approach to cumulative threats is crucial to reduce the piling pressure on all seabird species living in the Hauraki Gulf (Whitehead et al. 2019), especially in the present context of climate change (Bishop and Landers 2019).

The role of Auckland Council

The need to support seabird populations to thrive is clear, however conservation, management and protection efforts are not straightforward. Historically, seabirds have rarely been incorporated into active conservation management programmes – mainly due to the difficulty in accessibility and monitoring of seabird populations with most species now only breeding on offshore islands, and their nocturnal and underground nesting habits hindering access to individuals. Furthermore, seabirds are long-lived species. For example, procellariforms can live over 50 years, taking years to reach maturity and then laying only one single egg per year, requiring long-term monitoring in order to draw reliable conclusions on populations statuses and trends. Given the ecological importance and poor conservation statuses of seabird species, understanding what drives seabird population declines is critical to inform the development of more efficient and effective management strategies.

Auckland Council has statutory obligations to maintain and sustainably manage biodiversity, for both its intrinsic, and its ecosystem services value. Under the Resource Management Act 1991, Auckland Council, as a Unitary Authority, has responsibilities as both a Regional Council and Territorial Authority in relation to the maintenance and restoration of indigenous biodiversity. The combined regional and district council responsibilities include: to develop, implement and review policies and methods to maintain indigenous biodiversity. The Council must also respond to the requirements of the National Policy Statement on Indigenous Biodiversity (Ministry for the Environment 2024), which guides the development of the management approaches.

In 2012, Auckland Council released the Indigenous Biodiversity Strategy (Auckland Council 2012) which set out the vision, strategic objectives, measures and principles for the management of indigenous biodiversity in the Auckland region. This document applies to indigenous biodiversity on both public and private land. Among its objectives is the need to achieve long-term recovery of the greatest number of threatened species that includes the Auckland region in their range, and particular regard is given to species and ecosystems that are unique to Auckland. Methods to deliver this include ensuring significant indigenous biodiversity is identified and protected from inappropriate use and development, and ecosystem restoration.

In 2017, Sea Change – Tai Timu Tai Pari, Hauraki Gulf Marine Spatial Plan (Hauraki Gulf Marine Park 2017)) set the aim to halt further decline in biodiversity and to restore species diversity so that there are healthy and functioning populations within the Hauraki Gulf Marine Park. This Marine Spatial Plan included specific recommendations to "Regularly monitoring reproductive success" as a management action for seabirds.

To help fulfil its obligations to manage and restore indigenous biodiversity, Auckland Council established a Natural Environment Targeted Rate (NETR) which was included in residential property rates across Auckland from July 2018. NETR is expected to raise $311m over 10 years and supports (amongst other key focus areas) key activities in and around Auckland's islands and marine environments to protect native marine ecosystems and species. This is often done by undertaking monitoring, surveillance, threat response action, and developing policy planning responses.

Through NETR, Auckland Council established a regional Seabird Monitoring and Research Programme in 2019 (hereafter referred to as 'the Seabird Programme'), funded until 2030. This was a first for New Zealand local government and established a significant commitment to improving the state of seabirds in Auckland.

Objectives of the Seabird Programme

The main objective of the programme is establishing monitoring and research of seabird populations across the region to improve knowledge which can inform management actions to reduce threats and protect seabirds in the Auckland region.

Goals of the programme include:

- Increase knowledge on the presence, health, and trends of seabird populations in the Auckland region.
- Understand the factors affecting population distributions and trends to advise management actions.
- Identifying the most effective actions to maintain and restore seabird biodiversity in Auckland.

The information provided by the Seabird Programme will support other Auckland Council management activities such as the identification of Biodiversity Focus Areas, the Regional Pest Management Plan, and the Treasure Islands Programme, among others.

Purpose and overview of this report

This technical report provides an overview of the Seabird Programme, the rationale behind the establishment of the different monitoring and research projects and the initial findings. It is divided in seven main parts:

- Section 2 describes the species prioritisation and programme initiation, explaining how the species breeding in the region and different sites were selected and prioritised for monitoring and research.
- Section 3 describe the projects developed to fill knowledge gaps on prioritised species and the preliminary results.
- Section 4 presents monitoring and research projects on prioritised sites where there are multiple species per site.
- Section 5 outlines collaborative and student projects that the Seabird Programme has supported which has diversified and widened the programme perspective and reach.
- Chapter 6 illustrates new emerging research projects to investigate some of the threats that endanger seabird species.
- Section 7 summarises and discuss the findings to date, their implications for management activities and the next steps with updated priorities.

Supporting information

This report is one of a series of technical publications prepared in support of *Te oranga o te taiao o Tāmaki Makaurau – The health of Tāmaki Makaurau Auckland's Natural Environment in 2025: a synthesis of Auckland Council State of the Environment reporting*.

All related reports (past and present) are published on the Knowledge Auckland website.

All data supporting this report can be requested through our **Environment Auckland Data Portal**. Here you can also view live rainfall data and use several data explorer tools.

2 Species Prioritisation and Programme Initiation

Species prioritisation process

To establish a sound and effective monitoring and research programme for restoration, a prioritisation exercise to identify knowledge gaps was required to identify the most pressing monitoring and research needs.

At the start of the Seabird Programme in 2019, the first step of this prioritisation exercise was to determine which species are breeding in the region, where they are breeding, what their population sizes are and if population trends are known. There was good knowledge of which species breed in the Auckland region (Southey 2009, Gaskin and Rayner 2013), but the available information on where these species breed, and their population state and trends were often patchy and incomplete. To understand the scale and nature of the knowledge gaps, a comprehensive literature review of all published material was undertaken to find what information was already available for each of the species known to breed in Auckland. Experts working on seabird research in the Auckland region were also contacted to collect relevant information held by them, including data from unpublished studies. The external contributors included: Elizabeth Bell (Wildlife Management International Ltd., WMIL), Dr Brendon Dunphy (University of Auckland), Chris Gaskin (Northern New Zealand Seabird Trust, now The Seabird Trust), Dr Tim Lovegrove (previously Environmental Services, Auckland Council), Dr Matt Rayner (Auckland War Memorial Museum Tāmaki Paenga Hira), Graeme Taylor (Department of Conservation, DOC), Dr Christy Wails (Northern Illinois University, USA).

This initial information provided an essential baseline to assess future population statuses and trends, identify the reasons for any underlying changes detected, and what potential threats and follow-up actions are required to improve these populations.

A summary of the findings is provided in Appendix 1 (Section 10) to this document and includes the following information:

- Level of endemism (e.g. endemic, native, introduced, etc.), conservation status according to the New Zealand Threat Classification System as published by DOC (Robertson et al. 2017, subsequently updated by Robertson et al. 2021) and population trend (e.g. declining, increasing or stable).
- Overall and regional distribution
- Known threats to the species
- Past and present New Zealand research and regional monitoring studies available
- Known monitoring and research priorities for the species.

To help prioritise and establish what species most urgently needed monitoring and research work a rationale schematised in the diagram in Figure 1 was used. This was a step-by-step process in which, for each species, a ‘Yes’ or ‘No’ decision was made to move from one step to the next, until the assignment to a priority category.

Firstly, the New Zealand Conservation Status (Robertson et al. 2017, Robertson et al. 2021) was considered to determine if the species was nationally Threatened or At Risk, or not.

Secondly, the species was categorised according to the presence or not of recent (less than 5 years old) or ongoing studies by evaluating the information gathered during our literary review of all published and unpublished "grey" literature. In this step, monitoring studies that specifically investigate population status and trends were separately considered from other scientific research, allowing for a broader and sound knowledge of the different species, including for example their ecology, physiology, etc. and a deeper insight into potential threats (Table 1).

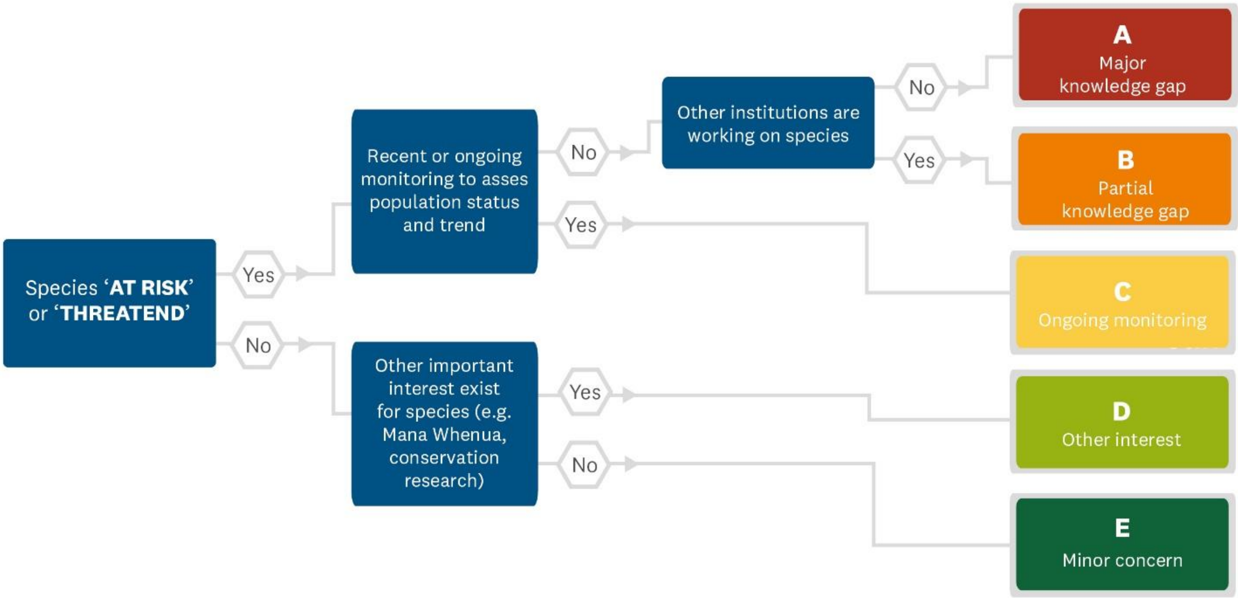

Figure 1. Process for how species were prioritised for monitoring and research in the NETR seabird programme. Details and rationale explaining the categories are in the main text.

For most species, there was insufficient information available to determine their population and conservation statuses at the regional level. Where available, regional population information was included to provide a robust regional view and input to the prioritisation. For example, spotted shag / kawau tikitiki (*Phalacrocorax punctatus*) were considered as 'Not Threatened' at a national level (Robertson et al. 2017), but data collected in the Hauraki Gulf indicated that it was quickly declining in the Auckland region, requiring immediate conservation action (Tim Lovegrove, *pers. comm.*), and for this reason it was classified as Regionally Threatened in the prioritisation. After the prioritisation was completed, the conservation status of spotted shag was reassessed as Threatened – Nationally Vulnerable (Robertson et al. 2021). This change was a result of identifying a significant and ongoing decline in the number of breeding pairs nationwide raising concern for the overall population trend.

Other important aspects were also considered in the categorisation exercise such as a cultural importance for mana whenua. Traditionally, many seabirds are considered taonga to Māori, with these birds having played a cultural role in navigation, harvesting, eating practices and the lunar ecological calendar (maramataka). For example, sooty shearwater / tītī (*Ardenna grisea)* and grey-faced petrel / ōi (*Pterodroma gouldi*) are of recognised importance for Māori customary harvest (Drummond 1918, Powell 1947).

The other important aspects that were considered included the existence of specific interests held by stakeholders – for example land managers such as Council Parks staff, local boards, restoration groups and other community members – or if the species are important for education programmes to promote awareness and engagement, or useful for research purposes (e.g. research for seabird restoration). This last research aspect is of particular importance to understand how to successfully restore seabirds on the mainland. For example, understanding the ability of grey-faced petrel to repopulate Auckland's mainland, a rare attribute for petrels and shearwaters, will provide insights for how to restore populations of other seabird species. Consequently, the species important for one or more of the above aspects have been attributed to a specific priority category, even when their conservation status is 'not threatened'.

Following this step-by-step process using the data collected in the literature review, five categories of priority were identified (Figure 1).

- A = Species with a major knowledge gap. These are the species most urgently needing investigation and monitoring.
- B = Species with partial knowledge gap. These species are the subject of monitoring and/or research from other institutions, but available data are limited to date and/or do not cover specific aspects needed to inform Council management.
- C = Species with ongoing monitoring and research. These species already are subject of intense monitoring and research from other institutions because of their conservation status. Some of them are endemic to the Auckland region (i.e. black petrel) and thus critical for the programme, so we will collaborate when needed.
- D = Species important for mana whenua, stakeholders, education, and/or research purposes.
- E = Species of minor concern and that are for the moment excluded from our monitoring.

Table 1 provides a summary of all the factors evaluated and values for each species, as well as the attributed category of priority. The table also lists all the species name in English and Māori accompanied by the scientific name.

Priority species for Auckland

As summarised in Table 1, the prioritisation process identified nine threatened species with a major knowledge gap (category A).

- Black petrel / Tākoketai / Tāiko (only outside of the main colony on Hirakimatā / Mount Hobson on Aotea / Great Barrier Island)
- Cook's petrel / Tītī (*Pterodroma cookii*)
- New Zealand white-faced storm petrel / Takahikare (*Pelagodroma marina maoriana*)
- Sooty shearwater / Tītī
- New Zealand little penguin / Kororā (*Eudyptula minor minor)*
- Pied shag / Kāruhiruhi (*Phalacrocorax varius varius)*
- Black shag / Māpunga (*Phalacrocorax carbo novaehollandiae)*
- Little black shag / Kawau tūī (*Phalacrocorax sulcirostris)*
- Caspian tern / Taranui (*Hydroprogne caspia)*

And six species with a partial gap (Category B).

- Black-winged petrel / Karetai kapa mangu (*Pterodroma nigripennis)*
- Fluttering shearwater / Pakahā (*Puffinus gavia)*
- Northern diving petrel / Kuaka (*Pelecanoides urinatrix urinatrix)*
- North Island little shearwater / Totorore (*Puffinus assimilis haurakiensis)*
- Little shag / Kawaupaka (*Microcarbo melanoleucos brevirostris)*
- Spotted shag / Kawau tikitiki

Of the *Not threatened* species identified, two were recognised as having particular cultural interest or of importance for research and education (Category D).

- Australasian gannet / Tākapu
- Grey-faced petrel / Ōi

Monitoring site selection

The study areas were selected based on their importance for seabirds. A list of locations with the presence of high seabird biodiversity and/or of priority A species, and areas significant for other priority categories was identified from the available information and site pilot surveys. Other areas that are reported to be important for seabirds but where the knowledge of breeding species is particularly poor or missing (see below) were also included. Monitoring feasibility was added as a criterion to ensure resources were optimised by favouring the monitoring of species that were present at the same site(s).

Studying seabirds in the selected locations will provide two different kinds of essential information. Firstly, insights that are site specific to the monitored locations will be collected. The study of these sites will provide information of the importance of these areas for seabirds, and evidence for their inclusion into Auckland Council's management priorities. Secondly, all seabird studies will enable a deeper knowledge of the overall population trends and species ecology. This is important for improving conservation management at all locations where the species breed. Studying species on pest-free islands and places where they are already protected and/or managed is important to gain a comprehensive understanding of each species and to enable the application of information learned from these locations to other areas that have the potential for restoration.

The main locations are:

> <u>Te Wao nui a Tiriwa / Waitākere Ranges</u>: The Auckland mainland has several very important seabird areas, as well as potential restoration sites. One key area is the Waitākere Ranges which contains the most breeding seabirds on Auckland's mainland (particularly if including up to Muriwai). The Waitākere Ranges also contains one of New Zealand's most important mainland burrowing seabird sites at Te Henga / Bethells Beach where five species breed (little penguin, diving petrel, flesh-footed shearwater, grey-faced petrel, sooty shearwater), as well as white-fronted tern. However, there is relatively little known about where other populations are in the Waitākere Ranges and how well they are breeding. There also are significant shag, penguin and tern sites elsewhere on the mainland that should be monitored.

> <u>The Noises Islands</u>: Population information is lacking for seabirds breeding on this group of islands. In 2019, The Noises Trust in partnership with the Auckland War Memorial Museum Tāmaki Paenga Hira and the University of Auckland started an advocacy project seeking ecosystem-based protection of The Noises as a model for conservation in the Hauraki Gulf. A proposal for marine protection around

The Noises, known as Ōtata mauri ora, was submitted to the Government in 2021 . The proposal highlighted the need for an informed review of biodiversity indicators to guide and support marine restoration. The implementation of this marine protection proposal will also be the perfect opportunity to study restoration impacts. Ruapuke / Maria Island is especially worth monitoring as it hosts one of the only two known colonies of New Zealand white-faced storm petrel in the region, but nothing is known about their population size and trends. Motuhoropapa and the other islands in this group lack a comprehensive list of species present.

Te Hauturu-o-Toi / Little Barrier Island (hereafter Hauturu): Monitoring seabirds on Hauturu is essential for understanding the broader seabird populations of the Hauraki Gulf, as its long-standing Nature Reserve status and areas of remnant mature forest make it a critical stronghold for species like Cook's petrel and an indispensable site for gathering data on the region-wide status of vulnerable species such as the black petrel. It is the only other known breeding site for this threatened endemic species outside of Aotea / Great Barrier Island, but no consistent population monitoring is carried out here creating a significant knowledge gap for the species. Information gathered at this site is of fundamental importance to understanding the status and trend of the overall black petrel population, and the extent of threats affecting them. Knowledge from Hauturu will help identify mitigation and restoration approaches for Aotea / Great Barrier Island, where most of the population breed.

Hauturu is the regional stronghold for the Cook's petrel population, which was last surveyed in 2007 but no monitoring happened afterwards, including following the removal of 547 chicks between 2012 and 2016 for establishing new colonies at Cape Sanctuary and Boundary Stream (C. Mitchell pers. com.; Hozumi et al. 2011). Understanding the Cook's petrel population status and trends on Hauturu will help understand patterns of species recovery and expansion for this and other species like little and fluttering shearwater, northern diving petrel and grey-faced petrel.

Aotea / Great Barrier Island (hereafter Aotea): Glenfern Sanctuary is a predator-controlled area on Aotea where several seabird species are reported to breed, including black and Cook's petrel, but where regular seabird monitoring had never been carried out before. Further work on Aotea is being developed in collaboration with Ngāti Rehua Ngātiwai ki Aotea Trust, Tū Mai Taonga and the Aotea Great Barrier Island Environmental Trust to promote Aotea as a seabird island.

Pokohinu / Burgess Island: On this island there is a high concentration of seabird species (nine) with many of our priority A species breeding there. In particular, some rare species like the black-winged petrel and the sooty shearwater are reported to breed here, with this site being the only known breeding location for black-winged petrel within the Auckland region.

Motukino / Fanal Island: There is very little information on the avifauna of this island, however it is fairly large (73 ha) with large forest areas with almost no recent modification (de Lange et al. 1995), and thus contains potentially large areas of high-quality seabird habitat. Very little survey work has been conducted on this island, and hence it is a high priority site for surveying for seabirds.

Other Mokohīnau Islands: There is little information on what species breed on the different islands of this archipelago, except for Pokohinu / Burgess Island.

A map of selected locations and all monitored seabird sites under the Seabird Programme is shown in Figure 2. The map also shows locations that are specific to certain prioritised species (e.g. Tarahiki Island for spotted shags).

Figure 2. Map of seabird colonies and sites monitored in the Seabird Programme. The details of the monitoring activities for each site and the species monitored are provided in the different sections of this report.

Monitoring activities

Following the prioritisation of species, engagement was started with mana whenua, DOC, landowners and other stakeholders in order to enable access to colonies. Field work was commenced with setting up long-term monitoring for the highest priority species at the selected sites. The initial focus of the monitoring activities was to estimate colony size, number of breeding nests (presence of an egg and incubating adult), and the breeding success (percentage of breeding burrows that fledged a chick). Regular surveys were planned throughout each species' breeding season for several years to achieve estimates for population trends and health status. For colonies where regular monitoring is not feasible due to, for example – site inaccessibility, occasional surveys to collect basic data and use of indirect methods (e.g. automatic acoustic recorders, camera-traps, etc.) to gather the maximum population information and data were used.

A feedback loop system for the programme was established to promote re-evaluation of the available knowledge as new information and insights become available, so the process could be adjusted in a continuous and dynamic way (Figure 3). This feedback system allows for further refinement of species assessments as well as re-prioritising actions and management needs for each species to deliver robust and specific monitoring and research projects. The information gathered through our programme will be used to inform potential restoration actions for Auckland Council and other stakeholders to implement.

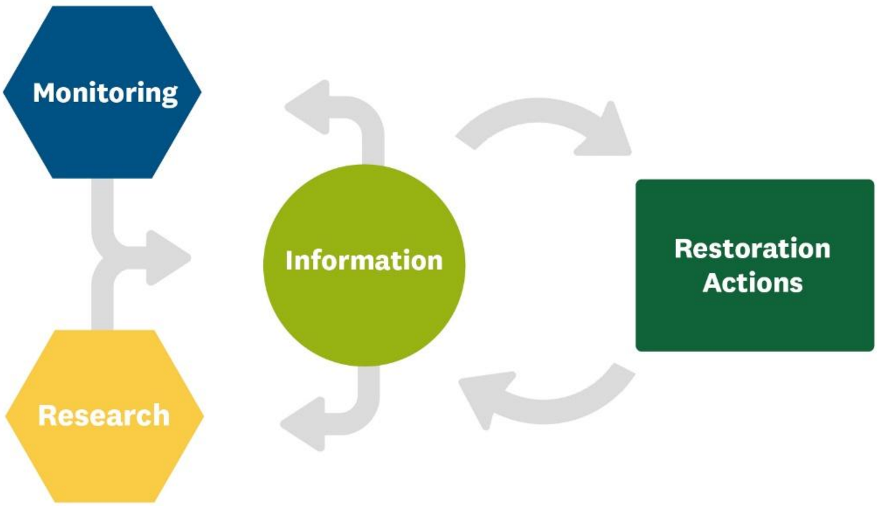

Figure 3. The feedback loop system for developing restoration actions for improving the state of Auckland's seabirds and shorebirds.

Research projects

As part of this regional monitoring programme, discrete research projects have also been initiated. Recording and reporting on only the population size and trend of a species is not sufficient to recommend or influence management options, as information about the possible causes of the observed trend is missing. For this, coupling population monitoring with supplemental data gathered through specific research projects is needed to improve our knowledge on seabirds.

Different seabirds occupy different habitat and ecological niches, meaning they may face similar but often different threats. For example, petrels', shearwaters' and penguins' foraging grounds are exclusively at sea, while gulls, terns and most shags may use also coastal habitats to forage (e.g. estuaries, lakes). The marine environment presents different threats to seabirds, and different marine environments (e.g. coastal or pelagic) entail different threats for these birds. Understanding these threats is essential for their protection and restoration.

Consequently, research projects have been set-up or are being developed to track birds at sea during their foraging trips (see section 3.5), investigate pollutants and contaminants in the birds' tissues (see section 6.1), assess the impacts of warmer temperatures on breeding success (section 6.2), as well as other projects addressing questions about their threats and how they are impacted by them (section 5.1). Additionally, research investigating how pest animals are affecting seabird population health on the mainland and how this can be addressed is underway and will inform restoration and management decisions (section 4.2).

Table 1. Summary table of the species breeding in the Auckland region, their conservation status and attributed priority.

Common name	Māori name	Scientific name	Endemic status	NZ conservation status	Ongoing or recent monitoring	Ongoing or recent research	Category of priority
Black petrel	Tākoketai/Tāiko	*Procellaria parkinsonii*	Endemic	Threatened-Nationally Vulnerable	Yes	Yes	C (A[1])
Black-winged petrel	Karetai kapa mangu	*Pterodroma nigripennis*	Native	Not Threatened	Limited	No	B[2]
Cook's petrel	Tītī	*Pterodroma cookii*	Endemic	At Risk-Relict	No	No	A
Flesh-footed shearwater	Toanui	*Ardenna carneipes*	Native	Threatened-Nationally Vulnerable*	Yes	Yes	C
Fluttering shearwater	Pakahā	*Puffinus gavia*	Endemic	At Risk- Relict	Limited	Yes	B
Grey-faced petrel	Ōi	*Pterodroma gouldi*	Endemic	Not Threatened	Yes	Yes	D
Northern diving petrel	Kuaka	*Pelecanoides urinatrix urinatrix*	Native	At Risk- Relict	No	Yes	B
North Island little shearwater	Totorore	*Puffinus assimilis haurakiensis*	Endemic subspecies	At Risk-Recovering	Limited	Yes	B
New Zealand storm petrel	Takahikare-raro	*Fregetta maoriana*	Endemic	Threatened-Nationally Vulnerable	Yes	Yes	C
New Zealand white-faced storm petrel	Takahikare	*Pelagodroma marina maoriana*	Endemic subspecies	At Risk-Relict	No	Limited	A

Table 1. Summary table of the species breeding in the Auckland region, their conservation status and attributed priority.

Common name	Māori name	Scientific name	Endemic status	NZ conservation status	Ongoing or recent monitoring	Ongoing or recent research	Category of priority
Pycroft's petrel		*Pterodroma pycrofti*	Endemic	At risk-Recovering	Yes	No	C
Sooty shearwater	Tītī	*Ardenna grisea*	Native	At Risk- Declining	Limited	Limited	A
New Zealand little penguin	Kororā	*Eudyptula minor minor*	Endemic subspecies	At Risk- Declining	No	Limited	A
Australasian gannet	Tākapu	*Morus serrator*	Native	Not Threatened	Yes	Yes	D
Black shag	Māpunga	*Phalacrocorax carbo novaehollandiae*	Native	At Risk-Naturally Uncommon*	No	No	A
Little black shag	Kawau tūī	*Phalacrocorax sulcirostris*	Native	At Risk-Naturally Uncommon	No	No	A
Little shag	Kawaupaka	*Microcarbo melanoleucos brevirostris*	Endemic subspecies	Not Threatened*	No	No	B[2]
Pied shag	Kāruhuruhi	*Phalacrocorax varius varius*	Endemic subspecies	At Risk-Recovering	No	No	A
Spotted shag	Kawau tikitiki	*Phalacrocorax punctatus*	Endemic	Not Threatened*	Yes	No	B[3]
Black-billed gull	Tarāpuka	*Chroicocephalus bulleri*	Endemic	Threatened-Nationally Critical*	Yes	No	C
Red-billed gull	Tarāpunga	*Chroicocephalus novaehollandiae scopolinus*	Endemic subspecies	At Risk- Declining	Yes		C

Table 1. Summary table of the species breeding in the Auckland region, their conservation status and attributed priority.

Common name	Māori name	Scientific name	Endemic status	NZ conservation status	Ongoing or recent monitoring	Ongoing or recent research	Category of priority
Southern black-backed gull	Karoro	*Larus dominicanus*	Native	Not Threatened			E
Caspian tern	Taranui	*Hydroprogne caspia*	Native	Threatened-Nationally Vulnerable	No	No	A
New Zealand fairy tern	Tara iti	*Sternula nereis davisae*	Endemic subspecies	Threatened-Nationally Critical	Yes	Yes	C
White-fronted tern	Tara	*Sterna striata*	Native	At Risk-Declining	Yes	No	C

*Note: Species names as per Checklist Committee (OSNZ) 2022. NZ Conservation status as per Robertson et al. 2017. * species for which the conservation status changed after the assessment at the start of the Seabird Programme (Robertson et al. 2021). Category of Priority: See main text for description. [1]Only one of the two known colonies is studied, while there is a major knowledge gap on Te Hauturu-o-toi. [2]Species classified as Not Threatened at the national level, but declining numbers and the total lack of monitoring justify the assignment to category B. [3]This species is classified as Not Threatened at the national level but it has been recognised as Threatened regionally. For this reason, it has been given the category of priority B.*

3 Projects on prioritised species

3.1 Black petrel on Te Hauturu-o-toi

Black petrels are a medium-sized seabird endemic to the Auckland region. They are known by the name of tākoketai by Ngāti Rehua Ngāti Wai ki Aotea, the tangata whenua and mana whenua of Aotea, and by the name of tāiko by Ngāti Manuhiri, the tangata whenua and mana whenua of Hauturu. Once widespread on the mountains and hills (300+ metres above sea level) of the North and northern South Islands of New Zealand, they now only breed on Hauturu and Aotea (Taylor 2000a) as a result of the introduction of feral cats (*Felis catus*), feral pigs (*Sus scrofa*), mustelids (*Mustela sp.*) and rats (*Rattus sp.*) which, together with changes to habitat availability, caused the extirpation of black petrels from the mainland. While Hauturu is now a predator-free island, feral pigs, feral cats, ship rats (*R. rattus*) and kiore (Pacific rats, *R.* exulans) are present on Aotea and have been recorded at the main breeding colony on Hirakimata / Mount Hobson on Aotea, representing a major threat (Bell 2013 [updated 2022]).

Black petrels are regularly caught by commercial and recreational fishers both in New Zealand and overseas and are recognised as the most at-risk seabird in New Zealand from commercial fishing; in fact they are the only species classified in the "very high risk" category of the National Plan of Action for reducing the incidental catch of seabirds in New Zealand fisheries (Ministry for Primary Industries 2013, Richard and Abraham 2013, Richard et al. 2017, Fisheries New Zealand 2020). Black petrels are ranked as *Nationally Vulnerable* under the New Zealand Threat Classification System (Robertson et al. 2021) and *Vulnerable* on the IUCN Red List of Threatened Species (BirdLife International 2023).

