KEY DEMOGRAPHIC PARAMETERS AND POPULATION TRENDS OF TĀKOKETAI/BLACK PETRELS (*PROCELLARIA PARKINSONI*) ON AOTEA/GREAT BARRIER ISLAND: 2023/24

Key demographic parameters and population trends of tākoketai/black petrels (*Procellaria parkinsoni*) on Aotea/Great Barrier Island: 2023/24

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Frontispiece: Tākoketai/black petrel (*Procellaria parkinsoni*) family in study burrow on Aotea/Great Barrier Island, 2022 (© Ed Marshall, WMIL).

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EXECUTIVE SUMMARY

This report is part of the ongoing study of the tākoketai/black petrel (*Procellaria parkinsoni*) on Aotea /Great Barrier Island that began in the 1995/1996 breeding season.

During the 2023/24 breeding season 482 tākoketai study burrows were intensively monitored within the Mt Hobson/Hirakimata study area on Aotea.

There were 306 (63.5%) burrows occupied by breeding pairs, 58 (12%) occupied by non-breeding birds, and 118 (24.5%) were unoccupied at the time of check. Overall, 222 chicks were produced from the study burrows representing a fledgling success rate of 72.5%, but five chicks were found to be below weight and smaller in size during the May chick banding trip, and most of these chicks were not expected to survive to fledging. This would further reduce overall breeding success to 70.9%.

Nine census grids were monitored within the study area and accounted for 199 of the inspected study burrows. Of these, 120 were occupied by breeding pairs (60.3%) and 86 chicks were produced representing a fledging success rate of 71.7%. Again three of these chicks were in poor condition and were not expected to fledge, reducing breeding success to 69.2%.

A total of 700 adults and 223 fledgling chicks were captured during the 2023/24 field season with 274 adults banded this season (including 204 from study burrows). Of the 223 fledgling chicks banded during the 2023/24 field season, 212 were banded in study burrows and eleven chicks were banded on the surface or from random non-study burrows. An additional ten chicks from within the study burrows fledged prior to the banding trip in May.

There have been nocturnal surveys undertaken throughout the 29-year study period, but only over the past three seasons (2021/22 to 2023/24) has this effort been increased to 6-8 hour (between 9.15 pm to 5.15 am) searches each night. Over 940 nights of ad-hoc surveys undertaken between 1995/96 and 2020/21, 811 adults were recaptured, of which 365 were already banded and 108 were returned chicks. Over 41 nights of intensive surveys between 2021/22 and 2023/24, 427 adults were recaptured, of which 219 were already banded and 83 were returned chicks. At-sea surveys have also been conducted by WMIL over this same period with only 22 banded birds being caught and nine being recaptured chicks (Burgin 2024). The percentage of banded tākoketai caught out of all captures is higher for intensive night surveys (51.3%) than the ad-hoc surveys (45%) and much higher than the at-sea surveys (4.8%). This pattern is also the same for the percentage of returned chicks captured (intensive 19.4%, ad-hoc 13.3% vs at-sea 2%), for the number of banded tākoketai caught per survey (intensive n=5.3, ad-hoc n=2.1, at-sea n=1.5) and for returned chicks caught per survey (intensive 2.0 returned chicks/survey, ad-hoc 0.6 returned chicks/survey, at-sea 0.6 returned chicks/survey).

There have been a total of 461 returned chicks recaptured at the colony since they were banded prior to fledging. Of these, 126 returned chicks were identified during the 2023/24 breeding season; 30 of which were caught for the first time at the colony. Not all cohorts were represented this season as no re-captures of returned chicks were made from the 1995/96, 1996/97, 2001/01 and 2003/04 cohorts. Over the entire study, the majority of the 461 returned chicks were from the 2010 /11 cohort followed by the 2006/07 cohort. Understanding the factors affecting return rates of chicks within the 35-ha study site is vital. 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, it is recommended that effort to obtain this data is completed with urgency.

Additional monitoring of feral pig and other predator occurrence and impact on tākoketai at Cooper's Castle was undertaken this season. Visual deterrents were established at two breeding burrows with trail cameras placed to record images and video. Footage confirmed rat presence only. There were no feral cat predation events and two rat predation events at the study colony on Hirakimata this season. Introduced species still pose a threat to the tākoketai population and it is imperative pest control measures continue.

WMIL recommends that:

- Intensive population monitoring using the study burrows on Aotea continues with three visits (i.e., at egg-laying (December); at chick hatching/chick guard in late January/early February and at chick fledging in late April/early May) per season to the colony to track population trends and determine impacts to the birds and colony.
- Multiple-night expeditions to focus on recruitment (i.e., nocturnal surveys to capture pre-breeders and returned chicks) to the Aotea study colony continue to determine juvenile survival and recapture probabilities.
- Sexing of all tākoketai caught during the recruitment expedition and in the study burrows is completed to determine any sex biases and survival differences between sexes at the colony and within the study burrows.
- A focused, consistent and repeatable mark/recapture session (e.g., a 2-hour capture period at known launch sites) is completed over a number of nights to capture as many banded and unbanded birds as possible. Data can then be used to provide another population estimate and compared to estimates obtained from at-sea captures and burrow monitoring.
- Transect surveys across the core tākoketai habitat (1000 ha around the summit) are undertaken to provide an updated population estimate for the core breeding area of Aotea.
- Satellite tracking of chicks to, and in, South American waters is undertaken to determine migration routes and foraging areas to estimate risk in these areas.
- The possibility of collaborative at-sea capture expeditions in Ecuador is investigated. Discussions between DOC and New Zealand Government with Ecuadorian Government and researchers will have to be conducted to enable this type of collaborative work. At-sea work in Ecuador could determine the level of juvenile tākoketai presence in this area and risk within this area, and this mark/recapture work could provide another population estimate to compare with the New Zealand data.
- Further investigation to determine whether particular areas of the colony are more at risk to rainfall events than others (e.g., burrows in flatter areas being more prone to flooding) as a preliminary assessment on climate resilience.
- In-depth modelling on the effect of age, age difference in pairs, and experience on breeding success is completed to understand this relationship in tākoketai.
- Analysis of, and comparison between, breeding success in public, and non-public, access areas is completed to determine whether human disturbance is a factor at the Aotea colony.
- Investigation into possible deterrence methods of all predators, but specifically feral pigs and feral cats, should be continued at Cooper's Castle.

Key demographic parameters and population trends of tākoketai/black petrels (*Procellaria parkinsoni*) on Aotea/Great Barrier Island: 2023/2024

1. INTRODUCTION

1.1 Introduction

Tākoketai/black petrels (*Procellaria parkinsoni*) are a medium–sized endemic seabird that only breeds on Te Hauturu–o–Toi/Little Barrier Island and Aotea/Great Barrier Island in the Tīkapa Moana/Hauraki Gulf of Aotearoa New Zealand. Tākoketai are ranked as Nationally Vulnerable under the New Zealand Threat Classification System and Vulnerable on the IUCN Red List of Threatened Species (BirdLife International 2020, Robertson et al. 2021). They are recognised to be at risk of being adversely impacted by high rates of bycatch in commercial fisheries within New Zealand's Exclusive Economic Zone (Richard et al. 2020). Of the 196 observed captures of tākoketai recorded between 2002 and 2021, 51.5% of captures occurred in bottom-longline fisheries, 30.1% in surface-longline fisheries and 18.4% in trawl fisheries (https://protectedspeciescaptures.nz/PSCv7/; accessed 18/7/2024). Tākoketai on Aotea are also exposed to threats on land, principally depredation by ngeru mohoao/feral cats (*Felis catus*), kiore/rats (*Rattus* spp.) and poaka/feral pigs (*Sus scrofa*) (Bell 2013).

To monitor the ongoing population-level impacts of commercial fisheries on tākoketai, it is necessary to quantify population parameters such as annual burrow occupancy rates, annual reproductive success as well as both adult and juvenile annual survival rates to create accurate assessments of population trends. To this end, a long-term research project aimed at quantifying these population parameters was initiated in 1995/96 (Bell & Sim 1998). During this first season, three 40 m x 40 m study grids were set up within the largest known breeding colony on Hirakimata/Mt Hobson on Aotea, and all burrows within the grids were marked and monitored. Additional burrows located within 10 m of the public walking tracks were also monitored. In 1998/99, the number of study grids was increased to six, and then to nine in 1999/00 (Bell & Sim 2000a, Bell & Sim 2000b). Over the years, additional burrows situated near the public walking tracks have continued to be added (Bell et al. 2023), so that by the 2023/24 season a total of 482 study burrows were being monitored by Wildlife Management International Limited (WMIL).

This report provides a summary of the results of the monitoring work undertaken on Aotea by WMIL in the 2023/24 season, with updates on the trends in several population parameters including both annual burrow occupancy and annual reproductive success.

Te Reo names are used throughout the document for all bird species and locations after the first use (e.g., tākoketai/black petrel or Aotea/Great Barrier Island) and common English names for all mammalian predator species after the first use (e.g., ngeru mohoao/feral cat).

1.2 Objectives

This project extends on demographic work funded by commercial fisheries levies and the Department of Conservation (DOC) and Ministry for Primary Industries/Fisheries New Zealand (MPI/FNZ) since 1996.

As tākoketai are a species at high risk from commercial fisheries in northern New Zealand, continuing research on this species is necessary to gather current rates of adult mortality, breeding success,

juvenile survival and recruitment until suitable mitigation methods significantly reduce the capture risk to this species.

The main objectives for the 2023-24 season are:

a. To monitor the key demographic parameters at the breeding colony of this threatened seabird to reduce uncertainty or bias in estimates of risk from commercial fishing.

b. Capture tākoketai in burrows and on the surface on the upper slopes of Hirakimata to identify returning known aged birds. This is a priority task to determine if low return rates are due to lack of philopatry to the study area rather than high mortality rates.

c. Attach a range of tracking tags (GLS, GPS, satellite transmitters and TDRs) to tākoketai to determine their current foraging range both in New Zealand and on migration.

2. METHODS

2.1 Field methods

A network of 482 study burrows has been established within a c. 35-ha study area in the vicinity of Hirakimata on Aotea (Figure 1). The colony residing around the Hirakimata summit represents the highest density of logistically accessible tākoketai on Aotea and was the reason underlying the establishment of the study site. Additionally, previous research programmes on tākoketai that had taken place at Hirakimata before the establishment of WMIL's monitoring programme increases the importance of the site (Hunter et al. 2001, Imber 1976, Imber 1987, Imber et al. 2003a, Scofield 1989). For instance, the oldest known age bird re-sighted in the 2023/24 season is a 36-year-old bird that was banded as a chick in 1988 (WMIL, unpublished data).

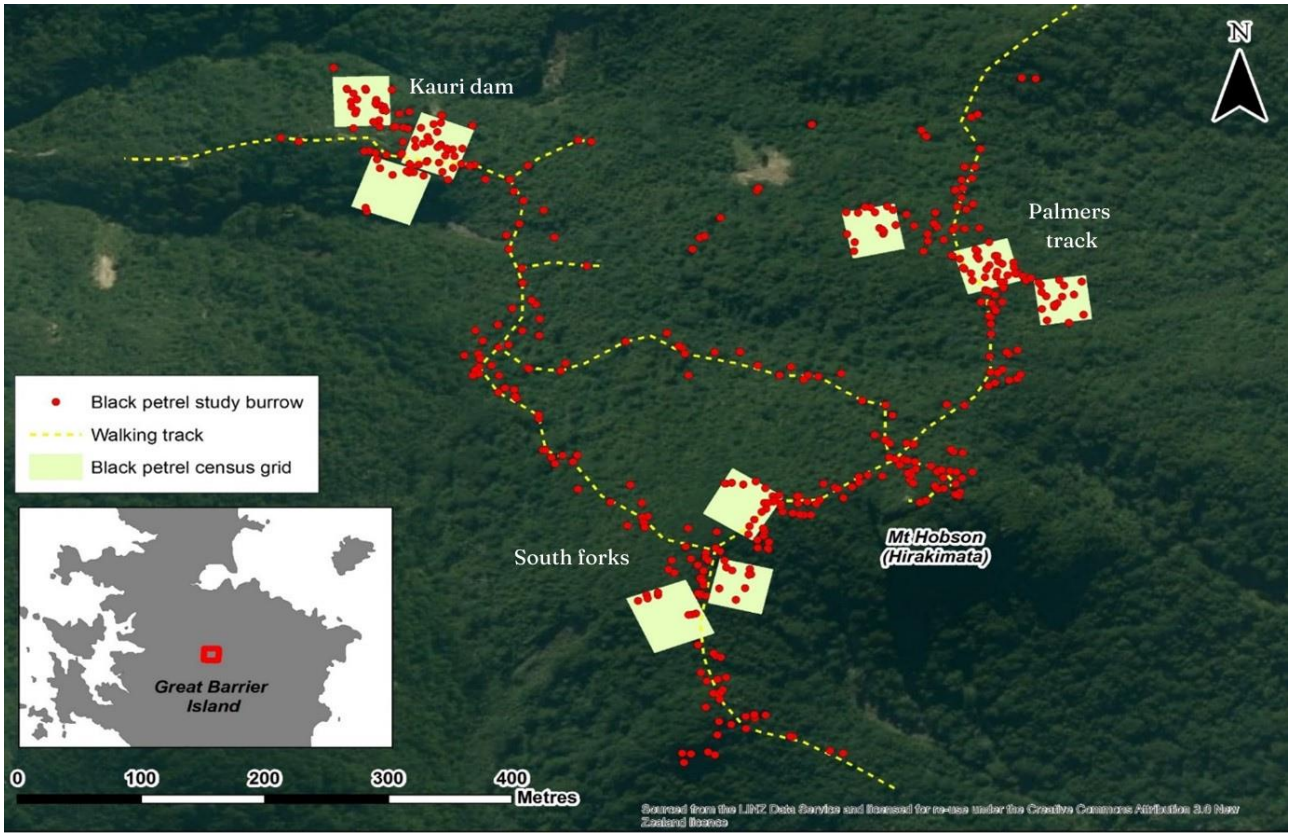

Figure 1: *Map of the 482 tākoketai/black petrel (Procellaria parkinsoni) study burrows (red points) that have been established in the vicinity of Mt Hobson/Hirakimata on Aotea/Great Barrier Island. Yellow dashed lines are public walking tracks and highlighted squares are census grids (Kauri Dam, South Forks and Palmers Track).*

Study burrows (burrows where demographic data is recorded) have been progressively established over the past 29 years and to date include 199 burrows (with two new burrows found in December 2023) located within nine 40 m x 40 m census grids, plus a further 283 arbitrarily selected burrows situated within approximately 25 m of public walking tracks (Figure 1).

The first three census grids were established within previously known high density tākoketai breeding habitat located over ridgelines in remnant (un-milled) podocarp broadleaf mixed forest. The boundaries of the second three and last three census grids were randomly selected within appropriate habitat hypothesised to maintain breeding populations (e.g., over ridgelines within either remnant forest or secondary re-growth forest (where kauri was only logged selectively in the past; Figure 1).

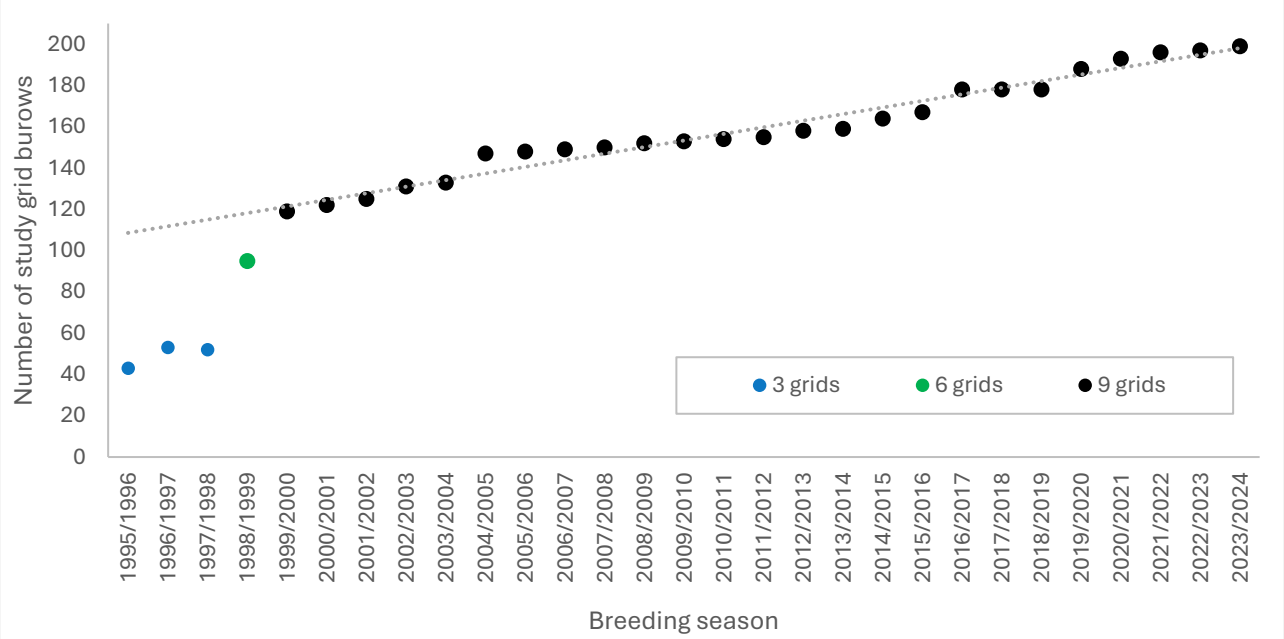

Figure 2: *The total number of tākoketai/black petrel (Procellaria parkinsoni) census grid burrows monitored each breeding season on Aotea/Great Barrier Island between 1995 to 2024.*

Census grid sizes at the start of the study were 100 m^2 in January 1996 and subsequently increased to 1600 m^2 by April 1996 during the chick fledging period. Being within the vicinity of public walking tracks allows faster traversing of the study site. The average distance from the centre of the nine census grid ranges between 1 to 61.7 m (mean distance is 25 m ± 17.4 m SD) from walking tracks. At the establishment of a census grid, an exhaustive grid-like search was conducted on foot by researchers traversing together in a line one metre apart within the grid boundaries. All occupied, empty, and potential (burrows in the process of being dug out) were recorded. On three separate occasions (December 2009, January 2010, and December 2015) further searches by a seabird detection dog was conducted in each census grid to identify any missed burrows. Burrow occupancy rates in the nine study grids likely provide the most consistent and representative measure of burrow occupancy across the study area, as they are unaffected by the occasional preferential addition of active breeding burrows to the study burrow network outside of the study grids that has occurred in previous years. For this reason, trends in burrow occupancy rates within the study grids provide the best measure of whether tākoketai burrow occupancy is increasing or decreasing within the study area (Figure 2).

Up until the 2018/19 season, when burrows are found outside of census grids, they are automatically added into the study if they are found within c. 10 m of the public walking tracks, or if the burrow when found, contained a breeding adult that was previously banded as a chick. Currently any new burrows that are found are only added into the study if they are within the census grids (Figure 3) or contain a breeding adult that was previously banded as a chick.