To obtain accurate assessments of population trends for this species and to quantify population parameters such as annual burrow occupancy rates, annual adult reproductive success, as well as adult and juvenile annual survival rates, a long-term research project was initiated at the largest known breeding colony in Aotea on Hirakimata in 1995/96 (Bell and Sim 1998): it is still ongoing 29 years later providing fundamental information (Bell et al. 2024). However, the extent of the population outside the study area on Aotea is largely unknown and there is uncertainty over the population status and trends on Hauturu (Gaskin and Rayner 2013, Ministry for Primary Industries 2013, Richard et al. 2017, Bell et al. 2020, Bell 2021).

On Hauturu, the main known breeding area is along the main ridge between the Thumb and Mt Orau. Monitoring work on black petrel was only conducted sporadically and on a limited number of burrows [by Mike Imber in 1971-75, 1978/79 and 1981-84 in 22 study burrows (Imber 1987); in 1985-1988 in 60 study burrows, as part of the transfer of black petrel chicks from Aotea to Hauturu (Imber et al. 2003a); and in 1997-1999 in 97 study burrows]. The most recent monitoring happened in the years 2014-15 and 2015-16 on a total of 123 and 145 burrows, respectively, including most of the original Imber study burrows (Bell et al. 2015, Bell et al. 2016a). These data offer a snapshot of the population in time but has limited use for understanding long-term population trends and dynamics, population structure and survival rates. Until recently, the lack of resourcing had prevented the ability to undertake the necessary long-term monitoring; the Seabird Programme now has the opportunity to fill this knowledge gap.

An accurate estimate of the global population size and trend of black petrels, and in particular the number of mature breeding pairs and recruitment and survival rates is key information required to assess the long-term viability and sustainability of the population, as well as to assign an accurate regional, and thus national, conservation status. Given the high risk of irreversible decline for this regionally endemic species, monitoring on Hauturu is of high priority. This will allow to gain an overall population perspective on health, trends and threats, and to gather knowledge and information to inform the implementation of effective management on other populations.

3.1.1 Methods

To address the knowledge gaps for black petrels on Hauturu and quantify population parameters such as annual burrow occupancy, breeding rates, annual reproductive success, and adult and juvenile annual survival rates, a long-term monitoring programme was initiated. A collaboration was established with Elizabeth Bell at WMIL. who was the last to monitor this colony in the 2015-16 breeding season. Bell shared the locations of 149 previously monitored burrows, including the original study burrows established by Mike Imber (see above). These burrows are spread along the central ridge of the island, predominately above 400m altitude in very steep ledges and slopes. The area is covered with the dense cloud forest vegetation and is a very fragile environment.

The study area was visited twice during each of four consecutive breeding seasons (2020-21 to 2023-24); in December to monitor for breeding and nest occupancy rates and then late April to check for fledging chicks and estimate breeding success. In 2023, the burrows were monitored for chicks in early March because the island was closed for a rāhui in April.

All burrows were inspected to detect any occupying adults. If an adult was present, it was removed from the burrow, banded (or the band number recorded if it was a recapture) and then returned to the burrow. The burrows were also inspected for the presence of eggs or eggshell fragments to determine the breeding status, and the absence of this sign was used to identify non-breeding birds. Occupied burrows were then re-checked in late April, at the end of the breeding season, to look for fledging chicks, which were then banded, and the totals used to calculate breeding success.

All study burrows were accessible either through the main entrance or via an opening that had been excavated through the burrow roof or wall into the chamber. This opening was covered by a piece of wood or a rock and sealed to water infiltrations using vegetation.

3.1.2 Results and discussion

The same study burrows from previous surveys were monitored for four consecutive breeding seasons between 2020 and 2024, including the burrows initially studied in the 1980s and 90s. In December 2022, the monitoring was extended to include additional burrows identified through a dog survey undertaken in 2016 (Bell et al. 2016a), but they had not been included in the network of study burrows and had not been monitored since their initial detection. Results of the monitoring are presented in Table 2. The table also reports the data from the last three previous monitoring trips for comparison (Bell et al. 2015, Bell et al. 2016a).

Nest occupancy by breeding black petrels has historically been recorded as low on Hauturu respect to Aotea, with a recorded maximum of only 55.8% in the 2015/16 breeding season (Bell et al. 2016a) (Table 2). Data from the first three years of monitoring show that only about 30% of the burrows were occupied by breeding birds, with the lowest occupancy during the 2022/23 breeding season, when only about 24% of burrows were occupied by a bird on egg. This breeding season was characterised by an extreme La Niña event and consecutive wet weather, which likely impacted the birds – inducing them to start breeding later than usual and in lower numbers. The following year, on the contrary, our monitoring reported higher numbers of breeders, with about 50% of the burrows occupied.

The monitoring from this programme also found a reduced number of burrows occupied by non-breeding individuals (i.e. without an egg) with respect to historical data (Table 2). After fledging, juvenile black petrels spend the first 4-6 years of their life at sea without ever coming back to land. After these years at sea, they start to come back to the colony, prospecting for a potential nesting burrow and to find a partner (Bell 2013 [updated 2022]). Most of the birds identified as non-breeders in burrows (i.e. occupying a burrow but without an egg) are such prospectors. Thus, the reduced number of non-breeders observed may suggest a reduction in the number of prospecting birds. The long-term monitoring data from Aotea show alarmingly low levels of recruitment, with the average age of birds in the colony increasing with the lack of young adults coming back to breed (Bell et al. 2024). The lack of recruitment into the population is a significant concern as it suggests high rates of mortality at sea for immature birds that do not return to breed, preventing the natural renewal of the population. The causes for low recruitment rate need to be understood as it compromises the survival of the species in the long term.

Among non-breeders also are those adults who have lost their partner and so need to find a new one, or pairs that skip one season of breeding, but still visit the colony. Skipping breeding is a common event in petrels and long-lived species during years with harsh environmental conditions as an adaptive strategy to conserve energy and resources, thereby enhancing long-term adult survival and reproductive success over an individual's lifespan (Cubaynes et al. 2011, Bell et al. 2013, Oro et al. 2014). In the 2022/23 breeding season, the observed number of non-breeders was slightly higher than the other years of monitoring in this programme. This could be another effect of adverse La Niña conditions that year that induced an increased number of birds to skip breeding.

Breeding success (the proportion of breeding nests that successfully fledged a chick) during the first three years of monitoring was also lower than previously recorded in past studies on Hauturu, and it was comparable during the fourth year. Again, the breeding season 2022/23 was remarkably negative. Black petrel burrows were checked in March 2023 during the Cook's petrel fledging monitoring trip (see section 3.2) to check for any late breeding in the empty burrows or the burrows occupied by non-breeders during the previous trip. A re-check of 58 of the burrows monitored in December 2022, including most of the breeding burrows, identified only a few supplemental breeding burrows indicating some late breeding attempts; but, it also revealed that about one third of the breeding burrows had already failed approximately two months before fledgling time (Table 2). In April 2023 our regular monitoring trip had to be cancelled due to a rāhui placed on the island restricting the access. Thus, we could not assess the final breeding success for the 2022/2023 season.

During the chick monitoring trips, occasionally a chick would be found in some of the nests that had been identified as non-breeders during the previous trip checking for burrow occupancy. This may indicate these nests started breeding later than the monitoring, or that the egg was already present but undetected at the time. These burrows are indicated in Table 2 as additional number of chicks (shown on the breeding success line) but are not included in the calculation of the breeding success so to avoid a positive bias.

Table 2. Comparison of burrow occupancy across the years for all monitored black petrel study burrows on Hauturu.

	1996/97*	2014/15**	2015/16*	2020/21	2021/22	2022/23	2023/24
N of burrows	97	123	145	109	117	145	117
Breeding	39 (40.2%)	55 (44.7%)	81 (55.8%)	29 (26.6%)	34 (29.1%)	33 (22.8%)	59 (50.4%)
Non-breeding	16 (16.5%)	18 (14.6%)	26 (17.9%)	2 (1.8%)	4 (3.4%)	10 (6.9%)	2 (1.7%)
Unknown status	-	-	-	7 (6.4%)	6 (5.1%)	14 (9.6%)	3 (2.6%)
Non-occupied	43 (44.3%)	50 (40.7%)	38 (26.2%)	68 (62.4%)	68 (58.1%)	75 (51.7%)	53 (45.3%)
Breeding success	-	47 (85.5%)	69 (85.2%)	22/29 (75.9%)	25/31 (80.6%)	20/30 (66.7%)	50/59 (84.7%)
Occupied by Cook's petrel				2 (1.8%)	4 (3.4%)	16 (10.4%)	N/A

*Note: N of burrows = number of monitored burrows. Breeding = number of breeding burrows. Non-breeding = number of burrows occupied by non-breeding adults. Unknown status = number of burrows with an adult observed for which was not possible to assess the breeding status. Non-occupied = number of known black petrel burrows found empty. Breeding success = number of burrows containing a fledging chick / number of burrows checked previously detected as breeding that were rechecked. Occupied by Cook's petrel = number of black petrel study burrows found occupied by Cook's petrel. *data from or reported in Bell et al. 2016a. **data from Bell et al. 2015.*

The monitoring data initially showed a reduction in the proportion of breeding burrows, a decrease in breeding success and a drop in non-breeders with respect to previous surveys on the island. These data could be suggesting a decline in the population, which would be counter to expectations given Hauturu is the only predator-free area where this species breeds. However, the last year of monitoring showed breeding occupancy and success rates similar to past surveys.

During the 2022/2023 season, the lowest breeding occupancy and success were recorded, with an increased number of birds skipping breeding (see above). This is likely a consequence of the extreme wet weather that affected Auckland during the whole summer, and similar outcomes were also reported for the main colony on Hirakimata (Aotea), where they recorded the lowest breeding success in 28 years of monitoring, at 61% (Bell et al. 2024). Long-lived species may choose to skip breeding when environmental conditions are not favourable (see above). However, the expected increase in frequency of extreme weather events and adverse climatic conditions (Pearce et al. 2020) may represent a new important threat for the species.

During monitoring, some of the burrows historically occupied by black petrels were found to be occupied by Cook's petrel (Table 2). The Cook's petrel population on Hauturu has increased significantly since feral cat and kiore/Pacific rat eradication, counting now hundreds of thousands of individuals (See section 3.2). They start their breeding season about one month earlier (Taylor and Rayner 2013 [updated 2022]), potentially creating competition for burrows. Also, the loud calling of Cook's petrels at night largely outnumber black petrels, possibly drowning out the male black petrel clacking from the burrows, which may negatively interfere with mate attraction behaviour. A full count of the black petrel burrows taken over by Cook's petrel was only done in the 2022/2023 breeding season when 16 burrows previously occupied by black petrel were instead occupied by Cook's petrel. An assessment of any potential trend is not possible yet; however, this is something worth ongoing monitoring.

When monitoring burrows, all captured adults were identified (i.e. either by banding or recording a previous band) to allow for future studies of population structure and dynamics (Table 3). The banding data shows a high number of recaptures of birds already banded in the past, which is expected given the high partner and nest fidelity of this species, i.e. they tend to breed always in the same nest and with the same partner during the course of their long life (Bell 2013 [updated 2022]). One of the birds recaptured during the 2022-2023 breeding season was a bird banded as a fledging chick in 2015, which was now breeding in a burrow just few meters away from the burrow it fledged from. This was the first time that a returned chick was recaptured on Hauturu. About one-third of the captured birds were non-banded, i.e. they had never been captured before. This could suggest positive and negative implications. On one hand, new birds coming to the colony may indicate a good recruitment level into the breeding population; on the contrary, changes in pair composition and breeding birds may suggest an instability in population structure, with established breeding adults with lost mates needing to find new partners. Such instability maybe a reason for the decreased number of breeding burrows on the island, and an indication of a potential vulnerability in the health status of the population. Ongoing long-term monitoring is required to understand what is happening.

Table 3. Number of black petrel recaptured and newly banded during monitoring, including both adults and fledgling chicks.

	2020-21	2021-22	2022-23	2023-24*
Recaptures of birds banded prior to 2020	23	23	25	7
Recaptures of birds banded during the Seabird Programme	-	7	3	3
TOTAL RECAPTURES	23 (59%)	30 (70%)	28 (58%)	10*
Number of new-banded adults	16 (41%)	13 (30%)	20 (42%)	0*
TOTAL ADULTS	39	43	48	10
Number of new-banded chicks	22	25	0	46
TOTAL NUMBER OF BIRDS	**61**	**68**	**54**	**56**
Bands recoveries from birds found dead	1	0	0	0

**Breeding monitoring trip delayed until end of January, so most of the adults had already left the chick alone.*

Overall, these observations highlight how long-term monitoring including collecting banding data, is fundamental to disentangling yearly fluctuations in breeding numbers from the overall population stability and trends. This is particularly important for long-lived seabirds, like black petrels, that have delayed breeding, lay only one egg per year and can breed for over 30 years.

3.1.3 Next steps and management implications

Long-term monitoring of the black petrel population on Hauturu is necessary to accurately inform the species population status and trend on the island, beyond the annual fluctuations in breeding activity this initial monitoring of four-breeding seasons has shown. The study of the colony on Hauturu is important to gain insights on the black petrel population and its dynamics as a whole and acquire knowledge to inform effective management and protection recommendations. Long-term monitoring on Hirakimata shows that despite seasonal fluctuations over the duration of the study, both breeding success and burrow occupancy by breeding birds appear to have downward trends (Bell 2021). A clear view of the whole population (colonies at Aotea and Hauturu) is necessary to identify how to support the survival of this endemic species long-term. Continuing parallel monitoring on the two colonies will allow for comparison of breeding rates and productivity, enabling investigation of factors that could be driving observed differences and, ultimately, affecting population trends. Such comprehensive monitoring will also help understanding the level of philopatry and exchanges of individuals from the two colonies (e.g. if birds banded on one colony are found breeding on the other colony).

It would be beneficial to set up monitoring of fixed study plots as on Aotea (Bell et al. 2024), as well as to increase the number of the study burrows on Hauturu. This would help to clarify if the decreased occupancy observed in the historical study burrows is due to a decrease in breeding pairs or if the birds have moved to different burrows/areas and would allow for a better comparison between the two colonies. Further monitoring would also help to understand possible interactions and competitions with Cook's petrel, and whether the increasing Cook's petrel population may be limiting the expansion of black petrels on Hauturu.

These findings so far suggest the need for continued monitoring and, when a trend becomes clearer, appropriate management actions should be identified and considered, especially for the main colony on Hirakimata (Aotea). While Hauturu is pest-free, introduced mammalian predators including feral cats, kiore and ship rats are present on Aotea and black petrels are killed every year by rats and cats (Bell 2013 [updated 2022]). It is important to note that black petrels managed to persist on Aotea despite the presence of invasive predators, likely due in part to Norway rats and mustelids remaining absent. An invasion by one of these species would have catastrophic effects on black petrels just as their arrival on the mainland did for the extirpation of black petrel from the mainland. This emphasises the importance of managing predator populations at place as well potential invasion pathways.

A further threat to the population is feral pigs. Their presence limits the expansion of black petrels on Aotea outside of Hirakimata and has the potential to destroy the population should the feral pig population expand into Hirakimata. However, pigs are also considered valuable as a food source by local hunters and mana whenua. To understand the views of the local community about the interactions between pigs and black petrels and explore the perception of non-lethal control methods, we collaborated on a specific socio-ecological study described in section 5.2 of this report.

A major issue for black petrel appears to be the lack of recruitment. Understanding juvenile survival and recruitment is necessary for accurate demographic modelling and for species risk assessment modelling. In this aim, the Seabird Programme collaborated with WMIL in the establishment of a project aimed at capturing black petrels at sea to assess if apparent low juvenile survival is biased by dispersal away from study colonies (See section 5.3).

Finally, during the surveys, samples were collected of chest feathers from both adults and chicks. These are to be analysed for the presence of heavy metals and other contaminants (See section 6.1), as well as for pigmentation as a measure of bird quality (See section 5.1). Such analyses will provide further insights on the health of these birds. Feather samples could also be analysed for stable isotopes to compare with samples from Aotea to investigate possible differences in foraging habitats between the two colonies.

3.2 Cook's petrel

Tītī Cook's petrel (*Pterodroma cookii*) is a small petrel species endemic to New Zealand (Imber et al. 2003b, Taylor and Rayner 2013 [updated 2022]). Previously a common species throughout mainland New Zealand, the introduction of invasive mammalian predators has significantly impacted their numbers and restricted their distribution to two pest-free offshore islands at the extremities of its former breeding range, Hauturu and Whenua Hou / Codfish Island off Stewart Island, where it is present in great numbers. Such geographically distinct populations are recognised as separate subspecies: northern Cook's petrel (*P. c. cookii*), and southern Cook's petrel (*P. c. orientalis*), respectively. The northern subspecies also count a small population of scattered burrows on Aotea, but it is on the brink of extirpation by cats, rats and feral pigs and it is considered not viable (Imber et al. 2003b, Gaskin and Rayner 2013, Taylor and Rayner 2013 [updated 2022]). This extremely reduced range, in respect to the original historic one, justifies the classification of the species as *At-Risk – Relict* under the New Zealand Threat Classification System, despite the increasing population trend (Robertson et al. 2021). Northern Cook's petrel have elevated importance as a regionally endemic subspecies.

Introduced predators still are one of the major threats for this species on Aotea, where rats preying on chicks reduce the productivity of this population to virtually zero (E. Bell *pers. comm.*). There is a lack of regular monitoring to quantify the impacts of predators and to assess the population trend for Cook's petrel. The population on Hauturu recovered well after cat and kiore were eradicated and has subsequently been expanding, with the last census in 2004/2005 estimating the population at 286,000 breeding pairs (Rayner et al. 2007a). Recently, breeding of this species was recorded on Ōtata (see section 4.1) and Tāwharanui (J. Ross *pers. comm.*), two predator free areas, suggesting that introduced predators are a major factor preventing Cook's petrel from recovering on Aotea and from expanding to mainland sites. Evidence suggests that eradication of introduced invasive mammalian predators is a driving factor for Cook's petrel expansion (Towns et al. 2006).

Cook's petrel is the only petrel species known to cross the mainland over the Auckland isthmus at night to forage in the Tasman Sea from their breeding sites in the Hauraki Gulf in the East (Imber et al. 2003b, Gaskin and Rayner 2013). This exposes these birds to the threats of light pollution which seems to particularly affect this species by disturbing and disorienting birds (Gaskin and Rayner 2013, Heswall et al. 2022). In fact, a recent study showed that this species has a higher chance of becoming grounded in the Auckland urban area than any other seabird species, and that bird groundings increase with the intensity of city lights (Heswall et al. 2022). Most grounded birds are fledglings, and a high number of them are rescued every year from the Auckland Central Business District after being disorientated from their route by urban night lights (Gaskin and Rayner 2013, Heswall et al. 2022). Over 30% of rescued Cook's petrel do not survive due to the injuries suffered as a consequence of disorientation and collision, e.g. head trauma, internal bleeding (Heswall et al. 2023). Light pollution also threatens Cook's petrels at sea; several Cook's petrel have been reported to die after colliding with the lighthouse on Pokohinu Burgess Island after being disorientated from their flights at sea (*pers. obs.*, C. Gaskin & E. Whitehead *pers. comm.*) and preliminary studies on seabird attraction by artificial lights on fishing vessels count Cook's petrel among the most attracted seabirds both in the Hauraki Gulf and off the South Island (Lukies et al. 2021, Goad et al. 2023).

Plastic pollution is another threat to the Auckland population of Cook's petrel. The exposure risk to plastic pollution is higher in northern New Zealand, and thus for the population breeding on Hauturu, than on

Whenua Hou (Clark et al. 2023). Such divergence in risk of plastic ingestion becomes extreme during the non-breeding season. Cook's petrel from Hauturu migrate to the northeast Pacific, where the exposure to plastic pollution is among the highest in the world, while birds from Whenua Hou migrate to the Humbolt Current where the risk is low. Cook's petrel from Hauturu are recognised as the population at the highest risk from plastic pollution in New Zealand, and the sixth highest in the world (Clark et al. 2023). It is thus of primary importance to quantify plastic ingestion for this species to inform management to address this threat.

Despite the array of threats affecting this species and the information gaps on population status and trends – the last monitoring and population estimate on Hauturu happened in 2004/05 (Rayner et al. 2007a) – there is no regular monitoring, including following the removal of 547 chicks between 2012 and 2016 for translocation to establish new colonies at the Cape Sanctuary and Boundary Stream, Hawkes Bay (C. Mitchell *pers. com.*; Hozumi et al. 2011). Monitoring population dynamics and trends following the removal of chicks for translocation is crucial to determine the effects of the disturbance on the population. In fact, a decline in breeding occupancy was observed in the burrows repeatedly used for translocation, i.e. where the chick was removed during several consecutive years (C. Mitchell *pers. comm.*), but no follow up monitoring to quantify and assess the impacts on population dynamics and stability was carried out. So, to address the identified knowledge gaps and to gain an understanding of their population health and stability, we started population monitoring of the main population on Hauturu (this section) and of the relict population at Glenfern Sanctuary, Aotea (Section 4.3.). Such monitoring will also provide valuable information to support targeted management for this regionally endemic subspecies.

3.2.1 Methods

To determine population stability and to quantify population parameters such as annual burrow occupancy and breeding rates, annual reproductive success, and to estimate both adult and juvenile annual survival rates, we started a long-term monitoring programme for Cook's petrel on Hauturu. To set up our monitoring, we contacted DOC rangers working on the island or those that had participated in previous relocations of the chicks from Hauturu to Boundary Stream and Cape Sanctuary. From them, we obtained a map of the burrows previously used to take the chicks, for us to use as study burrows. The burrows were spread across two main areas of the island, on the Thumb track and in the Orau area on three different ridges. Both areas are above 500 m above sea level on steep terrain and covered in dense vegetation.

Monitoring started in December 2020 in parallel to black petrel monitoring (Section 3.1) as they have overlapping breeding seasons, so to optimise resources. We visited the island twice per breeding season; in December to monitor for breeding adults and nest occupancy rates, and late February/early March to check for fledging chicks and estimate breeding success. During each visit, we thoroughly inspected all burrows to detect any occupying adults. If an adult was present, it was removed from the burrow, banded (or the band number recorded if a recapture) and returned to the burrow. The burrows were also inspected for the presence of eggs or eggshell fragments to determine the breeding status, and the absence of this sign was used to identify non-breeding birds and unused nests. Occupied burrows were then re-checked in late February/early March to look for fledging chicks and calculate breeding success. As Cook's petrel burrows have a very long and convoluted entrance tunnels, all study burrows have a man-made opening that has been excavated through the burrow roof or wall allowing for direct access the nest chamber. This opening was covered by a piece of wood or a rock and sealed using vegetation to prevent water infiltrating.

3.2.2 Results and Discussion

The Cook's petrel colony on Hauturu was monitored for three consecutive breeding seasons: 2020/2021, 2021/2022 and 2022/2023 (Table 4). Due to unforeseen circumstances, the field trip in December 2021 was cut short, so it was limited to a subset of burrows. The following trip to monitor chicks also had to be cancelled and so breeding success for that year (2021/2022) could not be calculated.

Monitoring results show that a majority of burrows were occupied by breeding birds (59.3-64.2%). Breeding success was also high, especially in the 2020/2021 breeding season when 88.1% of breeding burrows successfully fledged a chick. It is interesting to note that this species managed to breed more successfully during the 2022/2023 summer when due to extreme La Niña weather patterns, many other species (e.g. black petrel 3.1, white-faced storm petrel 3.3, grey-faced petrel 4.1) suffered poor breeding outcomes. Over this period, 64% of burrows were occupied by breeders and 62% successfully fledged a chick. Facing global climate change, in which extreme weather events are expected to increase, long-term monitoring may help reveal what factors made this species seemingly more resilient to this than others.

Cyclone Gabrielle still had significant impacts on the island. Numerous treefall covered and destroyed burrows. More importantly, a large landslip destroyed a vast area, preventing access to one of the areas where study burrows are located. Consequently, it was not possible to check 16 of the 88 breeding burrows previously identified. It was not possible to determine if the slip also covered the area with the study burrows, thus destroying them too, or only the track to access them.

Table 4. Comparison of burrow occupancy and breeding success for all monitored Cook's petrel study burrows on Hauturu.

	2020/21	2021/22	2022/23
N of burrows	115	27	137
Breeding	70 (60.9%)	16 (59.3%)	88 (64.2%)
Non-breeding	-	2 (7.4%)	5 (3.6%)
Unknown status	15 (13%)	1 (3.7%)	6 (4.4%)
Non-occupied	28 (24.3%)	7 (26.0%)	35 (25.5%)
Unknown occupancy	1 (0.9%)	1 (3.7%)	3 (2.2%)
Breeding success	59/67 (88.1%)	-	42/68 (61.8%)

Note: N of burrows = Number of burrows monitored. Breeding = number of breeding burrows. Non-breeding = number of burrows occupied by non-breeding adults. Unknown status = number of burrows with an adult for which was not possible to assess the breeding status. Non-occupied = number of known Cook's petrel burrows found empty. Unknown occupancy = number of monitored burrows for which it was not possible to assess the presence of a bird (too deep or convoluted). Breeding success = number of burrows containing a fledging chick / number of burrows previously detected as breeding that were rechecked.

Breeding success on Hauturu was 33% on average between 1971 and 1982, but less than 13% in 1984-2003, and 68% in 2003 (Imber et al. 2003b). It is estimated that kiore may have killed 70-90% of chicks over the 2001 and 2002 breeding seasons. The eradication of feral cats by 1980 increased the number of breeding pairs, but the resulting increase in kiore numbers (i.e. mesopredator release) reduced the potential productivity by about 83% (Imber et al. 2003b, Rayner et al. 2007c). Monitoring results show the recovery of the Cook's petrel population on Hauturu after predator removal, highlighting once more the importance of predator-free environments for seabird restoration. Observations of breeding Cook's petrel on Ōtata Island (Section 4.1) and at Tāwharanui Open Sanctuary (J. Ross *pers. comm.*) highlight the possibility of natural re-colonisation when areas are made predator free, and the high potential for the recovery of the population on Aotea if predators were to be removed. Given their historical distribution, Cook's petrel have a high degree of habitat flexibility (Rayner et al. 2007b) making this species a good candidate to recolonise (or to be reintroduced) to the mainland in areas where predators are eradicated.

To investigate population dynamics and stability, we have started to band all captured adults and fledging chicks. Number of banded birds are reported in Table 5. Previous banding studies on Hauturu Cook's petrel are scarce, so almost all birds were banded during our programme and the number of recaptures is slowly starting to increase after three years of monitoring. More years of monitoring and banding will be needed to obtain insights into the population. A few birds banded before the start of our programme were recaptured (Table 5), and all were found in the same area around Mount Orau. The DOC banding database showed that these birds were banded in 2004 and 2006 as adults breeding in the same area where they were recaptured. Considering that the minimum breeding age for this species is around four years-old, these birds were at least 25 years-old or older, highlighting their long breeding life and site fidelity.

Table 5. Number of Cook's petrel recaptured and newly banded during monitoring, including both adults and fledgling chicks.

	2020-21	2021-22	2022-23
Recaptures of birds banded prior to 2020	2	0	5
Recaptures of birds banded in the previous breeding seasons.	-	4	31
TOTAL RECAPTURES	2	4	40
Number of new-banded adults	86	15	53
TOTAL ADULTS	90	21	93
Number of new-banded chicks	81	-	54
TOTAL NUMBER OF BIRDS	**171**	**21**	**147**

3.2.3 Next steps and management implications

Data show encouraging numbers of breeding pairs and good breeding success from monitoring over three recent breeding seasons, but long-term monitoring is needed to assess population stability and trends. Continuing banding individuals in burrows will provide insights into population structure, and nest and partner fidelity, which are among the main indicators of stability, and will support future management planning and enable an update to the last population estimate calculated in 2004 (Rayner et al. 2007a).

The Cook's petrel population breeding on Hauturu was identified as the most at risk from plastic pollution (Clark et al. 2023). Now that regular breeding monitoring has been established, specific research investigating plastic ingestion would need to be designed to assess this threat.

Further research is also needed to improve our knowledge about the impacts of artificial lights on this species so to establish effective mitigation measures both on land and at sea. Specific monitoring should focus on quantifying light strikes and understand behavioural patterns driving Cook's petrel's vulnerability to light attraction. Auckland Council is currently collaborating with the University of Auckland to develop a project to investigate this threat and find ways to reduce it. The knowledge presently available is enough to suggest that light strikes are a threat to the Hauraki Gulf population. The Convention on Migratory Species (CMS) formulated guidelines on light pollution. New Zealand is a signatory to the CMS, and DOC is promoting the CMS guidelines as a means of reducing light pollution impacts on protected species. It is therefore important to start raising an awareness of this issue.

3.3 White-faced storm petrel

The white-faced storm petrel (hereafter WFSP) is known to Māori as takahikare, which means "dancing on the waves". It is a sub-species, endemic to New Zealand breeding on a number of islands off the North, South, Stewart, Chatham, and Auckland Islands (Taylor 2000b). Within the Auckland region, there are two confirmed breeding populations on Pokohinu / Burgess Island, Mokohīnau, and Ruapuke / Maria Island, The Noises (Figure 2). It is considered a very abundant species, with over a million breeding pairs nationwide, however the last national population estimate dates back to approximately 40 years ago (Robertson and Bell 1984). Despite the high numbers, the national conservation status of WFSP is *At-Risk* and the population is considered to be *Relict*, i.e. "a taxa that has undergone a documented decline within the last 1000 years and now occupy less than 10% of their former range, and with a population that is stable or slowly increasing" (Robertson et al. 2021).