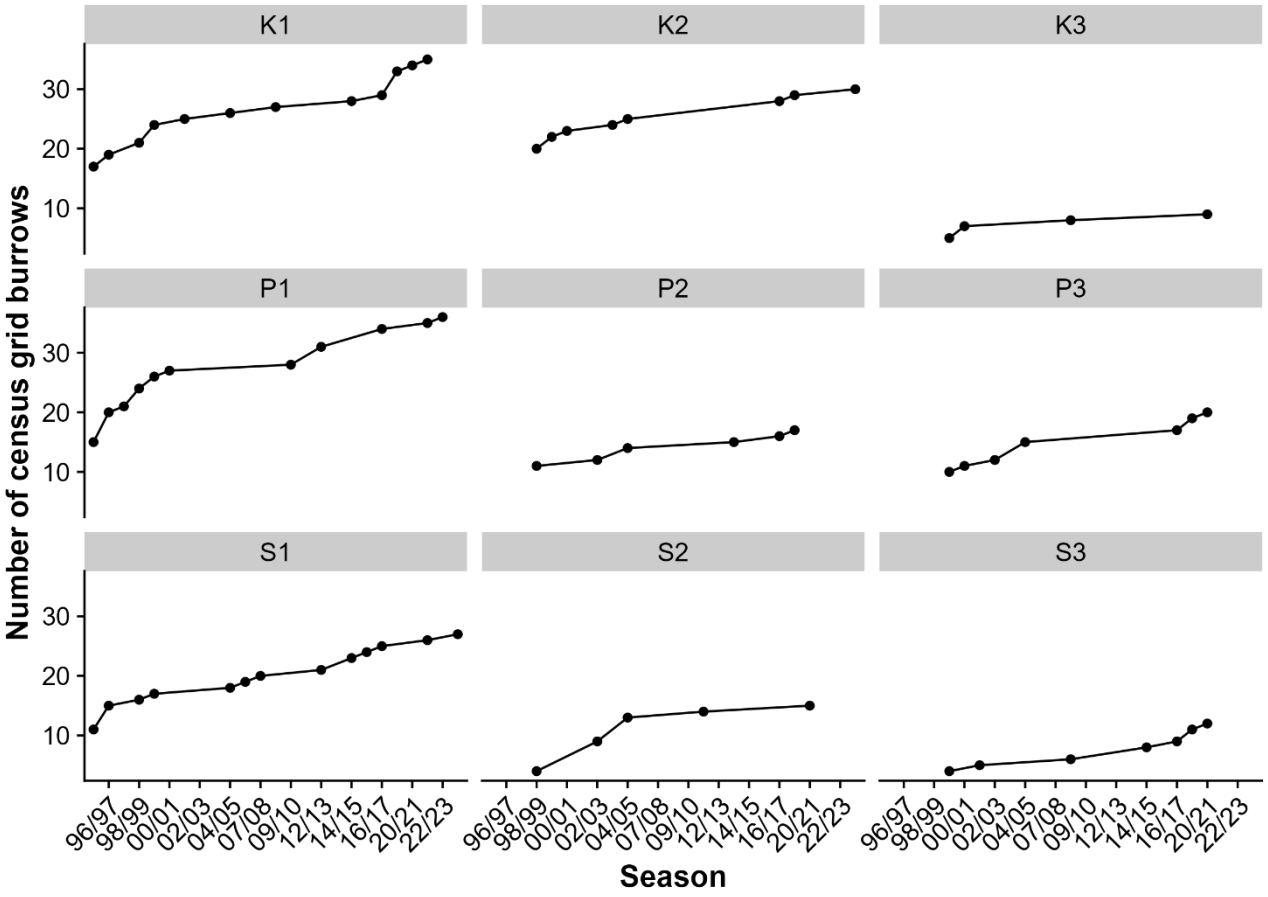

Figure 3: *The cumulative number of tākoketai/black petrel (*Procellaria parkinsoni*) census grid burrows added to each census grid on Aotea/Great Barrier Island between 1995/96 and 2023/24 breeding seasons (Note: the first point for each study grid indicates when the study grid was first established. Only the breeding seasons where burrows were added are included along the x-axis).*

The additional 283 arbitrarily selected study burrows were found through a combination of haphazard searching and seabird detection dogs. Other burrows that are found further than c. 10 m from public walking tracks are noted and are often returned to in subsequent seasons in order to increase the number of banded birds into the study but data on breeding status and occupancy is not collected.

To facilitate accurate monitoring, 328 study burrows have had study hatches installed (68%), providing easier access to one or more chambers within the burrow and to reduce interaction time with the bird by the researchers. Of these burrows with hatches installed, larger/internally complex burrows have had two (18 burrows, 3.7%) or three (7 burrows, 1.5%) hatches installed. Depending on the internal complexity of the burrow, and accessibility and temperament of the bird within the burrow, retrieval of the bird may take between 1-30 min.

The first visit to the Hirakimata study area occurred from 4 to 14 December 2023 (Trip 1) and was focused on identifying recruits (i.e., birds banded as chicks returning to the colony to breed). Timing of this trip was aimed at coinciding with the end of the pre-egg laying exodus and the start of the egg laying period when large numbers of birds would be returning to the island. During the recruitment trip, the field team systematically searched the colony each night from 9.15 pm (approximately 1 hour after dusk when the first non-breeding tākoketai began calling) to 5.15 am (dawn). Birds were captured on the surface, at launch sites, and in burrows. For all night-work, captured birds were checked for bands, and any band numbers were recorded. If unbanded, a band was applied to the bird's leg, before being subsequently released. Before release, a small mark was made on each bird's forehead using white correction fluid to provide a means of visually checking whether a bird had already been captured, if encountered again on the same or another subsequent night.

The study burrows were monitored during Trip 1 as well as again in two subsequent trips to the colony. The second visit occurred from 7 February to 28 February 2024 (Trip 2) and coincided with late incubation/hatching/early chick rearing. Trip 3 occurred from 29 April to 7 May and coincided with the late chick rearing/chick fledging period. The number and timing of trips to the colony each breeding season vary from year to year depending on additional project goals, but at a minimum will contain two trips to cover the late incubation/hatching/early chick rearing and late chick rearing/fledging (Table 1).

Table 1: *Breeding cycle of tākoketai/black petrel (Procellaria parkinsoni) on Aotea/Great Barrier Island (WMIL, unpublished data; also see Imber 1987).*

Breeding stage	Time period
Return to colony	From 10 October
Pre-egg-laying exodus ('honeymoon')	15 October to 15 November
Egg laying	15 November to 31 December (peak 1-15 December)
Incubation	15 November to 28 February
Guard phase	10 January to 15 March (peak 1-15 February)
Chick rearing	15 January to 30 June
Fledgling	10 April to 30 June (peak 1-20 May)

To determine the breeding status and breeding outcome for each burrow, and to record the adult occupants of each burrow, each study burrow was checked once in Trip 1, at least twice during Trip 2 and once in Trip 3. During each burrow check, any resident adults were removed from the burrow, and checked for bands. If banded, the band number of each bird was recorded, otherwise the bird was banded with an individually numbered size H stainless steel band. Unbanded adult petrels that are caught in a burrow on an egg or with a chick are given an age estimate of eight years (from the average age of first breeding; Appendix 1), whereas an unbanded adult caught on the surface or in a burrow without an egg or chick was assumed to be at least five years of age (estimated from median age of first return; Appendix 1). Before being returned to the burrow, a small mark was made on each bird's forehead using white correction fluid to provide a means of visually checking whether the same bird was still occupying the burrow during subsequent checks, without having to remove the bird to read its band. The presence of an egg or chick was also recorded. After each check, a palisade of twigs was erected over the burrow entrance to provide a quick means of checking for recent activity (i.e., arrivals and departures of parents switching incubation/brooding duties) during subsequent checks of the same burrow. As Trip 2 was carried out during hatching/early chick rearing a large amount of these burrow checks were carried out at night, particularly during the second half of the trip, to intercept adults returning to feed chicks. During the final trip of each season (Trip 3), fledgling chicks found in the study burrows were extracted and banded. There were several instances of chicks from study burrows that were assumed to have fledged before they were able to be banded. The fledged status of these empty burrows was determined by the presence of down feathers and the dandruff-like substance produced by newly emerging flight feathers (i.e., flakes of waxy sheaths from the feather bases) in the burrow and burrow entrances.

For the two trips focused on assessing the burrow demographics (Trip 2 and Trip 3) the field team also spent several nights walking the public track system within the 35-ha study area, capturing any tākoketai found on the ground.

2.2 Adult Tracking

Tracking was undertaken during Trip 2 (February) to obtain tracks of foraging adults during hatching/early chick rearing. Each breeding bird found in a study burrow was weighed before GPS devices were deployed. Adults with hatching eggs or guarding very young chicks were selected for tracking.

Six birds were fitted with i-GotU™ GPS devices, pre-encased in resin for waterproofing. Devices weighed ~22 g. and were between 2.4-2.8% of the body weights of tracked adults. The GPS devices were programmed to take one position fix every 10 minutes.

Devices were attached by back mount by taping the feathers with five pieces of Tesa tape® and superglue (Figure 4). Once devices had been attached, the birds were placed back in their burrow. Burrows were checked daily to ensure they had left and then checked every few days to retrieve devices when they had returned from a foraging trip.

Figure 4: *Back-mounted i-GotU GPS devices deployed on breeding tākoketai/black petrels (Procellaria parkinsoni), 2023/24.*

2.3 Chick Tracking

Satellite tracking of tākoketai chicks was undertaken to determine chick fledgling migration routes over this monitoring period. Devices were deployed on suitable chicks during Trip 3. Any chicks in burrows were weighed, wing length measured, and the length of their primaries assessed to find those close to fledging. Fifteen chicks were selected with minimal down (especially across the back), weighing over 790 g and with wing lengths greater than 317 mm. Telonics TAV-2617™ satellite devices (17g) were used for tracking these fifteen chicks. Five pieces of Tesa tape were used to tape the device to feathers on the backs of the chicks (Figure 5). One device was attached using the outrigger method, which in addition to taping to the back of the bird also had four Teflon® ribbon loops attached to each corner of the device and taped to more feathers on the back of the chick (Figure 5). Devices were set to take fixes for one hour per day (around 11 pm) to extend battery life. All devices were between 1.8-2.1% of the body weights of the tracked chicks.

Figure 5: *Tākoketai/black petrel (Procellaria parkinsoni) chick with a Telonics TAV-2617™ satellite device attached using the Outrigger method, Great Barrier Island/Aotea, May 2024.*

2.4 Poaka/Feral pig deterrence

A pilot trial aimed at investigating a potential low-cost tool for deterring feral pigs away from active tākoketai burrows was run in February/March 2024. Optical effects (LED lights and aluminium strips) has shown some evidence at deterring feral pigs from a lured site (Denzin et al. 2020). As such, a low-cost option (compact disc, CD) were trialled on Aotea as one side of a CD is highly reflective. At one active burrow identified at Cooper's Castle, three CDs per burrow were hung from vegetation by string within a c. 5 m radius around the burrow entrance. CDs were hung c. 45 cm above the ground to be approximately within the visual field of feral pigs. Two trail cameras (Browning® Dark Ops Pro X 1080) were set up to record any interactions. One trail camera was programmed to take a photo following movement and the other one was programmed to take video. One camera faced the burrow entrance and at least one CD with the other camera installed in the opposing direction to have at least the other two CDs within field view. All cameras and CDs were installed on the 22 February 2024 and removed on 4 March 2024. All images and videos taken were reviewed manually following their retrieval.

2.5 Disease screening

With the deadly strain of avian influenza (H5N1) circumnavigating through seabird populations around the globe (https://www.doc.govt.nz/our-work/wildlife-health/avian-influenza/), increased surveillance protocols have been implemented at the tākoketai colony in an effort to understand baseline disease ecology prior to the anticipated arrival of the virus in Aotearoa New Zealand. Choanal and cloacal samples were taken from ten tākoketai chicks (Table 2) following the DOC protocols for Seabird

Sampling for Avian Influenza Surveillance (K. McInnes, DOC, *pers. comm.*). Samples were sent to Otago University for processing.

Table 2: *Summary of disease samples taken from tākoketai/black petrels (Procellaria parkinsoni) on Aotea/Great Barrier Island April 2024.*

Sample ID	Date	Band Number	Age	Sex	Weight (Body condition)	Health observations
1	6/05/2024	H58053	Chick	Unknown	770 g (good)	Looked healthy
2	6/05/2024	H48041	Chick	Unknown	840 g (good)	Looked healthy
3	6/05/2024	H48086	Chick	Unknown	690 g (good)	Looked healthy
4	6/05/2024	H48087	Chick	Unknown	710 g (good)	Looked healthy
5	6/05/2024	H48024	Chick	Unknown	845 g (good)	Looked healthy
6	6/05/2024	H48027	Chick	Unknown	945 g (good)	Looked healthy
7	6/05/2024	H48089	Chick	Unknown	720 g (good)	Looked healthy
8	6/05/2024	H48028	Chick	Unknown	800 g (good; bill tip cracked)	Looked healthy
9	6/05/2024	H48091	Chick	Unknown	650 g (skinny)	Underweight
10	6/05/2024	H47825	Chick	Unknown	920 g (good)	Looked healthy

2.6 Data entry and analysis

All mark–recapture and breeding status data were entered into a Microsoft Access™ database at the completion of each trip. Microsoft Excel™ was used to calculate breeding occupancy and breeding success as percentages which was then compared to previous years. The statistical software R (R Core Team 2022) using the 'ggplot2' package (Wickham 2016) was also used to visualise a variety of demographic parameters (e.g., number of burrows within the study, the age distribution and mean age and its standard deviation, and number of birds banded as chicks re-sighted at the colony from each cohort).

3. RESULTS

3.1 Burrow occupancy and breeding success

The number of census grid burrows has continued to increase over time since 1995 (Figure 2 and 3). The total number of census grid burrows has steadily increased from 43 in 1995/96 to 199 in 2023/24 (Figure 2 and 3). Some study burrows within the grids have been abandoned and are not used by breeding tākoketai, but these burrows are still checked each season. Tākoketai are highly unlikely to be displaced by other seabird species present on Aotea. The only other burrow-nesting seabird that nests inland on Aotea and overlaps with the habitat of tākoketai is the tītī/Cook's petrel (*Pterodroma cookii*), approximately 65% smaller in size than the tākoketai (Bell & Sim 1998, Imber et al. 2003b). However, due to sustained predation by mammalian predators, this species is at an extremely low density on Aotea (Imber et al. 2003b), and within the study site only seven tītī breeding burrows have ever been found.

Of the 482 study burrows (199 census burrows and 283 non-census study burrows) monitored during the 2023/24 breeding season, 306 (63.5%) were occupied by breeding birds, 58 (12%) were occupied by non-breeding birds and 118 (24.5%) were unoccupied during each visit (Table 3).

Of the 199 census grid burrows, there were 120 burrows occupied by breeding tākoketai (60.3%), 1% lower than the 29-year average census grid breeding burrow occupancy rate of 61.3% (Table 3; Figure 6). Non-census study burrows breeding occupancy was 65.7% (186 out of 283 burrows), 4.5% lower than the 29-year average of 72% (Table 3; Figure 6).

Table 3: *Summary of breeding success of tākoketai/black petrels (Procellaria parkinsoni) (percentage of breeding burrows that fledged a chick; number of successful fledglings followed in parentheses) at Hirakimata/Mt Hobson on Aotea/Great Barrier Island between 1995 and 2024 within census grid burrows, non-census study burrows and all burrows combined. The number of census grid, non-census and total number of study burrows are the number of burrows where a breeding attempt was observed.*

Breeding season	Census grid burrows breeding success % (no. of chicks fledged)	Number of census grid burrows occupied by breeders % (total census grid burrows)	Non-census study burrows breeding success % (no. of chicks fledged)	No. of non-census burrows occupied by breeders % (total no. non-census burrows)	Total Breeding success % (No. of chicks fledge)	Total no. of study burrows occupied by breeders % (total no. study burrows)
2023/24	**71.7% (86)**	**60.3% (199)**	**73.1% (136)**	**65.7% (283)**	**72.5% (222)**	**63.5% (482)**
2022/23	56.3% (67)	60.4% (197)	63.4% (123)	68.6% (283)	60.7% (190)	65.2% (480)
2021/22	77.3% (99)	65.3% (196)	71.4% (142)	70.3% (283)	73.7% (241)	68.3% (479)
2020/21	72.4% (84)	60.1% (196)	78.3% (159)	71.7% (283)	76.2% (244)	67.0% (476)
2019/20	71.6% (78)	58.0% (188)	76.9% (143)	66.9% (278)	76.2% (221)	63.3% (466)
2018/19	69.6% (71)	57.3% (178)	76.1% (143)	69.6% (270)	73.8% (214)	64.7% (448)
2017/18	63.5% (61)	53.9% (178)	62.8% (115)	67.8% (270)	63.1% (176)	62.3% (448)
2016/17	67.0% (69)	57.9% (178)	67.9% (128)	69.6% (273)	67.6% (198)	65.0% (451)
2015/16	62.6% (67)	64.1% (167)	68.5% (126)	68.9% (267)	66.3% (193)	67.1% (434)
2014/15	68.3% (69)	61.6% (164)	69.6% (133)	71.0% (269)	69.2% (202)	67.4% (432)
2013/14	68.4% (65)	59.7% (159)	71.1% (123)	65.3% (265)	70.1% (188)	63.2% (424)
2012/13	80.9% (72)	56.3% (158)	80.9% (152)	71.5% (263)	80.9% (224)	65.8% (421)
2011/12	80.2% (73)	58.7% (155)	54.9% (90)	65.1% (252)	63.9% (163)	62.7% (407)
2010/11	60.4% (58)	62.3% (154)	61.6% (106)	68.3% (252)	61.2% (164)	65.8% (406)
2009/10	72.4% (63)	56.9% (153)	73.2% (123)	66.1% (254)	72.9% (186)	62.7% (404)
2008/09	70.1% (68)	63.8% (152)	73.0% (127)	72.2% (241)	72.0% (195)	69.0% (393)
2007/08	71.3% (67)	62.7% (150)	80.6% (133)	72.7% (227)	77.2% (200)	68.7% (377)
2006/07	80.4% (78)	65.1% (149)	84.0% (136)	72.4% (225)	82.7% (215)	69.5% (374)
2005/06	69.9% (65)	62.8% (148)	61.2% (101)	75.3% (219)	64.3% (166)	70.3% (367)
2004/05	75.3% (64)	57.8% (147)	77.0% (114)	67.6% (219)	76.4% (178)	63.7% (366)
2003/04	79.5% (62)	58.6% (133)	62.7% (89)	72.1% (197)	68.6% (151)	66.7% (330)
2002/03	59.2% (45)	58.0% (131)	56.5% (70)	65.3% (190)	57.5% (115)	62.3% (321)
2001/02	76.5% (62)	64.8% (125)	65.8% (75)	69.5% (164)	70.3% (137)	67.5% (289)
2000/01	80.5% (62)	63.1% (122)	73.2% (71)	69.8% (139)	76.4% (133)	66.7% (261)
1999/00	66.3% (55)	69.7% (119)	78.6% (77)	73.1% (134)	72.9% (132)	71.5% (253)
1998/99	70.8% (46)	68.4% (95)	80.2% (65)	68.6% (118)	76.0% (111)	68.5% (213)
1997/98	77.1% (27)	67.3% (52)	81.4% (57)	70.7% (99)	80.0% (84)	69.5% (151)
1996/97	69.4% (25)	67.9% (53)	75.4% (49)	73.9% (88)	73.3% (74)	71.6% (141)
1995/96	87.0% (20)	53.5% (43)	90.0% (36)	87.0% (46)	88.9% (56)	70.8% (89)
Average	**71.6% (63)**	**61.3% (144)**	**72.0% (108)**	**70.2% (219)**	**71.8% (171)**	**66.6% (365)**

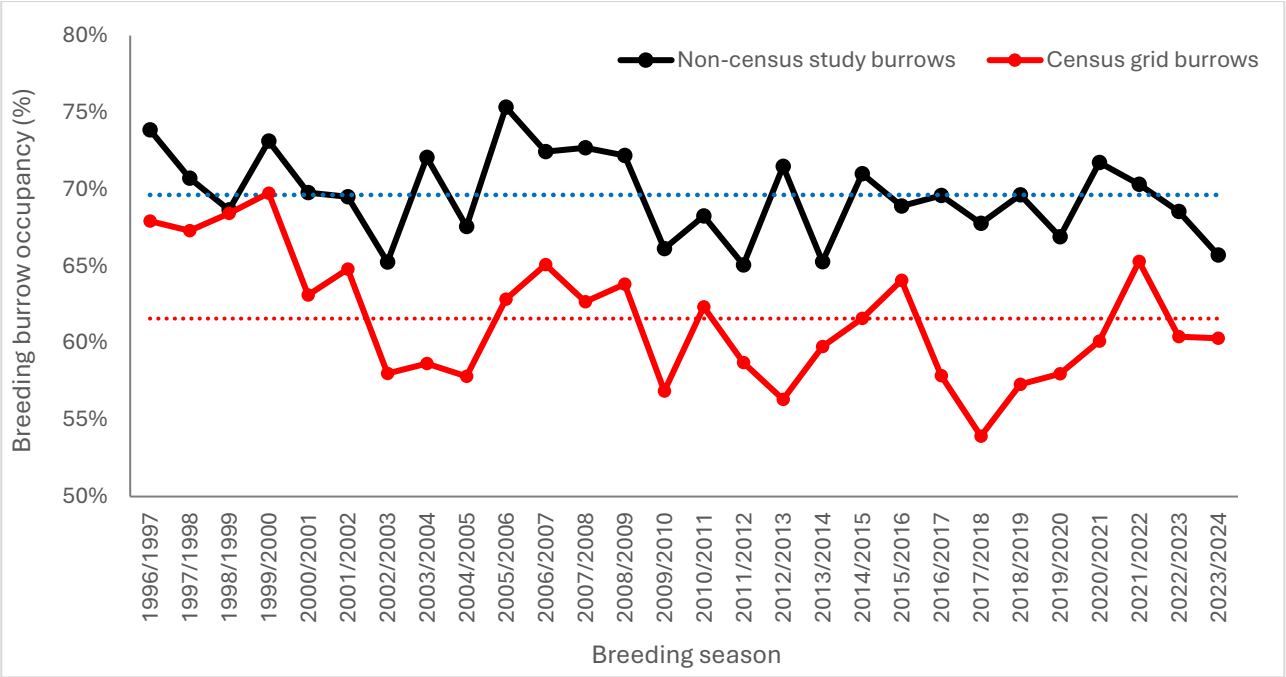

Figure 6: *Percentage of census grid burrows (n=199, red) and non-census study burrows (n=283, black) occupied by breeding tākoketai/black petrels (Procellaria parkinsoni) at Hirakimata/Mt Hobson on Aotea/Great Barrier Island between 1997 and 2024 (dotted line represents the mean occupation of census grid burrows (red) and non-census study burrows (black) over 29 years by breeding tākoketai).*

Breeding success within the census grids was 71.7% (86 chicks fledged and 34 breeding failures) and within the non-census grids was 73.1% (136 chicks fledged and 50 breeding failures) (Figure 7 and Table 3). Of the 306 study burrows that were occupied by breeding birds during the 2023/24 breeding season, there were 84 breeding failures (17.4%) and 222 chicks were produced (72.5% breeding success; 1.3% higher than the 29-year average of 71.2%) (Table 3; Figure 8).