The species is extremely vulnerable to all introduced mammalian predators, and populations have been lost when predators have reached formerly predator-free islands. Several hundreds of WFSP were killed when Norway rats colonised The Noises Islands in 1959-1960 triggering a rat-poisoning initiative by a group of schoolchildren from Waiheke and their teacher Alistair McDonald, which was followed up by the New Zealand Wildlife Service. In 1964, rats were finally eradicated from Ruapuke saving the population, but unfortunately the population on David Rocks was extirpated (Cunningham and Moors 1985). Most colonies are on soft friable soil and the trampling of the tiny burrows by cattle and other ungulates is a significant threat which caused the destruction of many colonies, including historically on Pokohinu / Burgess Island. At sea, WFSP are threatened by plastic pollution; there is evidence that up to 79% of WFSP ingest plastic debris (Furtado et al. 2016). Even if this issue has yet to be fully understood, such a high proportion is concerning and could have important impacts on population health.

Both Pokohinu and Ruapuke are now predator-free islands, and this change saw the recovery of the WFSP breeding populations immediately after predators were eradicated (Cunningham and Moors 1985, McFadden and Greene 1994, Ismar et al. 2014. See chapters 4.1 and 4.4 for more details on the islands), but knowledge on the recent status of the populations today is lacking. WFSP were previously studied on Pokohinu to investigate their breeding biology (Rayner et al. 2017b), but there have not been studies of their population size, trends and dynamics. In the Auckland region, the size of populations is unknown and requires assessment (Gaskin and Rayner 2013). Considering that both The Noises and Mokohinau Islands are among those sites that are identified as having high ecological importance (see section 4.1, and 4.4), and to address the identified knowledge gaps, a population monitoring programme for this species was started on both colonies.

3.3.1 Methods

WFSP are a difficult species to monitor due to a number of constraints linked to the species sensitivity and the habitat where they nest. Adults cannot be banded by capturing birds from the nest burrow when they are incubating the egg, as is general practice for many other species, because this causes nest desertion (Rayner et al. 2017b). Burrows are therefore only checked for occupancy and breeding by gently sliding the hand in the burrow and under the incubating adult to feel for the presence of the egg, or with the help of a burrowscope (e.g. an endoscope camera allowing inspection of the inside of burrows). This practice allows for an estimate burrow occupancy to be assessed, and later breeding success, but doesn't provide information about individuals nor survival rates.

To estimate population size and survival of individuals, a mark-recapture project was set-up to capture the birds at night and band them. Mark-recapture is a method for estimating abundance and survival which involves capturing a number of animals, marking them, releasing them back into the population, and then determining the ratio (proportion of marked to unmarked animals) of the population when marked and unmarked animals are captured at a later date (Thompson et al. 1998).

In October 2020, before the peak of egg-laying period and when there is the most activity at the colony, a trial was started to assess the feasibility of capturing the birds at night at the colony using a spotlight to attract them to the ground. In October 2021 and 2022, standard mist-nets were used for captures as a more effective method. This involved using two polyester, six-metre-wide mist-nets, with 30 mm mesh. The presence of a boardwalk on the top of Ruapuke meant that the nets could be put up right in the middle of the colony, while on Pokohinu, they were put on the rocky edge of the colony so not to risk trampling on burrows. Nets were deployed at dusk, so to capture the birds as soon as they started coming back to the colony at night. Nets were constantly monitored so that caught birds would be immediately removed. When captured, the birds were individually put into cotton bags so to stay calm while waiting to be processed. One at the time, the bags were opened, the bird was taken out, banded and assessed for the presence of a brood patch to ascertain the breeding status (Rayner et al. 2013). After all the measures were taken, the birds were gently released by opening the hand and letting them fly or leaving them on the ground. Before release, as per standard practice, they were marked with correction fluid on the forehead, so they were recognisable in case of subsequent recapture that night and therefore could be immediately released.

3.3.2 Results and discussion

The monitoring of WFSP populations under this programme has been impacted by COVID-19 restrictions and adverse weather limiting access to the colonies. Monitoring on Pokohinu was particularly impacted, making data collected so far inconsistent.

Breeding monitoring

During the 2019/2020 breeding season, both colonies on Ruapuke and Pokohinu were monitored. On Ruapuke, a total of 135 burrows were monitored, of which only 32 were occupied (23.7%), 27 with breeding birds on an egg and five by a cold egg found alone in the nest, whereas 103 burrows were empty. On Burgess, 61 burrows were found; 18 of those burrows were occupied (29.5%): two burrows were occupied by an incubating adult, four by a cold egg, eight had a chick and four had a chick accompanied by an adult (Table 6). In January 2020, 29 of the previously occupied burrows on Ruapuke were checked. Of these, 15 burrows were successful breeders (51.7%), with chicks being found and banded, whereas the remaining 14 burrows were found empty. On Pokohinu, 18 of the previously occupied burrows were monitored, counting 10 fledglings, three dead chicks and five empty burrows, and totalling 56% breeding success.

Monitoring of burrows was not possible during the 2020/2021 breeding season, and it resumed during the 2021/2022 breeding season on Ruapuke only. On Ruapuke, the installation of a new boardwalk running on top of the island allowed the access to the top of the colony where burrow density is the highest. There, in November 2021, 48 burrows were checked, of which 34 were occupied by breeders (70.8%); 25 by breeding birds on an egg and nine by cold eggs alone in the nest. Fourteen burrows were empty. In January 2022, 30 of the previously occupied burrows were monitored: 20 were successful breeders, with 18 chicks being found and banded, and two empty burrows showing clear signs that the chick had just fledged. Ten burrows were empty, with four of those collapsed (Table 6).

During the 2022/2023 breeding season it was again possible to access both islands to assess nest occupancy and breeding. On Ruapuke, during the October mist-netting trip (see below) one occupied nest with a bird on an egg was found. In the following November, 43 other burrows were monitored; of these, 21 burrows were occupied, 13 with breeding birds on an egg and eight with a cold egg found alone in the nest, while 23 burrows were empty. On Pokohinu, burrows were inspected at the end of October, past what is the known peak of laying date (Rayner et al. 2017b), but over the 46 burrows checked, only two were occupied by a breeding adult and all the others were empty, highlighting low occupancy (Table 6). In early February 2023, on Ruapuke, only five of the previously occupied burrows were successful breeders (26.3%), with chicks being found and banded. The remaining burrows were empty. While searching for more chicks around the island, only two more chicks were found among a high number of burrows which were all empty. The survey happened on the 4 February, just few days after the Auckland Anniversary Weekend Flood; all the burrows – and the whole island – were incredibly wet or flooded, with the few found chicks looking wet and ruffled, and in poor physical condition. The extreme weather prevented the access to Pokohinu, so it was not possible to survey the island for breeding success of the two breeding burrows and to look for more chicks.

During the 2023/2024 breeding season, once again only Ruapuke was accessible for monitoring both in November to monitor occupancy and at the end of January to look for fledglings. In November, 63 burrows were monitored; of these 51 were occupied, 37 with an adult and 14 nests had an egg alone. Of the 37 burrows with an adult, the presence of an egg was confirmed in 20 of them, while for the other 17 the breeding status was non confirmed. 12 burrows were empty. Overall, confirmed breeding occupancy was 54%%. The following January, 48 of the previously occupied burrows were monitored (32 of the confirmed breeding burrows, and 16 of the unknown breeding status). Ten chicks were found from the breeding burrows, including two chicks from burrows in which the egg was detected alone (no adult present). Of the remaining burrows, three were containing failed egg and the remaining 35 were empty. Breeding success for the year was 31% (Table 6).

Overall, data so far highlight significant interannual variability in both nesting occupancy and breeding success. Importantly, findings highlight the species' vulnerability to climatic conditions and extreme weather events. In particular, there is a critical need to better understand how changes in El Niño/La Niña climate patterns influence breeding outcomes and the broader ecology of these seabirds. Long-term, consistent monitoring will be essential for identifying trends, assessing threats, and informing effective conservation strategies to support the resilience and persistence of these populations.

Table 6. Synthesis of takahikare / white-faced storm petrel monitoring results showing breeding occupancy and breeding success on the two colonies of the Auckland region, Ruapuke and Pokohinu. Details on numbers of burrows are presented in the main text.

Breeding season	% Occupancy		Breeding success %	
	Ruapuke	**Pokohinu**	**Ruapuke**	**Pokohinu**
2019/2020	23.7	29.5	51.7	55.6
2020/2021	*NA*	*NA*	*NA*	*NA*
2021/2022	70.8	*NA*	66.7	*NA*
2022/2023	47.7	4.3	26.3	*NA*
2023/2024	54.0	*NA*	31.3	*NA*

Population size estimate

On Ruapuke, the capture and marking effort has increased over the three years of the project. In 2020, two non-consecutive nights of captures were carried out (approximatively five and four hours), with two people in the field using the spotlight only. In October 2021, captures were done during two consecutive nights using both mist-nets and light attraction for about five hours per night, again with a team of two in the field. Whereas in October 2022, as a result of the end of COVID-19 restrictions, a full team of four people was in the field, capturing again with a combination of mist-nets and light attraction for about five hours per night. Numbers of birds captured in each year are reported in Table 7. In October 2023, continuous adverse weather prevented the access to the island and no data were collected.

Across the years, also four fluttering shearwaters and one common diving petrel were incidentally captured and banded, showing their presence on the island at night.

Table 7. Number of birds banded and recaptured during night captures for the WFSP mark-recapture project on Ruapuke.

Ruapuke	2020	2021	2022
New bands	139	367	496
Recaptures	-	4 (1%)	40 (7%)
Total captured	139	371	536

These numbers of captures and recaptures suggest that several thousands of birds may be breeding on Ruapuke. This estimate still has significant uncertainty around it because three years of data are not enough to obtain a reliable estimate from the mark-recapture model. Notwithstanding, this already is a big step forward in the understanding the population status on the island.

The situation on Pokohinu was very different as the access to the island was only possible in October 2020 and 2022 (See section 4.4), and the numbers of captured birds were much lower. In 2020, using only the spotlight, a team of two could only capture eight birds. In 2022, improving the efficiency of captures using mist-nets and with four people in the field, the numbers of captured birds increased (Table 8) but capture rates were much lower than Ruapuke comparatively. Unfortunately, the absence of recaptures so far prevents the calculation of a population size estimate, and more capture and marking sessions will be needed. There are physical differences between the colony sites on the two islands that likely affect the catch rates at each site and impact the effectiveness of mist-netting as a catching technique. The colony on Pokohinu is larger with birds more dispersed than on Ruapuke; and its location in the Outer Hauraki Gulf exposes it much more to strong winds, making the mist-nets likely to be more visible to the birds there and prone to birds avoiding the nets or escaping the nets due to wind gusts.

Table 8. Number of WFSP banded and recaptured during night captures for the mark-recapture project on Pokohinu.

Pokohinu	2020	2021	2022
New bands	8	*NA*	166
Recaptures	-	*NA*	0
Total captured	8	*NA*	166

One of the birds recaptured on Pokohinu in October 2022 was wearing an old band. From the DOC banding database, it was possible to find that the bird was banded as a chick on Pokohinu in January 2012, making it over 10 years old. This recapture adds useful information about the longevity of these small seabirds.

3.3.3 Next steps and management implications

Monitoring of WFSP was successfully established on Ruapuke, and it is starting to provide important information about population size and status. It is important now to achieve the same regular monitoring on Pokohinu to have a broader understanding on the whole regional population. Ruapuke and Pokohinu are different islands with different ecological environments, both on land, where they have different recovery trajectories after pest removal, and at sea, as they are located in the Inner and Outer Hauraki Gulf, respectively. These differences likely entail different pressures for the birds breeding in each of the colonies and hence make it not possible to extrapolate the data obtained on one colony to the other. Data obtained so far show high variability in nest occupancy and breeding success across years; long-term monitoring is thus needed to understand if this variability is impacting the stability of the population or if there is a hidden trend, or if there is a hidden trend.

The extreme weather events at the beginning of 2023 had negative impacts on the birds and their colony. This highlights the need to better understand how El Niño Southern Oscillation affects the ecology and breeding, and potentially the survival of this species in a scenario where extreme events are expected to increase in frequency and intensity. Other threats such as the impacts that contaminants like heavy metals and plastics appear to affect population health (Furtado et al. 2016), and their effect on Auckland populations needs to be assessed.

During the years of our monitoring, Auckland Council started a pest-plant removal programme on Ruapuke to reduce the invasive mile-a-minute (*Dipogon lignosus*), an evergreen perennial climber that was suffocating native vegetation. Such removal is proving to be effective and having positive outcomes not only for native vegetation but also for the white-faced storm petrels. In weed-free areas, the birds have easier access to their burrows, avoiding the risks of getting entangled and trapped in the vine, and burrows are in higher concentrations than in areas still infested. These observations strongly support the continuation of the weeding effort. This is the type of targeted and specific management recommendations that can be identified through the Seabird Programme.

3.4 Auckland shags

Shags are large seabirds of the Phalacrocoracidae family and Pelecaniformes order. Five shag species are present in the Auckland: pied shag / kāruhiruhi, little shag / kawaupaka, black shag / māpunga, little black shag / kawau tūī , and the New Zealand endemic kawau tikitiki / spotted shag. The spotted shag population of the Auckland region suffered a dramatic decline in the last 50 years, and it is considered as Threatened (Galbraith 2012, Lovegrove 2015, Robertson et al. 2021). For this reason we developed a specific project for this species that is reported in section 3.5 and 4.1.1. So, hereafter the term "shags" refers only to the four species belonging to the genus *Phalacrocorax*.

Auckland shags occupy a variety of habitats for breeding and foraging, ranging from coastal waters to inland freshwater lakes and streams, including in urban settings. Pied shags can also be found on offshore islands, whereas black shags are mostly found inland or use inshore lakes close to the coast. They typically nest in large colonies above ground in trees or scrub, often overhanging water or cliff edges, and often multiple species associate together (Taylor 2000a, Taylor 2000b, Coleman 2010, Gaskin and Rayner 2013). Shags are top predators, foraging mainly on crustaceans and fish; they are mobile foraging animals that may act as indicators of resource distribution in estuarine systems and coastal waters (Dorfman and Kingsford 2001).

The main threats to shags are linked to their interactions and conflict with human activities. Shags were persecuted for decades by fishermen – and sometimes still are – due to a perceived competition for commercially interesting prey species (Taylor 2000a, Taylor 2000b, Gaskin and Rayner 2013). Shags are at significant risk from fishing activities such as unattended set nets, drift nets, beach seine fisheries, with adults being vulnerable to entanglement in abandoned set nets, and bycatch in commercial bottom longline fisheries (Conservation Services Programme 2010, Gaskin and Rayner 2013, Rowe 2013). Colonies are threatened by human disturbance, which can cause egg abandonment and vulnerability to predation by gulls (Taylor 2000a, Taylor 2000b). Also, increasing coastal development and associated coastal vegetation removal is greatly reducing the availability of sites where shags can safely breed (Taylor 2000a).

The New Zealand conservation status for the pied shag is *At Risk – Recovering*, with an increasing population trend (Robertson et al. 2021). However, there are regional variations in the rates of increase, with the northern North Island showing slower population growth, and the Auckland and South Auckland populations showing a gradual increase both in terms of number of colonies and breeding pairs. These populations have historically fluctuated and stabilised at periods, indicating unclear issues and trends in the region (Bell 2013).

Little shag conservation status was recently changed from *Not threatened* to *At Risk – Relict* following a marked decline in the numbers recorded (Robertson et al. 2021). Their populations are regionally decreasing in Auckland, with a few colonies reported to have disappeared since the 1980s or fallen below stable numbers (Taylor 2013 [updated 2022], Robertson et al. 2021). The need to estimate their population size and trend, as well as to understand their population dynamics and breeding biology, are acknowledged research priorities (Taylor 2000b, Gaskin and Rayner 2013).

Both the black shag and the little black shag are considered *At-Risk*, with a *Relict* and *Naturally Uncommon* status, respectively (Robertson et al. 2021). Their breeding biology as well as their populations and distributions are unknown both nationally and regionally requiring urgent monitoring (Gaskin and Rayner 2013), with only one report of breeding little black shag known so far in Auckland (Gill and West 2016).

These significant knowledge gaps together with the threats that these birds face, make them a high priority for monitoring and research. More comprehensive knowledge of their population distributions, trends and dynamics in the Auckland region, as well as their breeding biology, would help provide a more accurate regional population status and assess the need for management actions. Monitoring will also be crucial to help estimate the mortality caused by fishing lines and nets. This cause of mortality may have been overlooked and needs urgent assessment. Our data will help to assess the threat and possibly inform mitigation measures.

3.4.1 Methods

To identify the knowledge gaps regarding shags distribution and breeding numbers in the Auckland region, a literature review was started, collating all available information, published and unpublished, about known colony locations around the region. Then, a systematic survey of the coastline, including harbours, estuaries and Hauraki Gulf islands begun to resurvey all historic colonies and search for unreported/new ones, and record shag species and numbers. Monitoring was carried out by boat or foot, according to the location. The numbers of adults, occupied nests, empty nests and the number of juveniles or chicks, if any were visible in the nests, were counted at each located colony or roost.

After the initial survey of the whole region to locate shag colonies, the region was split into three areas and monitoring planned foreach area on a three yearly cycle, so each colony shall be monitored at least once every three years. To gain deeper insights into population trends, some colonies were selected to be monitored yearly. They were chosen to represent different breeding environments, i.e. urban, coastal and offshore islands, and for their accessibility. Colonies monitored on a yearly basis are Ōrakei, Panmure and the Chelsea Estate Heritage Park as urban colonies; Red Beach and Okoromai Bay as coastal, and Ōtata as an offshore island (Figure 4 and Figure 5). More colonies will possibly be added to this list in the future for better regional representation.

In October 2022, a collaboration with the Auckland Council EEMU Lakes Monitoring Programme started. This programme monitors the long-term water quality of Auckland lakes with 15 freshwater lakes across the region monitored monthly. The Lakes Monitoring Team begun to monitor for the presence of shag roosts and colonies, and make counts according to the same protocol, and the same timeframes.

Surveys were mainly carried out during September to November, which corresponds to one of the two peak laying periods in pied shags that overlaps with the breeding time of the other species (Armitage 2013 [updated 2022], Powlesland 2013a [updated 2022], Taylor 2013 [updated 2022]). Opportunistic surveys were also carried out outside this timing as shags breed year-round. Clutches are started each month, and the breeding cycle takes on average six months, so any time of the year is suitable for assessing the presence of a colony. Timing of surveys will be taken into account when evaluating colony attendance and numbers of breeders.

3.4.2 Results and discussion

The project was highly impacted by COVID-19 restrictions and by some logistical issues in the use of the boat that prevented the ability to perform boat-based surveys in 2020 and 2021, and thus the ability to reach the majority of the colonies.

Between September 2019 and October 2023, most of the region has been surveyed but due to the forementioned delays, the coastlines of Aotea and the Mokohinau Islands, have not been visited yet. Figure 4 and Figure 5 show the locations of the colonies of pied shag and little shag, respectively. This map does not include colonies that were reported in the past, which we haven't yet visited to verify their presence today. Qualitative analysis of the map with respect to previous reports (Gaskin and Rayner 2013) shows different distributions of pied shag colonies and a detailed analysis will be needed to understand the real magnitude and meaning of such shifts once the initial regional survey is completed. This map therefore does not include colonies that were reported in the past, which have not been visited yet to verify their presence today. Promisingly, 14 little shag colonies were located, while only two had previously been reported (Gaskin Auckland region (Gaskin and Rayner 2013). During this project, one colony of little black shags was found at Lake Kawaupaku, next to the West Coast and the Waitākere Ranges. While the mapping is not complete, it is an encouraging starting point to gain more knowledge of this species in Auckland. Numerous roosting locations were also recorded that will hopefully lead to find more colonies. The only previously known Auckland breeding site for little black shag was at Western Springs Lake (Gill and West 2016), but we did not

and Rayner 2013).No colonies of black shag and little black shag had previously been reported in the find any little black shag when this site was surveyed. This might be due to the early time of our survey happened in late September, while their breeding season is reported to start in October (Armitage2013 [updated 2022]). A supplemental survey of the site will be needed to ascertain the presence or disappearance of that colony.

During the surveys, black shags were encountered at different locations. So far, only one breeding site was confirmed at Spectacle Lake at Te Ārai, in the northern Auckland region.

The Seabird Programme started a collaboration with the South Auckland branch of Birds New Zealand (Ornithological Society of New Zealand). Since then we have received many indications of colonies from members which will be very valuable for future monitoring and for achieving a full regional map of colonies for all four species of shags.

During one of our monitoring trips to Lake Kawaupaku, a dead pied shag was found entangled in a fishing line hanging from a tree, and on another trip, a shag was found dead floating in the same lake. Another three dead shags were found washed up on Ōtata during one winter in 2021, all showing signs of entanglement with fishing gear (The Noises Trust, *pers. comm.*). Finally, a non-identified shag was found entangled in a rope and hanging from a tree at the South Manukau Head colony. All these findings occurring only over a few months suggest that entanglement in fishing gear and other floating debris probably is more of a widespread issue than what was previously thought, and likely underestimated, representing a potentially significant threat for the species.

The extreme weather events in Auckland in early 2023 had serious impacts for shag colonies. Figure 6 shows the destruction of two colonies at Lakes Kawaupaku and Kauwakatai following Cyclone Gabrielle. Such observations suggest that climate change and the potential increase in frequency and intensity of extreme weather events may have significant impacts on these species by destroying existing breeding sites and potential breeding habitat.

Figure 4. Location and size of pied shag / kāruhiruhi colonies in the Auckland region. The size of the points illustrates the number of active nests in each colony. Note that Aotea and the Mokohinau Islands have not been surveyed yet (see text).

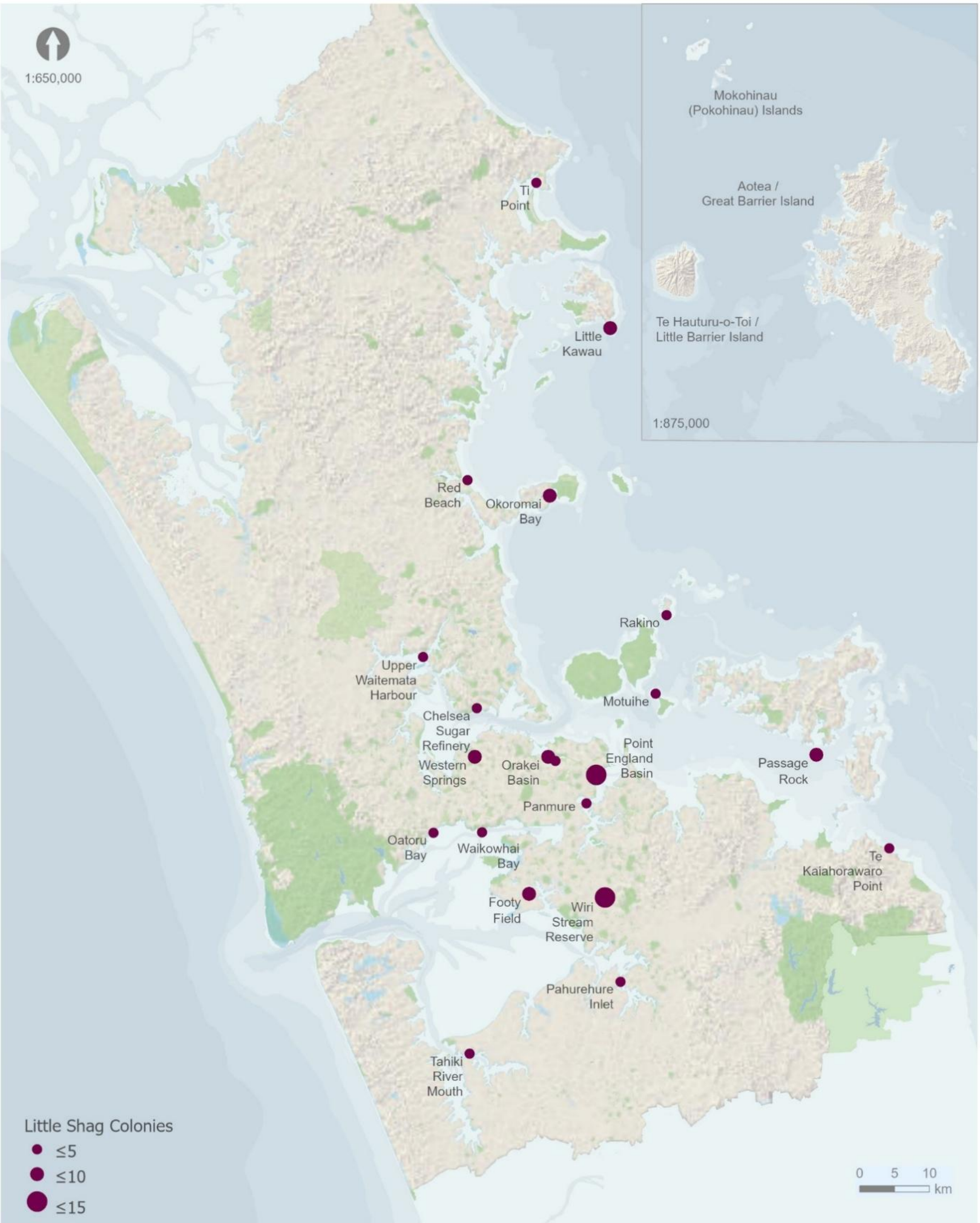

Figure 5. Location and size of little shag / kawaupaka colonies in the Auckland region. The size of the points illustrates the number of active nests in each colony. Note that Aotea and the Mokohinau Islands have not been monitored yet (see text).

Figure 6. Impacts of Cyclone Gabrielle on shag colonies. In the upper panel, a slip has destroyed the pied and little black shag colony at Lake Kawaupaku. In the lower panel, a helicopter view of Lake Kuwakatai showing the fallen trees due to the cyclone winds, destroying the pied shag colony that was there.

3.4.3 Next steps and management implications

The first of our next steps is to complete the initial regional survey and distribution map and to start the planned cyclic regular monitoring of colonies across the region. From the data of the colonies monitored annually, we will be able to start gaining insights on the population state and trend of these colonies.

As shags are visible species present in accessible areas, we are evaluating the feasibility of a citizen science project to increase shag and colonies counts, and thus available data, following examples as other existing national projects for biodiversity (e.g. NZ Garden Bird survey, the Great Kererū Count, cetaceans national census, etc). Such a project would also be important for education and to create awareness about shags, address the perception of these birds as a nuisance and promote their indigenous biodiversity value.

The numerous findings of shags entangled with fishing gear during our surveys highlighted the need to quantify the impacts of entanglement and fishing bycatch on these species, so to assess the magnitude of this threat and to be able to advise potential mitigation measures. A database to record shag entanglement reports has now been established, and we are initiating a citizen science project to encourage the reporting of entangled birds (dead or alive) in collaboration with Birds New Zealand. Also, an advocacy programme may encourage set net users and recreational fishers to report accidents involving shags and to adopt practices that will minimise seabird bycatch – however no such programme has been scoped or established yet.

Interactions with humans can cause other threats to these birds. Pied shags at the urban colony at Panmure Basin have been fed by the local community for a long time and many birds have now become habituated to humans. These birds can be found on the ground, on and around the walking track where people, dogs and bikes continuously pass (*pers. obs.*). Such behaviour risks the birds being chased, injured and potentially killed by dogs.

Other management implications include the protection of these birds and their habitats on land. Populations frequently depend upon coastal trees for roosting and breeding thus the maintenance of native vegetation on the water's edge is important to sustain heathy breeding populations. Auckland Council has a role in habitat and vegetation protection under the Resource Management Act. By identifying and mapping the shag colonies across the region through this project, we can then help ensure that the vegetation that they currently rely on is protected and advocate for the protection of other areas of habitat important to them.

3.5 Spotted shag

Spotted shag / kawau tikitiki is a New Zealand endemic that breeds on coasts from Rakiura / Stewart Island up to the Auckland region (Szabo 2013 [updated 2022]). The national population was classified as *Not threatened* at the moment of our initial assessment for the start of this programme but believed to be *regionally threatened* as result of a recent crash in its Auckland population, making them a regional priority for monitoring, research and management. More recently, spotted shags were reassessed as Threatened – Nationally Vulnerable following a significant and ongoing decline in the number of breeding pairs nationwide (Robertson et al. 2021).

Over the last 50 years the Auckland population decreased from nine breeding colony sites, including two on the west coast at Te Henga and Muriwai, to only one main colony in the Hauraki Gulf at Tarahiki Island (~450 birds) near the eastern end of Waiheke Island (Figure 2) with two other small colonies off Waiheke (~70 birds in total) (Rawlence et al. 2019). The reasons for this fast decline of the Auckland population are unknown requiring urgent investigation to halt the extinction of spotted shag from the Auckland region. This led former Auckland Council scientist, Dr Tim Lovegrove, to initiate monitoring of the spotted shag population from 2015 to establish a baseline and trend of the Auckland population. Other recent work on the population includes genetic studies that have shown the Auckland population to be genetically distinct from other populations in the south (Rawlence et al. 2019), which further increases the conservation priority of this species. Further morphological studies are required to confirm or deny whether the Auckland population is a subspecies, which the Auckland Museum and other collaborators are planning to conduct in the future.

The Seabird Programme was quick to become involved with the spotted shag programme, given the high risk of losing this seabird. We teamed up with Lovegrove and Dr Matt Rayner (Auckland Museum Tāmaki Paenga Hira) in 2019 to help with the population monitoring and to investigate the reasons for the decline. Generally, little is known about spotted shags given little work has previously been done on the species (Szabo 2013 [updated 2022]). The Auckland population is even less understood, including about the basic biology of the species such as the timing of their breeding, and even less about their foraging ecology (both spatial use and diet). This led to the establishment of a multi-year tracking study and isotopic diet analysis in 2019 by Rayner which Lovegrove and the Seabird Programme joined the tracking component in pursuit of understanding the species' foraging ecology, and namely what areas the birds are using, why, what spatially explicit threats exist, and hence what management actions can be taken to halt their decline. The Seabird Programme also collaborated with Rayner and Lovegrove with a restoration project on Ōtata Island (The Noises) attempting to re-establish a breeding colony on this pest free island (Section 4.1.1).