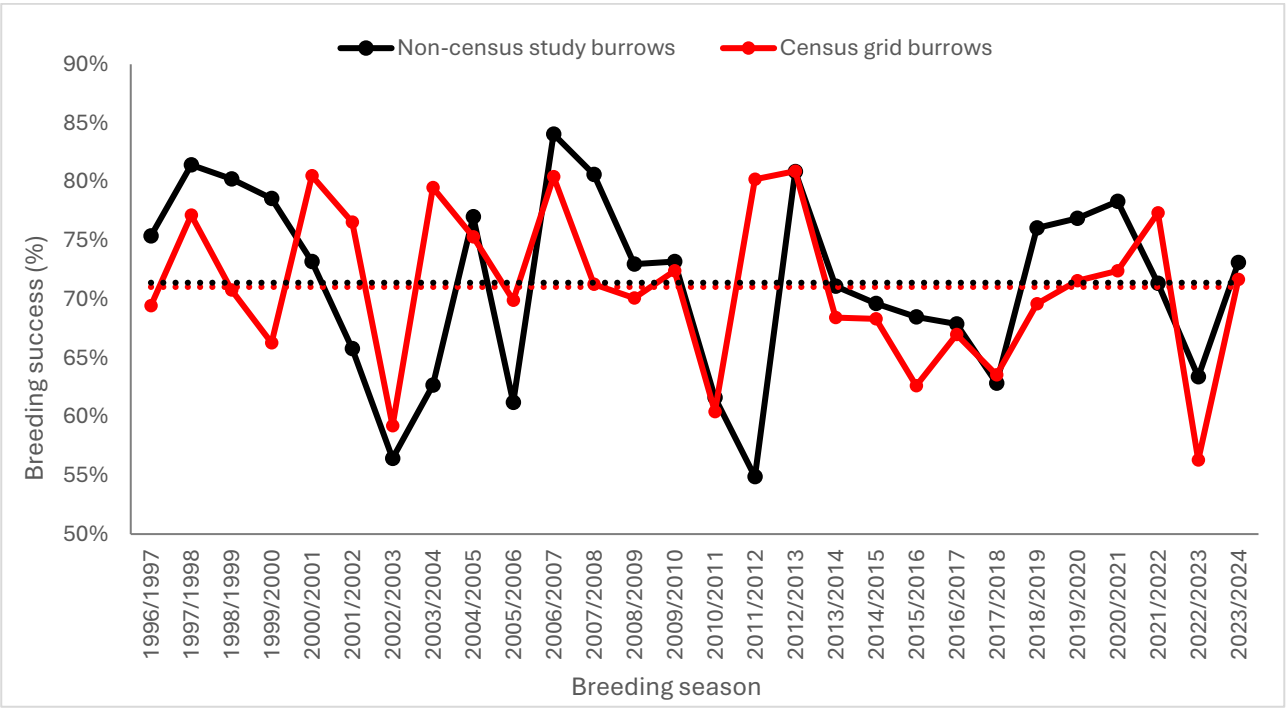

Figure 7: *Breeding success (percentage of breeding burrows that fledge a chick) of all tākoketai/black petrel (Procellaria parkinsoni) non-census study burrows (n=283, black) and census grid burrows (n=199, red) at Hirakimata/Mt Hobson on Aotea/Great Barrier Island between 1996 and 2024 (the dotted line represents the mean breeding success of census burrows (red) and non-census burrows (black) over 29 years).*

Overall breeding occupancy in all study burrows was 63.5%, 3.1% below the average over the 29-year study. However, breeding success this season was 72.5%, 0.7% higher than the average over the 29-year study. Breeding success in all study burrows combined has bounced back from last year where breeding was impacted by poor weather (Cyclone Gabrielle) resulting in a low breeding success rate of 60.7% (Figure 8). Comparing rainfall to breeding success shows a weak pattern with higher rainfall resulting in lower breeding success, but this is not consistent across the 29-year study (Figure 8).

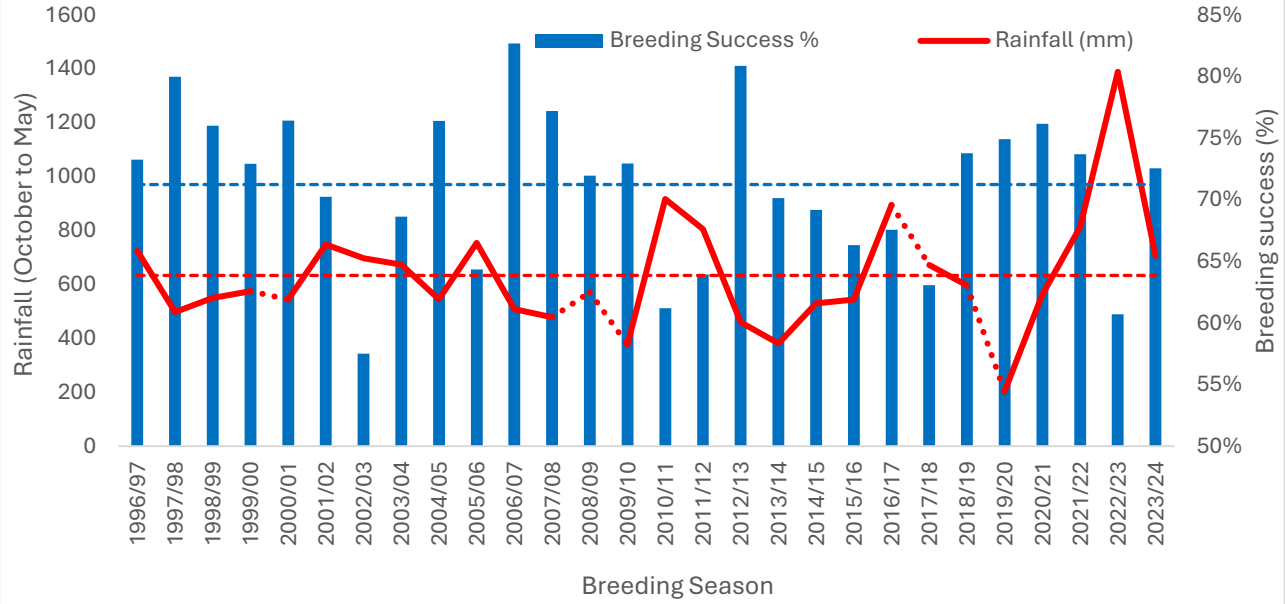

Figure 8: *Annual rainfall (red line; dotted sections are where data is limited), average annual rainfall (red dashed line), tākoketai/black petrel (Procellaria parkinsoni) breeding success (blue bars) and average breeding success over 29-years (blue dashed line) on Aotea/Great Barrier Island between 1996 and 2024. Rainfall data obtained from the National Climate Database (https://cliflo.niwa.co.nz/) for Leigh Weather Station (closest weather station to Aotea collecting daily rainfall data).*

Causes of breeding failure in the 2023/24 breeding season included rat predation of two eggs found in burrows with rat chew marks (*n*=2), eggs or chicks that disappeared from breeding burrows (*n*=50), crushed eggs (*n*=3), infertile eggs (*n*=2), abandoned eggs (*n*=15), embryonic deaths (*n*=2), eggs that failed but the cause could not be confirmed (*n*=4), and chick deaths (*n*=6).

There was no feral cat predation within the study burrows this season and Table 4 provides a summary of feral cat predation events within the study burrows since 1995.

Table 4: *Number of tākoketai/black petrel (Procellaria parkinsoni) chicks from study burrows, chicks from non-study burrows and adults predated by ngeru mohoao/feral cats within the Hirakimata/Mt Hobson colony on Aotea/Great Barrier Island between 1995 and 2024.*

Season	Number of study burrow chicks predated	Number of non-study burrow chicks predated	Number of adults predated
1995/96	0	1	2
1996/97	0	1	1
1997/98	0	0	1
1998/99	2	1	2
1999/00	2	1	2
2000/01	1	1	1
2001/02	2	1	1
2002/03	3	4	2
2003/04	2	1	1
2004/05	0	0	1

Season	Number of study burrow chicks predated	Number of non-study burrow chicks predated	Number of adults predated
2005/06	2	1	1
2006/07	0	1	0
2007/08	0	0	0
2008/09	0	1	0
2009/10	0	0	0
2010/11	1	0	0
2011/12	0	1	1
2012/13	0	1	0
2013/14	0	1	0
2014/15	0	1	0
2015/16	0	2	0
2016/17	2	3	2
2017/18	0	0	1
2018/19	0	1	1
2019/20	0	1	1
2020/21	0	1	1
2021/22	1	1	1
2022/23	0	1	1
2023/24	0	0	0
Total	**18**	**28**	**24**
Average	**0.6 ± 0.2 (SE)**	**1.0 ± 0.2 (SE)**	**0.8 ± 0.1 (SE)**

3.2 Population age structure

Of the 153 breeding tākoketai identified within the nine census grids in the 2023/24 season, 40 birds were of known age (banded as chicks) and 113 were estimated aged birds (banded as adults). The age range was 7 to 36 years and 6 to 35 years for known and estimated age birds, respectively (Figure 9A). For known age and estimated age birds, the most common ages were between 10-15 years and 10-14 years old (Figure 9A). Outside the census grids, there were 235 breeding tākoketai found in monitored burrows of which 47 were of known age and 188 were estimated age birds in the 2023/24 season. The age range was 7 to 35 years old and 6 to 33 years old for known and estimated age birds, respectively (Figure 9B). The most common ages for known birds were between 9 and 10 years, with another peak between 17 and 19 years. For estimated age birds, the most common ages were concentrated between 9 to 14 years (Figure 9B).

Since monitoring began in 1995/96 the average known age of breeding tākoketai within study burrows located inside and outside the census grids has slowly increased over time from an average age of 5 and 6 ± 1.4 years in 1995/96 to an average age of 13.6 ± 6.1 and 12.8 ± 6.0, respectively (Figure 9C). Overall, the average age (and variation) of known age breeding birds within census grid burrows has been generally increasing every breeding season since the peak observed in 2002/03. The average age of known aged breeding bird in burrows not in the census grid burrows has largely followed the pattern of birds within census grid burrows.

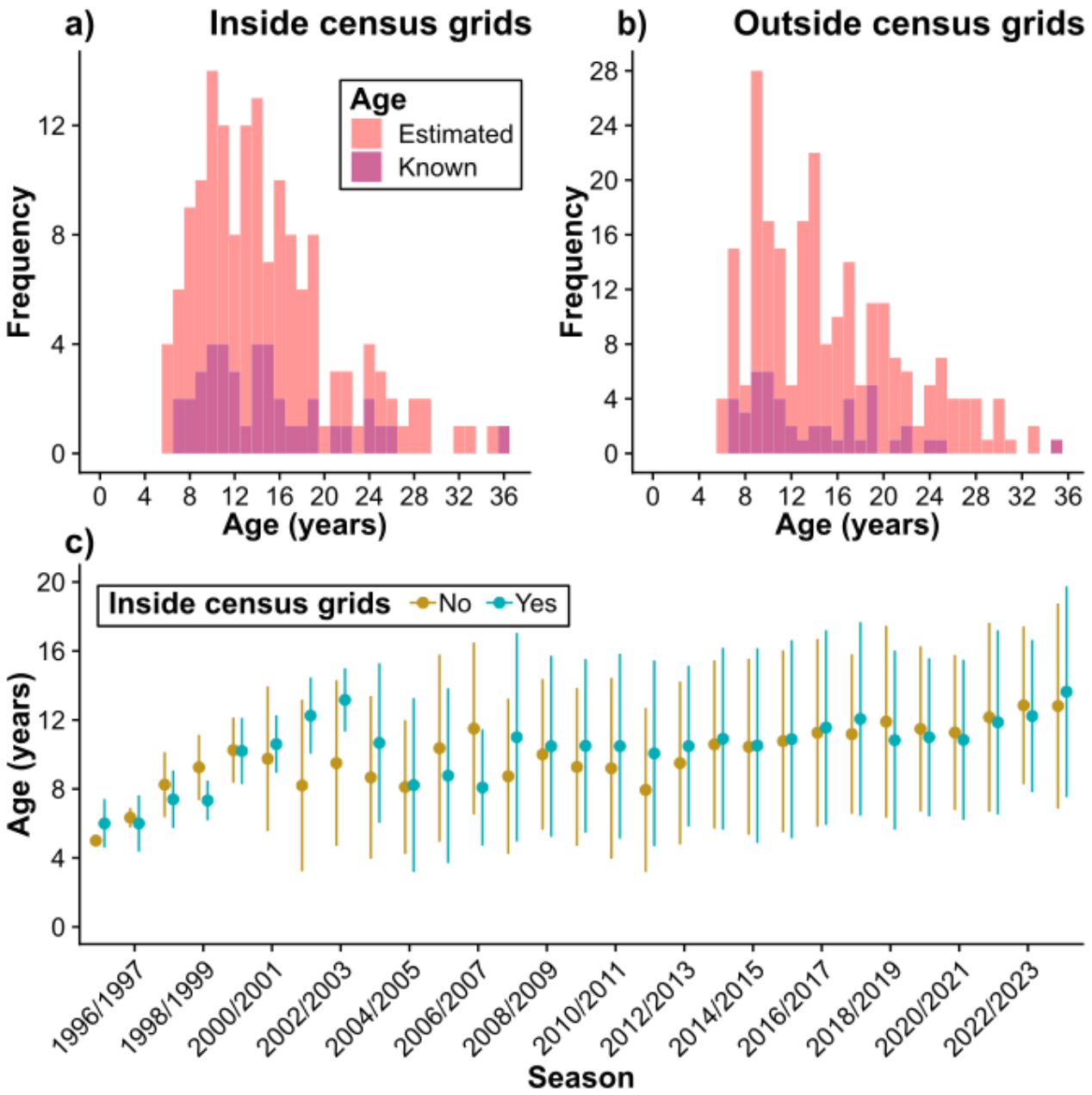

Figure 9: *The age distribution of the breeding tākoketai/black petrel (Procellaria parkinsoni) adults studied at Hirakimata/Mt Hobson on Aotea/Great Barrier Island located within study burrows within (a) census grids and (b) outside census grids during the 2023/24 season. Birds banded at the colony as adults are assumed to be at least 5 years of age if found on the surface or if found in burrows as non-breeders. Unbanded adult breeding birds are estimated to be 8 years of age. Birds banded as chicks are of known age; c) the mean (± standard deviation) age of known age breeding tākoketai/black petrels per season between 1995/96 and 2023/24.*

3.3 Recaptures during intensive nocturnal surveys

There have been nocturnal surveys undertaken throughout the 29-year study period, but only over the past three seasons (2021/22 to 2023/24) has this effort been increased to 6-8 hour (between 9.15 pm to 5.15 am) searches each night. During the intensive survey period, between 12 and 16 surveys were undertaken each season equating to between 42.9% and 52% of all nights spent at the colony (Table 5). Prior to this intensive period, under 20% of nights at the colony had ad-hoc night surveys completed (Table 5) and between 0 and 49 banded birds (and between 0 and 15 returned chicks) caught each season. Over the past three years 41 intensive night survey periods were undertaken, with 16 nights completed in 2023/24 (Table 5). At-sea tākoketai capture work has also been conducted over this same

period by WMIL (Burgin 2024), and tākoketai capture rates are compared with this nocturnal colony-based work in Table 5.

Table 5: *Number of tākoketai/black petrels (Procellaria parkinsoni) caught during night surveys within the Hirakimata/Mt Hobson colony on Aotea/Great Barrier Island between 1995 and 2024.*

	Ad-hoc on-land surveys (1995/96 to 2020/21)	Intensive on-land night surveys				All on-land night surveys combined	At-sea surveys
		2021/22	2022/23	2023/24	All intensive on-land surveys combined		
Number of days at colony	940	25	28	37	**90**	1030	
Number of surveys	171	13	12	16	**41**	212	**15**
Percentage of night surveys over trip	18.2%	52.0%	42.9%	43.2%	**45.6%**	20.6%	
Total number of birds	811	55	264	108	**427**	1238	**463**
Number of new (unbanded) birds	446	24	127	57	**208**	654	**438**
Number of banded birds	365	31	137	51	**219**	584	**22**
Number of returned chicks	108	13	52	18	**83**	191	**9**
Average number of birds caught per survey	4.7	4.2	22.0	6.8	**10.4**	5.8	**30.7**
Average number of new (unbanded) birds caught per survey	2.6	1.8	10.6	3.6	**5.1**	3.1	**29.2**
Average number of banded birds caught per survey	2.1	2.4	11.4	3.2	**5.3**	2.8	**1.5**
Number of returned chicks caught per survey	0.6	1.0	4.3	1.1	**2.0**	0.9	**0.6**
Percentage of banded birds out of all birds caught	45.0%	56.4%	51.9%	47.2%	**51.3%**	47.2%	**4.8%**
Percentage of returned chicks out of all birds caught	13.3%	23.6%	19.7%	16.7%	**19.4%**	15.4%	**1.9%**
Percentage of new (unbanded) birds out of all birds caught	55.0%	43.6%	48.1%	52.8%	**48.7%**	52.8%	**94.6%**

The percentage of banded tākoketai caught out of all captures is higher for intensive on-land night survey work (51.3%) than the ad-hoc on-land night surveys (45%) and much higher than the at-sea surveys (4.8%) (Table 5). This pattern is also the same for the percentage of returned chicks captured (intensive 19.4% ad-hoc vs 13.3% vs at-sea 1.9%) (Table 5). The number of banded tākoketai caught per survey is also higher for the intensive on-land night surveys (n=5.3) compared to both the ad-hoc on-land night surveys (n=2.1) and at-sea surveys (n=1.5) (Table 5). Again, this pattern continues for returned chicks caught per survey, with intensive surveys (2 returned chicks/survey) being higher than both ad-hoc and at-sea surveys, and interestingly ad-hoc and at-sea surveys have the same capture per survey rate (0.6 returned chicks/survey). However, these difference in captures rates between methods (e.g., intensive vs at-sea surveys) is to be expected given the small vs broad spatial scales at which each method employs.

3.4 Survival and status of returned chicks

A total of 625 adults and 228 fledgling chicks were captured during the 2023/24 season (Table 6 and Table 7). A total of 121 adults were banded during the 2023/24 season (Table 6 Table 7), of which 59 were captured in the study burrows. Of the 228 fledgling chicks banded during the 2023/24 season, 214 were banded in the study burrows (Table 6). Ten chicks from study burrows fledged prior to banding (i.e., evidence of down, pin feathers and droppings were obvious in the now-unoccupied burrow during the Trip 3 check). The remaining 14 chicks that were banded were caught in random burrows (n=2) or on the surface during night surveys (n=12). The adults not banded in study burrows were located in either non-study burrows or were located on the forest floor during nocturnal searches. There were 54 adults banded during the recruitment trip in December. The bands of two chicks from the 2022/23 season were located outside their burrow entrances proving that these two chicks failed to fledge. The previous season's breeding success data was updated with this new information.

Table 6: *Summary of the number of tākoketai/black petrels (Procellaria parkinsoni) captured, banded, re-captured adults and chicks (i.e., returned to the colony to breed) at Hirakimata/Mt Hobson on Aotea/Great Barrier Island between 1995 and 2024. Several fledglings located in study burrows had fledged before being banded, thus the number of fledglings banded may be less than the number fledged shown in Table 3. The total number of fledglings banded includes birds found either on the surface or in burrows not located within the study site (see Figure 1).*

Breeding season	Number of captures	Number of all adult recaptured	Number of adults banded	Number of fledglings banded in study burrows	Total number fledglings banded
2023/24	625	504	121	214	228
2022/23	793	490	174	119	129
2021/22	999	638	107	227	254
2020/21	1103	703	136	233	264
2019/20	960	636	154	155	170
2018/19	898	562	122	201	214
2017/18	800	541	84	154	175
2016/17	1121	476	244	173	354
2015/16	978	617	177	171	184
2014/15	918	536	167	200	215
2013/14	860	539	120	185	201
2012/13	1021	546	249	212	226
2011/12	551	340	48	161	163
2010/11	685	457	83	139	145
2009/10	789	510	107	160	172
2008/09	875	489	183	191	203
2007/08	594	347	56	191	191
2006/07	672	371	85	210	216
2005/06	632	332	155	141	145
2004/05	650	330	135	177	185
2003/04	536	358	67	108	111
2002/03	637	392	182	60	63
2001/02	621	346	115	136	160
2000/01	555	320	98	128	137
1999/00	542	257	150	130	135
1998/99	404	158	130	111	116
1997/98	296	151	59	81	86
1996/97	300	51	180	67	69
1995/96	129	30	40	48	59

Of the parents occupying the 306 breeding study burrows during the 2023/24 breeding season, a total of 436 (71.2%) were captured and identified (139 burrows had both parents identified, 158 burrows had one parent identified and nine burrows had no parents identified (either chicks alone or a failed breeding

attempt before the January trip occurred). The percentage of parents captured within census grids was similar at 72.5% (a total of 174 of 240 parents were identified and captured within 120 census grid burrows where a breeding attempt took place). Both parents were identified in 58 burrows, 58 burrows had one parent identified and four burrows had no parents identified (either chicks alone or a failed breeding attempt before the January trip occurred). This is lower than normally achieved, most likely due to Trip 2 being scheduled for February rather than late January/early February, and when breeding attempts had failed either prior to, or during Trip 2, and therefore adults were unlikely to be spending much time in their burrows during the rest of the season.