3.5.1 Population monitoring

Monitoring occurs annually at the three remaining spotted shag sites in Auckland: Tarahiki Island, Anita Bay (Waiheke), Hooks Bay (Waiheke). In late August during the birds' incubation phase, a boat-based survey team using binoculars take a count of all birds and nests.

Rayner is leading the analysis of the population monitoring results which will be presented in a future publication. In brief, 2025 will represent the eleventh year of survey data being collected for this study with the population showing considerable variation year on year but with an overall continued decline of 2-5 nests per year. As with long-lived seabirds, it is important to have a long enough time series to be able to understand the population trends. The spotted shag population appears to continue to be declining but requires further monitoring to confirm this observation. Ongoing research is needed to continue to better understand the threats affecting this species.

3.5.2 Tracking study

Pathtrack 15-gram GPS loggers were attached to eight spotted shags from the Tarahiki colony (most via nest captures and thus from breeding birds) in spring of 2020 (Figure 7). The loggers were attached to harnesses fitted to the birds (with a 'weak link' so that loggers would remain on birds for at most a year and then fall off). A solar power base station system was installed at two locations on Tarahiki Island which remotely downloads the spatial data from the loggers upon detection of the birds when they return to the colony. Another deployment of Pathtrack GPS loggers was completed in 2021 with another 10 birds tracked. Rayner established a new collaboration in 2022 with Oregon State University which was to test out new mobile phone network-based GPS loggers they designed. Fourteen of these cell loggers were attached to birds over the 2022-23 summer, in pursuit of gathering more detail on the birds' spatial ecology over the summer and autumn period.

Preliminary findings of this study were presented at the BirdsNZ conference in 2021 (Rayner et al. 2021a). Briefly, the first deployment of eight tracked spotted shags produced ~54,000 locations which were widely distributed across the Firth of Thames, with the areas to the north dominated by fast-travelling commuting birds and to Thames to the south by slower birds. The key foraging areas were focused at Matingarahi on the southeast coast of Auckland whereas on the western Coromandel coastline there were many foraging sites from the southern end of the Firth of Thames right up the full coastline. The majority of foraging behaviour was focused in areas where mussel farms are located.

Figure 7. Pathtrack GPS logger attached to a spotted shags at Tarahiki Island colony.

3.5.3 Next steps

Further monitoring is required to confirm population trends, and the tracking study needs to be completed (one last bird still tracking at time of writing) to perform a full analysis of data. Rayner is currently preparing a report to the Department of Conservation Services Program examining the overlap between the tracking data and the GPS locations of set net fisheries in the Firth region. These studies will provide important guidance for the direction of future work on the species particularly around fisheries mitigation and or netting restrictions as it appears set net fisheries are a key driver of mortality in this species.

3.6 Australasian gannet

Australasian gannet / Tākapu (*Morus serrator*) is a large, charismatic seabird that breeds in dense colonies on flat ground in coastal areas both on the mainland and on islands. Colonies are primarily located in the North Island of New Zealand, with some colonies also in south-east Australia (Ismar 2013 [updated 2022]). In Auckland there are three major colonies, with the largest on Mahuki Island (Aotea), and the largest mainland colony at Muriwai. Almost 1400 breeding pairs of gannets nest on Muriwai's Otakamiro Point (Frost 2017), making this Auckland's largest mainland seabird colony. There are also another ~200 nests on the neighbouring Motutara (Pillar Rock), and ~30 nests on Oaia Island, which is 1.5 km southwest of the mainland Muriwai colony.

The Muriwai colony is very well known, being one of Auckland's most visited spots by Aucklanders and other tourists. The local community is passionate about the gannets, and hence great concerns were raised when the majority of birds abandoned their nests in late 2010, believed to be related to the strong La Niña oceanic conditions (Veldhuizen 2011). The Muriwai Environmental Action Community Trust (MEACT) was already taking action to setup a community-based monitoring programme in consultation with Auckland Council and gannet experts Dr Stefanie Ismar (GEOMAR Helmholtz Centre for Ocean Research Kiel) and Dr Gabriel Machovsky-Capuska (NutriLens/Massey University). This monitoring programme was originally managed by MEACT for the first two seasons (2011-12, 2013-14) of data collection, and then Auckland Council took over from 2014, and subsequently it was integrated into the NETR Seabird Monitoring and Research Programme upon its creation in 2018. The gannet monitoring programme remains a community-based monitoring project with local community members having a significant involvement in the collection of the data.

Gannets are considered *Not Threatened* under the New Zealand Threat Classification System (Robertson et al. 2021), however it is important to continue the monitoring as both the species and the site are of special interest for a variety of reasons. Collected data provide population and breeding success information for our largest mainland seabird colony, in one of Auckland's Regional Parks at Muriwai, and from a west coast site where there is very little seabird monitoring data (the majority of projects are in the Hauraki Gulf). The monitoring data is of interest to a variety of researchers and stakeholders, including the Auckland Council's Regional Parks staff who manage the site, and hence these data are useful for assessing management activities at Muriwai Regional Park. Information on the population health of gannets is useful for understanding the larger marine ecosystem health of the area, given gannets and seabirds are potential useful indicators; as top predators, changes to gannet breeding success may be an indication of health of the lower food chain and ecosystem health of the ocean (Montevecchi 2007, Ramos and Furness 2022).

The gannet monitoring is also of great interest to both the local community, MEACT, and other members of the wider community of which many come from afar to experience the gannets from the close viewing platforms provided in the regional park. Several news stories have been published about the colony and the monitoring work taking place (Timoti 2011, 2013, 2014, 2015a, 2015b). The site is also regularly used by educators, including the University of Auckland who have been running field trips to the site for many years as part of the student's coursework who together conduct an annual count. Hence, continuing to track the population health of the Muriwai gannet colony via this productivity monitoring work provides important data for tracking the health of the west coast gannet population and the wider marine health of the surrounding ocean areas, while also continuing to act as an important engagement and educational tool for the local community.

3.6.1 Methods

Gannet productivity monitoring was established at the Muriwai gannet colony in late August 2011 using a sample of gannet nests viewable from the southern platform at Otakamiro Point. A wire was placed on the ground in the colony to demarcate the sample area, which included 66 gannet nests in the first year of monitoring. Observations were made during the whole breeding season until fledging by trained community members. From the viewing platform, each nest was checked using binoculars for the presence of adults, eggs and chicks, and from these observations annual breeding success was calculated.

After the first two breeding seasons of monitoring, some refinements were made as a result of learnings from the project and the unfortunate realisation that the first two years of data were incomplete and not useable. The key changes were that instead of daily observations made throughout the entire breeding season, weekly observations were instead taken. It was also decided to reduce the number of observers to those that could provide regular commitment to the monitoring as it had become clear that experience was important for the collection of accurate data. Thus, from year three only one to a maximum of three community members collected data each breeding season, thus allowing adequate experience to be gained from more time observing the colony. Data collection was also checked for quality several times each season once Auckland Council took over management of the project in the third year. A different data sheet was also developed from the third year using a photograph of the nests instead of relying on the marker wire which was hard to see as the colony guano built up and buried the wire underground below the nests (which is monitored to ensure it remains safe to the birds). It was also found to be challenging to have confidence the same nests were being monitored in the inner areas away from the wire, and from year three markers were installed on the colony to help observers align the photograph to the colony as well as help identify individual nests. The number of nests observed has varied between years, with additional nests added to increase the total sample size, but always with the original area adequately covered to preserve the long-term time series design of this monitoring.

3.6.2 Results and Discussion

Analysis was planned to be after at least a decade of data was captured, and ideally after another significant La Niña event occurred after the one recorded in 2010-2011. As of 2025, there has been 13 breeding seasons of data, however, unfortunately, the first two years of data had to be discarded (see above). Additionally, there were some challenges in accessing the colony over COVID-19 lockdowns in 2020-21, and the extreme weather of 2022-2023 (Salinger et al. 2024) resulted in the lowest breeding success of the entire study. Hence, it has been decided to capture productivity data till the end of the 2024-2025 breeding season before a full analysis is conducted and published, allowing to assess for a return to average breeding results.

3.6.3 Next steps and management implications

The full analysis of all data collected so far will take place over late 2025. The planned publication, which will include management implications, should be available by 2026. In the short term, it is recommended that the current pest animal management activities that occur in the Muriwai Regional Park continue as they are likely benefitting the gannets and the other seabird species present in this area and dogs should continue to be prohibited in the Otakamiro Point area, given dogs are known to kill gannets.

Monitoring is recommended to continue longer-term so as to understand the potential negative effects of La Niña / El Niño oceanic conditions on gannet population dynamics.

An emerging threat to New Zealand birds is the anticipated arrival of highly pathogenic avian influenza (HPAI). In 2022, one of the Australasian gannet's closest relatives, the Northern gannet (*Morus bassanus*), experienced mass mortalities at their colonies in the North Atlantic Ocean from HPAI (Careen et al. 2024). Other vagrant bird species visit Auckland's gannet colonies, such as brown (*Sula leucogaster;* Knight, N. 2013 [updated 2022]) and red boobies (*Sula sula*; Miskelly, C. M. 2016 [updated 2023], which may potentially carry the virus. Given these exposure risks and how significant HPAI may impact gannets, it is imperative that ongoing population monitoring continue at Muriwai and also be expanded to other gannet colonies in the region, namely the largest colony on Mahuki Island, Aotea, so that we can monitor for the arrival of HPAI and its potential impacts on this species.

4 Projects at prioritised sites

4.1 The Noises – Ōtata

The Noises archipelago is composed by four main islands – Ōtata (15 ha), Motuhoropapa (8 ha), Ruapuke / Maria Island (1 ha) and the David Rocks (0.3 ha) – and the smaller islands of Orarapa / Haystack, Ike, Scott and Sunday, along with rocky outcrops, and rocky reefs. They lie at the edge of the inner Hauraki Gulf / Tīkapa Moana / Te Moananui-ā-toi, approximately 24 km northeast of Auckland and 2.2 km from Rakino Island, the closest neighbour (Figure 8). All the islands are forested, and they are considered to have some of the best indigenous vegetation cover of any of the inner Gulf islands, with the flora consisting of plants typical of both inner and outer gulf islands (Cameron 1998). The current terrestrial habitat supports a diverse community of native invertebrate and vertebrate fauna, including *Threatened* and *At-Risk* species such as wētāpunga (*Deinacrida heteracantha*), flax snail / pupurangi (*Placostylus hongii*) and Duvaucel's gecko (*Hoplodactylus duvaucelii)* (Rayner et al. 2021b).

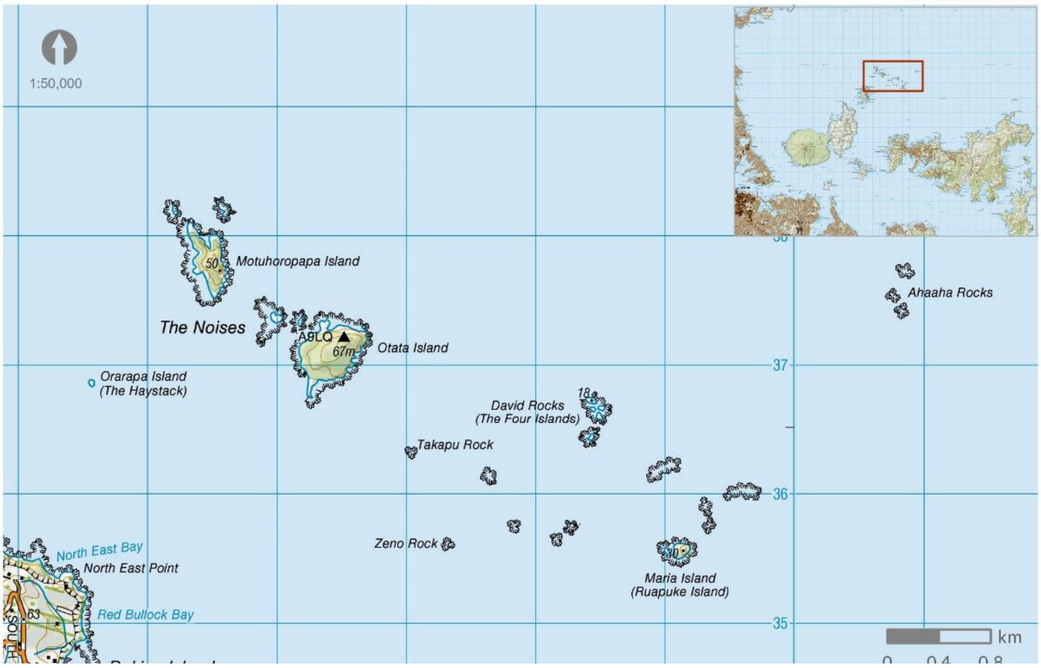

Figure 8. The Noises Islands group. Upper-right insert shows the location of the Noises (red rectangle) within the Inner Hauraki Gulf Tikapa Moana.

The Noises are home to a diverse seabird community with at least ten breeding species (five petrels, two gulls, one shag, one tern, one penguin) (Rayner et al. 2021b). This community represents the most diverse seabird assemblage in the inner Hauraki Gulf and is regionally significant. The islands are recognised as an important breeding site within the Hauraki Gulf for white-faced storm petrel, grey-faced petrel, northern diving petrel, white-fronted tern, pied shag and formerly spotted shags (Cunningham and Moors 1985), and Ōtata has been recognised to offer great potential for a restoration programme to encourage spotted shags to recolonise their former breeding ground (Ritchie 2017).

All the islands of the group have been free of introduced predators since 2002 (Rayner et al. 2021b). Ruapuke was the first island in New Zealand, and likely in the world, to be declared predator free after a poisoning effort by the New Zealand Wildlife Service that eliminated rats in 1964 (Cunningham and Moors 1985; Section 3.3). Being predator-free along with the special flora and fauna naturally present give The Noises outstanding conservation value, and the potential to be one of the best sources of flora and fauna for future ecological restoration projects occurring in the inner Gulf (Cameron 1998, Rayner et al. 2021b).

A Noises Islands Biodiversity Management Plan, published in 2017 (Ritchie 2017), highlighted among the priorities the need for surveys to update on fauna, and for the implementation of a proactive management programme. In the past, some seabird surveys were carried out, showing good number of burrows, mainly occupied by grey-faced petrel and some little penguin, and the presence at night of fluttering shearwater and common diving petrel (Gaskin 2017, Russell et al. 2017, Lukies 2019), but no regular monitoring was ever carried out to assess populations numbers, statuses and trends over the long-term. Anecdotal evidence suggests the abundance of nesting little penguin has declined since the 1970s (Sue Neureuter, *pers. comm.*). The Biodiversity Management Plan also included the restoration of a spotted shag colony and the installation of an acoustic attraction system to attract other birds to nest on the islands (Ritchie 2017).

For the reasons outlined above, The Noises group was identified as priority location for seabird monitoring and research. We started a collaborative project with The Noises Family Trust, which manage the islands, and Tāmaki Paenga Hira Auckland War Memorial Museum, for long-term seabird monitoring on The Noises with the aim of gathering knowledge about the seabird species present and their population statuses and health, as well as for colony restoration. This project was included in the broader monitoring plan for The Noises Islands published in 2021 called "Ōtata mauri ora: a 50-years monitoring and restoration plan for Ōtata" aiming to capture ecological change across The Noises ecosystem in anticipation of protection being implemented over the marine environment matching existing protections on land (Rayner et al. 2021b). Having a sound knowledge on the population statuses and trends of seabird species on this island is important if we want to assess restoration success in the Hauraki Gulf. The sub-projects that were started in this collaborative framework are outlined below and include both monitoring and restoration trials.

4.1.1 Spotted shag colony restoration

As detailed in section 3.5, the Auckland population of spotted shag experienced a significant reduction in the last 50 years. Colonies on The Noises were known in 1910 but were progressively hunted until legal protection of the species was granted in 1931 (Falla 1938). By the 1950s, 40 spotted shags were recorded at a nesting colony on Ōtata Island, and 200 on David Rocks. In 1970, the colony on Ōtata counted 24 nests and about 100 birds, and David Rocks seven nests with 25 birds, but disappeared soon after and was never recolonised (Millener 1970, Cunningham and Moors 1985).

With the aim to help the population reestablish at a former breeding location, a spotted shag restoration site was set up on Ōtata in early 2019 (Figure 9, Figure 10) led by Matt Rrayner (Auckland Museum) in collaboration with Tim Lovegrove (previously, Environmental Services, Auckland Council) and the Seabird Programme (see also Evans 2019). There, an acoustic attraction system that broadcast spotted shag calls and spotted shag decoys to function as visual attraction cues were deployed to attract the birds to the site. Fake guano was also scattered around the site to create similar visual cues to a natural colony (Figure 9.). This technique is a well-established method in seabird restoration projects (e.g. Sawyer & Fogar 2013).

In April 2021, a group of spotted shag visiting the site was reported. This was the first observation of spotted shag on Ōtata for decades and is a promising start for this restoration project. Since then, a few more sightings have been reported, but so far, the birds have only stopped for short stays.

Figure 9. Decoys of spotted shag / kawau tikitiki and fake guano on the cliff of Ōtata to function as visual attraction cues in the aim to restore the existing colony that disappeared in the 1970s.

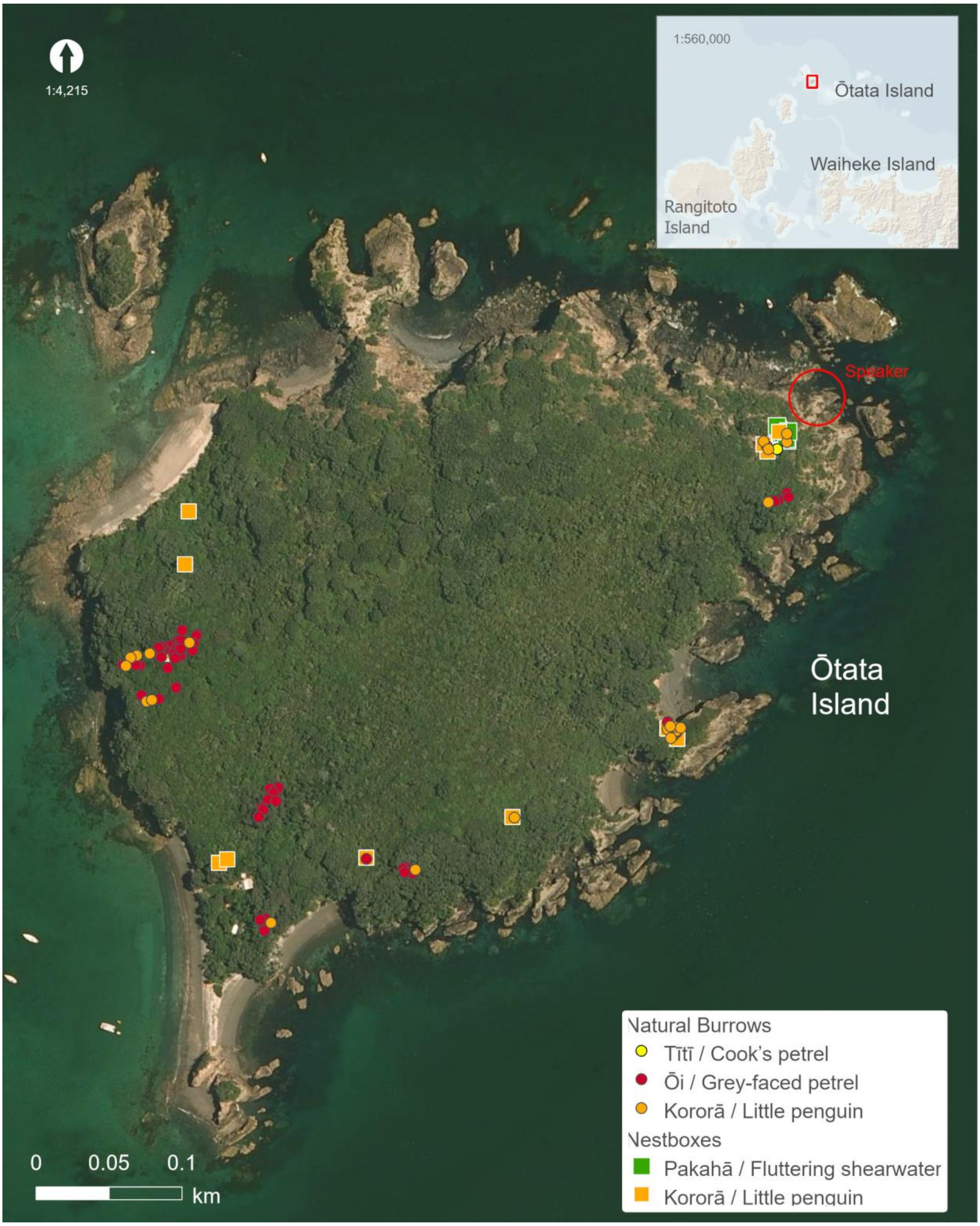

Figure 10. Map of the study burrows established on Ōtata in August 2021.

4.1.2 Burrow nesting seabirds' population monitoring

In the aim to establish a long-term population monitoring for the seabird species breeding on Ōtata, in August 2021, 80 burrows were identified and marked in different locations around the island to be our study burrows (Figure 10). Since then, monitoring has been carried out for three consecutive years, slightly increasing the number of study burrows at each year. Detailed results of monitoring are presented in Table

9 and Table 10. In all years, most of the burrows were occupied by grey-faced petrel (Figure 11) and some by little penguin. A variable number of burrows was found empty (i.e. non-occupied) each year. Many of the burrows on Ōtata are very deep, and for some of them it is not possible to confirm the breeding status of the bird observed inside, i.e. it was not possible to confirm if it was incubating an egg.

Figure 11. An ōi / grey-faced petrel sitting in front of one of the study burrows on Ōtata.

The colony was also visited in December of every year to inspect grey-faced petrel burrows for the presence of chicks and calculate the breeding success for the year; results are presented in Table 10.

Interestingly, in 2022, occupancy of grey-faced petrel was the lowest of the recorded years with only 28% of burrows occupied. At the same time, breeding success was the highest among the monitored years, with over 80% of chicks successfully fledging. Grey-faced petrels are winter breeders and birds were not at the colony during the extreme weather events of the summer 2023. However, during the following breeding season, started in August 2023, the proportion of occupied burrows slightly increased (39% confirmed breeding), but breeding success was much lower at only 60% (Table 10). This is a lower success than the previous year, but that it is in alignment with the low breeding success of all the monitored species across the Gulf for this year (see other sections). Lower breeding success has previously been identified for grey-faced petrel populations in the Auckland East coast compared to the West coast (E.g. Ihumoana Island vs Te Hāwere-a-maki colonies. Welch 2014), as East coast colonies have less food resources available to raise their chicks (Whitehead 2018). Thus, the lower breeding success found in the Ōtata colony is consistent with that earlier observation. Further monitoring is needed to establish population trends and possibly link yearly fluctuations to environmental factors such as El Niño/La Niña weather oscillations and weather events and how this also maybe impacting already more limited food resources.

Only very few burrows were found occupied by little penguin. Even if during the three years of monitoring the overall number of burrows slightly increased, the number of confirmed breeders decreased, and more penguins were occupying burrows but without breeding (Table 9 and Table 10). Penguins are less synchronised in their breeding than procellariforms, with the laying period spanning between July and September. It could then be that little penguins on Ōtata are delaying their breeding, laying the eggs after the monitoring period. Also, little penguins can have a second breeding period in December if the first clutch failed early or if they did not breed in winter. Considering the threats that this species is facing, more intense and targeted monitoring is needed to understand the population status and the breeding cycles on Ōtata and assess breeding success.

Table 9. Counts of burrows occupied by grey-faced petrels / ōi and little penguins / kororā on Ōtata during the different years of monitoring. In all years monitoring happened during the month of August.

Year	Ōi / Grey-faced petrel				Kororā / Little penguin				Non occupied	Total monitored
	Breeding	Non-breeding	Unknown	Total	Breeding	Non-breeding	Unknown	Total		
2021	34	3	15	52	9	0	5	14	14	80
2022	23	0	11	34	8	1	7	16	32	82
2023	33	3	7	43	4	5	9	18	24	85

Note: Breeding = burrows in which we could confirm the presence of an egg. Non-breeding = burrows occupied by non-breeding adults. Unknown = burrows occupied by an adult but for which the breeding status could not be determined. Non occupied = empty burrows in which no bird was detected. Total monitored = total number of burrows monitored in that year.

Table 10. Burrow occupancy for both species on Ōtata during the monitored years, and breeding success for ōi / grey-faced petrel.

Year	Ōi / Grey-faced petrel			Kororā / Little penguin	
	Breeding occupancy	Total occupancy	Breeding success	Breeding occupancy	Total occupancy
2021	42%	65%	68.8%	11%	17%
2022	28%	42%	81.3%	1%	19%
2023	39%	51%	60.7%	5%	21%

As the majority of grey-faced petrel burrows are too deep to be able to capture and identify with banding the breeding birds, petrels were captured and banded at night in the area where there are most of the study burrows. Over time this will allow to gather information about population size and individuals' survival, as well as to compare findings with other grey-faced petrel monitoring projects, such as the long-term monitoring project in Te Henga (Gaskin 2021). Captures were done during two consecutive nights during the August trip when most birds visit the colony and petrels can be easily captured on the ground when sitting outside of burrows. Banding data are presented in Table 11. Interestingly, one of the birds recaptured in August 2022 was a bird banded as a chick in Te Henga in November 2008, showing possible dispersal from the west to the east coast. Banding of grey-faced petrel is occurring at a number of other Auckland colonies (e.g. section 4.1 in Gaskin 2021, Russell et al. 2022), and the banding at Ōtata under this project will help contribute to an understanding of the dispersal and movements of this species as it continues to recover in the region.

Ōtata was also home for some unexpected species, which highlights the ecological and conservation importance of this island. In November 2020, during a preliminary trip for the establishment of the long-term monitoring project, a breeding pair of Cook's petrels was discovered. This was the very first record of this species breeding on The Noises. The following January, a healthy chick was in the burrow. Both the adult and the chick were banded so to be identifiable if ever recaptured. In the following two years, the burrow appeared visited and cleaned, but no more breeding happened.

Table 11. Number of ōi / grey-faced petrels banded and recaptured during night captures on Ōtata.

	2021	2022	2023
New bands	14	32	22
Recaptures	-	2	6
Total captured	14	34	28

At the beginning of December 2021, a banded sooty shearwater was found in a burrow. The bird had a brood patch, a sign of breeding, but there wasn't any egg in the burrow where it was found. Banding records identified that this shearwater was banded at Kauwahaia Island, Te Henga in 1990 as a chick, making it 31 years old. Sooty shearwater formerly bred on the Mokohīnau Islands, but survey work is required to determine if they continue to breed there and in what numbers (see section 4.4). This observation of a potentially breeding individual on an inner Hauraki Gulf Island is noteworthy and shows that monitoring projects can also have value for incidental discoveries.

4.1.3 Installation of artificial nest boxes

In the recent years, fluttering shearwater have been seldomly reported to breed on Ōtata. Early counts from the early 1960s and 1977-1983 report that these birds were commonly seen flocking in the Inner Hauraki Gulf during autumn and winter, but they were not observed on land on The Noises and the breeding was not confirmed (Cunningham and Moors 1985). Recent findings of occasional burrows on Ōtata and birds on the surface at night on Maria (See section 3.3) suggest that the species might be trying to use these islands as a breeding site. Fluttering shearwaters start to visit the colonies in August to start breeding late September (Gaskin 2013 [updated 2022]) when grey-faced petrel and little penguin are already occupying burrows for breeding. Therefore, to increase potential breeding possibilities we began a pilot trial of nest boxes for fluttering shearwaters. These were installed next to the sound system for the spotted shags (See 4.1.1), which at night was set to broadcast calls of four seabird species: grey-faced petrel, fluttering shearwater, white-faced storm petrel and diving petrel.

In August 2021, seven nest boxes for fluttering shearwater were installed (Figure 10), one of which was occupied a month afterwards by a breeding pair from which a chick fledged. Two other nest boxes showed signs of recent visitation by seabirds. The following season, in August 2022, one of the nest boxes was occupied by a fluttering shearwater, whereas two had been occupied by little penguin. In the past, a number of nest boxes for little penguin were installed around the lower part of the island, but only one box has ever been occupied and only periodically (Neureuter family *pers. comm.*). Thus, finding penguin breeding in nest boxes, in a novel area on a very steep side of the island, was a positive surprise that prompted the relocation of some of the unused penguin nest boxes from the low land to this higher area on the island. Figure 10 shows the present location of nest boxes, after they were relocated. Hopefully they will be occupied in the future providing supplemental breeding site for this species, where they will also be easier to monitor.

4.1.4 Pied shag colony monitoring

Ōtata is also home for a colony of pied shag that have been monitored during the island surveys. Number of birds and nest counted are reported in Table 12. In addition to pied shags, during the visit in 2020, one little shag was observed roosting on the same tree with the pied shags. No breeding has ever been reported for this species on Ōtata, and visits were only seldom. Ongoing monitoring will help detect if this species does start visiting Ōtata more often.

Table 12. Count of pied shag individuals and nests at the Ōtata colony.

Date	Nests	Adults	Chicks/ Juveniles	Empty nests
August 2023	5	15	0	0
August 2022	5	18	0	0
August 2021	14	25	9	1
October 2020	10	19	4	0

4.1.5 Next steps and management implications

This project has established a baseline for regular long-term monitoring of seabirds on Ōtata, and it is well integrated in the wider framework of the Ōtata mauri ora project (Rayner et al. 2021b). Continuous monitoring will provide the much-needed information on seabird populations health and trends at this important site in the middle of the Hauraki Gulf. In the future, it would be helpful to integrate such monitoring with surveys on other islands of The Noises group, e.g. Motuhoropapa and David Rocks, to gather information on the breeding species and populations statuses across the whole archipelago.

Increasing the level of little penguin monitoring, both in this location and elsewhere around the Hauraki Gulf, is needed. Monitoring so far shows low numbers of burrows with only very few breeding pairs, and more attention should be given to this species to understand breeding occupancy and measure breeding success. Little penguins appear to be highly impacted by storms and marine heatwaves, and they are often found in high numbers washing up on beaches. To understand the status of the population in the region, monitoring is needed to improve our knowledge on numbers of birds breeding at different locations but also starting to gain insights into population dynamics (e.g. survival rates, nest fidelity, population stability). For this, the Seabird Programme will increase monitoring where individuals are marked and identified. Penguins cannot be banded as other birds; an alternative and most common method to individually mark penguins is the use of micro-chips. Future monitoring will start using this technique to achieve a sounder investigation of population dynamics for this species.

Maintaining the predator free status of this group of islands is essential for seabirds to thrive in this location, as is a healthy marine ecosystem. A proposal for marine protection (High Protection Area) around The Noises was included in legislation introduced to parliament in August 2023. At time of writing, it is at the second reading stage. The creation of a High Protection Area around The Noises would support the recovery of the marine ecosystem that surrounds the islands, allowing for seabird species that breed there and forage in the Inner Hauraki Gulf (e.g. little penguin, white-faced storm petrel, fluttering shearwater) to be able to find food resources in the proximity of their breeding sites. This is of particular importance for penguins, which forage in more coastal waters next to their colonies and that are highly impacted by overfishing and the depletion of marine resources.

Finally, it is important to note that numerous ships headed to the port of Auckland use the area next to Rakino and The Noises to station at night waiting to enter the port. It is well known that artificial lights at night have a detrimental effect on nocturnal seabirds, disorienting them and causing strikes and groundings (Lukies et al. 2021, Heswall et al. 2022, Goad et al. 2023). Therefore, an assessment of the specific impacts on breeding seabirds of artificial lights from vessels stopped around seabird colonies at night is needed.

4.2 Waitākere Ranges restoration research

The greater Waitākere area is arguably the most important mainland seabird area in Auckland with its high diversity and numbers of breeding seabirds. Some of these include kororā / little penguin, ōi / grey-faced petrel, tarāpunga / red-billed gull, tākapu / Australasian gannet, and tara / white-fronted tern (Davis et al. 2018). Te Henga is one of the most important burrowing seabird sites in New Zealand with five species breeding there: kororā / little penguin, ōi / grey-faced petrel, tītī / sooty shearwater, toanui / flesh-footed shearwater and kuaka / northern diving petrel (Davis et al. 2018). The southern end of Te Henga also has breeding tara / white-fronted terns, further identifying Te Henga as a hotspot of seabird breeding activity on the mainland. The Te Henga petrels and shearwaters are monitored in the key areas on Kauwahaia and Ihumoana Islands by DOC scientist Graeme Taylor. Taylor's study of the grey-faced petrels on Ihumoana is one New Zealand's longest seabird studies, spanning over three decades.

Auckland Council began formally investigating the presence of seabirds in the greater Waitākere area in 2016 when a survey was conducted covering from the southern end of Muriwai beach south to Te Henga (Landers 2017). This survey revealed for the first time a significant grey-faced petrel population breeding at several locations in the Muriwai area (Figure 2). It showed grey-faced were breeding on the mainland of Te Henga as well as at Kirikiri Bay. Little penguins were also found to be breeding at a number of sites along this coast. Consequently, Auckland Council continued to investigate other potential breeding locations in the Waitākere Ranges as funding became available through the Seabird Programme, with several surveys conducted.

After the first survey, Auckland Council began working with staff at the University of Auckland on several Waitākere-based projects aimed at increasing our knowledge of the seabird population health and potential management actions we could take to help improve the state of seabirds in the Waitākere Ranges and other mainland areas, such as work on the conservation physiology of mainland seabirds (See section 5.1) (Dunphy et al. 2015, Zhang et al. 2019, Dunphy et al. 2020).

4.2.1 Methods

Seabird surveys using a seabird detection dog, i.e. a dog trained in detecting the smell of burrowing seabirds in the middle of the bush and pointing his handler at burrows. These surveys were carried out at the times and locations described in Table 13 and showed in Figure 2. The main aim was to find any seabird nests (focusing on grey-faced petrel) and assess how many were active.

As a follow up to these surveys, work began with Professor James Russell at the University of Auckland to develop a PhD project that focused on monitoring the identified petrel breeding sites in the Waitākere Ranges and answer other vital questions relating to the restoration of seabirds on the mainland. PhD student, Michael Fox, began working on this project from 2021, although significantly affected by COVID-19 challenges that year. Fox finished his data collection in early 2024. The project aims were to answer the following:

1. How does predator abundance influence grey-faced petrel breeding success, and how does this relationship change throughout the breeding season?
2. What level must predators be reduced to for grey-faced petrels to breed successfully on the mainland?
3. To what extent is genetic isolation by distance and genetic structuring present in the recovering grey-faced petrel population in northern Aotearoa?
4. What factors predict positive community attitudes and support for habitat management to restore grey-faced petrel populations?

The site list for this work included all the largest colonies identified in the above seabird dog surveys at: Muriwai, Te Henga, Piha, Karekare, Whatipu, Cornwallis (Figure 2).

Table 13. Dates and locations of bird surveys in the Waitākere Ranges using a detection dog.

Month	Year	Survey Area
*April	2016	Te Henga Track
*August/September	2016	Te Henga, Muriwai, Kirikiri Beach
**October	2017	Muriwai, Piha (North and South)
**October	2018	Cornwallis
**May	2019	Inaka, Opou, Okewa Reserve, Kauri Point, Arapito Point Reserve, Huia, Cornwallis, Whatipū, Piha North, Whites Beach, Marawhara, Piha South, Karekare
**October	2019	Cornwallis, Muriwai, Mercer Bay, Karekare, Anawhata, Whites Beach
**November	2020	Te Henga, Muriwai, Piha South, Taitomo Island
**August	2022	Te Henga, Whatipū, Taitomo Island, Piha South, Piha North, Whites Beach, Kaitarakihi Point, Cornwallis, Okewa Reserve

**Surveys conducted prior to the establishment of the NETR Seabird Monitoring and Research Programme (Landers 2017). **Surveys conducted in collaboration with the University of Auckland.*

4.2.2 Major findings

All seabird surveys resulted in identifying new grey-faced petrel burrows. Activity in suspected active burrows was also reconfirmed. These results set the baseline for the implementation of the seabird restoration research project.

The results of the seabird restoration research project have been written up in Michael Fox's PhD thesis, which at time of writing is under examination by the University of Auckland assessment committee. A variety of results will also be published in multi-institutional journal articles in 2025-26.

Below is a brief high-level summary of some of the major findings from this work:

1. Grey-faced petrel can have relatively high breeding success in the presence of introduced mammalian predators, as long as the abundance of key predators (stoats, Norway rats, and ship rats) are reduced to below threshold levels through predator suppression during the early-chick rearing phase (late August-October).
2. Outside of the most vulnerable period (early chick-rearing phase), predator abundance does not seem to have a relationship with grey-faced petrel nest success; however, caution should be advised, as potentially existing predator suppression programmes reduce predator numbers below their threshold in the monitored sites. Subsequently, grey-faced petrels are more resistant to predator abundance during the egg-laying and late chick-rearing phases (July-early August and November-December).
3. Grey-faced petrels show little genetic differentiation within the Greater Auckland Area (West Auckland, Inner Hauraki Gulf and Outer Hauraki Gulf), which supports the theory that grey-faced petrel are genetically panmictic with gene flow occurring between colonies.
4. Banding data reveals that philopatry remains the predominant behaviour for grey-faced petrels. Evidence of short and long-distance dispersal is promising for facilitating the recolonisation of extirpated colonies.
5. The Waitākere Ranges community are generally supportive of increased predator control and other habitat management approaches to support the restoration of grey-faced petrel, a species they know little about.
6. Those in the Waitākere Ranges community with a more positive attitude to grey-faced petrels and who have higher nature-relatedness scores are more supportive of habitat management approaches to support the restoration of grey-faced petrels.

4.3 Aotea – Glenfern Sanctuary

Glenfern Sanctuary is an 83ha area on the North-West of Aotea Great Barrier Island founded in 1992 in reforested farmland, which became an Auckland Council regional park in 2016. The sanctuary constitutes approximately 1/3 of the Kotuku Peninsula and protects a regenerating mixed broadleaf forest from invasive species (https://www.glenfern.org.nz/), defended by a 2.1 km predator-proof fence that surrounds the whole peninsula. The sanctuary was created as a safe haven for the important and endangered biodiversity inhabiting the area, including endemic bird and reptile species (e.g. black petrel, kaka – *Nestor meridionalis*, Chevron skink – *Oligosoma homalonotum*). The site was also the target of a predator eradication effort in 2009 through aerial drops of brodifacoum, and is subject to ongoing ground-based trapping and monitoring. Predator control has significantly reduced kiore and ship rat incursion and population density (Gronwald and Russell 2020).

Ongoing predator management in the sanctuary allows for some of the highest diversity of indigenous fauna in the Auckland region (second only to Te Hauturu-o-Toi), with a high percentage of native bird species in the area (Landers et al. 2021). More specifically, Glenfern serves as the breeding grounds to three seabird species: tākoketai / black petrel, tītī / Cook’s petrel and kororā / little penguin (Lukies and Gaskin 2023). However, there only are remnant populations of black and Cook’s petrels nesting in the area, with the second possibly dispersed from the Hauturu population (Gaskin and Rayner 2013). Both species only seem to currently breed in scattered burrows but were likely widely present before the incursion of invasive species (Gaskin and Rayner 2013). There is an urgent need for monitoring and management of these seabird populations , considering both species are limited to breeding in Aotea and Hauturu only, making the species vulnerable to large scale habitat disturbances and predation events (See also section 3.1 and 3.2). Seabird population studies and evaluation in the Glenfern Sanctuary can contribute valuable information to threat assessments, and future management strategies for habitat restoration and pest removal, in efforts to expand populations of both species on the island and elsewhere; and in the first instance, to support the recovery of these quite small populations within the sanctuary.

4.3.1 Activities and first findings

In November 2022, seabird surveys were commenced to assess the status of Cook's and black petrels at Glenfern and to evaluate the feasibility of a long-term monitoring project involving Glenfern trustees and mana whenua. The overall goal of this project is to build local capacity for long-term seabird monitoring on Aotea. Several confirmed or potential burrows for both species were already known by the Sanctuary managers thanks to past occasional seabird surveys giving a good starting point, but regular monitoring had never been carried out before.

Figure 12. Seabird detection dog Miro (DabChick NZ) looking at the tītī / Cook's petrel that he just found.

A first trip in mid-November 2022 aimed to survey Cook's petrel breeding activity. Forty-eight Cook's petrel burrows previously recorded in the Glenfern Sanctuary database were monitored. Only two of those had adults incubating eggs (nest occupancy 6.3%), two burrows had non-breeding adults, and 32 burrows were empty. The remaining burrows were too deep to ascertain the breeding status, despite the use of a burrowscope. In January 2023, during the black petrel monitoring trip (see below), a chick was present in both breeding burrows, and another chick in a burrow that had not previously been inspected.

Two following trips aimed to survey black petrel breeding and their breeding success in January and April 2023, respectively. Thirty-three known black petrel burrows were monitored; of those, only three had adults incubating eggs, and one burrow had a broken egg at the entrance with a fully developed yet dead chick inside, indicating breeding failure (nest occupancy was 12.1%). A pair of non-breeders was found in a burrow, whereas 24 burrows were empty. The remaining four burrows were too deep to ascertain occupancy. At the end of April, chicks were banded in all three burrows in which there was an incubating adult.

These initial findings highlighted a surprising low breeding occupancy for both species, although breeding success was relatively good. Ground surveys to check for known burrows unveiled that most of these had been unused for some time, if ever, and that many of the burrows recorded in the database were only potential burrows in which birds had never been observed before. This highlighted the need for a new survey of the Sanctuary to search for new burrows for both species to better understand the number of birds breeding there.

To search for occupied burrows, a certified seabird detection dog, Miro, and his handler Joanna Sim from DabChick NZ were employed. Miro has been trained in detecting the smell of burrowing seabirds, and his skilled nose is able to find and point his handler at burrows in the middle of the bush (Figure 12). In December 2023, thanks to the seabird detection dog, it was possible to find eight new black petrel burrows (of which four with the confirmed presence of an egg), and six new Cook's petrel burrows (of which two were confirmed breeders). A second dog survey in February 2025 located another 17 new Cook's petrel burrows (of which seven with a confirmed chick), one more black petrel burrow and two kororā / little penguin burrows.

The employment of a trained seabird detection dog proved to be a very effective method in locating new burrows in the bush and showed that more burrows than initially thought are in the Glenfern Sanctuary. These burrows will now be employed as study burrows for yearly monitoring so to follow the populations and gather data about breeding and breeding success.

4.3.2 Next steps and management implications

The pilot surveys showed that regular monitoring at Glenfern Sanctuary is feasible and can provide valuable information towards the assessment of black and Cook's petrel population statuses. Long-term, annual monitoring of these populations will help reveal breeding patterns and hopefully the factors driving these patterns. Supplemental surveys employing a seabird detection dog in other areas of Glenfern that have not been surveyed so far would be beneficial to locate more burrows to include in ongoing monitoring. Dog surveys would also be important in finding other seabird species within the sanctuary. Little penguins are already known to breed at Glenfern, and two more burrows were found during the last dog survey, but numbers and population trends are unknown. Other species like fluttering shearwater and common diving petrel are suspected of being present in or visiting the area. If confirmed, this would elevate the ecological and conservation value of this fenced area as an important restoration site for seabirds.

The employment of a seabird detection dog proved to be the most effective system to locate new burrows. It is advisable to carry out regular surveys (e.g. every three years) so to detect possible increases in burrow numbers and hence in the populations, in addition to the yearly monitoring of this new set of study burrows that we have identified.

The continuation of predator control in the Glenfern Sanctuary is of fundamental importance if we want to create a safe site for seabird populations to breed and expand and to provide healthy forest to support native biodiversity. Combining the data from invasive predator trapping and monitoring with data from the seabird monitoring will add valuable information to guide management efforts. The constant trapping effort to reduce introduced predators provides an indication of the variation of predator pressure over time. Continued seabird monitoring will provide further information on the presence, and success of seabirds at this site, whilst relating it to different levels of introduced predators' pressures. Such information will be particularly valuable for management purposes to understand levels of predators that enable seabird populations to be sustained.

Glenfern is an important restoration site on Aotea and in the Auckland region, it also has an important role for conservation advocacy and education opportunities of the park visitors. Working in collaboration with mana whenua and increasing the possibilities for the local community to be involved by joining monitoring, will help build local knowledge and skills to monitor and look after seabird species in a sustainable way and, in the long-term, promoting seabird monitoring as a regular practice in Glenfern.

4.4 Pokohinu / Burgess Island

Pokohinu / Burgess Island is located 25 km northwest of Aotea in Te Moananui-ā-Toi / the outer Hauraki Gulf; it is the second largest island of the Mokohinau Islands group, measuring 56 ha. Pokohinu is gazetted as a Scenic Reserve and a Lighthouse Reserve with open public access. The installation of a lighthouse in 1883 brought people and their livestock to live on the island. This resulted in much of the native vegetation being cleared and replaced by pasture species, and fire being regularly set to suppress the tussocky sedges (Esler 1978), until 1980 when the lighthouse was automated. The island was declared pest free following the removal of feral goats (*Capra aegagrus*) by the Wildlife Service in 1973 (Whitaker 1974 cited in Ismar et al. 2014), and kiore in 1990 by DOC (McFadden and Greene 1994). Since then, native vegetation has been left to naturally regenerate and no habitat restoration has been undertaken, apart from limited weed control and the demolition of the lighthouse keepers' houses (Ismar et al. 2014).

Since becoming rat-free, Pokohinu has transformed into a seabird biodiversity hotspot, known to support seven species of burrowing Procellariiformes: grey-faced petrel / ōi, fluttering shearwater / pakahā, sooty shearwater / tītī, little shearwater / totorore, common diving petrel / kuaka, black-winged petrel / karetai kapa mangu and white-faced storm petrel / takahikare, as well as other seabirds like little penguin / kororā and red-billed gull / tarāpunga (Ismar et al. 2012, Gaskin and Rayner 2013, Ismar et al. 2014). Such richness of species has allowed the island to become a living laboratory for numerous studies on seabird biology and physiology (Rayner et al. 2017a, Rayner et al. 2017b, Berg et al. 2018a, Dunphy et al. 2020, Gaskin (ed) 2021). However, so far population studies remained limited (Ismar et al. 2012, Ismar et al. 2014, Russell et al. 2017), and there is little or only anecdotal knowledge about seabird populations recovery and present status. All of the seven burrowing seabird species were identified with major (little penguin, white-faced storm petrel, sooty shearwater) or partial (black-winged petrel, common diving petrel, little and fluttering shearwater) knowledge gap during the prioritisation process (Section 2). This highlighted the need for more systematic population studies in this location.

Pokohinu also holds a particular cultural importance as customary rights to harvest grey-faced petrels are still exercised by Ngāti Rehua Ngātiwai ki Aotea under the Grey-Faced Petrel (Northern Muttonbird) Notice 1979, pursuant of section six of the Wildlife Act 1953. Mokohinau are the only islands in the region where cultural harvest is presently allowed.

4.4.1 Activities and first findings

Monitoring on Pokohinu under this programme has encountered issues and delays due to COVID-19 restrictions and bad weather impacting the access to the island, consequently data collection has been inconsistent. Despite the constraints, the island was visited four times between 2019 and 2022 to gather data on different species including white-faced storm petrels – for which the results are reported in a dedicated section of this report (3.3) – black-winged petrel, northern diving petrel, sooty and North Island little shearwater.

Black-winged petrel (hereafter BWPE) were reported to breed on the island for the first time in late January 2011 when nine burrows where found (Ismar et al. 2012). Subsequently, between 2017 and 2019, only two breeding and one non-breeding pairs were observed in those burrows (C. Wails *pers. comm.*). In December

2019, ground surveys were carried out to locate known and new burrows of this species. Of the nine previously known burrows, only five of those located next to the Met Service weather station could be found and none on the north-west slope of the northern headland. In the monitored burrows, one pair of non-breeding BWPE and two grey-faced petrel chicks were found, whereas the other two burrows were empty. Several burrows were also checked in the surroundings and different areas on the island, and they were all unoccupied. These burrows were monitored again the following February, and they were all empty except for one BWPE non-breeding adult. During both trips, at dusk, a few individuals (<10) were seen and heard flying over the weather station and the northern part of the island, in the same areas as previously reported (Ismar et al. 2012).

Figure 13. A pair of non-breeding karetai kapa mangu / black-winged petrels was found into a new burrow on the north-west slope of Pokohinu / Burgess Island in February 2020. Photo taken with the "burrowscope" used for the nest inspection.

The field trip in February 2020 aimed to search for both BWPE and sooty shearwater burrows. Searches for both species were carried out with random ground surveys of the areas where these species were previously reported and using play-back calls. All petrels and shearwaters have species-specific calls that allows them to be identified. They generally call at night at the colony and respond to calls from conspecifics, also from their burrows. Broadcasting a recorded call (play-back) in the colony often stimulates the birds sitting in their burrows to call back, allowing surveyors to locate the burrow by listening and following the answer call. Play-back calls for these species were obtained from the New Zealand Birds Online website (https://nzbirdsonline.org.nz/) and were a useful method as both species answered broadcasted calls from the burrows both at night and during the day. Using this method two new BWPE burrows on the north-west slope of the island and one sooty shearwater burrow on the north-east side were located. The two BWPE burrows were occupied by an adult on an egg and by a pair of non-breeders (Figure 13). The sooty shearwater burrow was on a steep slope in a non-accessible area, so we could not check for breeding activity. Results from this initial survey suggest that the already small breeding populations of both species on Pokohinu are further reducing, and supplemental studies are necessary to confirm this potential trend. Unfortunately, it was not possible to reach the island again during the following breeding seasons of these two species.

In October 2020 and 2022, while capturing WFSP with spotlight and mist-nets and searching for grounded birds at night (see section 3.3), other species were also incidentally captured and banded. In October 2020, only using a spotlight to attract birds, 20 diving petrels and two little shearwaters were captured and banded in one night. In October 2022, birds were captured using mist-nets, spotlighting, and by searching for grounded birds. Over two nights, 76 diving petrels were captured and banded and four individuals banded in 2020 were recaptured, eight little shearwaters and one grey-faced petrel were also captured. While these numbers are still too low to be used for population estimates, they are promising with regards to the possible use of the mark-recapture method (see 3.3) for future applications on these and other species at the site.

4.4.2 Next steps and management implications

Further surveys and the establishment of regular, long-term monitoring will be required to gain an understanding of population statuses and trends of the seabird species on Pokohinu, particularly for BWPE and sooty shearwater which appear to be present in very low numbers. Only with multi-season (long-term) data, it will be possible to understand population trajectories and explore possible factors underlying them.

During the visits, an appreciation of how the vegetation is regenerating on the island could be taken on board. This is positive for the restoration of the island, however it points at the need for track maintenance, not only up to the lighthouse, but also forward to the Met Service weather station and the northern headland. White-faced storm petrels and diving petrels were often found resting and running under muehlenbeckia (*Muehlenbeckia complexa*) and harakeke / flax (*Phormium tenax*). If these plants overgrow over the path, it makes hard to spot the birds while walking on the island, especially at night, when birds are out and active also on the ground, increasing the risk of stepping on them with potential lethal consequences.

While other islands in the Mokohinau Group are restricted access Nature Reserves, Pokohinu is gazetted as a Scenic Reserve and a Lighthouse Reserve with open public access. It is important to monitor the potential impacts that public access could have on the island and its biodiversity and to manage related risks, for example possible re-introduction of rats or fire.

Given that Pokohinu is managed by DOC, it is recommended that Auckland Council will discuss the above track maintenance and public access issues with DOC and advocate for action. Auckland Council can contribute via regularly reporting back any updates on these issues to DOC after visits to the Mokohinau.

In 2021 exotic caulerpa (*Caulerpa brachypus* and *C. parvifolia*) was detected around the Mokohinau Islands. Mitigation measures to prevent the spread of this pest seaweed include the prohibition of access to Pokohinu by boat, which has limited our access ability for survey. In addition, at the end of 2022 a notice from DOC prohibited access to the northern headland of Pokohinu for health and safety reasons, until adequate mitigation measures are put into place. As of time of writing, the site is still closed, preventing further monitoring.

5 Supporting projects

5.1 Conservation physiology – Study of stress hormones

Variations in marine conditions can affect food quality and availability for seabirds, with potential impacts for entire populations when resources become limited (Cairns 1987, Harding et al. 2013). When going through periods of limited food resources, seabirds show a range of signs of increased stress in their bodies, including higher production of stress hormones (Kitaysky et al. 2010, Will et al. 2015) and production of feathers of lower quality (Keddar et al. 2015, Sparrow et al. 2017). Such signs of stress can be quantified and compared to variation in ocean conditions (e.g. water temperature) and, if stress signs reflect environmental changes, their monitoring can be used as predictors of habitat change (Cairns 1987, Piatt et al. 2007a). High levels of stress hormones in the blood for prolonged periods of time have negative impacts in health (e.g. lower immunity) and development of youngsters (e.g. cognitive impairment) (Kitaysky et al. 1999, Kitaysky et al. 2003, Will et al. 2015). If signs of high stress levels are detected in enough individuals in a population, they might serve as warnings of future population instability (Cairns 1987, Parsons et al. 2008, Dunphy et al. 2020). In seabirds, the stress hormone corticosterone (CORT) and feathers' pigmentation (e.g. feather colour brightness) can be measured to quantify signs of stress in an individual (Kitaysky et al. 2007, Satterthwaite et al. 2012, Parker Fischer et al. 2017). If these are found to successfully reflect changes in environmental conditions, they can be used as integrative monitoring tools for population and ocean health. However, the relationships between signs of stress and environmental conditions are complex and require extensive research for validation.

To begin validating the reliable use of seabird feathers as a new monitoring tool for marine and population health and helping advance new monitoring technologies for seabird populations and their habitat, a masters project was designed in collaboration with the University of Auckland.

5.1.1 Activities and findings

The project aimed to investigate whether variation in CORT levels deposited in grey-faced petrel adults and chick feathers and feather brightness reflect changes in ocean conditions (e.g., temperature, primary productivity). It also looked at whether parental feather CORT and brightness predict breeding success and offspring quality.

The work was carried out by Maíra Fessardi, a master student at the University of Auckland supervised by Dr Kristal Cain and Dr Brendon Dunphy. Results from this project are reported in her thesis titled "Stress physiology of grey-faced petrels: interannual measures of feather corticosterone as a conservation tool" (Fessardi 2022). In brief, results indicate that feather CORT levels may be a valuable predictor for breeding parameters in the Ihumoana Island grey-faced petrel population. Accordingly, feather pigmentation appeared as a promising predictor of breeding success. However, the research highlights that the relationship between physiological parameters and environmental variables is complex and subject to a range of behavioural adaptations. Continued research and validation are necessary to advance the field. A journal article with more detailed results and conclusions is currently in development in collaboration the University of Auckland.

5.1.2 Next steps and management implications

As a result of this study, the Seabird Programme will start incorporating feather pigment measurements of monitored species to validate the method for other species and to further investigate the potential of feather pigmentation measures as an indicator of marine and population health, in an ongoing collaboration with the University of Auckland.

Researching more integrative tools will contribute to more efficient monitoring to gather missing data in seabird health status and trends in Auckland. Improved seabird monitoring data will better inform necessary management and restoration decisions and improve budget and time allocation for seabird conservation. This is crucial in long-lived species that are challenging to monitor in short-term periods, especially under the effects of rapidly changing environmental conditions caused by climate change.

5.2 Black petrel and pigs on Aotea – A socio-ecological study

Aotea hosts the main remaining colony of the Auckland endemic black petrels, and the only other colony is on Hauturu, where it is showing signs of possible decline (Section 3.1). However, Aotea is not predator-free and, among other introduced predators, feral pigs represent an important risk for the survival of black petrels and other seabirds attempting to breed on the island. Feral pigs can have an exceptionally wide range of negative consequences within indigenous ecosystems beyond their native range, leading to habitat degradation and depletion of fauna, including decline and localised extinction of seabirds (Chimera et al. 1995, Barrios-Garcia and Ballari 2012, Russell et al. 2015, Bengsen et al. 2017, Wehr et al. 2018, Risch et al. 2021). However, feral pigs are much valued by some as a food resource (Albarella 2007). On Aotea, where both black petrel and pigs are present, conservation efforts to protect black petrel can come into conflict with the hunting community expectations of access to the pigs. This introduces a potential human-conflict dimension to conservation management. Understanding the wider community context is important for the success of management actions, especially on inhabited islands where conservation had been historically fraught with social challenges (Russell and Stanley 2018).

To understand the issues surrounding pig management and black petrel conservation on Aotea, we started a collaborative project with the University of Auckland, Wildlife Management International and the Southern Seabird Solutions Trust, with the support of Tū Mai Taonga. This study, employing a socio-ecological approach, was undertaken in partnership with mana whenua and the pig hunting community on Aotea; with mātauranga Māori central to the research to ensure cultural appropriateness.

5.2.1 Activities and findings

The study was designed in two parts. On one side, qualitative social science and mātauranga Māori was employed to understand the values of the pig hunting community, their perception of the threat the pigs represent for black petrel and the degree of support the community has toward options for management of pig impacts on black petrel colonies. In addition, community-held and traditional Māori knowledge of pigs was gathered, to inform understandings of the ecological interactions that pigs have with black petrels and the wider island ecosystem. The other part of the study aimed to quantify pig impacts on black petrel and their habitat. This involved ecological surveys and camera monitoring of black petrel colonies, to gather data on pig (and other predator) relative abundance and interactions.

The work was carried out by Christine Mansford, a master student at the University of Auckland supervised by Dr James Russell, with the support of all collaboration partners stated above, including the Seabird Programme. Results from this project are reported in her thesis titled "Understanding the significance of a culturally-valued *mahinga kai* species (wild pigs, *Sus scrofa*) for seabird conservation, and for community on Aotea (Great Barrier Island)" (Mansford 2023). In brief, results show that pigs are involved in restricting the range and driving population decline of black petrel, as well as degrading their breeding habitat within regenerating kauri (*Agathis australis*) forest. The community has a complex relationship with pigs, valuing them simultaneously as *mahinga kai*, and as an introduced species which has negative impacts within the natural environment. Hunters are opposed to total eradication to manage these impacts but are open to certain forms of pig control. The wider community supports management of pigs for broader objectives.

5.2.2 Next steps and management implications

WMIL (funded by DOC) carried out initial trials of non-lethal options for deterring pigs from black petrel habitat, to see how these methods perform at reducing pig impacts, while meeting community expectations (Bell et al. 2024). Further trials will test the efficacy of the use of olfactory (smell) or acoustic (sound) cues to condition pigs to avoid black petrel areas.

Integrating *mahinga kai* and ecological restoration values to inform targeted management of pigs around seabird breeding areas is an opportunity for further exploration with the community.