The cumulative number of birds banded as chicks identified returning to the colony (as either breeding or non-breeding adults) has steadily increased over time (Figure 10). In the 2023/24 breeding season the cumulative number of returned chicks recorded to date was 461, with 126 returned chicks recaptured at the colony this season. This includes 30 returned chicks that had not been previously recorded since being banded as fledglings. Of those 30 returnees, half were found on the surface during nocturnal searches of the colony (*n*=15) and the remainder were found in burrows as either non-breeders (*n*=6), successful breeders (*n*=3) or failed breeders (*n*=6). In addition, 15 returned chicks were captured at sea; nine in Aotearoa by WMIL (Burgin 2024) and four by Northern New Zealand Seabird Trust (Gaskin & Whitehead 2024) and two by Australian researchers in the Tasman Sea, (R. Clarke, *pers. comm.*). Only three of these returned chicks have also been caught at the Hirakimata colony.

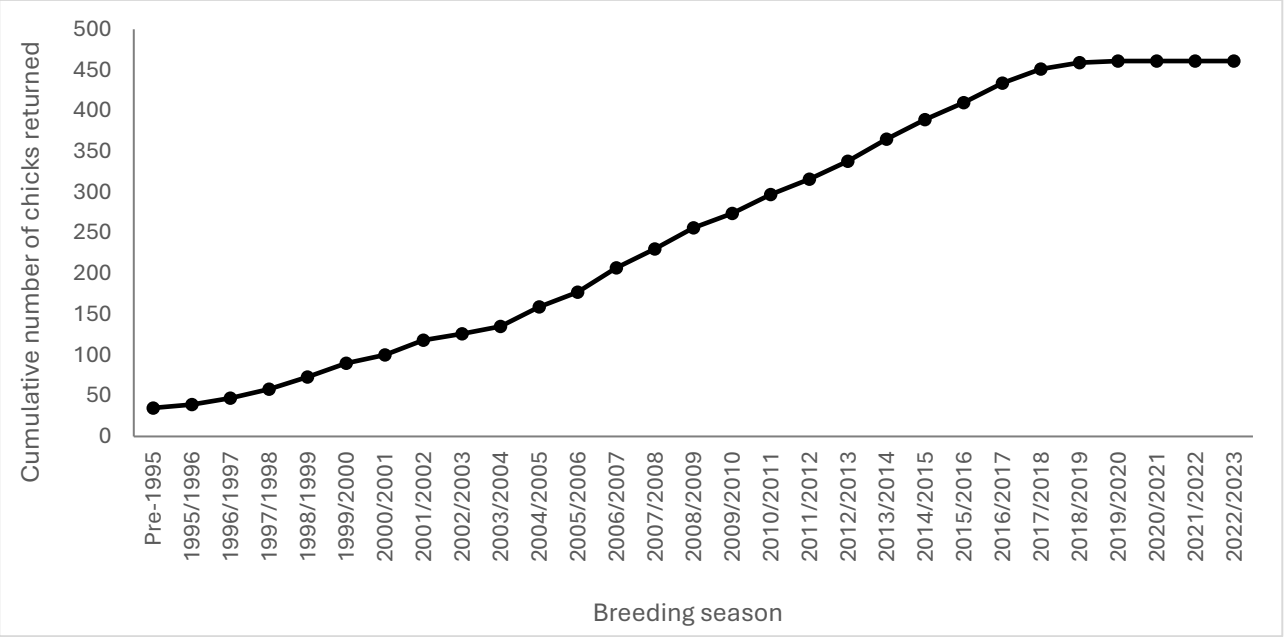

Figure 10: *The cumulative number of tākoketai/black petrel (Procellaria parkinsoni) adults banded as chicks that have returned to the colony as adults at Hirakimata/Mt Hobson on Aotea/Great Barrier Island. Note: the time period before 1995 encompasses approximately 20 years of chick banding records (1972-1992; e.g., the first returned chick was banded in 1972 and recaptured again in 1977).*

The age of tākoketai when first observed returning to the Hirakimata colony (regardless of breeding status) has fluctuated between 3 and 24 years since the 2002/03 breeding season (Bell et al. 2023). There have been 475 returned chicks recaptured as live birds (*n*=453) at the Hirakimata colony, live birds only caught at sea (*n*=14) or recovered as dead birds on Aotea or northern Aotearoa (*n*=8) (Appendix 8.1). Between the 1995/96 and 2023/24 breeding seasons, using only live tākoketai that have returned to Aotea, the mean age of first return was 6.9 ± 0.2 years, the mean age of first breeding attempt was 8.2 ± 0.2 years and the mean age of first successful breeding attempt was 8.5 ± 0.2 years (Appendix 8.1).

Table 7. *The number of captured, banded, and re-captured tākoketai/black petrel adults and chicks (Procellaria parkinsoni) at Hirakimata/Mt Hobson on Aotea/Great Barrier Island between 1995 and 2024. The total number of fledglings banded includes birds found either on the surface or in burrows not located within the study site.*

Season	No. banded	Pre-95	95/96	96/97	97/98	98/99	99/00	00/01	01/02	02/03	03/04	04/05	05/06	06/07	07/08	08/09	09/10	10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19	19/20	20/21	21/22	22/23	23/24	Not recaptured
63/64	2																															2
66/67	1	1																														0
71/72	10	3																														7
74/75	7																															7
75/76	12	1		1																												10
76/77	26																															26
77/78	69	1	2																													67
85/86	90	1	1	1	1	1	2	3	3	2	4	1	1							1	1	1	1	1		1						84
86/87	125	1	1				2	1	1	1	1		1		2	1																120
87/88	89	4	1	3	5	2	4	3	3	4	3	2	4	2	3	5	3	3	2	2	2	2	2	1	1	1	1	2	1	1	1	79
88/89	125	7	3	6	5	5	6	7	5	5	4	6	3	6	4	4	3	3	2	3	2	2	2	1	1	2	1	1	1	1		107
89/90	122	3	3	6	4	6	3	2	1	2	2	1	2	1	1	1	1	1		1												97
91/92	99	6	3	11	7	6	7	7	10	8	6	7	7	5	3	3	2	2	2	2	2	2	1	1	1						1	74
92/93	15	1	2	1		2	2	2	1	2	3	3	3	3	4	3	3	2	1	2	2	2	2									7
94/95	24		2	1	1	2	2	2	2	3	1	1	1	1	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1			19
95/96	100			15	14	14	17	15	13	15	13	8	12	13	7	8	9	9	5	5	6	4	3	3	3	2	2	2	1	2		71
96/97	249				113	86	85	73	66	61	45	42	40	47	28	30	28	22	12	21	15	14	15	13	10	8	9	9	3	4	2	98
97/98	144					32	32	30	33	30	19	14	18	13	13	17	14	11	12	10	9	5	5	5	5	4	5	5	3	2	1	49
98/99	246						98	82	70	70	50	44	39	33	32	37	33	25	17	29	19	17	18	16	12	9	9	10	6	5	3	123
99/00	246							85	78	67	51	52	52	37	31	39	31	32	20	22	17	15	20	11	9	7	7	6	5	3	5	156
00/01	282								51	51	41	22	35	29	28	33	28	21	12	22	18	14	15	16	13	12	12	9	8	5	6	153
01/02	265									62	40	24	21	19	20	27	23	15	16	21	19	16	17	16	18	8	9	9	9	14	10	168
02/03	245										69	54	56	54	40	56	50	38	26	36	34	31	27	20	19	17	16	16	13	4	6	134
03/04	177											21	31	23	21	26	25	24	15	23	19	15	17	15	17	15	15	14	9	9	3	123
04/05	320												48	35	33	48	52	42	28	47	43	38	35	32	27	26	28	27	21	16	7	212
05/06	251													45	36	49	45	35	23	35	28	27	25	16	15	15	10	12	12	4	4	158
06/07	301														33	46	42	35	22	43	45	38	40	24	24	24	27	21	21	15	12	207
07/08	247															29	20	19	18	32	23	23	20	12	14	16	15	13	10	13	4	184
08/09	387																72	59	46	66	54	53	51	37	38	41	40	38	30	18	15	256
09/10	278																	45	32	39	39	33	41	27	30	27	28	29	25	16	15	197
10/11	228																		25	40	32	35	38	31	34	36	33	35	28	20	10	149
11/12	211																			32	28	24	31	30	31	28	30	25	19	10	12	154
12/13	475																				70	71	68	48	55	47	56	45	43	27	25	339
13/14	321																					50	51	32	33	32	40	43	39	23	26	223
14/15	382																						54	44	34	40	35	36	29	22	26	282
15/16	362																							57	53	51	63	61	48	37	33	240
16/17	602																								40	39	40	44	37	41	19	512
17/18	258																									52	44	37	38	29	18	176
18/19	336																										52	50	42	27	25	271
19/20	321																											75	55	40	34	238
20/21	396																												64	42	27	61
21/22	361																												107	40	29	244
22/23	303																													174	24	129
23/24	349																														121	228

Figure 11 shows the range of ages that tākoketai have been when recaptured for the first time at the colony, as well as age of first-time breeders and first-time successful breeders. The youngest returnee detected was observed at 2.6 years in the 2011/12 breeding season (Bell. et al. 2022a).

During the 2023/24 breeding season, the median return age was 5.8 years (mean return age was 7.0 ± 0.3 years; min and max range 3.6-24.1 years; Figure 11), which was similar to the previous 2022/2023 breeding season (median 6, min and max range 3.6-34.7 years (Bell et al. 2023), and all returned chicks (median return age 5.7 years; min and max range 2.6-34.7; Appendix 8.1).

Despite the ongoing bi-annual visits to the study colony since 1995/96, some birds can remain undetected for many years. The oldest tākoketai recaptured for the first time since being banded as a chick, occurred during the 2022/23 season when a 34.7 year old was caught on the surface clacking outside a random, non-monitored burrow. Previously the oldest chick was caught during the 2011/12 breeding season at 26.6 years (Bell, et al. 2022b) and the oldest returned chick caught this season was 24.1 years old.

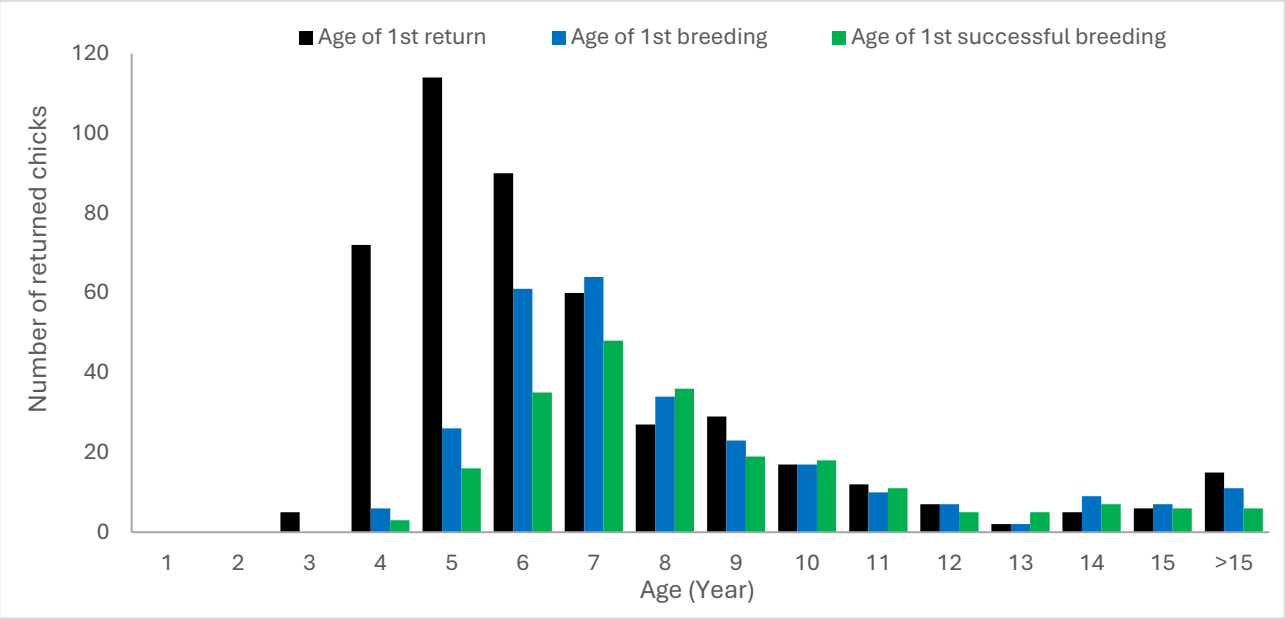

Figure 11: *The age of tākoketai/black petrels (Procellaria parkinsoni) banded as chicks that have returned to the colony as adults when first returned (black bars), when first recorded breeding (blue bars) and first recorded successfully breeding (green bars) on Aotea/Great Barrier Island.*

Despite a similar number of chicks being banded each year prior to fledging, the percentage of chicks (from each cohort) returning to the colony at Hirakimata on Aotea as adults is very low and fluctuates between 1.2-15.9% of chicks banded observed each year (Figure 12; Table 6 and Table 7).

Of the 126 adults first banded as chicks identified during the 2023/24 breeding season, the majority (*n*=14, 11.1%) of returned chicks were from the 2014/15 breeding season (6.5% of that cohort), followed by the 2013/14 cohort (*n*=13, 10.3%, or 6.5% of that cohort) (Figure 12).

Not all cohorts were represented this season as no returned chicks from the 1995/96, 1996/97, 1999/00 and 2003/04 cohorts were recaptured this season (Figure 12). There were two returned chicks from the 2019/20 cohort (one 3.6 and one 3.8 years of age at date of recapture) recaptured this season (Figure 12). All cohorts from the 2020/2021 breeding season onwards are still expected to be at sea until four years of age.

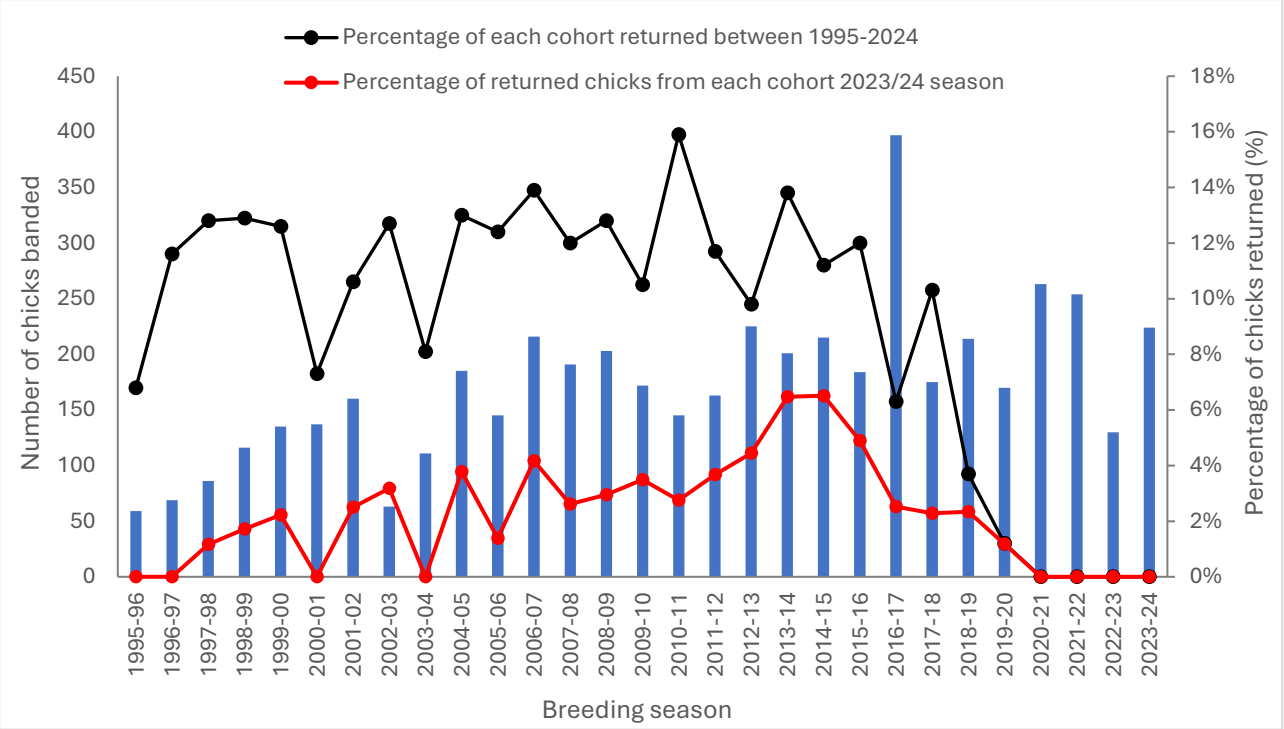

Figure 12: *The number of banded tākoketai/black petrel (Procellaria parkinsoni) chicks per year (blue bars) overlaid with the percentage of all banded chicks (1995-2024 black points and line; 2023/24 breeding season red points and line) from a particular breeding season cohort returning to the colony at Hirakimata/Mt Hobson on Aotea/Great Barrier Island as adults. Note: the number of chicks banded, and percentage returned before 1995 was intentionally not plotted. There were 583 chicks banded before 1995 and of these 6.0% have been re-observed as adults. Note: the left-hand side y-axis corresponds to the blue bars (number of chicks banded), whereas the right-hand side y-axis corresponds to the black (percentage of all returned chicks from a particular breeding season) and red line (percentage of returned chicks from a particular breeding season observed during the 2023/24 breeding season). There was a higher number of chicks banded in 2016/17 (n=397) due to random transect surveys undertaken within the 35-ha study area in May 2017 resulting in chicks in random burrows being banded. There was a reduced number of chicks banded in 2022/23 (n=130) due to the reduced breeding success caused by Cyclone Gabrielle and poor weather conditions over the chick banding period.*

The composition of each breeding seasons' cohort (i.e., the breeding season the chick hatched in) continues to vary each breeding season (Figure 13). Across the entirety of the study, the number of adults that were banded as chicks that subsequently returned to the colony as adults has increased steadily since the study's inception. Owing to the time lag between fledging and maturity, for the first five years of the study, only pre-1995 returned chicks are represented, which then steadily increase overtime (Figure 13). Changes in effort (e.g., increased night-work, multiple trips per year, use of detection dogs, etc.) likely accounts for the increase in re-sightings from 2011/12 to 2012/13 and 2019/20 onwards.