5.3 Understanding juvenile survival – Black petrel captures at sea

The main black petrel colony on Aotea, on top of Hirakimata, has been regularly monitored since the breeding season 1995/1996 (Bell et al. 2024). Since then, fledgling have been banded every year, with a total of 4742 chicks banded between May 1996 and May 2023 As of the last survey in May 2024, only 461 of those have ever returned to the colony and been recaptured (Bell et al. 2024). This corresponds to a recapture rate of only 9.2%, which is extremely low. Juveniles spend 4 to 7 years at sea, before coming back to land to be recruited into the active population, i.e. start breeding (Bell et al. 2023). Understanding the factors affecting return rates of chicks is crucial. It is important to determine whether it is related to low juvenile survival and/or recruitment or if it is simply due to a lack of detection. Understanding juvenile survival and recruitment is necessary for accurate demographic modelling and for species risk assessment modelling. Therefore, WMIL started a project aimed at capturing black petrels at sea to determine the proportions of unbanded versus banded birds, and to assess if apparent low juvenile survival is biased by dispersal away from study colonies. The Seabird Programme collaborated with the project and cofounded it.

5.3.1 Findings

Findings are presented in two reports prepared by WMIL (Crowe and Burgin 2021, Burgin 2022) and summarised here. At-sea catching trips were carried out in the waters north-east of the Marotere / Chicken Islands, and north of the Mokohinau Islands. Black petrels were lured next to the boat and then captured throwing a hand cast net (6ft). Birds were banded – or the band number recorded, if already banded – and then released with a mark of correction fluid to avoid recapturing the same bird, and gently released on the side of the boat. Overall, 230 black petrels were captured during four trips (total of nine days' worth of catching); of those seven were recaptures of birds already banded. Three of the recaptured birds were banded as chicks, two on Aotea and one on Hauturu. For two of those, this was the first recapture, meaning that these birds had not been reseen since they were banded five and six years before. The other birds were previously banded as adults either on Aotea (3) or Hauturu (1) (Crowe and Burgin 2021, Burgin 2022).

This work is now being continued by The Seabird Trust, funded by DOC (Gaskin and Whitehead 2024).

6 Emerging new projects

6.1 Study of contaminants: heavy metals

A prominent threat to seabird populations is the rate of contaminants deposited into the marine environment (Fort et al. 2014, Albert et al. 2019). Heavy metal contaminants are naturally produced and released into the environment and naturally integrate some biological processes (Albert et al. 2019). However, the intensification of human activities that release heavy metals into the marine environment (e.g., urbanisation, historical mining, and agriculture) raised the levels above natural thresholds (United Nations Environment Programme 2014).

The Hauraki Gulf hosts a range of human activities that can contribute to heavy metal contamination (Hauraki Gulf Forum 2020). Some of the biggest concerns in the region are primarily copper and zinc, followed by lead and mercury (Hauraki Gulf Forum 2023). Heavy metals can accumulate in sediment, reaching toxic levels in high doses and affecting ecosystem health (Dzielski et al. 2020). Commonly, where mercury is elevated, so are other metals, along with other stressors that might contribute to cumulative impacts. Monitoring of the Hauraki Gulf marine sediment over ~ 10 years (2012-2022) has shown that few sites had relevant levels of mercury, with no spatial pattern for increasing trends (Allen 2023). However, the ongoing emergence and potential multi-source accumulation of contaminants across the vast area of the Hauraki Gulf makes it challenging to monitor their progression and impacts (Ito et al. 2013, Hauraki Gulf Forum 2023). For example, pelagic areas where seabirds commonly forage are far from the coast and more inaccessible to monitoring. Further analyses, in more diverse habitats are required to have a more definitive understanding of trend direction and magnitude for these chemicals in the marine environment.

Heavy metals contaminate biodiversity directly through diet and indirectly by bioaccumulation in food chains, affecting top predators, like seabirds, disproportionately (Dzielski et al. 2020). Heavy metal intake circulates in the bloodstream of seabirds for a period of weeks to months after consumption (Dietz et al. 2009), and contaminants are excreted from the body, among other pathways, through feather growth (Dietz et al. 2009, Albert et al. 2019). Consequently, concentrations of heavy metals in feathers strongly reflect contaminant levels circulating in blood during the whole feather growth period (Markowski et al. 2013, Bottini et al. 2021). Thus, heavy metal levels extracted from blood informs on recent contamination, while feather levels inform on the whole period of feather development (Furness et al. 1986, Albert et al. 2019). High levels of heavy metals have been proven to affect individual health by being assimilated and causing damage to organs and tissues, and by wasting energetic resources to improve excretion of accumulated contaminants (Burger and Gochfeld 2001, Dzielski et al. 2020), and might affect entire populations if enough individuals are affected (Dzielski et al. 2020). Thus, monitoring levels of heavy metals in seabird populations can highlight areas of health concern for the populations themselves and their respective foraging ranges, pelagic environments not commonly accessed for monitoring (Evers et al. 2011, Mallory and Braune 2012, Markowski et al. 2013). Seabirds' intake and storage of heavy metals offer the chance to monitor ecological consequences of environmental pollutants and biodiversity exposure to contaminants.

6.1.1 Methods and goals

In order to estimate levels of contamination by mercury in seabird populations of the Auckland region and evaluate the inherent health risk, levels of contaminants will be measured and compared across different species and breeding sites. In the past four years, over 200 feather samples and almost 100 blood samples from five different species across seven locations have been collected and stored during the regular monitoring trips described in this report. Among the species sampled so far there are black, Cook's and grey-faced petrels and WFSP from Hauturu and Aotea, The Noises and Pokohinu.

The study will focus on blood samples from adults' and chicks' blood and feathers, which reflect contamination levels during the breeding season when birds forage in the Hauraki Gulf. In addition, feather from adults will also be analysed to uncover problematic levels of heavy metal contamination during the non-breeding season, which could be impacting adult health and reproduction. Stable isotopes analysis (SIA) will be compared to Hg levels to help specify the foraging area and dietarian components contributing to variation in results (Albert et al. 2019). Sample analysis is set to begin in June 2025 and blood and feathers samples will continue to be collected during future monitoring.

6.2 Nest temperature and breeding outcomes

As global temperatures rise due to climate change, it is critical to understand how heat affects wildlife, particularly during critical breeding seasons. High temperatures can disrupt breeding success in many species by affecting parental care, increasing physiological stress, and reducing food availability (Osborne et al. 2020, Russell et al. 2022). Burrowing seabirds, which rely on stable microclimates within their nesting habitats, are particularly vulnerable to temperature fluctuations. Increased burrow temperatures in breeding seabirds negatively affect breeding success by increasing the risk of hyperthermia in chicks and incubating birds (Ropert-Coudert et al. 2004, Kelsey et al. 2015), reducing nest attendance, and potentially leading to breeding failure. High temperatures can also negatively impact offspring quality and overall breeding potential, especially during marine heatwaves (Osborne et al. 2020, Russell et al. 2022).

Despite their ecological importance, limited research exists on how thermal changes affect different seabird species, especially in the Hauraki Gulf. This study aims to investigate the relationship between external temperatures and the internal microclimate of burrow nests, and whether these factors influence breeding success. Understanding these dynamics may help inform conservation strategies in the face of a changing climate.

6.2.1 Methods and goals

To assess the impact of temperature variations on reproductive outcomes, temperatures will be measured both inside and outside breeding burrows of different species and at different sites, using miniaturised temperature loggers. The study will aim to understand how internal burrow temperature varies in relation to the outside environment temperature, and if these variations affect breeding behaviour and success. Temperature will be monitored in nest-boxes as well, when available. Nest boxes are known to offer less temperature buffer than natural burrows; understanding which are the temperature thresholds will help to understand how to increase their benefits to provide safe breeding sites and restore populations.

7 Discussion

This report outlines the development of the first regional Seabird Monitoring and Research Programme by a local government organisation in New Zealand. This report has detailed the rationale behind the prioritisation and choices of species and locations to monitor and research, and has presented the activities carried out so far including initial results.

In the first five years of the Seabird Programme, monitoring and research projects were successfully established for a number of priority species and sites across the region, gathering important new knowledge. The main findings so far include:

- The black petrel / tāiko population on Hauturu is small despite high protection, showing yearly fluctuations in the number of breeding birds. They appear to potentially be vulnerable to extreme weather events (3.1).
- Cook's / Tītī petrels are showing positive numbers of breeding birds and good breeding success. In 2023, breeding results appeared to indicate a possible higher resilience to the extreme weather events that impacted other species. However, a small part of the colony was destroyed as a result of the weather events and the effects of this are not yet fully understood (3.2).
- A first population estimate of white-faced storm petrel / takahikare was calculated for the population at Ruapuke. Despite the high level of uncertainty due to low number of repetitions, it shows that several thousands of birds are probably breeding there. Interannual variability in both nest occupancy and breeding success is high and the species appears to be vulnerable to extreme weather events (3.3).
- An initial map of shag colonies for the region was compiled. This work is not completed yet, but present findings show that pied shags / kāruhiruhi are the most abundant species. However, colonies have a different distribution than past reported data. Little shag / kawaupaka colonies are more abundant than what was previously reported. Black / māpunga and little black / kawau tūī shags are rare, but previously unreported colonies of these species are being found (3.4).
- Population counts of spotted shag / kawau tikitiki reveal large variation year to year, with signs of continued decline over time. A tracking study of foraging birds is ongoing (3.5).
- Ōtata (The Noises) in an important seabird site. Monitoring of grey-faced petrel / ōi showed a relatively stable population, whereas little penguin / kororā were present in low numbers and only few of them were breeding. Trials for restoration of spotted shag / kawau tikitiki, fluttering shearwater / pakahā and little penguin / kororā are ongoing (4.1).
- The restoration research projects in the Waitākere Ranges highlighted that grey-faced petrel / ōi can have relatively high breeding success in the presence of introduced mammalian predators if these are below a certain threshold level. The most vulnerable time is the early chick-rearing phase. The Waitākere Ranges community are generally supportive of increased predator control and other habitat management approaches to support the restoration of grey-faced petrel (4.2).
- The pilot trial for seabird monitoring feasibility at Glenfern Sanctuary on Aotea was successful even if first findings evidenced low numbers of occupied burrows. The employment of a seabird detection

dog located more active burrows for both black / tākoketai and Cook's petrel / tītī, as well as some little penguin / kororā burrow. Regular, long-term monitoring is feasible and relevant (4.3).

- The access to Pokohinu / Burgess Island was inconsistent preventing the collection of reliable data. Only very few burrows of black-winged petrel / karetai kapa mangu and only one of sooty shearwater / tītī were found during the initial survey, highlighting the need for further monitoring to identify trends. Monitoring is needed for all seabird species on Pokohinu(4.4).

The establishment of these projects provide a baseline for long-term studies, which are essential if we want to identify population trends or patterns, to better understand species restoration requirements, and to evaluate the impact of conservation efforts and environmental issues. Seabirds are long lived, with delayed maturity (long generation times), high adult survival and low reproductive rates, so timescales for population processes are very long (Nisbet 1989). The first few years of monitoring provided important information on the presence of species in specific areas, their abundance, breeding chronology and annual breeding success; however, most changes in the populations and their environment take place over prolonged periods. Long-term research work is then essential to document these changes and to gain insights into important factors such as age-related issues (e.g. survival, reproductive performance), year-to-year variation and the influence of infrequent events or cyclic phenomena (Wooller et al. 1992). This is the case, for example, in the understanding of the effect of El Niño Southern Oscillation on birds' behaviour, breeding and survival. Long-term research enables detection of changes in seabird diet, foraging distributions and physiology in response to changes in the marine environment, climate change, and pollutants. Only long-term, consistent monitoring can reveal population trends that annual variations would otherwise hide. Such monitoring may also allow to link variations to environmental variables or threats to inform specific management (Wooller et al. 1992).

The projects established under the Seabird Programme provide a baseline for assessing accurate estimates of population size and understanding population trends. These are key pieces of information required to inform conservation status assessments and management decisions for threatened seabirds. Both an accurate population estimate, and key demographic parameters are needed to inform risk assessment. For this, data should be collected over the lifespan of the species, but also through inter-generational studies of fledglings as they return to their natal colonies and recruit into the breeding population.

While, long-term monitoring and research is needed, data gathered so far are still informative. Recently, programme data were used for the Auckland Council assessment of the conservation status of the bird species of the Auckland region (Woolly et al. 2024). Understanding the threats and estimating the population size and trend within the region for each species, utilised data collated in the Seabird Programme to date, and as further data is gathered in subsequent years, it will contribute to future editions of this assessment. The new knowledge generated by this work has been helpful in revaluating and re-prioritising the species, and to direct our future work, and identify research needs (see 7.1).

Seabirds are the most endangered group of birds globally (BirdLife International 2018) and are sensitive to a number of threats both on land and at sea. Some of the main threats that need to be managed in order to see populations persist and thrive are outlined below in relation to the initial findings the Seabird Programme:

Introduced mammalian predator control / eradication

Predator control is one of the most important actions to restore suitable seabird habitat and make it safe for breeding birds (Croxall et al. 2012, Dias et al. 2019). An example is the recovery of the white-faced storm petrel population on Ruapuke Island that had almost completely disappeared from The Noises (Cunningham and Moors 1985), and was saved by the removal of rats, with the population now estimated in the thousands of individuals (Section 3.3). Another example is recovery and increase in Cook's petrel population size and breeding success following eradication of rats on Hauturu (Veitch 2001, Gaskin and Rayner 2013, section 3.6). Such success provides incentives for future management strategies; Cook's petrel population was last estimated at 286,000 pairs (Rayner et al. 2007a) and the recent records of breeding birds on Ōtata (Section 4.1) and Tāwharanui (Russell 2021) highlight the possibility of natural re-colonisation if we continue to generate predator free areas. Incursions of predators in predator free areas (e.g. Mokohinau, The Noises) or of predator species where they are not present (e.g. Norway rats and mustelids on Aotea) would have dramatic impacts, emphasising the importance of managing predator populations at place as well as potential pathways for distribution.

Monitoring before, during and after predator control or eradication initiatives is important to inform restoration and recolonisation of managed areas (Buxton et al. 2014). An example is Aotea. Aotea has great potential for restoration and becoming a seabird hot spot in the Hauraki Gulf. It is the home of the principal remaining colony of the endemic black petrel and other seabirds sensitive to introduced predators that could be thriving if provided a safe environment to breed. Since 2021, the Tū Mai Taonga Project defined a *Pathway to Eradication*, "a longer-term, adaptive approach to realising a predator-free future for Aotea in the aim to protect and restore local biodiversity and all the taonga species that live on the island". The project is proceeding under the leadership, guiding vision and tikanga of the Ngāti Rehua Ngātiwai ki Aotea Trust. Auckland Council is among the partners and funders of this ambitious and extremely valuable project. To support seabirds monitoring to evaluate the effects of eradications and measure restoration, the Auckland Council Seabirds Programme Team joined the "Aotea Seabird Island Working Group" lead by the Aotea Great Barrier Environmental Trust and composed of seabird experts, local community, tangata whenua and Tū Mai Taonga leaders, with the goal to understand which seabirds are still present in the areas that are undergoing pest eradication, and measure population changes following rat and cat removal.

Monitoring is also necessary to provide evidence of how mammalian pest species can drive population declines and how their removal could foster restoration. In order to improve the conservation status of threatened seabirds, so that they have resilient, expanding populations, it is important to understand what pest threshold levels management objectives could be based upon. This is particularly important for improving seabirds on the mainland, where eradication may not be possible. The PhD work of Fox (Section 4.2), showed the crucial times and pest densities which affect grey-faced petrel populations on the west coast of Auckland. Ultimately, to restore seabirds requires both continuing to eradicate pests on islands but also to create a suitable environment for seabird populations establishment and expansion on the mainland where many species were once abundant (Gaskin and Rayner 2013). Auckland Council manages large areas of the mainland, such as in the Waitākere Ranges, which contain important opportunities to improve seabird habitat and contribute to restoring seabirds in the region.

Impacts of extreme weather events and vulnerability to climate change

Extreme weather events like those of early 2023 can have significant impacts on breeding seabirds by damaging colonies with slips, erosion and flooding, and causing high chicks mortality rates, as it was observed for black petrels (Section 3.1), Cook's petrel (Section 3.2), white-faced storm petrels (Section 3.3) and shags colonies (Section 3.4). The frequency of extreme weather events is expected to increase in Auckland (Pearce et al. 2020), highlighting the need for a sound risk assessment and implementation of mitigation measures to preserve seabird populations. Studying seabird responses to extreme climatic events can also provide metrics for potential impacts on other species and whole ecosystems, making them ideal sentinel species for monitoring coastal social-ecological systems in the context of global change (Martin et al. 2025).

In addition to the increase in extreme weather events, climate change affects seabird species in several different ways. High temperatures can disrupt breeding success in many species by affecting parental care, increasing physiological stress, and reducing food availability (e.g. Russell et al. 2022). Sound research projects that seek to understand the effects of climate change on the species and their ecology are of paramount importance, especially given the limited information currently available on seabirds in Auckland. A study is currently being developed to investigate how external temperatures influence the microclimate within nest burrows and the potential impacts on breeding success (Section 6.2).

The impacts of long-term climate variation are particularly profound for slow-breeding species with reduced clutch size (e.g. all petrels and shearwaters lay only one egg per year), and large spatial habitat requirements. Consequently, seabirds are ideal indicators for monitoring the changes within the marine ecosystem (Hazen et al. 2019, Velarde et al. 2019). Long-term studies of seabirds and the collection of precise annual data can offer precious insights into the effects of climate change on marine ecosystems across broad spatial scales (Montevecchi and Myers 1997, Piatt et al. 2007b).

Habitat loss on land and at sea

Breeding colonies face direct threats from human disturbance, while marine pollution and overfishing further endanger many species (Dias et al. 2019, Whitehead et al. 2019). Restoring both terrestrial and marine habitats is therefore crucial to providing safe environments for seabirds to breed and forage (Rayner et al. 2007b, Croxall et al. 2012). To understand their use of habitat, tracking seabirds during their foraging trips at sea allow to understand the species' foraging ecology, and what areas the birds are using, why, what spatially explicit threats exist (Sections 3.5). At sea, mitigating fishing pressures around seabird habitats is essential for creating safer, more sustainable ecosystems for all species, and these studies will provide valuable information needed to establish effective management and protection. On land, in addition to removing introduced predators, also restoring and protecting native vegetation is necessary to create suitable seabird habitat. Efforts such as removing invasive species like mile-a-minute weed on Ruapuke helps native vegetation regenerate, benefiting breeding populations of white-faced storm petrels (Section 3.3). Similarly, the protection of large trees overhanging the water's edges supports healthy breeding populations of shags (Section 3.4).

Interaction with human activities

At sea, seabirds are attracted to fishing vessels by discards, bait, and offal, but can become hooked, entangled in nets, or injured by fishing gear. These incidental captures (bycatch) are a significant threat to seabird populations, leading to the death of hundreds of thousands of birds annually (Dias et al. 2019, Whitehead et al. 2019). While targeted monitoring of bycatch and the implementation of mitigation measures is ongoing in many fisheries and for many procellariforms (e.g. Abraham 2021, Reid et al. 2023), little is still known about impacts on shag species. During the surveys, several shags were found dead, with signs of entanglement in fishing gear (Sections 3.4 and 3.5). Such findings highlight the need to quantify the impacts of fishing activities and entanglement on shag species and to assess the magnitude of this threat. Data from this assessment will help inform the design of mitigation measures in fisheries to protect shag species. An advocacy programme may also be needed to encourage set net users and recreational fishers to report accidents involving shags and to adopt practices that will minimise seabird bycatch.

On land, gannets and penguins are often killed by dogs. Well informed and enforced dog rules, as well as educations programmes for pet owners are important to minimise, and possibly eliminate, this lethal threat.

Emerging diseases

Emerging diseases are another important threat that needs to be considered when planning research and monitoring and for management. The most evident example is that of the highly pathogenic avian influenza (HPAI), which is ravaging birds' populations in several countries around the globe (Scientific Task Force on Avian Influenza and Wild Birds 2023, Dewar et al. 2024, WOAH 2025). HPAI has not arrived in New Zealand yet, but is anticipated to do so, with potentially devastating consequences for our avifauna. In addition to poultry, wild species that are particularly vulnerable to avian flu are the gannets, but also gulls, terns and other seabirds (Scientific Task Force on Avian Influenza and Wild Birds 2023, Tremlett et al. 2024). Continuous population monitoring of gannet colonies (Section 3.6) is fundamental for an early detection of mortality events or sick birds but will also provide vital data on the population statuses before, during and after any outbreaks to assess the impacts.

Artificial lights at night

The knowledge presently available is enough to suggest that light strikes are a threat to seabirds in the Hauraki Gulf as they are attracted and disoriented by lights from Auckland and coastal cities, but also by vessels (Lukies et al. 2021, Heswall et al. 2022, Goad et al. 2023). Some species are more impacted than others, with Cook's petrel being the most affected. Different types of lights affect seabirds differently. It is therefore important to continue to investigate into the problem to improve our understanding on the threat and possible mitigation measures. It is also important to create awareness of the issue now, and to develop best-practice advice for lighting for city and vessels lighting as the research progresses.

7.1 Updated priorities and next steps

Long-term monitoring is essential if we want to identify population trends or patterns, better understand the threats and restoration requirements of the different species, to inform conservation management decisions, and to evaluate effectiveness and success of management actions and policy decisions.

The knowledge gathered both from the Seabird Programme and other sources since the programme started has allowed us to re-evaluate knowledge gaps and priorities, and to establish a new set of priorities. The updated list of species and relative priority levels is presented in Table 14, together with the newly available Regional Conservation Status (Woolly et al. 2024). The table also illustrates the regional qualifiers that were applied to the seabird species during the regional conservation status assessment (Woolly et al. 2024), highlighting which species have been identified as data poor in relation to population size (DPS) and trend (DPT), or with conservation research needs (CR).

Key monitoring and research needs moving forward are:

- Continuing monitoring black petrels on Hauturu and Glenfern Sanctuary on Aotea to gain insights on the population status as a whole and population dynamics. Establish monitoring plots to assess variations in the breeding population and to improve the comparison with Aotea. Monitoring Hauturu will provide important knowledge and insights for management on Aotea and other areas. Expanding the monitoring to other areas of Aotea outside of the main colony will improve our knowledge on the wider population. Continued monitoring is needed to understand trends beyond natural annual variation.
- Continuing monitoring white-faced storm petrel to improve population estimate accuracy and understand threats, trends and survival rates.
- Targeted monitoring of little penguins across the region.
- Establishing Cook's petrel monitoring on Aotea to assess the status and viability of the population and assess effectiveness of increased predator control on the island.
- Complete the mapping of Auckland shags' colonies and establishing an ongoing monitoring programme.
- Continue monitoring the Muriwai gannets, especially with the impending threat and uncertainty of HPAI arriving in New Zealand. Additional monitoring at other gannet colonies around the region, including population censuses, should be established to have a robust regional population baseline.
- Continue monitoring and researching spotted shag to establish a robust population trend and identify what threats have been/are continuing to reduce their population.
- Increase studies of threats and threat assessment to inform management options, for example, contamination with heavy metals, impacts of artificial lights at night across Auckland and the impacts of pests on the mainland.
- Assess regional monitoring feasibility for Caspian tern and for black-winged petrel, North Island little shearwater, sooty shearwater and white-faced storm petrel on Burgess.

Table 14. Regional conservation status and updated priorities. The species for which the priority has changed are highlighted in bold.

Common and Māori name	**Auckland conservation status °**	**Qualifiers °**	**Updated category of priority**
Black petrel Tākoketai/Tāiko	Threatened – Regionally Vulnerable	CD, CI, CR, DPS*, DPT*, NStr, RE, RF, Rel	C (A[1])
Black-winged petrel Karetai kapa mangu	Regional coloniser	CD, DPS, DPT, IE	B[2]
Cook's petrel Tītī	At Risk – Regionally relict	CD, DPS*,DPT, NStr, NR, RE	A
Flesh-footed shearwater Toanui	Threatened – Regionally Critical	CD, CI, RR, S?O	B
Fluttering shearwater Pakahā	At Risk – Regionally relict	CD, DE, DPS, DPT, RR	B
Grey-faced petrel Ōi	Regionally Not Threatened	CD, CI, *DPS	D
Northern diving petrel Kuaka	AT Risk – Regionally Relict	CD, CI, DE, DPS, DPT, RR, SO	B
North Island little shearwater **Totore**	Threatened – Regionally Critical	CD, CI, DPS, DPT, RR	**A**
New Zealand storm petrel Takahikare-raro	Threatened – Regionally Vulnerable	CD, DPS, IE, NStr, OL, RE	C
New Zealand white-faced storm petrel Takahikare	At Risk – Regionally Relict	CD, CI, DE, DPS, DPT, RR	A
Pycroft's petrel	At Risk – Regionally Recovering	CD, DE, RN	C
Sooty shearwater Tītī	Threatened – Regionally Critical	CD, CI, CR, SO	A
New Zealand little penguin Kororā	Threatened – Regionally Vulnerable	CD, CI, CR, DPS, DPT, PD, RR	A
Australasian gannet Tākapu	Regionally Not Threatened	CI, SO	D
Black shag Māpunga	Threatened – Regionally Critical	CI, DPS, DPT, SO, Sp	A
Little black shag Kawau tūī	At Risk – Regionally Naturally Uncommon	CI, DPR, DPS, DPT, SO	A
Little shag **Kawaupaka**	Threatened – Regionally Endangered	CI, DPR, DPS, DPT	**A**
Pied shag Kāruhuruhi	At Risk – Regionally Recovering	CR, DE, DPS, DPT	A
Spotted shag **Kawau tikitiki**	Threatened – Regionally Endangered	CI, CR, DPT, RR	**A**
Black-billed gull Tarāpuka	Threatened – Regionally Endangered	CI, CR, DPT	C
Red-billed gull Tarāpunga	Threatened – Regionally Vulnerable	CI, CR, DPT	C

Common and Māori name	Auckland conservation status °	Qualifiers °	Updated category of priority
Southern black-backed gull Karoro	Regionally Not Threatened	DPS, DPT, SO	E
Caspian tern Taranui	Threatened – Regionally Critical	CI, DPS, DPT, SO, Sp	A
New Zealand fairy tern Tara iti	Threatened – Regionally Critical	CD, CI, CR, NStr, RF, RR	C
White-fronted tern Tara	Threatened – Regionally Vulnerable	CD, CI, CR	C

Note: The list of qualifiers and their definitions is in Appendix 2. ° from Woolly et al. 2024. [1]Only the main colonies on top of Hirakimata/Mount Hobson, Aotea are studied, while there is a major knowledge gap on Hauturu and other areas of Aotea. [2]Species classified as regional coloniser; declining numbers and the total lack of monitoring justify the assignment to category B.

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10 Appendix 1: Baseline information for species prioritisation

The information contained in this section was used to inform the prioritisation process described in Section 2 of this report and it is updated to late 2019-early 2020 when it was collated. Species names are according to the Checklist of the birds of New Zealand (Checklist Committee (OSNZ) 2022). Conservation status is according to the New Zealand Threat Classification System available at the time when this information was collected (Robertson et al. 2017). Changes in the updated New Zealand Threat Classification System (Robertson et al. 2021) are reported for completion.

10.1 Sphenisciformes

10.1.1 New Zealand little penguin – *Eudyptula minor minor* – kororā

Endemic subspecies.

Conservation status: At Risk-Declining.

Trend: Declining

10.1.1.1 Distribution

Little penguin are widely distributed along most New Zealand coastlines, especially where offshore islands provide protection from predators and disturbance, or where protection measures are in place on the mainland (Flemming 2013).

10.1.1.2 Regional distribution, population size and trend

Hauraki Gulf islands are among the major breeding areas in New Zealand, and a number of colonies are also present in various locations on the mainland on both coasts (Flemming 2013, Gaskin and Rayner 2013). There is only limited knowledge of some populations concerning size and trends, but an overall regional assessment is missing.

10.1.1.3 Known threats

Predation by introduced predators including cats, dogs and ferrets is causing a decline in many colonies. Human disturbance also is a problem in some mainland colonies. Little penguins respond well to predator control and provision of nest boxes to provide safe nesting sites (Flemming 2013, Gaskin and Rayner 2013). Little penguins at sea are at risk of entanglement in set nets (Taylor 2000b). Oil spills are a key threat to this subspecies (Taylor 2000b).

10.1.1.4 Past NZ research and regional monitoring studies

- Saddle Island (Te Haupa). Estimate that only 5-15 pairs attempted to nest each year between 1987-97 (Tennyson and Taylor 1999).
- Kawau Bay. Small numbers breeding on Motutara Island (Tennyson et al. 1997).
- Wooded Island. "Penguin burrows were scattered over the island from the shoreline to the summit. Three birds were seen in burrows in August, and moulted feathers were noted outside c. 12 burrows on the island's summit in February." (Taylor and Tennyson 1999)

- Waiheke. Two pairs nesting in a sea cave on the western side of Papakohatu (Crusoe Island) facing Motuhie (Lee 1999).
- Breeding biology and ecology in the Hauraki Gulf studied at Tiritiri Matangi (Chen 2004, Geurts 2006, Boyer 2010, Van Rensburg 2010).

10.1.1.5 Present or recent NZ research and regional monitoring studies

- MSc thesis studying stress physiology and space use in little penguin colonies from three Hauraki Gulf study sites [Lady Alice Island (n = 37), Tāwharanui (n = 11) and Ōtata (n = 11)] and also from historic museum specimens.
- Some surveying using a seabird detection dog conducted in areas, such as in the Te Wao nui o Tiriwa (the Waitākere Ranges).
- Currently, some community groups are monitoring around the mainland, but the few available data are not enough to have a proper insight of the species at a regional level.

10.1.1.6 Monitoring and research priorities

Regional population size and trends, population dynamics and demography. Studies linking resource availability, foraging behaviour and spatial ecology are needed.

10.2 Procellariiformes

10.2.1 Black petrel – *Procellaria parkinsoni* – Tākoketai, Tāiko

Auckland region endemic species.

Conservation status: Threatened-Nationally vulnerable.

Trend: Declining.