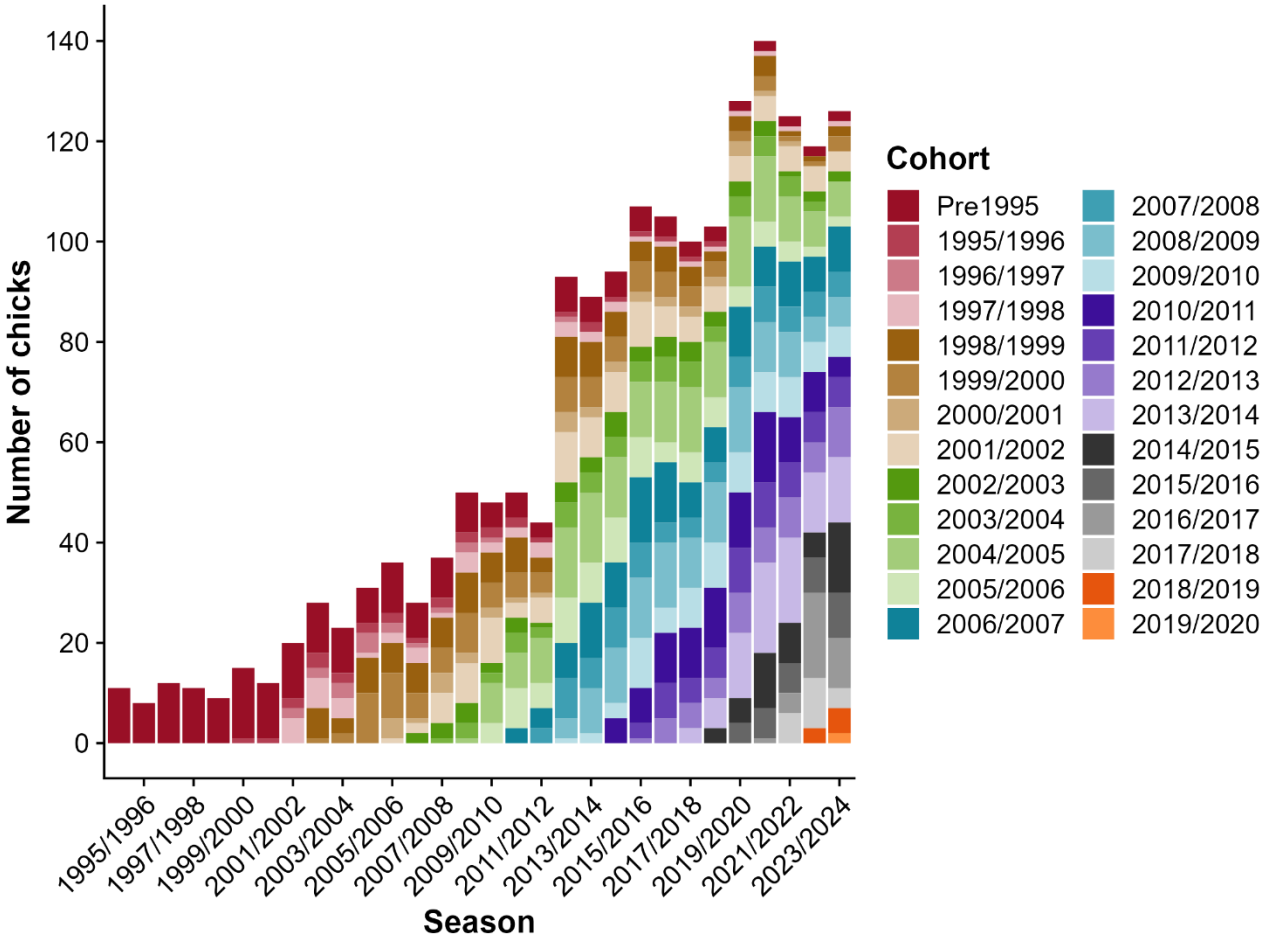

Figure 13: *The number of tākoketai/black petrel (Procellaria parkinsoni) returned chicks (banded as chicks and re-observed as adults) at Hirakimata/Mt Hobson on Aotea/Great Barrier Island during each breeding season (from 1995/96 to 2023/24), categorised by the breeding season the bird was born in (i.e., breeding season cohort). Note: the time period before 1995 encompasses approximately 20 years of chicks banding records (1972–1992, e.g., the first returned chick was banded in 1972 and recorded again in 1977).*

In addition to sightings at the study colony, 15 adults that were banded as chicks were resighted at sea. These include nine sightings by WMIL and four sightings by the Northern NZ Seabird Trust, as part of at-sea work aiming to increase capture effort outside the main study in an effort to better understand tākoketai recruitment rates (Burgin 2024; Gaskin & Whitehead 2024). Of those sightings, twelve were banded as chicks on Aotea (and three were also caught at the colony) and three were banded as chicks on Hauturu. Interestingly, two returned chicks were caught in the Tasman Sea (a five-year returnee sighted in January 2022 in the Bass Strait off the east coast of Victoria, Australia and a two and a half-year-old returnee chick sighted in December 2023 at Bass Canyon off the east coast of Victoria, Australia (R. Clarke, *pers. comm.*).

Whilst the proportion of individuals representing different cohorts fluctuates from year to year, the proportion of individuals representing older cohorts tend to diminish over time as younger cohorts return to the breeding colony (Figure 14). For instance, in the 2023/24 breeding season, the pre-1995 cohort was represented by two individuals and cohorts from between 1995/96 to 2002/03 were each represented by single individuals.

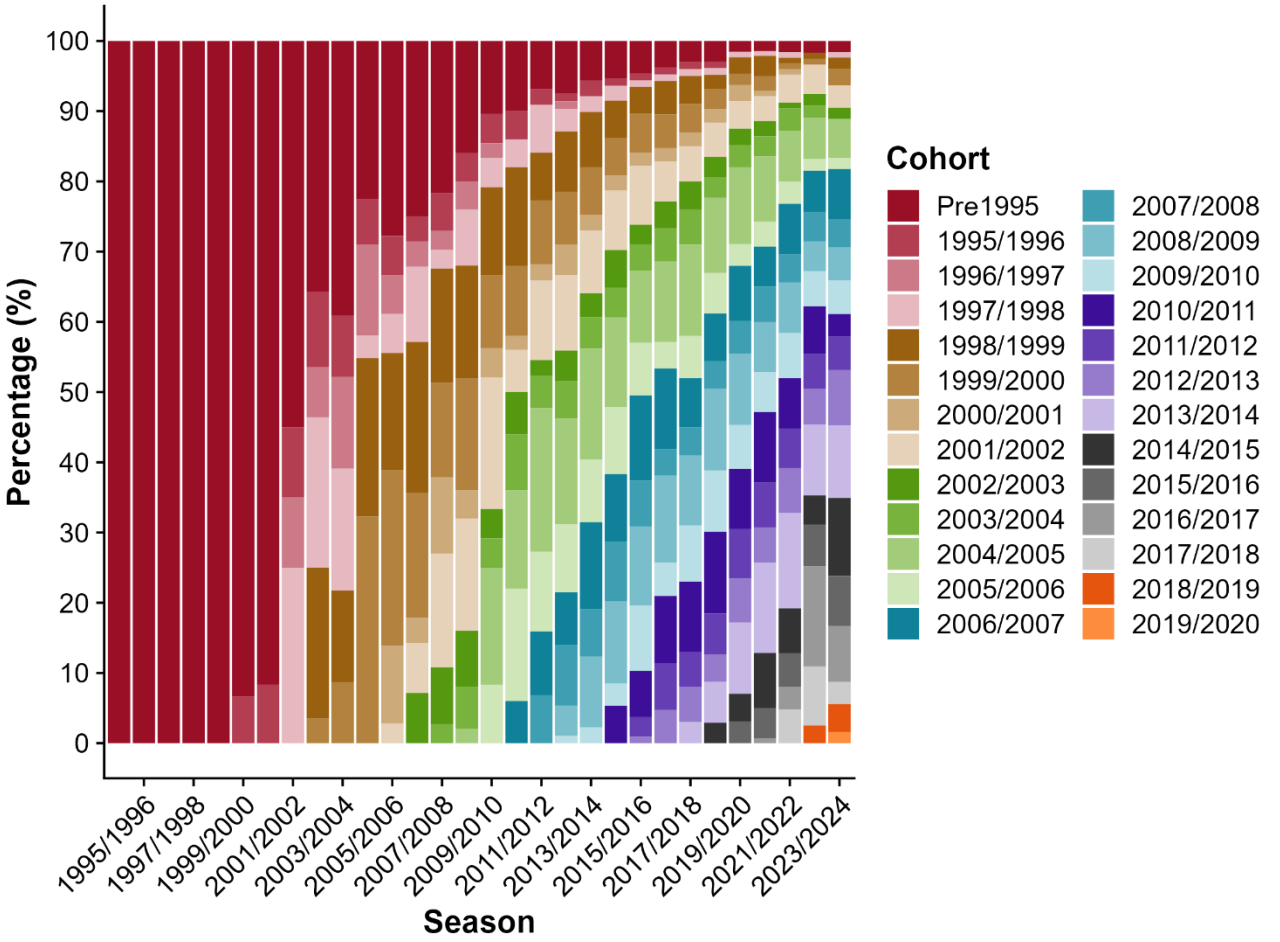

Figure 14: *The composition of each breeding seasons returned tākoketai/black petrel (Procellaria parkinsoni) chicks - proportion of returned chicks (banded as chicks and re-observed as adults) at Hirakimata/Mt Hobson on Aotea/Great Barrier Island during each breeding season (from 1995/96 to 2023/24), categorised by the breeding season the bird was born in (i.e., breeding season cohort). Note: the time period before 1995 encompasses approximately 20 years of chicks banding records (1972–1992, e.g., the first returned chick was banded in 1972 and recorded again in 1977).*

In the 2023/24 season 126 returned chicks were resighted at the colony with representatives from almost all previous cohorts (prior to 2019/20) since the study began (cohorts not present included; 1995/96, 1996/97, 2000/01 and 2003/04). The number of unique cohorts represented over successive breeding seasons is starting to show signs of plateauing. In the 2023/24 season, 22 cohorts were represented over the breeding season, one more than the 2020/21 and 2022/23 breeding season, and the same as the 2021/22 breeding season (if pre-1995 birds are classed as a single cohort; Figure 15).

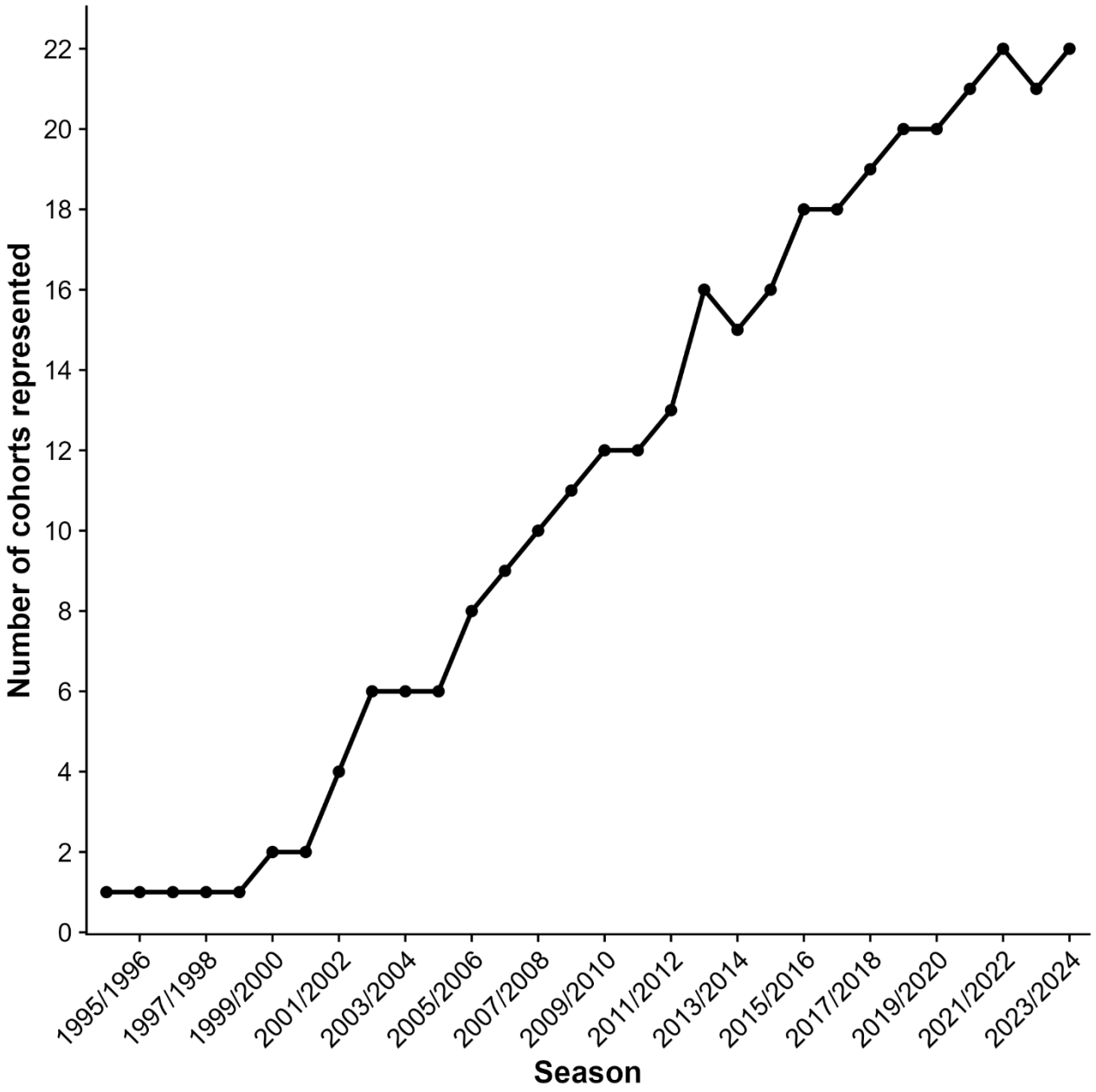

Figure 15: *The number of different breeding season cohorts represented by tākoketai/black petrel (Procellaria parkinsoni) returned chicks (banded as chicks and re-observed as adults) at Hirakimata/Mt Hobson on Aotea/Great Barrier Island during each breeding season (from 1995/1996 to 2023/24). Note: the time period before 1995 encompasses approximately 20 years of chicks banding records (1972–1992, e.g., the first returned chick was banded in 1972 and recorded again in 1977).*

3.5 Adult Tracking

Tracking on adult tākoketai was undertaken at hatching and early chick rearing. All tracked adults foraged in close proximity to Aotea, and near the east coast of Te Ika-a-Māui/North Island (Figure 16, Table 8). Tracks from individual adults are provided in Appendix 8.2. Devices were deployed on two females and four males and trip length varied from 1 to 5 days (Table 8). Chicks fledged from five of the six breeding burrows the adults were selected from, with a single chick disappearing before fledging at one burrow .

Table 8: *Summary of the i-GotU™ GPS device deployment on breeding tākoketai/black petrels (Procellaria parkinsoni) during hatching and early incubation at Hirakimata/Mt Hobson on Aotea/Great Barrier Island, February 2024.*

Band	Burrow	Sex	Date deployed	Date retrieved	Trip length (days)	Body weight change
H29809	140	Male	15/2/2024	21/2/2024	4	-90 g
H35241	143	Female	15/2/2024	18/2/2024	2	-100 g
H39714	65	Male	13/2/2024	17/2/2024	2	-60 g
H25536	417	Male	12/2/2024	18/2/2024	5	-100 g
H34854	364	Male	12/2/2024	16/2/2024	1	-190 g
H42064	361	Female	14/2/2024	19/2/2024	4	-105 g
Mean (± SEM)					**3 (± 0.6)**	**-107.5 (± 17.8) g**

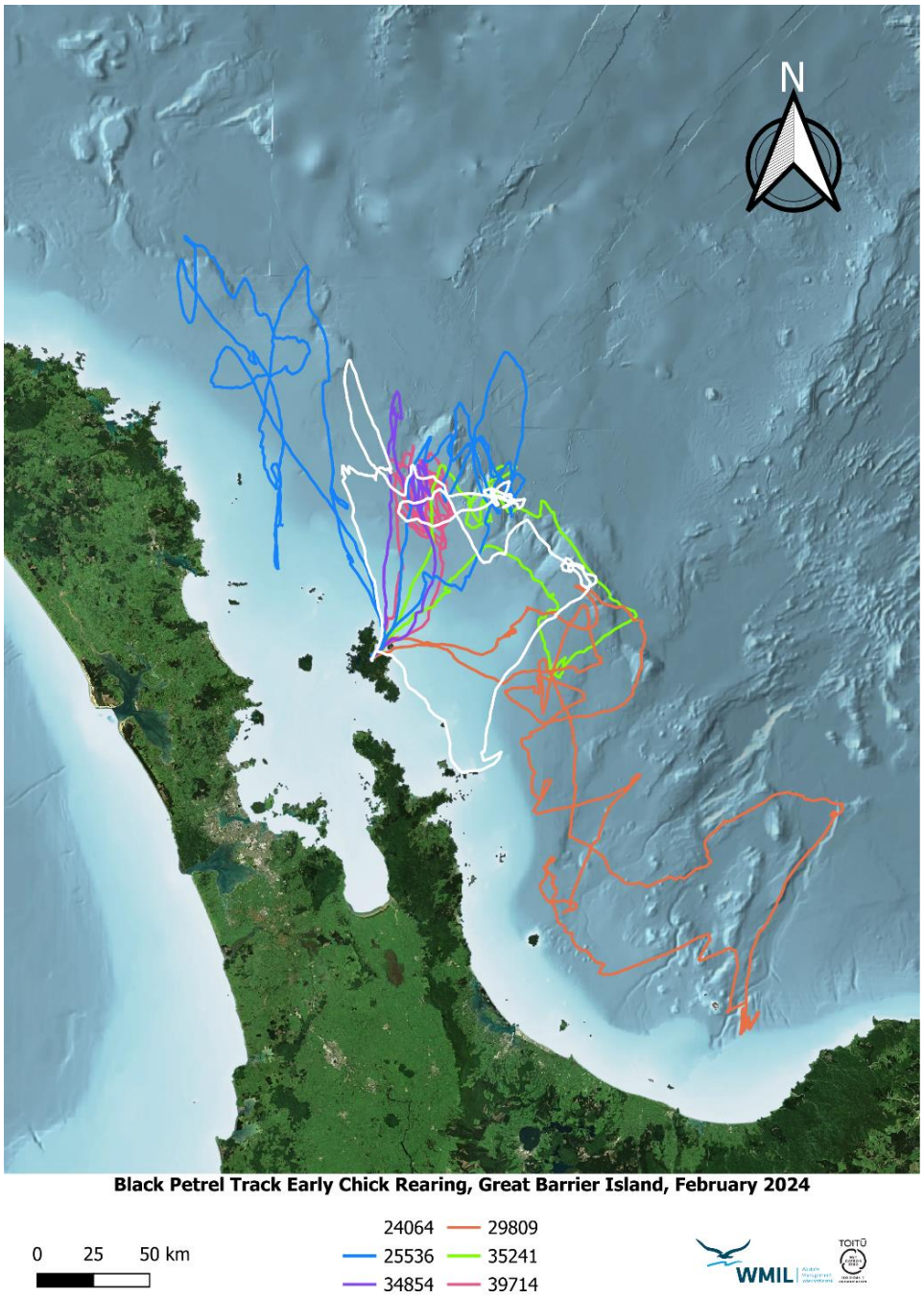

Figure 16: *Adult tākoketai/black petrel (Procellaria parkinsoni) tracks during early chick rearing, Aotea/Great Barrier Island, February 2024.*

3.6 Chick Tracking

Tracking devices were deployed on 15 tākoketai chicks prior to fledging in late April/early May (Table 9). One chick crash-landed in Tāmaki Makaurau/Auckland and did not survive, two crash-landed in Whangārei with one rescued, rehabilitated and released to continue migration and the other did not survive, and the remaining 12 birds fledged successfully and migrated from Aotea towards South America (Figure 17). Tracks from individual chicks are provided in Appendix 8.3.

Table 9: *Summary of the Telonics TAV 2617™ satellite device deployment on tākoketai/black petrel (Procellaria parkinsoni) chicks at pre-fledging at Hirakimata/Mt Hobson on Aotea/Great Barrier Island, 2024.*

Band	Burrow	Device #	Weight	Wing length	Date Device deployed (activated)	Date device stopped	Days device active	Notes
H47731	194	261492	805	347	30/04/2024 (4/5/2024)	26/06/2024	53	Crash landed South of Whangārei
H48052	71	261488	795	330	30/04/2024 (3/5/2024)	26/08/2024	118	Still active 26/08
H44206	435	261485	880	360	1/05/2024 (3/5/2024)	13/06/2024	42	
H47805	470	261482	880	336	3/05/2024 (9/5/2024)	15/06/2024	37	
H47777	112	261494	890	334	4/05/2024 (14/5/2024)	10/06/2024	27	
H47763	262	261491	805	351	4/05/2024 (6/5/2024)	10/06/2024	35	
H47734	137	261481	880	346	5/05/2024 (7/5/2024)	3/06/2024	27	Crash landed Whangārei - went to rehab facility and then released
H47736	146	261480	-	339	5/05/2024 (7/5/2024)	25/08/2024	110	Still active 25/08
H48084	463	261486	830	394	5/05/2024 (13/5/2024)	4/08/2024	84	
H48032	299	261487	920	350	6/05/2024 (2/5/2024)	3/06/2024	33	
H47787	434	261484	880	-	6/05/2024 (16/5/2024)	25/08/2024	101	Still active 25/08
H48067	336	261489	840	317	6/05/2024 (8/5/2024)	31/05/2024	24	
H48060	231	261490	950	356	6/05/2024 (9/5/2024)	15/05/2024	4	Crash landed Auckland
H48001	186	261483		341	6/05/2024 (23/5/2024)	15/06/2024	23	Outrigger Attachment
H48080	438	261493	800	327	6/05/2024 (11/5/2024)	21/08/2024	102	

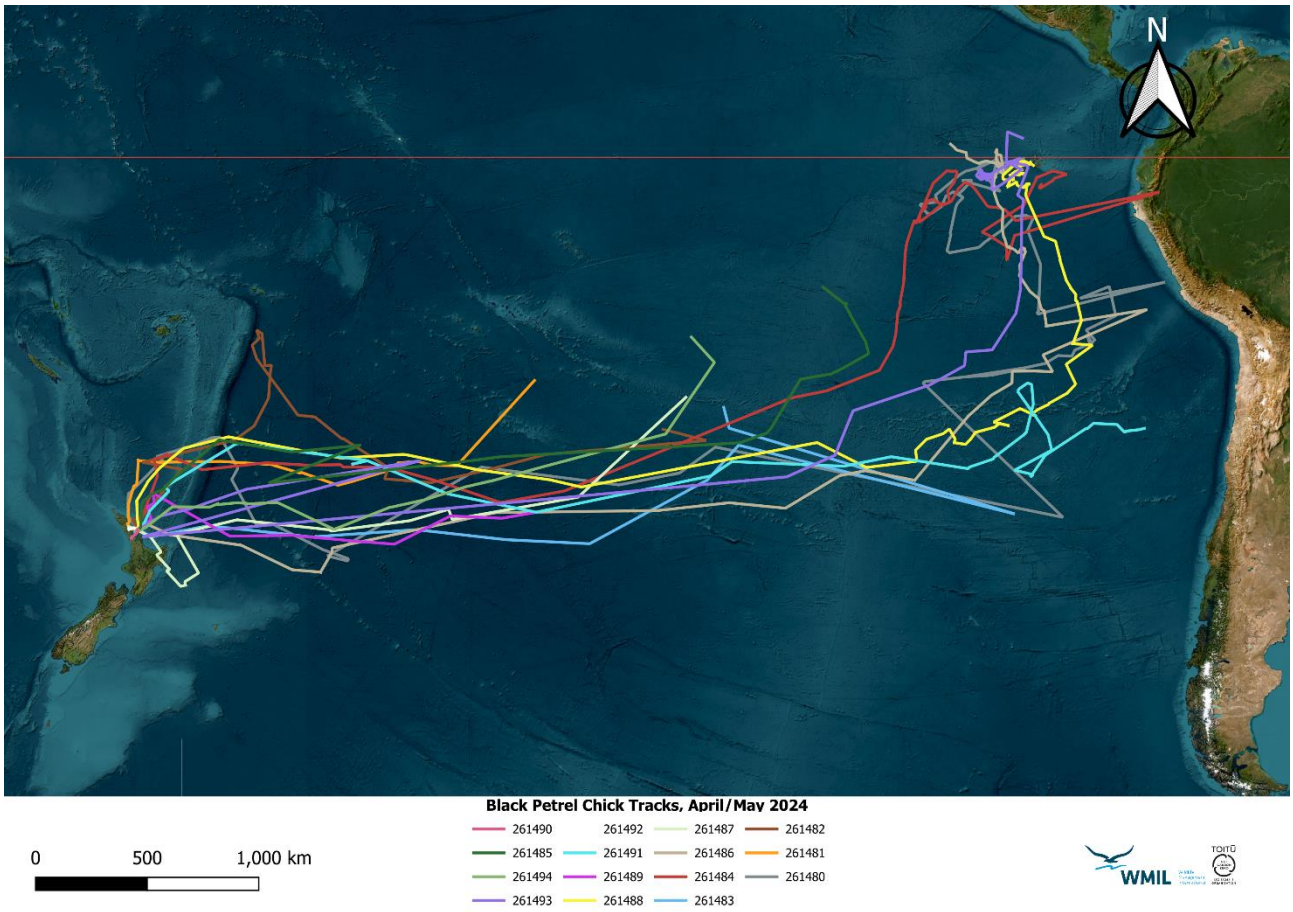

Figure 17: *Tākoketai/black petrel (Procellaria parkinsoni) chick tracks post-fledging from Aotea/Great Barrier Island, 2024.*

3.7 Deterrence of poaka/feral pigs from active tākoketai/black petrel burrows

Fresh feral pig sign was detected within the general area on surveys conducted over the same time period as the pilot trial (Lamb & Miskimmin 2024), however, no feral pigs were identified on camera. Thus, the efficacy of whether CDs act as a low-cost tool to deter feral pigs is inconclusive. The only invasive predator captured on camera during monitoring was a kiore/ship rat (*Rattus exulans*) (Figure 18).