10.2.1.1 Distribution

They breed in burrows on Aotea / Great Barrier Island and Te Hauturu-o-Toi / Little Barrier Island (Hauturu) in Tīkapa Moana-Te Moananui ā Toi / Hauraki Gulf (here after referred to as "the Gulf"). The largest colony is on Aotea and most recent data estimates 4336 breeding pairs within the top 1000 ha of Aotea (Black Petrel Working Group – E. Bell pers. comm.; Bell at al. 2022). The Hauturu colony was estimated at 620 breeding pairs (Bell et al. 2016a). At-sea counts have estimated 38,000 black petrels present in eastern tropical Pacific waters (Bell 2013 [updated 2022]).

10.2.1.2 Regional distribution, population size and trend

Endemic species of the Auckland region. Population on Aotea is declining. Only partial knowledge is available for the population on Hauturu.

10.2.1.3 Known threats

The introduction of feral cats (*Felis catus*), feral pigs (*Sus scrofa*), mustelids (*Mustela sp.*) and rats (*Rattus sp.*) and habitat loss caused the extirpation of black petrels from mainland. The mainland-based threat is thus the presence of feral pigs, feral cats, ship rats (*R. rattus*) and kiore (Pacific rats, *R.* exulans) on Aotea, which have been recorded at the main breeding colony on Hirakimata Mount Hobson (Bell 2013 [updated 2022]). Black petrels have been caught by commercial and recreational fishers both in New Zealand and overseas and are recognised as the most at-risk seabird in New Zealand from commercial fishing (Richard and Abraham 2013, Richard et al. 2017).

10.2.1.4 Past and present NZ research and regional monitoring studies

- The Aotea population has been intensively monitored since 1995 (Bell 2013 [updated 2022], Bell et al. 2023).
- On Hauturu partial monitoring on accessible/known nests and acoustic monitoring has been carried out for two consecutive breeding seasons from 2014/15 and 2015-16 (Bell et al. 2015, Bell et al. 2016a).
- Tracking studies of adults and fledglings from Aotea were carried out in the past recent years (Bell et al. 2016b, E. Bell pers. comm.)

10.2.1.5 Monitoring and research priorities

Information gaps and actions needed are discussed within the Black Petrel Working Group. They include e.g. investigating recruiting of juveniles into the population and tracking of the pre-laying period. Population size and trends and population dynamics on Hauturu.

10.2.2 Black-winged petrel – *Pterodroma nigripennis* – Karetai kapa mangu

Native species.

Conservation status: Not Threatened.

Trend: N/A

10.2.2.1 Distribution

Black-winged petrels are one of the most abundant seabirds in New Zealand, mainly breeding in the Kermadec Islands (2-3 million pairs. Taylor 2000a). Elsewhere the colonies are much smaller with few holding more than a thousand pairs and some of the newly established sites have just a few tens of pairs (Gaskin and Rayner 2013).

10.2.2.2 Regional distribution, population size and trend

Black-winged petrels are starting to colonise the Auckland region from the north. On Pokohinu / Burgess Island (Mokohinau Group), nine burrows were reported in 2011 (Ismar et al. 2012) and only two breeding and one non-breeding pairs were observed in those burrows between 2017 and 2019 (Wails et al. 2017, C. Wails *pers. comm.*). The regional population require monitoring to assess persistence and/or expansion (Gaskin and Rayner 2013). In particular, it would worth surveying Fanal and other Mokohinau Islands (Tim Lovegrove pers. comm.).

10.2.2.3 Known threats

The major threat to black-winged petrels is the introduction of mammalian predators on their breeding grounds. Fire is another risk. The risk to small gadfly petrels from fisheries impacts appears to be minimal (Taylor 2000a).

10.2.2.4 Past NZ research and regional monitoring studies

- On Pokohinu, monitoring was only occasional with very limited reports of breeding (Ismar et al. 2012, Wails et al. 2017)

10.2.2.5 Present NZ research and regional monitoring studies

- No monitoring is occurring at present.

10.2.2.6 Monitoring and research priorities

The ecology of black-winged petrels is poorly known. This includes their diet and foraging ecology, population dynamics, migratory behaviour, breeding and social behaviour. Regional population size and trends are missing, population dynamics and demography are unknown.

10.2.3 Cook's petrel – *Pterodroma cookii* – Tītī

Endemic species. Auckland region endemic subspecies.

Conservation status: At risk – Relict.

Trend: Increasing.

10.2.3.1 Distribution

The Northern subspecies (*P. c. cookii*) breeds only on Hauturu, Aotea; the Southern subspecies (*P.c. orientalis*) only on Whenua Hou / Codfish Island. Cook's petrels formerly bred throughout both the North and South Islands, on mountain tops and ranges. After hundreds of years of predation by introduced mammals, they became confined to just these three islands (Taylor 2000a). Between 2012 and 2016, 547 Cook's petrel chicks were translocated from Little Barrier to Cape Sanctuary and Boundary stream in the aim to establish new colonies (C. Mitchell pers. com.; Hozumi et al. 2011).

10.2.3.2 Regional distribution, population size and trend

Hauturu holds the largest Cook's petrel population, estimated at 286,000 breeding pairs in 2007 (Rayner et al. 2007a). The few pairs on Aotea are probably sustained through immigration from the nearby Hauturu colony. The Aotea population is declining towards extinction on the island (Taylor 2000a).

10.2.3.3 Known threats

Introduced predators are a major threat to Cook's petrels. After rat eradication in 2006 on Hauturu, the breeding success rate increased from 5% to 60% (Taylor and Rayner 2013 [updated 2022]). The few nests on Aotea suffer from high predation by rats, which probably is the main cause preventing the expansion of this colony (E. Bell pers. comm.) The risk to Cook's petrels from fisheries impacts appears to be minimal. These birds cross over the Auckland isthmus during the spring and summer nights, feeding in the Tasman Sea. During the crossing, they are often impacted by city lights, especially during fledging (Gaskin and Rayner 2013).

10.2.3.4 Past NZ research and regional monitoring studies

Breeding habitat and habitat modelling (Rayner et al. 2007a, Rayner et al. 2007b).

Foraging ecology (Rayner et al. 2008).

Population genetic structure (Rayner et al. 2010).

Migratory behaviour (Rayner et al. 2011).

10.2.3.5 Present NZ research and regional monitoring studies

- No recent studies have been carried out. No monitoring has occurred post chick harvesting from Hauturu for the colony establishment at Boundary Stream.
- There is a record of burrows on Aotea that were encountered by chance during other activities, but no population or breeding monitoring is occurring (E. Bell pers. comm.)

10.2.3.6 Monitoring and research priorities

Impact of artificial lights both on adults and fledglings. Population dynamics and trends following the removal of chicks for relocation during 5 consecutive years.

10.2.4 Flesh-footed shearwater – *Ardenna carneipes* – Toanui

Native species.

Conservation status: Threatened-Nationally vulnerable.

Re- assessed as At Risk – Relict in Robertson et al. 2021

Trend: Declining.

10.2.4.1 Distribution

Flesh-footed shearwaters/Toanui nest on islands around northern New Zealand and in Cook Strait. Recent surveys in New Zealand have found far fewer flesh-footed shearwater pairs than expected. The total New Zealand population is significantly less than 25,000-50,000 breeding pairs (Baker et al. 2010).

10.2.4.2 Regional distribution, population size and trend

Within the Auckland region, this species is naturally uncommon and only breeds at Kauwahaia, Te Henga/Bethells Beach (Gaskin and Rayner 2013), where it was increasing until 2000 (Taylor 2000b), but only 23 breeding pairs were left in 2012 (G. Taylor pers. com. in Waugh et al. 2013).

10.2.4.3 Known threats

Flesh-footed shearwaters are regularly caught as bycatch in several commercial fisheries (Richard et al. 2017). They are also frequently caught by recreational fishers; although most such birds are released with no or only minor injuries, there is disturbing evidence that many flesh-footed shearwaters are severely injured or killed by fishers hitting them to keep them away from fishing baits (Taylor 2013a). The species is particularly vulnerable to plastic pollution, showing incredibly high levels of ingestion posing a risk for both fledglings and adults health and survival (Buxton et al. 2013, Taylor 2013a, Lavers et al. 2014). The conservation status of this species was changed from declining to nationally vulnerable in 2013.

10.2.4.4 Past and present NZ research and regional monitoring studies

- Long-term monitoring at Kauwahaia Island, Te Henga (Graeme Taylor, DOC).

10.2.4.5 Monitoring and research priorities

Further studies on population demographics are urgently needed.

10.2.5 Fluttering shearwater – *Puffinus gavia* – Pakahā

Endemic species.

Conservation status: At risk-relict.

Trend: Stable.

10.2.5.1 Distribution

It is a ubiquitous seabird of inshore waters in the top half of New Zealand, especially in the north-eastern North Island and Marlborough Sounds-Cook Strait regions. Fluttering shearwaters are partial trans-Tasman migrants, and a considerable proportion of the population remain within local waters, including the Hauraki Gulf, throughout the winter months (Gaskin 2013 [updated 2022]).

10.2.5.2 Regional distribution, population size and trend

Flocks of up to 20,000 birds have been reported in the Hauraki Gulf (G. Taylor pers. obs.) indicating that at least 100,000 birds are possible (Taylor 2000b). Within the Auckland region, Fluttering shearwaters breed on the Mokohinau Islands, Wooded Island and Saddle Island off Aotea (Waugh et al. 2013), but regional population sizes and trends are unknown. They are naturally recolonising Hauturu following the rat eradication in 2004 (Gaskin 2013 [updated 2022]).

10.2.5.3 Known threats

All fluttering shearwaters' breeding colonies are on mammal-free islands, or islands where only kiore are present. Reinvasion of islands by mammalian predators is a major threat. Their relatively shallow nesting burrows are often in friable soils, and are easily collapsed by people moving through areas where they breed; access should be strictly limited. Fluttering shearwaters are not generally attracted to fishing vessels; however, because they feed by diving, commonly in flocks, they can be caught in set nets, at times in large numbers. Over-harvesting of schooling fish (e.g. kahawai, trevally, mackerel), principally through purse-seine fishing, could have a serious impact on fluttering shearwaters and other species that feed in association with these schools (Gaskin 2013 [updated 2022]).

10.2.5.4 Past NZ research and regional monitoring studies

- Up to 200 breeding pairs estimated on Wooded Island in 1999 (Taylor and Tennyson 1999). A review of historical monitoring data highlight low numbers and the lack of sound monitoring in the region also in the past (Waugh et al. 2013).

10.2.5.5 Present and recent NZ research and regional monitoring studies

- Breeding biology on Burgess Island (Berg et al. 2018b).
- Year-round distribution, activity patterns and habitat use (Berg et al. 2019).
- Ongoing study on ecophysiology and tracking movements at sea (E. Whitehead PhD project, University of Auckland).

10.2.5.6 Monitoring and research priorities

Missing regional population size and trends, population dynamics and demography.

10.2.6 Grey-faced petrel – *Pterodroma gouldi* – Ōi

Endemic species.

Conservation status: Not threatened.

Trend: Increasing.

10.2.6.1 Distribution

The grey-faced petrel is an endemic New Zealand species. Small colonies are scattered around the coasts of the upper North Island, mainly on headlands and peninsulas adjacent to the sea. Over 100 colonies are still present but most sites have fewer than 500 breeding pairs (Taylor 2013b). Grey-faced petrel is one of the few burrowing petrels to still survive on the New Zealand mainland, which has made it a subject of mainland restoration research and community-led habitat restoration projects (Dunn 2012, Miskelly et al. 2019).

10.2.6.2 Regional distribution, population size and trend

In the region, the biggest colony is on the Mokohinau Islands and smaller colonies are on several islands of the Hauraki Gulf. This species is also present in different areas of the mainland both on Auckland's west (e.g. Waitākeres, Bethells, etc.) and east coasts (e.g. Tāwharanui Regional Park).

Customary rights to harvest grey-faced petrels are still exercised by Ngati Rehua Ngātiwai ki Aotea under the Grey-Faced Petrel (Northern Muttonbird) Notice 1979, pursuant of section six of the Wildlife Act 1953. The Mokohinau are the only islands in the region where cultural harvest is allowed.

10.2.6.3 Known threats

The major threat to grey-faced petrels is mammalian predators on their breeding grounds, especially feral cats and rats, but also feral pigs and mustelids. Symptoms of avian pox virus have been observed in this species, and avian diseases may contribute to adult and chick mortality in some seasons (Taylor 2000b).

10.2.6.4 Past NZ research and regional monitoring studies

- Long-term studies of grey-faced petrels at several sites have improved our understanding of the ecology of this species. These studies included captive-rearing trials, testing of tracking devices, long-term banding projects and research on the breeding biology and diet. Grey-faced petrels occasionally follow fishing boats and sometimes occur as by-catch on long-line fisheries (Taylor 2013b).
- Monitoring at a restoration project on Motuora Island (Gardner-Gee et al. 2008).
- Population survey on Ōtata Island (The Noises) and Burgess Island (Mokohinau) to develop a national framework to monitor grey-faced petrels as an indicator species (Russell et al. 2017).
- Recent investigations identified significant differences in the timing of breeding, foraging ecology and impacts of oceanic processes on breeding between Auckland's west and east coast colonies requiring further investigation (Dunn 2012, Gaskin and Rayner 2013, Welch 2014, Whitehead et al. 2022).

10.2.6.5 Present NZ research and regional monitoring studies

- Grey-faced petrel have been monitored recently at a number of Auckland colonies including one of the longest seabird monitoring studies in New Zealand at the Te Henga by Graeme Taylor (DOC). Other monitoring projects are occurring at various locations in the Waitākere Ranges, Tāwharanui and Goat Island, Leigh by the University of Auckland.
- Mark-recapture studies collect samples yearly as various locations in the region (James Russell, University of Auckland).
- Various studies looking at eco-physiology and breeding success at the Te Henga colonies by the University of Auckland (Brendon Dunphy/Kristal Cain).
- Case study for mainland seabird restoration work being conducted by Auckland Council (Todd Landers).

10.2.6.6 Monitoring and research priorities

The reasons for why grey-faced petrel are one of the few burrowing petrels to still survive on the New Zealand mainland is not understood. This presents an opportunity to investigate what are the factors involved that allow this, which will provide insights into how to continue to sustain and further grow mainland grey-faced petrel populations, a topic which will also likely be relevant for other species to help facilitate further colonisation to the mainland by more vulnerable seabirds. It is generally believed grey-faced petrel are existing in mainland colonies because pest animals are low enough for the colonies to withstand and grow

(M. Fox pers. comm.), however how this varies with different pest animal species and different pest densities is not known. To begin to elucidate these hypotheses we need several years of productivity (breeding success) monitoring data across a range of mainland sites that have varying pest animal levels. This work will need to consider also other factors likely involved, such as those related to the species foraging ecology and space use. For example, Whitehead et al (2022) showed the importance of spatially varying nutritional stress in Auckland's grey-faced petrels, with east coast (Te Hāwere-a-Maki Goat Island) birds under greater stress in comparison to west coast (Te Henga) birds, likely to have significant effects on their breeding success.

Grey-faced petrel have significant cultural, social and spiritual significance to Hauraki iwi (Lyver et al. 2008).

10.2.7 New Zealand storm petrel – *Fregetta maoriana*

Auckland region endemic species.

Conservation status: Threatened-Nationally vulnerable.

Trend: Increasing.

10.2.7.1 Distribution

New Zealand storm petrels breed under tall forest in the interior of Hauturu. No accurate population data exists (Gaskin 2013 [updated 2017]).

10.2.7.2 Regional distribution, population size and trend

The low rate of resightings of banded birds (two up to 2013) suggests a population of hundreds if not thousands of birds (Gaskin 2013 [updated 2017]).

10.2.7.3 Known threats

The birds should thrive on Hauturu as long as the island is maintained pest-free. The conservation status of this species was changed from Data Deficient to Nationally Endangered in 2013, then to Nationally Vulnerable in 2016 as it was evident that the population was much larger than earlier estimates (Gaskin 2013 [updated 2017]).

10.2.7.4 Past NZ research and regional monitoring studies

- The species was rediscovered in 2003 after having been considered as extinct. The first nests were found in 2013 on Hauturu. Since then, big efforts are constantly made to find further burrows and to try establishing a colony with artificial nests (C. Gaskin pers. comm.).

10.2.7.5 Present NZ research and regional monitoring studies

- The NZ storm petrel working group (NNZST, Auckland Memorial Museum and other partners) is currently monitoring the known nests on Hauturu, trying to attract birds in artificial nests with acoustic broadcast and acoustic recording in different sites of the island to find other potential breeding areas.

10.2.7.6 Monitoring and research priorities

Use monitoring to establish data on population trend. Use genomic and or island surveys to establish if Hauturu is the sole population of this species. Use acoustic attraction and nest boxes to develop a study population on Hauturu to enable study of the species biology and provide a possible source of chicks if establishment of another population is deemed prudent (M. Rayner *Pers. Comm.*).

10.2.8 North Island little shearwater – *Puffinus assimilis haurakiensis*

Endemic subspecies.

Conservation status: At risk-recovering.

Trend: Increasing.

10.2.8.1 Distribution

This species is endemic to the wider Hauraki Gulf area. There are probably only about 10,000 pairs of North Island little shearwaters with notable populations on the Alderman Islands (c.4000 pairs) and Red Mercury Island (c.1000 pairs). Other islands have hundreds of pairs at best (Taylor 2000a).

10.2.8.2 Regional distribution, population size and trend

In the Auckland region, it only breeds on the Mokohinau Islands but numbers and trend are unknown.

10.2.8.3 Known threats

Little shearwaters are highly impacted by exotic predators. They can coexist with kiore, but breeding success and colony size is significantly reduced. They are not able to coexist with Norway or ship rats, feral cats or mustelids.

10.2.8.4 Present NZ research and regional monitoring studies

- Population monitoring and habitat preference on Burgess Island/Pokohinu, Mokohinau Islands. (C. Wails PhD project, University of Illinois, US)
- Conservation physiology on population breeding in the Hauraki Gulf (E. Whitehead, University of Auckland)

10.2.8.5 Monitoring and research priorities

Regional population size and trends. Studies on long-term population dynamics (age of first breeding, longevity, survival and mortality of adults and fledglings) are needed. Little shearwaters are winter breeders. Their breeding behaviour and many other aspects of their lives including diet and foraging ranges are not yet well known.

10.2.9 Northern diving petrel – *Pelecanoides uritrinax uritrinax* – Kuaka

Native species.

Conservation status: At risk-Relict.

Trend: Stable.

10.2.9.1 Distribution

There are probably more than a million pairs across all New Zealand, but few accurate colony estimates have been made (Taylor 2000a). Larger colonies are all out of the Auckland region; however, smaller colonies occur on the Mokohinau Islands, Hauturu (Lots Wife), Aotea (stack south-west of Opakau Island), Wooded Island (off Tiritiri Matangi Island) and Maria Island (The Noises Islands) (Taylor 2000a).

10.2.9.2 Regional distribution, population size and trend

Unknown with only limited knowledge of some populations. "It may not be that the population on Tiritiri Matangi is much smaller than that on the Mokohinau. In the late 1980s, Graeme Taylor estimated 4,000 pairs on nearby Wooded Island (200m away) and possibly up to 10,000 pairs. We don't know how many are there at present but the colony is still very active" John Stewart.

10.2.9.3 Known threats

Common diving petrels are extremely vulnerable to introduced predators, including rats, stoats, cats and weka. They are mainly found on small islands that have never had predators introduced or islands that have been cleared of predators (Taylor 2000a).

10.2.9.4 Past NZ research and regional monitoring studies

- Wooded island. Between 1000 and 10’000 breeding pairs were estimated in 1999 (Taylor and Tennyson 1999). “The abundance of diving petrel burrows was a dominant feature on Wooded Island. The density was estimated as 4-5 burrow entrances per m^2 on the summit plateau, 4 burrow entrances per m^2 on the north-east slope and 1-3 burrow entrances per m^2 elsewhere on the island.”

10.2.9.5 Present NZ research and regional monitoring studies

- Little or no monitoring is going on in the region and available data are not enough to have a proper insight of the species.
- Studies of foraging behaviour and ecophysiology are ongoing (various projects led by Dr Brendon Dunphy, University of Auckland).

10.2.9.6 Monitoring and research priorities

Regional population size and trends, population dynamics and demography.

10.2.10 Pycroft’s petrel – *Pterodroma pycrofti*

Endemic species.

Conservation status: At risk-recovering.

Trend: Increasing.

10.2.10.1 Distribution

Pycroft’s petrels breed on small offshore islands off the north-eastern coast of North Island, including Poor Knights, Hen & Chicken, Cuvier and Mercury Islands (Taylor 2000a). They are endemic to the wider Hauraki Gulf (Gaskin and Rayner 2013).

10.2.10.2 Regional distribution, population size and trend

A reintroduction project started on Motuora island, relocating birds from the Mercury Islands (https://www.motuora.org.nz/).

10.2.10.3 Known threats

The major threat to Pycroft’s petrels, as it is for all gadfly petrels, is the introduction of mammalian predators on their breeding grounds. Pacific rats eat most of eggs and chicks on the breeding sites where present until wide eradication programmes happened (Taylor 2000a). Fire is also a threat to this seabird with the northern islands becoming very dry in late summer. Little is known about the possible effects of pollutants such as plastics, chemical contaminants, and oil spills (Taylor 2000a).

10.2.10.4 Past NZ research and regional monitoring studies

None

10.2.10.5 Monitoring and research priorities

Monitoring translocation success and breeding on Motuora Island (being carried out by the Motuora Restoration Society).

10.2.11 Sooty shearwater – *Ardenna grisea* – Titi, hakoakoa

Native species.

Conservation status: At risk-declining.

Trend: Declining.

10.2.11.1 Distribution

Sooty shearwaters breed on numerous islands around New Zealand, from the Three Kings in the north and south, to islands around Stewart Island, as well as the New Zealand Subantarctic Islands (Newman et al. 2009). Birds from New Zealand forage over the south Pacific Ocean and Tasman Sea during the austral summer and are recorded as far south as the Antarctic waters. They migrate to the north Pacific Ocean in the austral winter and spread over the entire central and eastern Pacific Ocean (Taylor 2000b). There are no accurate estimates of the total New Zealand population, but based on recent detailed work on the large populations on The Snares and islands off Stewart Island, it was estimated that the national population was about 21 million birds (Newman et al. 2009).

10.2.11.2 Regional distribution, population size and trend

Within the Auckland region, this species breeds on the Mokohinau islands and Kauwahaia Island (Te Henga) (Gaskin and Rayner 2013). It is naturally very rare in the region, but actual numbers and trends are unknown (T. Lovegrove pers. comm.).

10.2.11.3 Known threats

Introduced mammals, particularly feral cats, rats, mustelids, feral pigs and dogs have extirpated most mainland sooty shearwater breeding colonies. Large breeding populations are now restricted to predator-free offshore islands (Taylor 2000b). The sooty shearwater is one of the seabird species most frequently observed killed in New Zealand fisheries (Richard and Abraham 2013, Richard et al. 2017). Customary rights are authorised under the Titi (muttonbird) Notice 2005 and Wildlife (Sooty shearwater (muttonbird/tītī/hakoko) harvest from Mangere Island) Notice 2020.

10.2.11.4 Past and present NZ research and regional monitoring studies

- Long-term monitoring at Kauwahaia Island, Te Henga (Graeme Taylor, DOC).
- Monitoring of breeding on Burgess Island/Pokohinu, Mokohinau Islands with no success in finding any (C. Wails PhD project, University of Illinois, US).
- Subject of University of Auckland research investigating cultural harvesting and contaminant aspects.

10.2.11.5 Monitoring and research priorities

Population sizes and trends are largely unknown and require evaluation, especially as it was not possible to find any bird breeding in the previously known colony on Pokohinu / Burgess Island (Wails et al. 2017, Wails et al. 2019). In light of the extremely wide distribution of this species, it may be used as an indicator of global oceanic changes and global scale processes, including climate change, food distribution and pollutants.

10.2.12 White-faced storm petrel – *Pelagodroma marina maoriana* – Takahikare

Endemic subspecies.

Conservation status: At risk-relict.

Trend: Declining.

10.2.12.1 Distribution

In New Zealand, white-faced storm petrels breed in dense colonies on islands free of introduced predators (Ismar et al. 2014). They were considered one of the country's most abundant seabirds with over one million breeding pairs (Robertson and Bell 1984), but recent estimates and knowledge of trends are missing.

10.2.12.2 Regional distribution, population size and trend

In the Auckland region, there are two known populations, on Pokohinu / Burgess Island and on Ruapuke / Maria Island (The Noises). The population on Burgess Island/Pokohinu has expanded rapidly following rat and livestock removal (Ismar et al. 2014) but the size of the population is unknown and requires assessment. It is thought that recolonising birds came from other Mokohinau Islands (Southey 2013), but colonies on these islands are unknown. The colony on Maria Island, The Noises, probably is made up of many hundreds of birds but it is unstudied (T. Lovegrove pers. comm.).

10.2.12.3 Known threats

White-faced storm petrels are small and extremely vulnerable to exotic predators on land, even mice, and so they breed only on predator-free islands (Taylor 2000b). Seventy-nine per cent of white-faced storm petrels in the Northeast Atlantic contain plastics (Furtado et al. 2016).

10.2.12.4 Past NZ research and regional monitoring studies

- Breeding biology (timing, chick growth, provisioning) and on-site translocation experiment conducted on Burgess Island/Pokohinu (Young 2013).

10.2.12.5 Present NZ research and regional monitoring studies

- Ongoing study on habitat preference on Pokohinu / Burgess Island, Mokohinau Islands. (C. Wails PhD project, University of Illinois, US)

10.2.12.6 Monitoring and research priorities

Regional population size and trends, population dynamics and demography. Year-round distribution at sea. Migratory patterns: The Kermadec subspecies (*P. m. albiclunis*) migrate to the eastern Pacific Ocean during non-breeding (Imber 1984), but it is unknown if they have subspecies or population-specific migratory destinations. Plastic ingestion.

10.3 Pelecaniformes

10.3.1 Australasian gannet – *Morus serrator* – Tākapu

Native species.

Conservation status: Not threatened.

Trend: Stable

10.3.1.1 Distribution

Australasian gannets nest in dense breeding colonies on the New Zealand mainland and coastal rocks and islands. Most gannetries are situated off the North Island.

10.3.1.2 Regional distribution, population size and trend

Australasian gannets breed in four different colonies in the region: Muriwai Beach, Horuhoru (Waiheke Island), Mahuki Island (Aotea/Great Barrier Island), Maori Rocks (Mokohinau Islands) (Gaskin and Rayner 2013). Populations of this species appear to be increasing annually at sites monitored and the largest colony in the Hauraki Gulf, on Mahuki Island, has benefitted from an increase in available breeding habitat after the removal of cattle (M. Rayner pers. obs. and J. Boow pers. com. in Gaskin and Rayner 2013).

10.3.1.3 Known threats

Mainland colonies are at risk of attacks by dogs and indirectly by humans disturbing colonies causing birds to flee nests, resulting sometimes in stampeding eggs and chicks (Taylor 2000b). Mortality rates are impacted by fishing lines from recreational vessels and starvation in young chicks (Machovsky-Capuska in Gaskin and Rayner 2013). The birds do not appear to be affected by rodents, and there is no information about the impact of feral cats and mustelids on eggs and chicks (Taylor 2000b).

10.3.1.4 Past and present NZ research and regional monitoring studies

A big number of studies have been carried out on several aspects, including breeding biology, foraging ecology, distribution and movements (a list can be found in Ismar 2013 [updated 2022]). A population count survey was conducted on several of the New Zealand colonies, including at Muriwai (Frost 2017).

10.3.1.5 Monitoring and research priorities

Regional population size and trends, population dynamics, demography, and foraging ecology. Year-round distribution at sea. HPAI surveillance.

10.3.2 Black shag – *Phalacrocorax carbo* – Māpunga

Native species.

Conservation status: At risk – Naturally Uncommon.

Re- assessed as At Risk – Relict in Robertson et al. 2021

Trend: Naturally uncommon.

10.3.2.1 Distribution

The black shag is almost cosmopolitan in distribution. It is widespread throughout New Zealand, although sparsely so, and the distribution of colonies is poorly known (Taylor 2000b).

10.3.2.2 Regional distribution, population size and trend

Completely unknown.

10.3.2.3 Known threats

Black shags were persecuted for decades by fishers. While few black shags are shot these days, it still occurs occasionally. The eggs and nestlings of tree-nesting black shags seem not to be preyed upon by possums, rats and stoats; however, the species is sensitive to disturbance by people and will leave nests when closely approached. Black shags swallow fish off broken-off portions of snagged fishing lines. If the lines come free, some birds are found dead with hooks penetrating the gut or caught up at tree roosts by sinkers or hooks from these lines. Set-nets left unattended in estuaries and harbours occasionally result in black shags drowning (Taylor 2000b, Powlesland 2013b [updated 2022]).

10.3.2.4 Past and present NZ research and regional monitoring studies

No study of NZ birds is known.

10.3.2.5 Monitoring and research priorities

Identification of breeding colonies within the region. Regional population size and trends.

10.3.3 Little black shag – *Phalacrocorax sulcirostris* – Kawau tūi

Native species.

Conservation status: At risk – Naturally Uncommon.

Trend: Naturally uncommon.

10.3.3.1 Distribution

They only occur in the North Island, but their population is poorly known both regionally and nationally. The national population is about 2000-4000 individuals with the majority breeding at the central North Island lakes (G. Taylor unpubl. in Taylor 2000b).

10.3.3.2 Regional distribution, population size and trend

Completely unknown.

10.3.3.3 Known threats

Foraging adults are at risk from entanglement in unattended set nets, which potentially could ensnare an entire feeding flock. Predators may take some eggs and chicks, but this has not been studied (Armitage 2013 [updated 2022]). The species is susceptible to human disturbance and will abandon nests and chicks temporarily allowing red-billed gulls and black-backed gulls opportunities to take eggs and chicks (Taylor 2000b).