Figure 18: *Images from trail cameras established for the poaka/feral pig (Sus scrofa) deterrence pilot trial at active tākoketai/black petrel (Procellaria parkinsoni) burrows at Cooper's Castle, Aotea/Great Barrier Island, 2024. (A) Kiore/ship rat (Rattus rattus) and poaka/feral pig deterrence setup uphill from active tākoketai/black petrel burrow, B) Adult tākoketai/black petrel at burrow entrance.*

4. DISCUSSION

4.1 Breeding Success and Population Demography

The tākoketai breeding success rate rebounded this season compared to the poor, weather-impacted 2022/23 season with the 2023/24 fledging success rate on Aotea being 72.5%; 0.7% higher than the 29-year average (71.8%). The fledgling success within the census grids was marginally lower (71.7%) than overall breeding success, but still higher than the 29-year average of 71.6% for the census grids. It is important to continue to monitor the tākoketai population on Aotea as the known age breeding population continue to age (increasing from an average of 6.1 years to 13.6 years since the 2002/03 season). Breeding success and reproductive performance in long-lived seabirds is affected by age, age at first reproduction, senescence, and experience (Aubry et al. 2009, Limmer & Becker 2010). The oldest known aged bird still being caught at the colony is 36 (banded as a chick in 1988 by Dr. Mike Imber) as a successful breeder. Another bird banded as a chick in 1989 (now 35 years old) was also caught again this season as a failed breeder; this bird has been caught every year since the 1995/96 breeding season. During the 2023/24 season two returned chicks were re-captured from the 2019/20 breeding season, at age 3.6 and 3.8, a year earlier than the typical return age. The average age of first return for all birds recaptured on Aotea is 6.9 years. Only an average of 10.5% of all cohorts banded on Aotea return to the Hirakimata colony to replace the aging breeding birds. Future, in-depth modelling on the effect of age, age difference in pairs, experience on breeding success will be needed to understand this relationship in tākoketai.

Comparison between rainfall and breeding success shows a weak pattern over time with more rainfall resulting in lower breeding success. However, this is not consistent across the 29-year study, and would need further investigation to determine whether particular areas of the colony are more at risk to rainfall events than others (e.g., burrows in flatter areas being more prone to flooding). It does appear that the tākoketai are more resilient to intensive rainfall events than other species such as toanui/flesh-footed shearwaters (*Ardenna carneipes)* (Ray & Burgin 2023). This difference in resilience is most likely due to habitat differences (i.e., terrain and substrate), but as extreme weather events increase in frequency and magnitude under climate change (Lunquist et al. 2011, Harrington et al. 2023), flooding events could occur more often, which in turn could significantly impact on tākoketai breeding success and recruitment into the breeding population. Five chicks were recorded underweight and small in May, and most of these are not expected to fledge. The parents of these chicks may be struggling to forage effectively reducing chick provisioning rates or amounts, or one parent may have died at sea as bycatch in fisheries, in storm or pollution events leaving only one parent to try to raise the chick. Again, continued monitoring at the Aotea colony to identify all birds in study burrows next season to determine whether any adults have not returned is vital to continue to track population trends and determine impacts to the birds and colony.

4.2 Predation

There was no recorded instance of feral cat predation within the study burrows or wider colony area this season. Live cage traps targeting feral cats are located around the Hirakimata summit and run prior to, and throughout the tākoketai breeding season. The Tu Mai Taonga (https://www.tumaitaonga.nz/) project aims to protect and restore native species and ecosystems through feral cat removal and intensified rat control, initially in the Aotea Conservation Park and Northern Aotea area. The Tu Mai Taonga team are monitoring these feral cat traps across the study colony and surrounding area, and in conjunction with DOC, will target any feral cats that are reported within the tākoketai study colony by the WMIL field team. There were two recorded instances of rat predation on eggs during the 2023/24 season, which was similar to the previous two seasons. Despite the low number of recorded rat predation incidences, rats, particularly ship rat, remain a common sight within the area. A trial of Good Nature A-24 traps is currently underway at Hirakimata and tracking tunnel monitoring is showing a reduction in rat numbers across the summit area (S. Dwyer, DOC, *pers. comm*.). Work at Cooper's

Castle showed a number of predators in the area including feral cats, rats, pigs and kiore/house mice (*Mus musculus*). Although there was no evidence of interaction with tākoketai in the area, ship rats were filmed close to, or directly outside, active tākoketai breeding burrows this season. Investigation into possible deterrence methods of all predators, but specifically feral pigs and feral cats, is ongoing. The ongoing control of predators is important to reduce land-based threats for tākoketai on Aotea.

4.3 Returned chicks

Cohorts of returned chicks appear to be mixed each breeding season, with no apparent dominating year group. The number of chicks banded each breeding season ranges from 59 (in 1995/96, when there were three census grids) to 254 (in 2021/22, when there are nine census grids). However, to date, less than 10.5% of all tākoketai chicks banded at the Aotea study colony have been re-captured in subsequent field seasons. There is a real lack of understanding whether the low return rates relates either to low juvenile survival and/or recruitment or is purely due to a lack of detection of banded birds within the 35-ha study site. Survival effort estimates, especially juvenile survival and recruitment are vital for accurate population estimates and risk assessment modelling, and it is highly recommended that effort to obtain data to fill this knowledge gap for tākoketai is completed with urgency.

Ad-hoc nocturnal surveys have been undertaken throughout the 29-year study period resulting in 108 returned chicks being recaptured over 117 surveys nights whereas focused intensive survey effort over the past three seasons results in 83 returned chicks caught over 41 survey nights. Results from these intensive surveys were consistently higher that the ad-hoc surveys or at-sea surveys for percentage of banded tākoketai caught out of all captures (intensive 51.3%, ad-hoc 45% vs at-sea 4.8%), percentage of returned chicks captured (intensive 19.4%, ad-hoc 13.3% vs at-sea 2%), the number of banded tākoketai caught per survey (intensive 5.3, ad-hoc 2.1, at-sea 1.5) and for returned chicks caught per survey (intensive n=2, ad-hoc n=0.6, at-sea n=0.6). Although ad-hoc surveys have provided recruitment data, these results highlight the value of focused intensive effort at the colony to recapture returned chicks and it is recommended that these intensive nocturnal surveys continue.

Of the 83 returned chicks recaptured during the intensive surveys, 23 (27.7%) were caught for the first time. This suggests that the intensive nocturnal effort has increased the detections of returned chicks at the colony. The detection rates for pre-1995 birds at the colony is lowering as these birds age, and the number of recaptures of returned chicks banded before 2000 is also declining. Additional surveys should be factored into subsequent breeding seasons to increase the number of returned chicks being recaptured. An increased team size could allow for more ground at the colony could be covered, which in turn could increase the chance of recapturing returned chicks. Focusing recapture effort at launch sites as well as surveys throughout the colony area is also likely to increase recapture rates. A focused effort (i.e., number of hours at specific launch sites over a number of nights) to determine the rate of banded to new (unbanded) birds could also give an indication of population size and would be comparable between seasons.

The percentage of banded to non-banded birds was higher at the colony (51.3%) compared to at-sea work (4.8%). Although this is likely related to the overall number of birds banded at the colony (9,469 birds; 3,876 adults, 5,593 chicks) and the high probability of recapture at a breeding colony, it is interesting to note that nearly three times as many birds were caught at sea (30.7 birds/survey) compared to the night surveys (10.4 birds/survey). At-sea work is more likely to encounter the wider tākoketai population (birds from across Aotea and Hauturu) and therefore more unbanded birds. It is important to understand that the study area covers only 35 ha of the estimated 1000 ha core habitat on Aotea (3.5%), and banding is likely to cover less than 10% of the overall estimated tākoketai population.

In order to fill this knowledge gap regarding recruitment and juvenile survival, it is recommended that additional methods including focused nocturnal effort at launch sites, seabird detection dogs, and additional transect surveys within core areas, should be employed in unison with on the ground study burrow monitoring. The dedicated nocturnal monitoring should be repeated with a bigger team to locate and identify returned tākoketai chicks within the current 35-ha study area. Tākoketai are nocturnal and

are highly vocal in the late evening. During the breeding season, un-paired males 'clack' (perform attraction calls) from or near their burrows to attract an un-paired female (Warham 1988). In addition, returning birds are easily located by the crashing sounds made through the forest canopy as they land to return to their burrows.

Another recommended method is the employment of seabird detection dogs to locate burrows occupied by breeding and non-breeding birds. Seabird detection dogs have been used successfully in the past within localised areas on Aotea and Hauturu (Bell et al. 2016a, Bell et al. 2016b). Expanding this effort into the wider core breeding area around Hirakimata will help to identify tākoketai hotspots and increase the probability of detecting returning birds. Previous experience with seabird detection dogs has found detection ability via scent of occupied, or recently occupied, burrows was up to 10 metres on either side of the track on calm days, with greater distances on the windward side of the track (up to 30 metres; Bell et al. 2016a). Tākoketai carry a distinctive smell that is immediately apparent when handling, but because burrow entrances can often be cryptic and hidden within dense vegetation the scenting ability of trained seabird detection dogs confers a unique advantage over other methods (e.g., transect surveys) and makes their use a highly effective tool to complement current methods.

At-sea captures has been another highly effective method to catch large numbers of birds within short time periods; rafting birds can be caught by throwing a cast net, or firing a net gun, and quickly pulled up onto the boat to be processed (Burgin 2024, Gaskin & Whitehead 2024). Between 2021 and 2024, over 15 surveys WMIL caught and banded 460 tākoketai, of which nine birds were recaptured chicks (Burgin 2024) and between 2023 and 2024, over seven surveys, Northern New Zealand Seabird Trust caught and banded 268 tākoketai, of which four were recaptured chicks (Gaskin & Whitehead 2024). These expeditions occurred between December and April, and the use of at-sea captures during the peak breeding season (November to January) will likely result in a higher volume of banded tākoketai identified and incorporated into the study. There is a possibility that at-sea captures may target birds that might not be able to be caught during burrow monitoring e.g., pre- or non-breeders (immature individuals or those that have failed to attract/find a mate), or birds that have a failed breeding attempt and have subsequently returned to sea. Like other *Procellaria*, tākoketai are highly philopatric (Warham 1996), and are suspected to exhibit sexed biased dispersal within the colony site. Males are suspected of returning closer to their natal areas whereas females are suspected of dispersing farther afield. Some males have been documented usurping their father and occupying their natal burrow (unpublished WMIL data). Because of this, we suspect that the identified returned chicks are predominantly male, however genetic confirmation of sex identity is needed to establish this trend, which is lacking for most individuals. At-sea captures would therefore likely reduce the likelihood of sex-biased detection.

A combination of these recommendations such as night banding, at-sea captures, transect surveys, and conservation dogs will work to improve detection probability and more accurately determine survival effort estimates as well as juvenile survival and recruitment. The implementation of these methods is crucial for the survival, determining population trend, and management of this endangered species.

5. RECOMMENDATIONS

WMIL recommends that:

- Intensive population monitoring using the study burrows on Aotea continues with three visits (i.e., at egg-laying (December); at chick hatching/chick guard in late January/early February and at chick fledging in late April/early May) per season to the colony to track population trends and determine impacts to the birds and colony.
- Multiple-night expeditions to focus on recruitment (i.e., nocturnal surveys to capture pre-breeders and returned chicks) to the Aotea study colony continue to determine juvenile survival and recapture probabilities.

- Sexing of all tākoketai caught during the recruitment expedition and in the study burrows is completed to determine any sex biases and survival differences between sexes at the colony and within the study burrows.
- A focused, consistent and repeatable mark/recapture session (e.g., a 2-hour capture period at known launch sites) is completed over a number of nights to capture as many banded and unbanded birds as possible. Data can then be used to provide another population estimate and compared to estimates obtained from at-sea captures and burrow monitoring.
- Transect surveys across the core tākoketai habitat (1000 ha around the summit) are undertaken to provide an updated population estimate for Aotea.
- Satellite tracking of chicks to, and in, South American waters is undertaken to determine migration routes and foraging areas to estimate risk in these areas.
- The possibility of collaborative at-sea capture expeditions in Ecuador is investigated. Discussions between DOC and New Zealand Government with Ecuadorian Government and researchers will have to be conducted to enable this type of collaborative work. At-sea work in Ecuador could determine the level of juvenile tākoketai presence in this area and risk within this area, and this mark/recapture work could provide another population estimate to compare with the New Zealand data.
- Further investigation to determine whether particular areas of the colony are more at risk to rainfall events than others (e.g., burrows in flatter areas being more prone to flooding) as a preliminary assessment on climate resilience.
- In-depth modelling on the effect of age, age difference in pairs, and experience on breeding success is completed to understand this relationship in tākoketai.
- Analysis of, and comparison between, breeding success in public, and non-public, access areas is completed to determine whether human disturbance is a factor at the Aotea colony.
- Investigation into possible deterrence methods of all predators, but specifically feral pigs and feral cats, should be continued at Cooper's Castle.

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8. APPENDICES

8.1 Appendix 1: Summary of returned chick captures

Table 10: *Number of captures, age at first recapture, age at first breeding and age at first successful breeding for tākoketai/black petrels (Procellaria parkinsoni) banded as chicks and recaptured in the study site on Aotea/Great Barrier Island or at-sea (Aotearoa/New Zealand waters or international waters) since the 1995/96 breeding season. Birds in red text have been recovered dead (but have previously been recorded as breeders or non-breeders at the Hirakimata/Mt Hobson colony). Birds in green text fledged from Te Hauturu-o-Toi/Little Barrier Island but were recaptured at the Hirakimata/Mt Hobson colony. Birds in orange text were translocated to Te Hauturu-o-Toi/Little Barrier Island but were recaptured back at the Hirakimata/Mt Hobson colony. Birds in blue text have only been recaptured at-sea.*

Band	Sex	Date banded	No. of captures	Age of 1st return	Age of 1st breeding	Age of 1st successful breeding
13614	U	10-May-88	1	11		
13618	U	10-May-88	5	10	6	6
13638	U	11-May-88	5	18	18	19
13641	**U**	**11-May-88**	**7**	**4**	**7**	**7**
21158	**U**	**24-Apr-87**	**1**	**10**		
21185	M	29-Apr-87	1	9		
22473	U	14-Mar-72	1	5		
22564	U	9-Apr-78	1	18	18	
23635	M	12-May-88	23	10	10	14
23649	**M**	**13-May-88**	**1**	**35**		
25525	M	15-Apr-99	10	7	8	10
25536	U	15-Apr-99	15	6	6	11
25546	M	16-Apr-99	10	5	5	11
25630	M	15-Apr-00	2	5		
25631[1]	M	15-Apr-00	1	4		
25635	M	15-Apr-00	6	5	5	6
25637	U	15-Apr-00	1	5		
25648	U	15-Apr-00	4	4	5	8
25651	U	15-Apr-00	16	5	6	6
25658	M	15-Apr-00	1	5	5	5
25659	U	15-Apr-00	2	6	6	6
25661	M	15-Apr-00	16	9	9	13
25663	U	15-Apr-00	6	4	7	8
25664	U	15-Apr-00	9	3	6	10
25669	U	15-Apr-00	2	5	5	5
25673	M	15-Apr-00	16	5	7	7
25677	U	15-Apr-00	1	7	7	7
26924	U	4-May-86	1	6		
26955	U	7-May-86	6	24	24	24
26956	**U**	**7-May-86**	**7**	**14**	**15**	
26980	**U**	**9-May-86**	**1**	**16**	**16**	**16**
26991	U	9-May-86	9	17	18	18
27012	**U**	**28-Apr-87**	**2**	**8**		
27032	U	29-Apr-87	2	7		
27058	U	30-Apr-87	7	14	14	14
27098	**U**	**11-May-88**	**1**	**15**	**15**	**15**
27512	U	6-May-88	2	6		
27568	U	27-Apr-89	4	11	11	11

[1] Also caught at sea in October 2020.

Band	Sex	Date banded	No. of captures	Age of 1st return	Age of 1st breeding	Age of 1st successful breeding
27604	M	27-Apr-89	29	7	7	8
27614	U	27-Apr-89	5	5		
27637	F	2-May-89	1	5		
27665	M	29-Apr-90	11	6	6	6
27666	U	29-Apr-90	4	4	7	7
27678	U	29-Apr-90	4	4	7	
27689	U	29-Apr-90	1	7	7	7
27702	F	29-Apr-90	13	6	6	6
27708	U	29-Apr-90	1	10		
27726	U	29-Apr-90	1	4		
27728	U	29-Apr-90	4	7	8	9
28085	U	2-Apr-01	1	5		
28089	U	2-Apr-01	1	15	15	
28572	U	6-Mar-92	23	4	4	4
29008	M	21-Apr-09	7	9	9	9
29018	U	21-Apr-09	3	7	7	7
29023	U	21-Apr-09	3	10	10	10
29027	U	21-Apr-09	1	5		
29047	U	21-Apr-09	8	6	7	7
29095	U	21-Apr-09	2	12	13	13
29098	U	21-Apr-09	3	4	7	7
29644	U	1-May-86	1	15		
29912	U	2-Apr-01	5	5	5	6
29927	M	2-Apr-01	10	9	12	12
29960	**M**	**13-Apr-00**	**8**	**9**	**9**	**9**
29964	U	14-Apr-00	1	24	24	
29978	U	14-Apr-00	6	9	14	14
30161	**U**	**12/04/2008**	**1**	**2**		
30167	U	12-Apr-08	1	4		
30175	U	12-Apr-08	1	5		
30177	**U**	**12/04/2008**	**1**	**3**		
30807	F	29/04/1997	5	9	9	9
30908	U	08-Apr-96	1	7		
30924	U	12-Apr-96	9	6	6	6
30930	M	14-Apr-96	20	4	5	5
30934	U	15-Apr-96	1	18		
31076	U	31-Mar-98	1	5		
31080	U	31-Mar-98	1	4		
31081	U	31-Mar-98	2	4		
31082	U	31-Mar-98	1	4		
31089	U	31-Mar-98	9	5	6	9
31194	M	03-Apr-97	1	5	5	
31322	**U**	**3/05/2006**	**1**	**3**		
31324	U	03-May-06	8	7	7	7
31340	U	04-May-06	1	9	9	9
31345	U	04-May-06	1	6		
31366	U	01-Apr-98	21	5	6	6
31370	U	01-Apr-98	5	5	8	
31377	U	02-Apr-98	1	4		
31382	U	02-Apr-98	5	4	5	5
31383	U	02-Apr-98	1	6		
31389	U	02-Apr-98	1	17	17	17
31405	U	03-Apr-97	3	6	7	7

Band	Sex	Date banded	No. of captures	Age of 1st return	Age of 1st breeding	Age of 1st successful breeding
31406	U	03-Apr-97	1	5		
31413	U	05-Apr-97	1	8	8	8
31415	U	05-Apr-97	2	7		
31422	U	05-Apr-97	1	16	16	
31424	U	05-Apr-97	5	6	8	8
31474	U	17-Apr-99	1	4		
31476	U	17-Apr-99	2	4	6	
31478	U	17-Apr-99	3	10	10	
31490	U	18-Apr-99	1	4		
31491	U	18-Apr-99	1	7		
31494	U	18-Apr-99	15	6	9	10
31495	M	18-Apr-99	17	4	5	5
31498	U	18-Apr-99	4	6	6	6
31527	U	18-Apr-99	1	4		
31537	U	19-Apr-99	6	8	8	8
31542	U	19-Apr-99	18	4	6	7
31546	U	19-Apr-99	1	9		
31956	U	02-Apr-01	2	7		
32063	U	05-Apr-01	1	5		
32073	U	05-Apr-01	2	6	19	
32091	U	02-Apr-01	1	7		
32099	U	02-Apr-01	13	5	8	8
32100	U	02-Apr-01	1	12	12	
32915	U	21-Apr-02	3	6	6	6
32921	U	21-Apr-02	1	11	11	11
32927	U	21-Apr-02	8	6	6	6
32957	F	21-Apr-02	10	5	6	7
32960	U	21-Apr-02	1	14	14	14
32979	U	21-Apr-02	1	5		
32980	M	21-Apr-02	13	4	11	11
32985	U	21-Apr-02	12	11	11	11
32995	M	21-Apr-02	10	11	11	13
33003	U	22-Apr-02	6	7	7	7
33015	U	22-Apr-02	4	6	14	
33035	U	22-Apr-02	15	6	7	7
33036	**U**	**22-Apr-02**	**2**	**8**		
33052	M	22-Apr-02	17	6	6	6
33055	U	22-Apr-02	1	8	8	8
33067	U	22-Apr-02	1	8		
33068	U	22-Apr-02	2	7	8	
33071	U	22-Apr-02	2	11	14	
33088	**U**	**22-Apr-02**	**1**	**3**		
33208	**M**	**15/05/2003**	**4**	**5**	**7**	
33218	U	16-May-03	2	5	6	
33225	U	16-May-03	1	4		
33226	U	16-May-03	1	12	12	
33244	M	16-May-03	12	6	10	10
33246	U	16-May-03	9	10	10	10
33248	U	16-May-03	10	6	8	8
33276	U	08-May-04	10	7	7	7
33335	U	08-May-04	2	5	7	
33369	U	09-May-04	9	9	8	8
33375	U	09-May-04	13	5	5	5

Band	Sex	Date banded	No. of captures	Age of 1st return	Age of 1st breeding	Age of 1st successful breeding
33376	U	09-May-04	2	8	8	
33380	U	09-May-04	1	4		
33389	M	09-May-04	10	6	6	6
33397	U	09-May-04	1	5		
33508	U	02-May-06	9	7	7	7
33518	U	02-May-06	1	4		
33528	U	02-May-06	11	7	7	7
33530	U	02-May-06	7	5	6	6
33540	F	02-May-06	12	4	7	7
33543	U	02-May-06	1	5		
33546	U	02-May-06	1	7	7	
33550	U	02-May-06	3	4	5	5
33575	U	03-May-06	11	5	5	5
33581	U	03-May-06	7	5	6	15
33584	U	03-May-06	1	9		
33589	F	03-May-06	5	5	5	5
33591	U	03-May-06	1	5		
33596	U	03-May-06	2	5	6	
33737	U	16-May-03	13	7	7	7
34273	U	27-Apr-05	9	7	7	7
34276	U	27-Apr-05	4	5	8	8
34278	U	27-Apr-05	6	12	12	12
34299	U	27-Apr-05	6	7	7	7
34304	U	27-Apr-05	12	8	8	8
34308	U	27-Apr-05	1	10	10	10
34317	U	27-Apr-05	11	8	8	8
34320	U	27-Apr-05	14	5	8	8
34338	U	27-Apr-05	14	5	6	6
34349	U	27-Apr-05	5	7		
34435	U	24-Apr-07	1	7	7	7
34445	U	24-Apr-07	1	15	15	15
34505	U	24-Apr-07	5	6	6	6
34513	U	24-Apr-07	1	9	9	
34520	U	24-Apr-07	5	5	12	12
34525	U	24-Apr-07	1	10	10	10
34527	M	24-Apr-07	12	6	6	13
34528	U	24-Apr-07	6	12	12	12
34535	U	24-Apr-07	7	9	9	9
34540	U	24-Apr-07	1	17		
34550	U	24-Apr-07	2	8	10	
34553	U	24-Apr-07	2	7	8	8
34573	U	24-Apr-07	2	16	16	16
34574	U	25-Apr-07	2	4		
34580	U	25-Apr-07	12	5	6	6
34599	U	25-Apr-07	1	6		
34600	U	25-Apr-07	3	5	7	
34607	U	25-Apr-07	1	10	10	
34610	U	25-Apr-07	4	7	11	
34612	U	25-Apr-07	6	9	14	14
34615	M	25-Apr-07	10	7	9	10
34621	M	25-Apr-07	5	4	9	9
34624	U	25-Apr-07	1	6		
34626	U	25-Apr-07	1	9		

Band	Sex	Date banded	No. of captures	Age of 1st return	Age of 1st breeding	Age of 1st successful breeding
34645	U	26-Apr-07	4	10	15	15
34649	U	26-Apr-07	1	17		
34655	U	26-Apr-07	1	9	9	
34660	U	26-Apr-07	7	4	5	5
34687	U	26-Apr-07	9	7	8	8
34698	U	26-Apr-07	2	7		
34713	M	10-May-04	6	13	13	13
34804	U	27-Apr-05	2	4	5	5
34808	U	28-Apr-05	1	8		
34820	U	28-Apr-05	12	6	6	10
34828	U	28-Apr-05	1	5		
34836	U	28-Apr-05	10	6	7	10
34837	U	28-Apr-05	6	9	14	14
34843	M	28-Apr-05	10	5	6	6
34867	U	22-Feb-05	1	7	7	7
34886	U	26-Apr-05	5	7	7	8
34891	U	27-Apr-05	1	15		
34895	U	27-Apr-05	5	14	15	15
34901	U	28-Apr-05	11	5	7	7
34903	M	28-Apr-05	13	5	7	7
34916	U	28-Apr-05	1	9	9	
34994	U	02-May-06	1	10	10	
35101	U	21-Apr-09	6	6	6	7
35130	U	22-Apr-09	1	8	8	
35131	M	22-Apr-09	7	5	10	11
35151	M	23-Apr-09	5	7	7	8
35160	U	23-Apr-09	4	5	6	6
35166	U	24-Apr-09	1	11	11	11
35180	U	24-Apr-09	2	7	7	7
35181	U	24-Apr-09	1	15	15	15
35186	U	24-Apr-09	3	4	6	
35187	M	24-Apr-09	8	5	6	6
35188	M	24-Apr-09	7	6	6	7
35189	U	24-Apr-09	1	4		
35193	U	24-Apr-09	8	5	6	6
35311	U	6-May-10	7	6	6	6
35313	U	6-May-10	9	6	6	9
35315	M	6-May-10	8	6	7	7
35316	U	6-May-10	2	6	7	7
35345	M	7-May-10	3	7	9	
35349	U	7-May-10	1	14	14	
35360	U	22-Apr-09	11	5	6	6
35361	U	22-Apr-09	8	5	6	6
35380	U	22-Apr-09	1	5		
35392	U	23-Apr-09	3	6	7	
35397	U	23-Apr-09	1	4	4	4
35399	M	23-Apr-09	7	8	10	10
35419	F	06-May-11	5	5	7	7
35421	U	06-May-11	2	8	8	
35436	U	06-May-11	1	5	5	
35439	U	06-May-11	2	4	6	
35444	U	06-May-11	2	5	7	
35450	M	06-May-11	5	7	10	

Band	Sex	Date banded	No. of captures	Age of 1st return	Age of 1st breeding	Age of 1st successful breeding
35459	F	06-May-11	6	5	8	10
35460	M	06-May-11	5	7	7	7
35466	U	06-May-11	2	5		
35481	U	06-May-11	3	5	10	11
35485	U	07-May-11	4	8	9	9
35489	U	07-May-11	2	4		
35490	U	07-May-11	2	4	5	
35493	U	07-May-11	3	5	5	5
35516	M	09-May-10	7	8	9	10
35518	U	09-May-10	2	4	6	6
35521	U	09-May-10	7	6	6	9
35571	U	08-May-10	1	3		
35574	U	08-May-10	7	5	6	10
35584	U	08-May-10	1	6		
35597	M	08-May-10	6	9	9	9
36112	M	10-Apr-08	4	5	10	10
36115	U	10-Apr-08	2	7	8	8
36118	M	10-Apr-08	4	5	7	
36124	U	10-Apr-08	3	8	8	8
36139	M	11-Apr-08	11	6	7	
36140	U	11-Apr-08	1	5		
36147	U	11-Apr-08	3	5		
36209	M	11-Apr-08	4	10	10	10
36213	U	11-Apr-08	8	9	9	10
36216	U	11-Apr-08	1	4		
36233	U	11-Apr-08	2	6	7	
36241	U	11-Apr-08	1	5		
36244	U	11-Apr-08	1	16	16	
36247	U	11-Apr-08	5	12	14	14
36248	U	11-Apr-08	1	7		
36270	U	12-Apr-08	1	13		
36271	U	12-Apr-08	1	7		
36277	U	12-Apr-08	2	7		
36290	U	13-Apr-08	11	5	6	7
36294	U	13-Apr-08	1	6	6	
36401	U	07-May-11	1	10		
36411	M	07-May-11	5	7	7	7
36419	M	08-May-11	8	6	7	7
36426	U	08-May-11	5	5	6	8
36427	U	08-May-11	3	4	12	12
36430	U	08-May-11	2	10	11	11
36431	U	08-May-11	4	7	7	9
36440	U	08-May-11	8	6	7	7
36441	U	08-May-11	6	4	9	9
36455	U	07-May-10	3	6	9	9
36470	U	07-May-10	1	6		
36474	U	07-May-10	1	4		
36476	U	07-May-10	1	5		
36495	U	08-May-10	6	6	6	8
36904	U	27-Apr-12	6	6	8	8
36906	U	27-Apr-12	2	11	11	11
36911	U	27-Apr-12	1	4		
36918	U	27-Apr-12	2	5		

Band	Sex	Date banded	No. of captures	Age of 1st return	Age of 1st breeding	Age of 1st successful breeding
36925	M	27-Apr-12	6	5	5	7
36930	U	27-Apr-12	7	5	7	8
36953	U	29-Apr-12	1	5		
36957	U	29-Apr-12	8	5	8	9
36968	U	29-Apr-12	1	8		
39678	U	29-Apr-12	1	12		
36994	U	28-Apr-12	5	4	8	8
37605	U	28-Apr-12	3	7	7	8
37606	U	28-Apr-12	1	6		
37615	F	28-Apr-12	5	6	6	8
37616	U	28-Apr-12	1	5		
37636	U	28-Apr-12	1	5		
37638	U	28-Apr-12	1	4		
37648	U	28-Apr-12	2	9	9	10
37659	U	29-Apr-12	3	8	8	8
38574	U	26-Apr-13	3	5	5	5
38476	U	26-Apr-13	1	11		
38582	U	26-Apr-13	2	10	10	
38592	U	26-Apr-13	1	7	7	7
38609	U	29-Apr-13	4	6	6	7
38654	U	27-Apr-13	1	9	9	9
38655	U	27-Apr-13	2	3		
38661	U	27-Apr-13	5	4	4	4
38668	U	27-Apr-13	2	9	10	10
38672	U	27-Apr-13	1	4		
38694	U	28-Apr-13	2	10		
38760	U	28-Apr-13	6	5	6	6
38777	U	28-Apr-13	2	4		
38780	U	28-Apr-13	3	7	7	7
38795	U	28-Apr-13	1	9		
38829	U	26-Apr-13	1	11	11	
38844	U	27-Apr-13	4	5	10	10
38847	U	26-Apr-13	1	8	8	8
38899	U	25-Apr-14	5	6	6	8
38969	U	26-Apr-14	2	4		
38979	M	26-Apr-14	1	6		
38983	U	26-Apr-14	4	6	7	7
38994	U	26-Apr-14	1	7		
39011	U	27-Apr-13	1	7		
39022	U	27-Apr-13	3	7	8	8
39039	U	27-Apr-23	1	11		
39044	U	27-Apr-13	7	4	6	9
39053	U	27-Apr-14	1	5		
39059	U	27-Apr-14	4	7	7	7
39063	U	27-Apr-14	4	6	6	6
39065	U	27-Apr-14	2	7	7	
39067	U	27-Apr-14	1	7		
39078	U	27-Apr-14	3	5	7	10
39088	U	27-Apr-14	1	4	4	
39310	U	25-Apr-14	5	6	6	6
39311	U	25-Apr-14	6	5	5	5
39318	U	25-Apr-14	4	6	6	6
39323	U	25-Apr-14	3	6	6	6

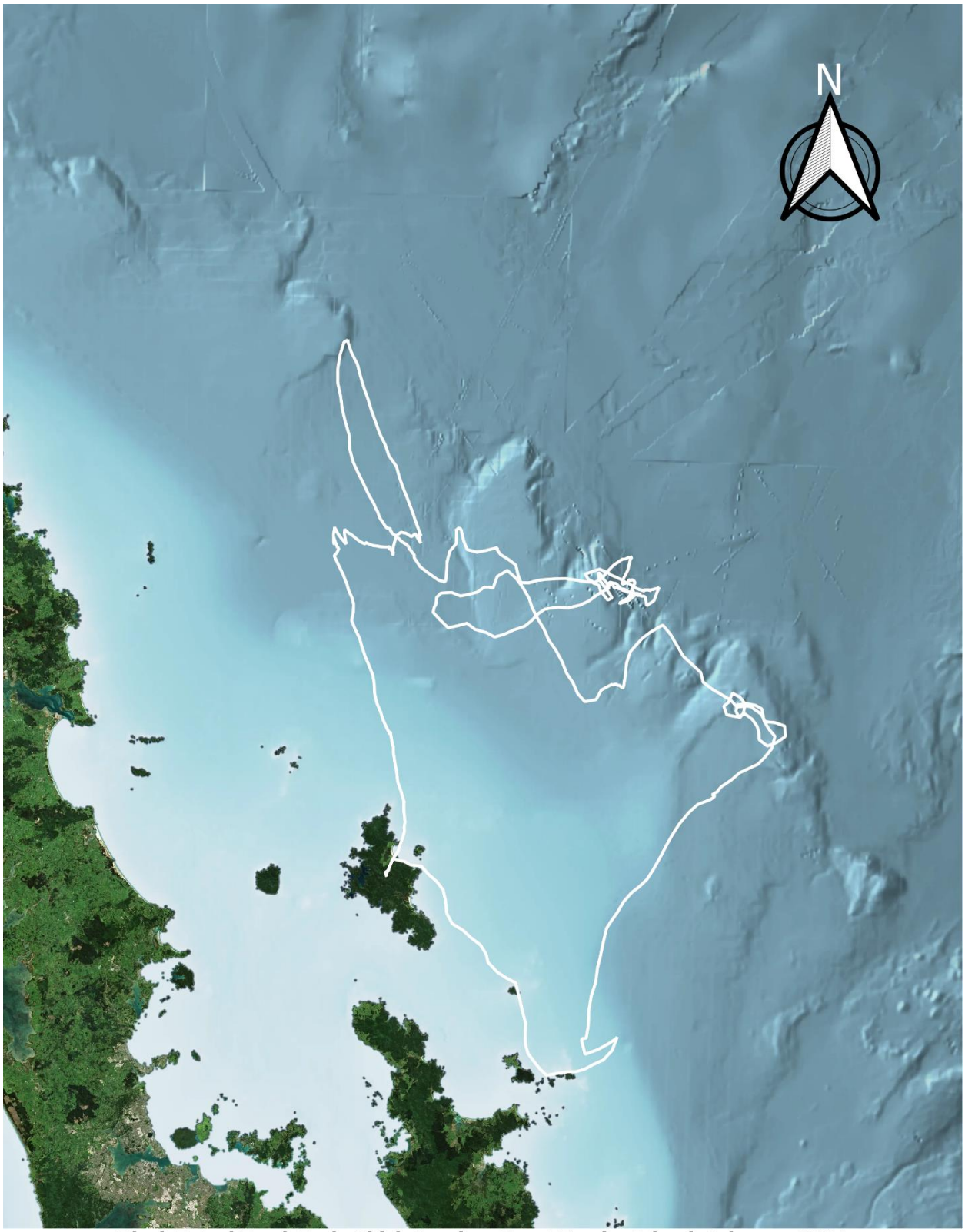
Band	Sex	Date banded	No. of captures	Age of 1st return	Age of 1st breeding	Age of 1st successful breeding
39340	U	25-Apr-14	3	5		
39341	U	25-Apr-14	3	6	7	10
39343	U	25-Apr-14	5	6	6	9
39460	U	27-Apr-14	4	5	5	5
39465	U	27-Apr-14	2	4		
39467	U	27-Apr-14	1	10		
39478	U	27-Apr-14	2	7	8	8
39480	U	27-Apr-14	3	8	9	9
39481	U	28-Apr-14	3	6	7	7
39484	U	28-Apr-14	1	5		
39491	U	28-Apr-14	1	8	9	9
39587	**U**	**23-Apr-15**	**1**	**7**		
39654	U	23-Apr-15	1	6		
39674	U	23-Apr-15	1	4		
39680	U	23-Apr-15	1	9		
39683	U	23-Apr-15	2	4		
39691	U	23-Apr-15	2	5	5	5
39692	U	23-Apr-15	2	6	7	7
39713	U	23-Apr-15	1	9		
39714	M	25-Apr-15	4	6	8	8
39721	U	23-Apr-15	1	6		
39735	U	23-Apr-15	3	6	6	6
40202	U	01-May-18	1	5	5	5
40223	**U**	**1-May-18**	**1**	**6**		
40235	U	02-May-18	2	4		
40237	U	02-May-18	1	4	4	
40239	U	03-May-18	1	4		
40320	U	08-May-18	1	4		
40344	U	08-May-18	1	5		
41175	**U**	**29-Apr-16**	**1**	**6**		
41182	**U**	**29-Apr-16**	**1**	**8**		
41183	**U**	**29-Apr-16**	**1**	**8**		
41303	U	25-Apr-15	3	7	8	8
41313	U	25-Apr-15	2	6		
41316	U	25-Apr-15	3	5	7	7
41317	U	25-Apr-15	1	4		
41324	U	25-Apr-15	1	6		
41334	U	25-Apr-15	1	7	7	7
41336	U	25-Apr-15	1	9	9	
41342	U	25-Apr-15	3	6	6	6
41343	U	25-Apr-15	5	5	7	7
41357	U	25-Apr-15	1	5		
41382	U	26-Apr-15	1	9		
41396	U	26-Apr-15	1	9	9	9
41399	U	26-Apr-15	3	6	8	
41400	U	26-Apr-15	2	8		
41490	U	5-May-16	2	5	6	
41493	U	5-May-16	1	7		
41507	U	11-May-88	17	11	12	12
41653	U	06-May-16	1	7		
41654	U	06-May-16	3	6	7	7
41656	U	06-May-16	1	6		
41673	**U**	**6-May-16**	**1**	**7**		

Band	Sex	Date banded	No. of captures	Age of 1st return	Age of 1st breeding	Age of 1st successful breeding
41691	U	07-May-16	1	5		
41704	U	7-May-16	1	7		
41713	U	07-May-17	2	6		
41732	U	07-May-17	2	5	7	7
41738	U	07-May-17	2	6		
41902	U	10-May-16	1	4		
41912	U	08-May-16	1	4		
41918	U	08-May-16	2	7	7	8
41923	U	08-May-16	1	4		
41932	U	08-May-16	1	6		
41938	U	8-May-16	1	8		
41955	U	9-May-16	1	8	8	8
41980	U	9-May-16	1	8		
41989	U	9-May-16	1	8	8	8
41992	U	8-May-16	4	5	6	6
41997	U	8-May-16	1	8		
42000	U	8-May-16	1	5		
42037	M	7-May-16	2	4	6	
42042	U	7-May-16	1	6		
42050	U	7-May-16	2	4	4	
42053	M	13-May-17	1	6		
42624	U	13-May-17	1	4		
42712	**U**	**1-May-17**	**1**	**7**		
42718	**U**	**1-May-17**	**1**	**7**		
42724	U	7-May-17	1	5	5	
42728	U	2-May-17	1	7	7	
42729	**U**	**2-May-17**	**1**	**5**		
42733	**U**	**7-May-17**	**1**	**5**		
42747	**U**	**4-May-17**	**1**	**7**		
42824	M	5-May-17	1	6		
42836	U	5-May-17	1	7		
42838	U	5-May-17	1	6		
42956	U	5-May-17	2	6	7	
42962	U	5-May-17	2	5		
42965	U	5-May-17	1	5		
42966[2]	U	5-May-17	2	6	7	7
42970[3]	M	5-May-17	1	6		
42979	U	6-May-17	1	6		
42999	U	7-May-17	2	6		
43018	U	8-May-17	1	6		
43022	U	8-May-17	1	6		
43025	U	10-May-17	1	6		
43026	U	10-May-17	1	6		
43043	U	10-May-17	2	6	6	6
43123	U	03-May-18	2	5		
43129	U	03-May-18	1	5		
43135	U	04-May-18	1	5		
43139	U	05-May-18	1	5		
43155	U	6-May-19	1	5		
43174	U	7-May-19	1	5		