10.3.3.4 Past and present NZ research and regional monitoring studies

No study of NZ birds is known.

10.3.3.5 Monitoring and research priorities

Identification of breeding colonies within the region. Regional population size and trends. Breeding biology require studies, including about timing.

10.3.4 Little shag – *Phalacrocorax melanoleucos brevirostris* – Kawau paka

Endemic subspecies.

Conservation status: Not threatened.

Re- assessed as At Risk – Relict in Robertson et al. 2021

Trend: Increasing (but decreasing in the region).

10.3.4.1 Distribution

The little shag is the most widely distributed shag species in New Zealand, found around all three main islands, in both marine and freshwater habitats, on the coast as well as inland (lakes, ponds, rivers and streams) and on offshore islands (Taylor 2000b).

10.3.4.2 Regional distribution, population size and trend

Little shags are reported to have decreased markedly in the Auckland region where some colonies have disappeared since the 1980s or fallen below 10 pairs. A well-established colony at Hobson Bay, Auckland, studied during the 1980s and 90s, died out despite most broods yielding one to three fledglings (Taylor 2013 [updated 2022]).

10.3.4.3 Known threats

The main threat to the little shag appears to be depletion of its prey species, particularly by pollution or habitat degradation. Take-over of nest sites by the larger pied shags can be a detrimental factor. As for other shag species, little shags are vulnerable to capture in recreational or commercial fishing nets and lines (Taylor 2000b, Taylor 2013 [updated 2022]). The species is susceptible to human disturbance and will abandon nests and chicks temporarily allowing red-billed gulls and black-backed gulls opportunities to take eggs and chicks (Taylor 2000b).

10.3.4.4 Past NZ research and regional monitoring studies

- Waiheke. Less than five nests in a pōhutukawa (*Metrosideros excelsa*) out of a cliff just below the summit on the eastern side of Koi islet. Few nests in a pōhutukawa on the eastern side of Papakohatu (Crusoe Island). Few nests on the most southerly rock stack of Passage Rock (Takapu) (Lee 1999).
- Kawau Bay. Kohatutara. Four empty nests probably of this species were recorded in October 1988. In December 1994, 15 nests containing 26 nearly-fledged chicks and 15 adults in a grove of pōhutukawa on the north-western side (Tennyson et al. 1997).

10.3.4.5 Monitoring and research priorities

Breeding biology require studies, including about timing. Research into taxonomy would benefit from the use of DNA techniques.

10.3.5 Pied shag – *Phalacrocorax varius varius* – Kāruhiruhi

Endemic subspecies.

Conservation status: At risk-recovering.

Trend: Increasing.

10.3.5.1 Distribution

Pied shag breeding is almost exclusively restricted to marine habitats, with few colonies recorded on freshwater lakes, further up rivers or on sewage ponds. Nests are predominately in native vegetation, and the presence of native vegetation to the water's edge is likely to be important in maintaining breeding habitat for pied shags (Bell 2013). Although the national population is increasing, there are some regional differences in rate of population increase and expansion. The northern North Island population has shown slower growth (1.5% per annum): the Far North population has remained stable; Northland initially increased to the 1980s but has since been declining; Auckland, South Auckland and the Bay of Plenty has seen steady gradual growth; whilst Gisborne/Wairoa has increased sharply since the 1990s (Bell 2013).

10.3.5.2 Regional distribution, population size and trend

It breeds at numerous sites across the region, both on mainland and offshore islands. Populations within the Hauraki Gulf were stable in 2012, while they are increasing in the rest of New Zealand (Bell 2013), possibly suggesting some issue within the region.

10.3.5.3 Known threats

Pied shag was identified at a high-moderate risk from fishing, primarily from poorly observed set net, inshore drift net and beach seine fisheries (Rowe 2013). At present there are no mitigation measures in place in these fisheries to protect shags, and the impacts on the population are unknown. Bycatch has also been recorded in commercial bottom longline fisheries (e.g. Conservation Services Programme 2010) and little is known about bycatch in recreational fisheries; however, a relatively high number of pied shags were found dead in colonies following entanglement by fishing line, and all fishing gear appeared to be recreational. Determining fisheries related risk to pied shag is problematic as little is known about their population size and breeding distribution (Bell 2013).

It is unknown whether changes in prey abundance as a result of commercial fishing or climate change has impacted, positively or negatively, the pied shag.

10.3.5.4 Past NZ research and regional monitoring studies

- Breeding biology studied in the early 1970s (Gaskin and Rayner 2013).
- Waiheke. Less than five nests in a Pohutukawa out of a cliff just below the summit on the eastern side of Koi islet. Few nests in a pōhutukawa on the eastern side of Papakohatu (Crusoe Island). One nest on the eastern side of Motukaha. Few nests on the most southerly rock stack of Passage Rock (Takapu) (Lee 1999).
- Review for the Auckland region breeding sites and trends done in 2012 (Bell 2013).

10.3.5.5 Present NZ research and regional monitoring studies

No monitoring or research is at present underway.

10.3.5.6 Monitoring and research priorities

There are no comprehensive studies of diet in New Zealand. Information on population size and breeding distribution is missing. There are no studies to evaluate fisheries bycatch and mitigation measures.

10.3.6 Spotted shag – *Phalacrocorax punctatus* – Kawau tikitiki

Endemic species.

Conservation status: Nationally not threatened.

Re- assessed as Threatened-Nationally vulnerable in Robertson et al. 2021

Trend: Increasing. – Threatened regionally.

10.3.6.1 Distribution

The spotted shag occurs only in New Zealand and formerly reached its northern limit on Auckland's west coast, the inner Hauraki Gulf islands and along the western side of the Coromandel Peninsula. The current total New Zealand population may be less than 30,000 pairs, with most of these in the South Island (Lovegrove 2017).

10.3.6.2 Regional distribution, population size and trends

Around Auckland, spotted shags still breed at Tarahiki (Shag Rock) and at two sites at the eastern end of Waiheke. Until the 1980s, they also bred on The Noises Group and on Auckland's west coast at Te Henga. Only about 900 birds remain in the Gulf (Lovegrove 2017).

10.3.6.3 Known threats

Nationally, it is classified as not threatened, but it is regionally threatened in the northern North Island. Threats include human persecution, possible predation by introduced mammals at breeding colonies, overfishing and fisheries by-catch, especially in set nets. Colonies at The Noises Islands in the Hauraki Gulf were reduced by illegal shooting in the 1980s, resulting in a localised decline. Auckland Council identified the spotted shag as a priority species in the region needing assessment of its status and distribution (Szabo 2013 [updated 2022], Lovegrove 2017).

10.3.6.4 Past and present NZ research and regional monitoring studies

- Auckland Council have been surveying the remaining spotted shag populations at Tarahiki and off Waiheke for several years now.

10.3.6.5 Monitoring and research priorities

Regional population size and trends, population dynamics and demography. Research on diet, population biology and their foraging ecology, namely, to understand why their population has crashed and how to stop this, are highly needed.

10.4 Charadriiformes

10.4.1 Caspian tern – *Hydroprogne caspia* – Taranui

Native species.

Conservation status: Threatened-Nationally vulnerable.

Trend: Declining.

10.4.1.1 Distribution

Caspian terns are very widely distributed around the world. In New Zealand, the species breeds throughout the North and South Islands. Caspian terns breed mainly on open coastal shellbanks and sandspits, and occasionally on braided river beds and at inland lakes (Fitzgerald 2013).

10.4.1.2 Regional distribution, population size and trend

Surveys for Caspian terns were conducted during 1971-75 and 1991-95 reporting for the Auckland region: 337 pairs in 2 colonies and 315 pairs in 3 colonies, respectively (Bell and Bell 2008).

Small colonies of 1-2 pairs are in Shoal Bay and Ngataringa Bay, Omaha spit and Horseshoe Island. A larger colony is in Mangawhai, just outside of the Auckland region. There is no regular monitoring (Tim Lovegrove pers. comm.)

10.4.1.3 Known threats

Caspian terns are susceptible to nest disturbance by people, their dogs, and off-road vehicles. Southern black-backed gulls and red-billed gulls may attack eggs and chicks following disturbance by people. Like other shore-nesting birds, chicks and eggs are vulnerable to predation by introduced mammalian predators such as cats, stoats and ferrets (Fitzgerald 2013).

10.4.1.4 Past NZ research and regional monitoring studies

- Koi islet, Waiheke. One pair at the southern extremity of the islet (Lee 1999).
- Kohatutara Island, Kawau Bay. One pair with two chicks in November 1984; one pair with a clutch in October 1988; one nearly fledged chick in December 1994 (Tennyson et al. 1997).

10.4.1.5 Monitoring and research priorities

Breeding biology is only partially known. Study of movements and ecology is required.

10.4.2 New Zealand fairy tern – *Sternula nereis davisae* – Tara iti

Endemic subspecies.

Conservation status: Threatened-Nationally critical.

Trend: Declining.

10.4.2.1 Distribution

The relict population of fewer than a dozen pairs survive between Whangarei in the north and Auckland to the south. There are currently c.40 fairy terns in New Zealand, with fewer than a dozen breeding pairs (Pulham and Wilson 2013 [updated 2023]).

10.4.2.2 Regional distribution, population size and trend

This tern is the most endangered of New Zealand's endemic birds (Pulham and Wilson 2013 [updated 2023]). Fairy terns breed successfully at four sites only in New Zealand, on which two are in the Auckland region: Pakiri River mouth (one pair since 2003), and Papakanui sandspit on the southern headland of the Kaipara Harbour. Since 2012, birds have occasionally nested at the Te Arai Stream mouth, just south of Mangawhai (Pulham and Wilson 2013 [updated 2023]).

10.4.2.3 Known threats

Fairy terns were once widespread around the North Island coast and at river mouths in the South Island. Fairy tern range contracted during the 19th and 20th centuries due to invasive predators, modification of coastal habitats and human disturbance during breeding. These factors continue to threaten the population and their survival depends upon intense management during the breeding season. Also, environmental factors such as spring tides, storm surges and mobile sand can affect breeding destroying the nests (Pulham and Wilson 2013 [updated 2023]).

10.4.2.4 Past and present NZ research and regional monitoring studies

Pro-active enhancement of nest sites by removing vegetation and/or adding appropriately coloured shell, is increasingly undertaken prior to the breeding season, to encourage nesting in the safest possible locations. A project is underway to restore an historical nesting site within the Kaipara Harbour using these techniques, as well as recorded calls and decoy models (Pulham and Wilson 2013 [updated 2023]). The level of genetic variation within the population is currently being investigated. Public awareness and education are ongoing, especially in communities adjacent to fairy tern nesting areas.

10.4.2.5 Monitoring and research priorities

The population is highly managed. Intensive population monitoring and research for mitigation of threats are of high priority.

10.4.3 White-fronted tern – *Sterna striata* – Tara

Native species.

Conservation status: At risk-declining.

Trend: Declining.

10.4.3.1 Distribution

Breeds around the coasts and offshore islands of North, South, and Stewart Islands (Taylor 2000a). The New Zealand population has declined markedly over the last 40 years and is currently regarded as At Risk/Declining.

10.4.3.2 Regional distribution, population size and trend

In 2017-2018 a colony search failed to find any sign of breeding at several known locations within the Hauraki Gulf, with one exception: on Tiritiri Matangi. The following breeding season (2018-2019) several 'new' colonies were found – three of them in locations where they had not been recorded breeding in recent years: Horuhoru Rock, Tokatu Point (Tāwharanui) and Hauturu / Little Barrier Island. The colony on the northeast coast of

Tiritiri Matangi remained the constant across both seasons. (C. Gaskin *pers. comm.)* There are also colonies in Hobson Bay break water, approx. 100 pairs, and Western Viaduct, approx. 10 pairs (T. Lovegrove pers. comm.). The population size and trend within the region is almost unknown. On the west coast, white-fronted terns breed at Muriwai (T. Landers *pers. comm.*).

10.4.3.3 Known threats

White-fronted terns often breed in ephemeral sites such as riverbeds, estuaries or river mouths that are subjected to frequent flooding. They nest in dense colonies which provide little protection against predation by introduced mammalian predators such as stoats, ferrets, cats, and rats. White-fronted terns often nest adjacent to red-billed gull colonies and some gulls, especially males, specialise in preying on the eggs and chicks of terns. Colonies of nesting terns are vulnerable to disturbance by people and their dogs (Mills 2013).

10.4.3.4 Past NZ research and regional monitoring studies

- Wooded Island. "A nesting colony of c. 30 nearly-fledged chicks and several adults was present on the north-west stack on 1 February. Empty nest sites were found scattered all over the stack." (Taylor and Tennyson 1999)
- Waiheke. Nani is an important breeding site for white-fronted terns – approx. 150 adults and 60 chicks in January 1997 and hundreds were seen resting. Kahakaha (Frenchman Cap) was a breeding site in the 1940s but no sign of breeding in 1996-1997 (Lee 1999).
- Saddle Island (Te Haupa). In 1989, 78 adults + 15 juveniles were recorded (Tennyson and Taylor 1999).
- Kawau Bay. Kohatutara. Birds reported nesting between 1959 and 1987. More than 300 pairs counted in 1984, most with one-egg clutch. 79 birds nesting in 1987. Few nests in 1988. No breeding sign in 1990 and 1995. Two nests with adult sitting on egg in 1994 (Tennyson et al. 1997).

10.4.3.5 Present NZ research and regional monitoring studies

A new monitoring project within the Hauraki Gulf started in 2019 leaded by the Northern NZ Seabirds Trust and in collaboration with Auckland Museum and Auckland Council.

10.4.3.6 Monitoring and research priorities

Studies on foraging ecology and population biology, including population size, trends and demography, are required.

10.4.4 Black-billed gull – *Chroicocephalus bulleri* – Tarapuka

Endemic species.

Conservation status: Threatened-Nationally critical.

Re- assessed as At Risk – Declining in Robertson et al. 2021

Trend: Declining.

10.4.4.1 Distribution

The black-billed gull is found only in New Zealand and is considered as the most threatened gull species in the world. Major population are found on braided riverbeds in the South Island. Only about 5% of the population breeds on the North Island, with about 1.6% of total breeding pairs (McClellan and Habraken 2013 [updated 2019]). Overall, the 2016/17 national census showed positive results in regard to the black-billed gull population (Mischler 2018). The reported number of breeding birds was higher than expected, and the trend since the 1990s does not fit the predicted decline of >70% over 3 generations which had warranted the Nationally Critical threat assessment (Robertson et al. 2017, Mischler 2018). The North Island was surveyed on the ground and had 992 nests. Most recently, the species was assessed as At Risk – Declining, acknowledging that historical data overestimated the magnitude of population decline, but there is residual uncertainty about the population trend (Robertson et al. 2021).

10.4.4.2 Regional distribution, population size and trend

In the Auckland region, two small colonies are on Motuihe Island (less than 10 pairs) and Tiritiri Matangi (less than 500 pairs). Other birds are reported breeding on Rangitoto, but colony sizes are unknown. Overall, black-billed gulls continue to expand their distribution in the North Island, and now also breed in the Kaipara, Manukau and Waitemata Harbours (Gaskin and Rayner 2013, Mischler 2018, T. Lovegrove pers. comm.). The North Island was surveyed on the ground and had 992 nests in 2016/17 (Mischler 2018), but number of breeding pairs in the region remain unknown.

10.4.4.3 Known threats

Black-billed gulls are affected by introduced predators such as cats, stoats, and ferrets which predate eggs, chicks and adults, and native kāhu swamp harrier (*Circus approximans*) and southern black-backed gull take eggs and chicks. Human impacts at breeding colonies can also be significant. In recent years, vehicles have been driven through a number of colonies, killing eggs, chicks, and even adults, and large numbers of adults have been shot. Loss of breeding habitat due to weed encroachment and change in agricultural practices (e.g. farming intensification and the use of pesticides and herbicides) also have a negative impact (McClellan and Habraken 2013 [updated 2019]).

10.4.4.4 Past and present NZ research and regional monitoring studies

- National breeding population estimate with both aerial and on the ground surveys, 2014/15 to 2016/17 (Mischler 2018).
- Included in the Birds New Zealand wader census in 2022 (Riegen 2023)

10.4.4.5 Monitoring and research priorities

Regional population distribution, size and trends, population dynamics and demography.

10.4.5 Red-billed gull – *Chroicocephalus novaehollandiae scopulinus* – Tarapunga

Endemic subspecies.

Conservation status: At risk-declining.

Trend: Declining.

10.4.5.1 Distribution

The red-billed gull is a very abundant species that breeds widely on offshore islands and coasts of North, South, and Stewart Islands, and inland at Lake Rotorua, North Island (Taylor 2000b). Nevertheless, it appears to have declined nationally since the mid-1960s. In particular, it has recently suffered huge declines at its three main breeding colonies on the Three Kings Islands, Mokohinau Islands and Kaikoura Peninsula (Robertson et al. 2017, Frost and Taylor 2018).

10.4.5.2 Regional distribution, population size and trend

One of the largest colonies was on the Mokohinau Islands and exhibited a marked decline in numbers. From the estimate 13000 birds in 1945, the population was steady around 250 pairs in the 2013-2018 period (Gaskin et al. 2019). Nesting red-billed gulls were remarkably sparsely distributed along the west coast (21 pairs at three sites). The largest of these was 10 pairs on Oaia Island-Muriwai (Gaskin et al. 2019). Other breeding sites in the region include Tiritiri Matangi Island and Koi Islet-Waiheke (Gaskin and Rayner 2013). During the season 2018-19, red-billed gulls were found to be breeding in significant numbers on Maori Rocks, up to 500-1000 pairs (Gaskin et al. 2019).

10.4.5.3 Known threats

Introduced predators are an important threat. Mustelids (especially stoats and ferrets) and feral cats take eggs, chicks, and adults at mainland colonies. Norway rats may also take eggs and chicks. Uncontrolled dogs are a major threat to eggs and chicks. Human disturbance is a primary cause of nest failure. Motorbikes and 4WD vehicles on beaches disturb nesting birds and sometimes destroy nest sites. Some red-billed gulls are caught on recreational fishing lines, and birds die after swallowing hooks or becoming entangled in the line (Taylor 2000b). Climate-induced fluctuation in the availability of krill, the principal food of the birds during the breeding season, has a major impact on breeding success (Mills 2013 [updated 2018]).

10.4.5.4 Past NZ research and regional monitoring studies

- A national survey of breeding red-billed gulls was carried out during 2014-2016 to establish the present status of the species (Frost and Taylor 2018).

10.4.5.5 Monitoring and research priorities

Movements and foraging ecology of Hauraki Gulf populations is unknown and require study.

10.4.6 Southern black-backed gull – *Larus dominicanus* – Karoro

Native species.

Conservation status: Not threatened.

Trend: Increasing

10.4.6.1 Distribution

It is very abundant throughout New Zealand in most habitats other than forest and scrub. There are hundreds of colonies throughout the country, many exceeding 100 pairs, and a few exceeding 1000 pairs.

10.4.6.2 Regional distribution, population size and trend

Large colonies are present on Rangitoto Island, only 8 km from Auckland city centre. The Rangitoto population exhibited rapid growth throughout the early 20th century, but it is declining since the 1980s, and colonies are experiencing number of key changes when compared to historical records and previous surveys (Galbraith and Krzyżosiak 2015).

10.4.6.3 Known threats

Southern black-backed gulls are the only unprotected native bird species in New Zealand (Wildlife Act 1953). Many gulls are shot, and some colonies are actively controlled by poisoning or egg pricking to limit the impacts of this species on native wildlife or to prevent bird strikes at airports. Mustelids (especially stoats and ferrets), feral cats, and Norway rats take eggs and chicks at mainland colonies. Uncontrolled dogs are a major threat to chicks. Human disturbance is a primary cause of nest failure. Some black-backed gulls are caught on recreational fishing lines, and birds die after swallowing hooks or becoming entangled in the line (Taylor 2000b).

10.4.6.4 Present or recent NZ research and regional monitoring studies

- Aerial survey and ground count by NNZST in 2017, but mainly (80%) at Three Kings islands, so out of the Auckland region.
- Counts on the Mokohinau until the 2018-2019 season.

10.4.6.5 Monitoring and research priorities

Movements unknown.

11 Appendix 2: List of national and regional qualifiers for the assessment of regional conservation status

Code	Qualifier	Qualifier Type	National/ Regional	Description
CD	Conservation Dependent	Pressure Management Qualifier	National	The taxon is likely to move to a worse conservation status if current management ceases. The term ‘management’ can include indirect actions that benefit taxa, such as island biosecurity. Management can make a taxon CD only if cessation of the management would result in a worse conservation status. The influence of the benefits of management on the total population must be considered before using CD. The benefit of managing a single subpopulation may not be adequate to trigger CD, but may trigger Partial Decline (PD). Taxa qualified CD may also be PD because of the benefits of management.
CI	Climate Impact	Pressure Management Qualifier	National	The taxon is adversely affected by long-term climate trends and/or extreme climatic events. The following questions provide a guide to using the CI Qualifier: Is the taxon adversely affected by long-term changes in the climate, such as an increase in average temperature or sea-level rise? If NO = no Qualifier but needs monitoring and periodic re-evaluation because projected changes to the average climate and sea-level rise may adversely impact the taxon (including via changes to the distribution and prevalence of pests, weeds and predators) in the future. If YES = CI Qualifier Is the taxon adversely affected by extreme climate events, such as a drought, storm or heatwave? If No = no Qualifier but needs monitoring and periodic re-evaluation because projected changes to the climate are likely to increase the frequency and/or severity of these events in the future. If YES = CI Qualifier Use of the Climate Impact Qualifier would indicate the need for more in-depth research, ongoing monitoring of climate impacts, and potentially a climate change adaptation plan for the taxon.
CR	Conservation Research Needed	Pressure Management Qualifier	National	Causes of decline and/or solutions for recovery are poorly understood and research is required.

Code	Qualifier	Qualifier Type	National/ Regional	Description
DE	Designated	Assessment Process Qualifier	National	A taxon that the Expert Panel has assigned to what they consider to be the most appropriate status without full application of the criteria. For example, a commercial fish stock that is being fished down to Biomass Maximum Sustainable yield (BMSy) may meet criteria for 'Declining', however, it could be designated as 'Not Threatened' if the Expert Panel believes that this better describes the taxon's risk of extinction
DPR	Data Poor: Recognition	Assessment Process Qualifier	National	Confidence in the assessment is low because of difficulties in determining the identity of the taxon in the field and/or in the laboratory. Taxa that are DPR will often be DPS and DPT. In such cases, the taxon is most likely to be Data Deficient.
DPS	Data Poor: Size	Assessment Process Qualifier	National	Confidence in the assessment is low because of a lack of data on population size.
DPT	Data Poor: Trend	Assessment Process Qualifier	National	Confidence in the assessment is low because of a lack of data on population trend.
EF	Extreme Fluctuations	Pressure Management Qualifier	National	The taxon experiences extreme unnatural population fluctuations, or natural fluctuations overlaying human-induced declines, that increase the threat of extinction. When ranking taxa with extreme fluctuations, the lowest estimate of mature individuals should be used for determining population size, as a precautionary measure.
EW	Extinct In The Wild	Pressure Management Qualifier	National	The taxon is known only in captivity or cultivation or has been reintroduced to the wild but is not self-sustaining. Assessment of a reintroduced population should be considered only when it is self-sustaining. A population is deemed to be self-sustaining when the following two criteria have been fulfilled: it is expanding or has reached a stable state through natural replenishment and at least half the breeding adults are products of the natural replenishment, and it has been at least 10 years since reintroduction.
FR	Former Resident		Regional	Breeding population (existed for more than 50 years) extirpated from region but continues to arrive as a regional vagrant or migrant. FR and RN are mutually exclusive.
HR	Historical Range		Regional	The inferred range (extending in any direction) of the taxon in pre-human times meets its natural limit in the region.

Code	Qualifier	Qualifier Type	National/ Regional	Description
IE	Island Endemic	Biological Attribute Qualifier	National	A taxon whose natural distribution is restricted to one island archipelago (e.g. Auckland Islands) and is not part of the North or South Islands or Stewart Island/Rakiura. This qualifier is equivalent to the 'Natural' Population State value in the database.
IN	Introduced Native		Regional	Introduced to the region, though not known to have previously occurred in it.
INC	Increasing	Pressure Management Qualifier	National	There is an ongoing or forecast increase of > 10% in the total population, taken over the next 10 years or three generations, whichever is longer. This qualifier is redundant for taxa ranked as 'Recovering'.
NS	Natural State	Biological Attribute Qualifier	National	A taxon that has a stable or increasing population that is presumed to be in a natural condition, i.e., has not experienced historical human-induced decline.
NO	Naturalised Overseas	Population State Qualifier	National	A New Zealand endemic taxon that has been introduced by human agency to another country (deliberately or accidentally) and has naturalised there e.g., *Olearia traversiorum* in the Republic of Ireland.
NR	Natural Range		Regional	The known range (extending in any direction) of the taxon meets it natural limit in the region.
NStr	National Stronghold		Regional	More than 20% of the national population breeding or resident for more than half their life cycle in the region.
OL	One Location	Population State Qualifier	National	Found at one location in New Zealand (geographically or ecologically distinct area) of less than 100 000 ha (1000 km2), in which a single event (e.g. a predator irruption) could easily affect all individuals of the taxon, e.g. L'Esperance Rock groundsel (*Senecio esperensis*) and Open Bay Island leech (*Hirudobdella antipodum*). 'OL' can apply to all 'Threatened', 'At Risk', Non-resident Native – Coloniser and Non-resident Native – Migrant taxa, regardless of whether their restricted distribution in New Zealand is natural or human-induced. Resident native taxa with restricted distributions but where it is unlikely that all sub-populations would be threatened by a single event (e.g. because water channels within an archipelago are larger than known terrestrial predator swimming distances) should be qualified as 'Range Restricted' (RR).
PD	Partial Decline	Pressure Management Qualifier	National	The taxon is declining over most of its range, but with one or more secure populations (such as on offshore islands). Partial decline taxa (e.g. North Island kākā *Nestor meridionalis septentrionalis* and Pacific gecko *Dactylocnemis pacificus*) are declining towards a small stable population, for which the Relict qualifier may be appropriate.

Code	Qualifier	Qualifier Type	National/ Regional	Description
PE	Possibly/Presumed Extinct	Pressure Management Qualifier	National	A taxon that has not been observed for more than 50 years but for which there is little or no evidence to support declaring it extinct. This qualifier might apply to several Data Deficient and Nationally Critical taxa.
PF	Population Fragmentation	Pressure Management Qualifier	National	Gene flow between subpopulations is hampered as a direct or indirect result of human activity. Naturally disjunct populations are not considered to be 'fragmented'.
RE	Regional Endemic		Regional	Known to breed only in the region.
Rel	Relict	Pressure Management Qualifier	National	The taxon has declined since human arrival to less than 10% of its former range but its population has stabilised. The range of a relictual taxon takes into account the area currently occupied as a ratio of its former extent. Reintroduced and self-sustaining populations within or outside the former known range of a taxon should be considered when determining whether a taxon is relictual. This definition is modified from the definition of the At Risk – Relict category in the NZTCS manual (Townsend et al. 2008). The main difference is that trend is not included in the qualifier definition. This enables the qualifier to be applied to any taxon that has experienced severe range contraction, regardless of whether that contraction continues or has been arrested. This qualifier complements the 'Naturally Uncommon (NU)' qualifier which can be applied to taxa whose abundance has declined but which continue to occupy a substantial part of their natural range.
RF	Recruitment Failure	Pressure Management Qualifier	National	The age structure of the current population is such that a catastrophic decline is likely in the future. Failure to produce new progeny or failure of progeny to reach maturity can be masked by apparently healthy populations of mature specimens. Population trend qualifiers
RN	Restored Native		Regional	Reintroduced to the region after having previously gone extinct there.

Code	Qualifier	Qualifier Type	National/ Regional	Description
RR	Range Restricted	Biological Attribute Qualifier	National	A taxon naturally confined to specific substrates, habitats or geographic areas of less than 1000 km^2 (100 000 ha), this is assessed by taking into account the area of occupied habitat of all sub-populations (and summing the areas of habitat if there is more than one sub-population), e.g. Chatham Island forget-me-not (*Myosotidium hortensia*) and Auckland Island snipe (*Coenocorypha aucklandica aucklandica*). This qualifier can apply to any 'Threatened' or 'At Risk' taxon. It is redundant if a taxon is confined to 'One Location' (OL).
S?O	Secure? Overseas	Population State Qualifier	National	It is uncertain whether the taxon is secure in the parts of its natural range outside New Zealand.
SO	Secure Overseas	Population State Qualifier	National	The taxon is secure in the parts of its natural range outside New Zealand.
SO?	Secure Overseas?	Population State Qualifier	National	It is uncertain whether a taxon of the same name that is secure in the parts of its natural range outside New Zealand is conspecific with the New Zealand taxon.
Sp	Sparse	Biological Attribute Qualifier	National	The taxon naturally occurs within typically small and widely scattered subpopulations. This qualifier can apply to any 'Threatened' or 'At Risk' taxon.
TL	Type Locality		Regional	The type locality of the taxon is within the region. Ignore if the taxon is or has ever been regionally extinct.
T?O	Threatened? Overseas	Population State Qualifier	National	It is uncertain whether the taxon is threatened in the parts of its natural range outside New Zealand.
TO	Threatened Overseas	Population State Qualifier	National	The taxon is threatened in the parts of its natural range outside New Zealand.
TO?	Threatened Overseas?	Population State Qualifier	National	It is uncertain whether a taxon of the same name that is threatened in the parts of its natural range outside New Zealand is conspecific with the New Zealand taxon.

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