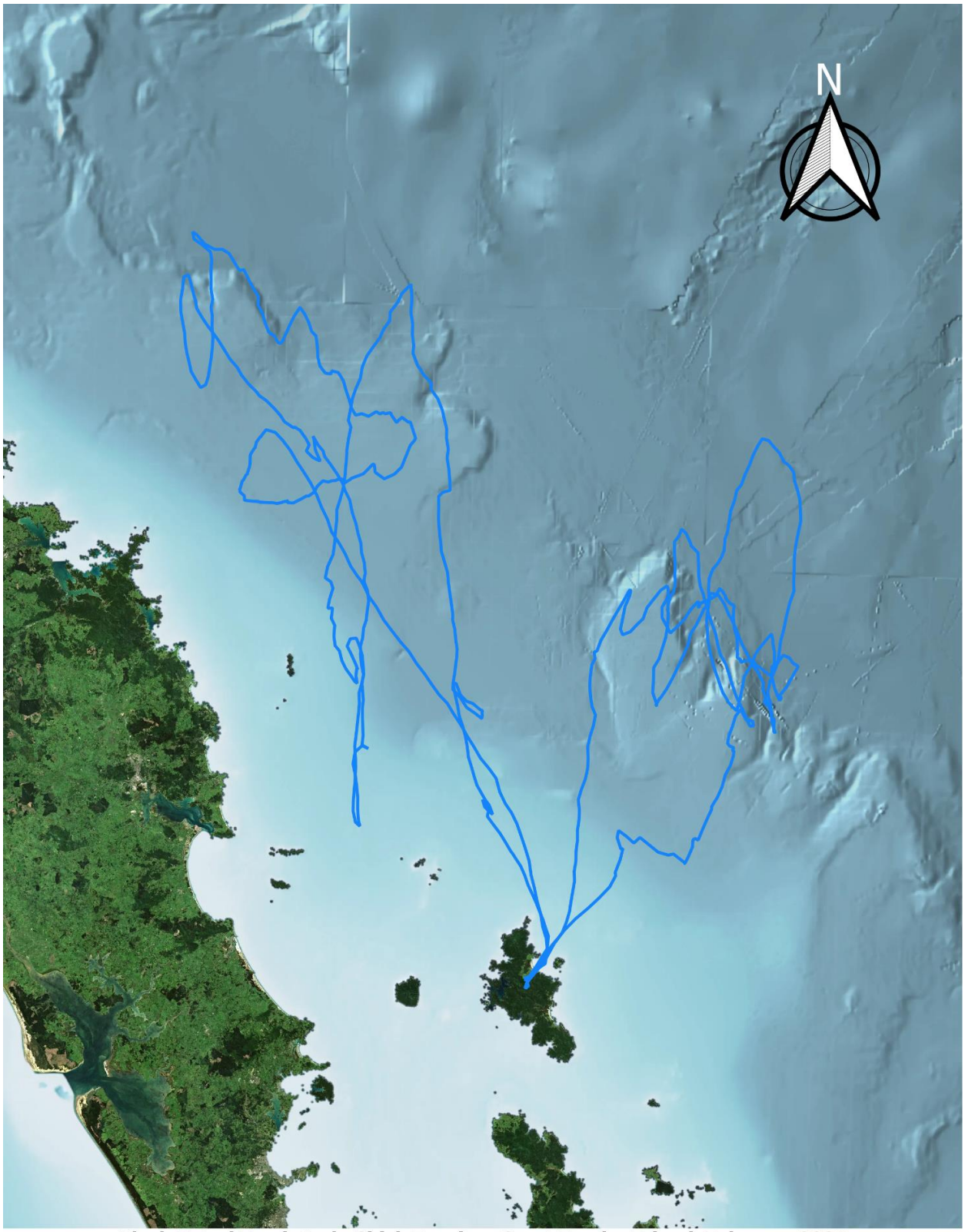
[2] Also caught at sea in May 2024.
[3] Also caught at sea in November 2022.

Band	Sex	Date banded	No. of captures	Age of 1st return	Age of 1st breeding	Age of 1st successful breeding
43268	U	02-May-29	1	4		
43346	U	30-Apr-19	1	5		
43352	U	08-May-18	1	4		
43355	U	09-May-18	1	4		
43358	U	9-Apr-19	1	6		
43365	U	9-Apr-19	1	6		
43375	U	09-May-18	1	4		
43382	U	16-May-18	1	4		
43390	U	17-May-18	1	5		
43433	U	05-May-19	1	4		
43451	U	03-May-19	1	4		
43472	U	3-May-19	1	5		
43488	U	4-May-19	1	5		
44347	U	17-May-20	1	4		
44414	U	15-May-20	1	4		
45704	**U**	**30-Apr-21**	**1**	**3**		
Mean (±SEM) – All birds (n=475)			**3.8 ± 0.2**	**6.8 ± 0.2**	**8.2 ± 0.2**	**8.5 ± 0.2**
Mean (± SEM) – Only live birds at Aotea colony (n=453)			**3.9 ± 0.2**	**6.9 ± 0.2**	**8.2 ± 0.2**	**8.5 ± 0.2**

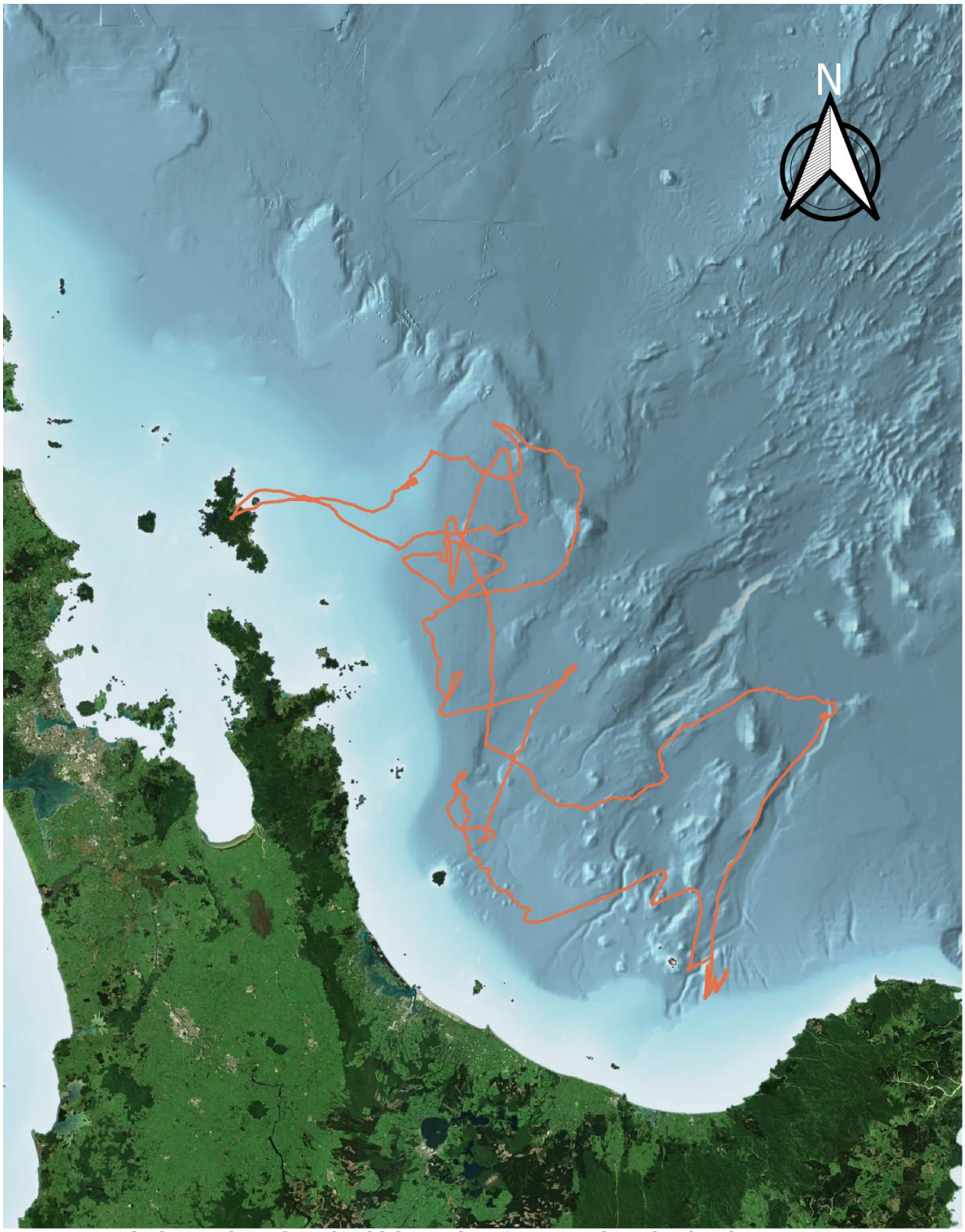
8.2 Appendix 2: Individual Adult tākoketai/black petrel tracks (Chick Rearing)



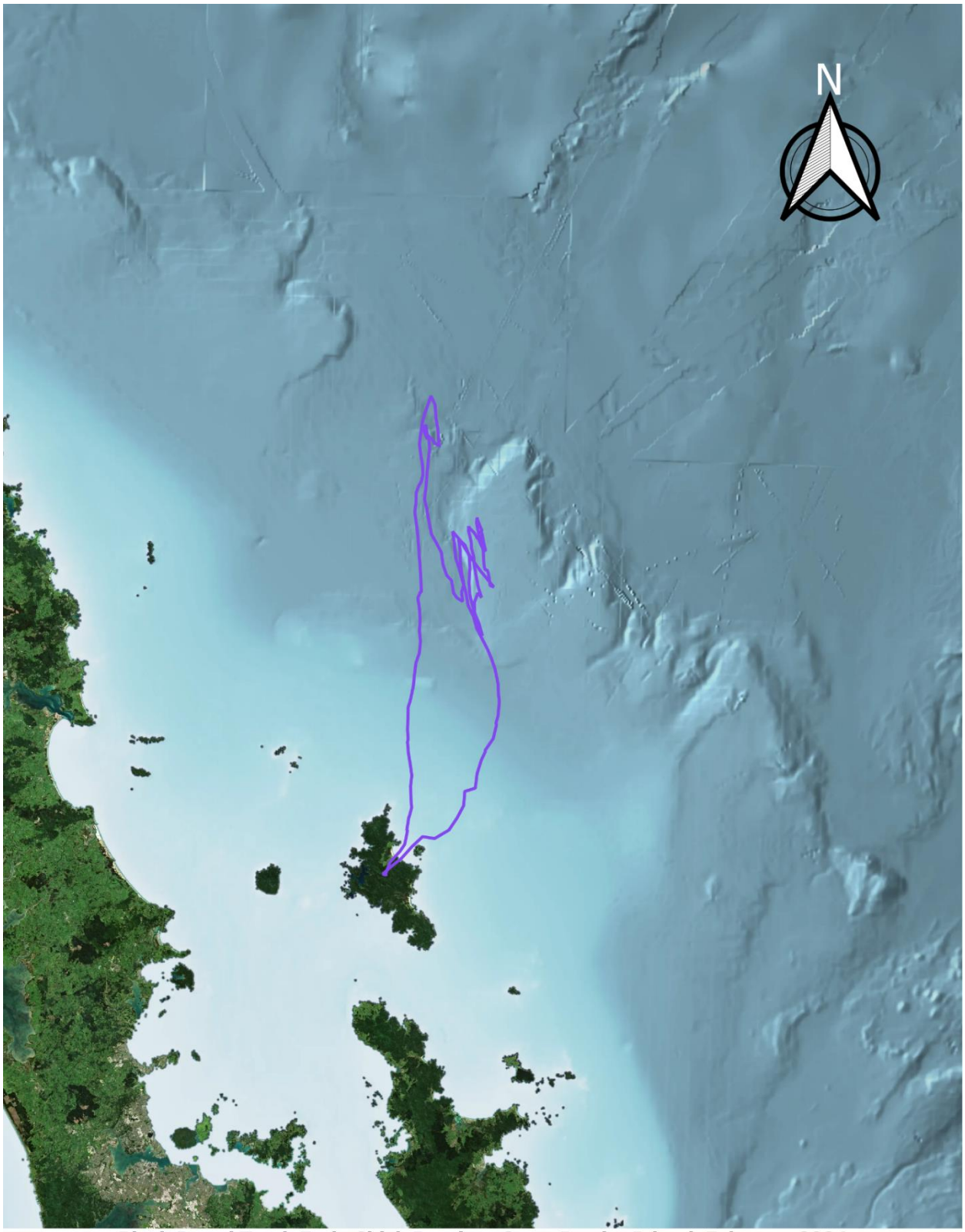
Black Petrel Track Early Chick Rearing, Great Barrier Island, February 2024



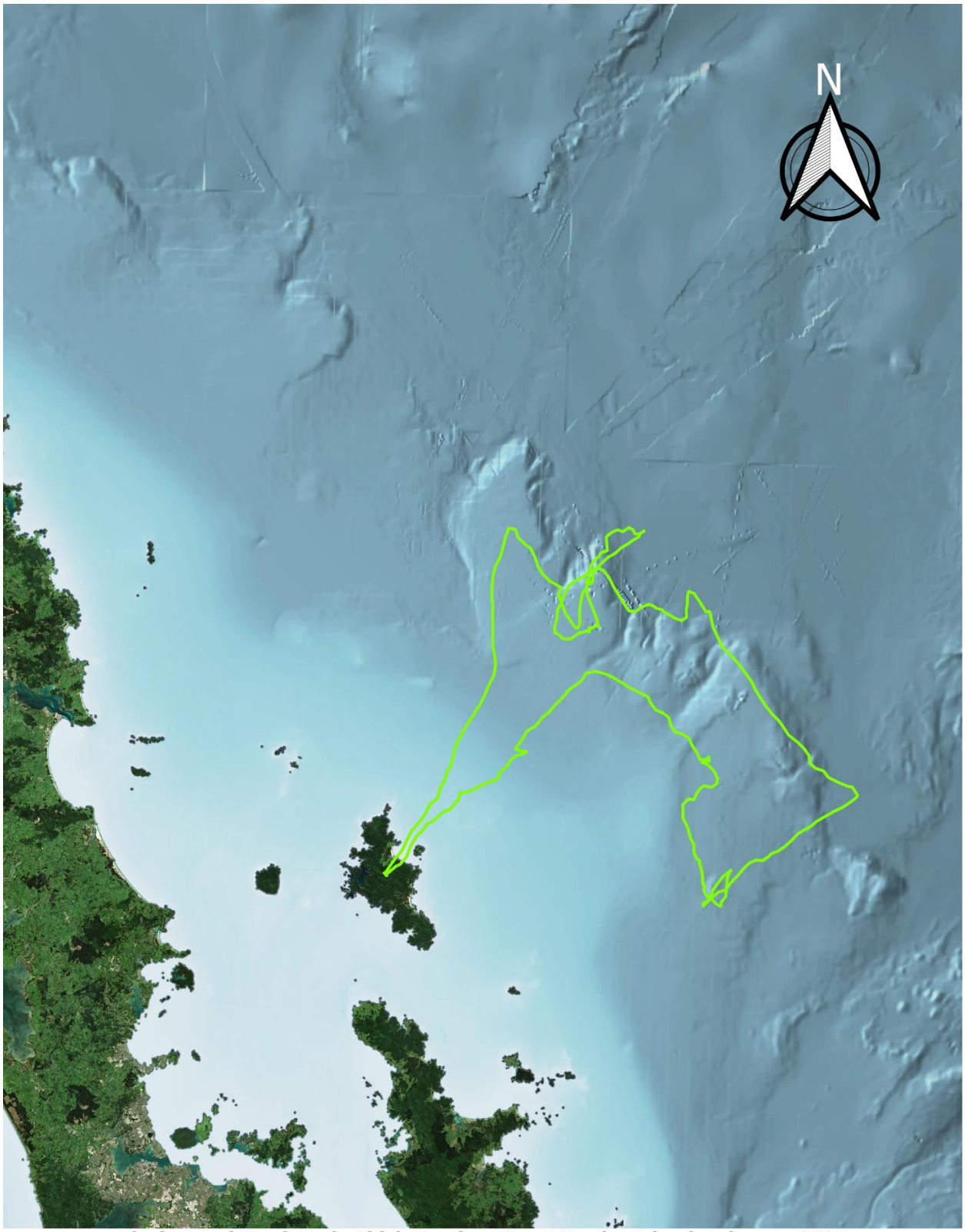
Black Petrel Track Early Chick Rearing, Great Barrier Island, February 2024



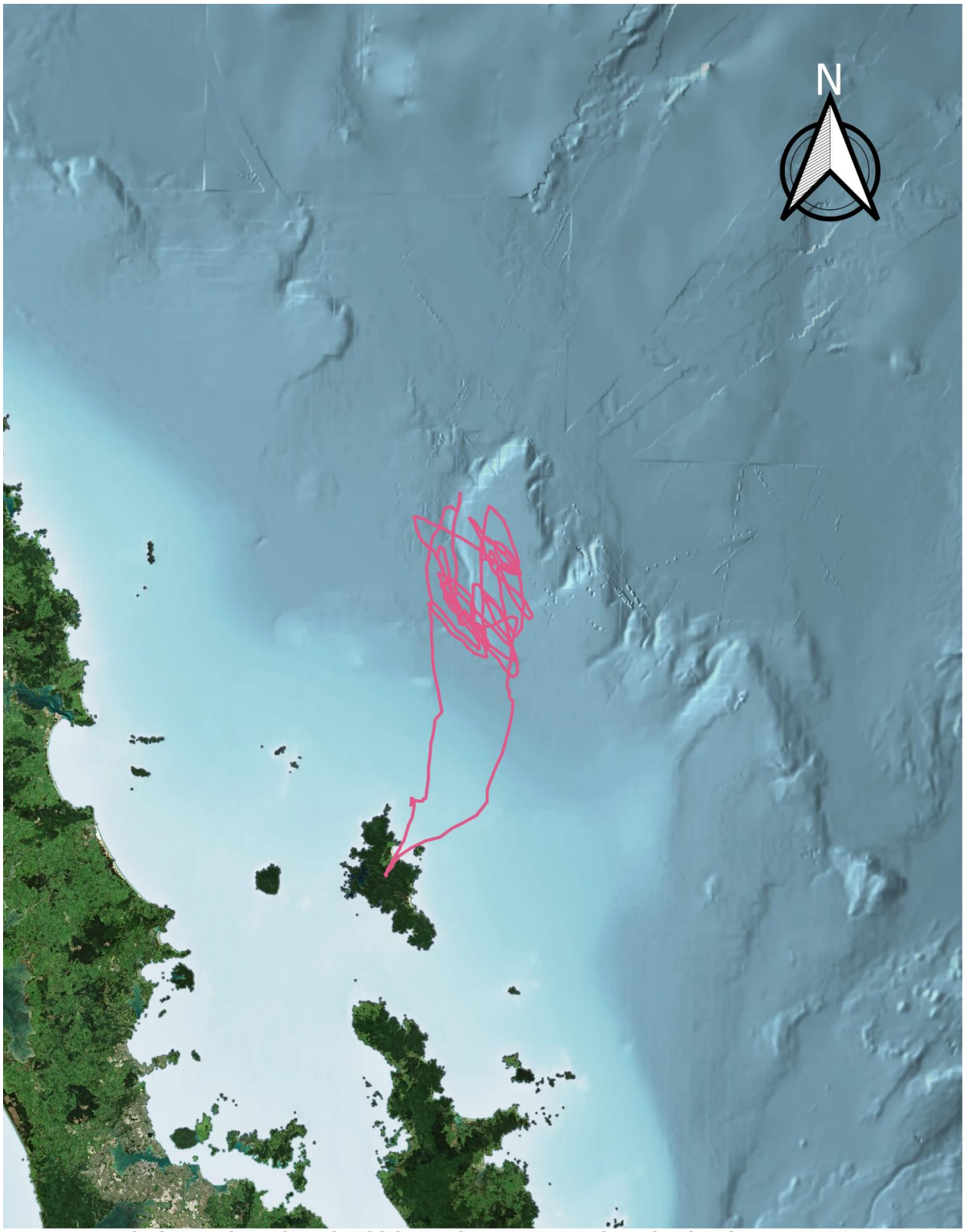
Black Petrel Track Early Chick Rearing, Great Barrier Island, February 2024



Black Petrel Track Early Chick Rearing, Great Barrier Island, February 2024

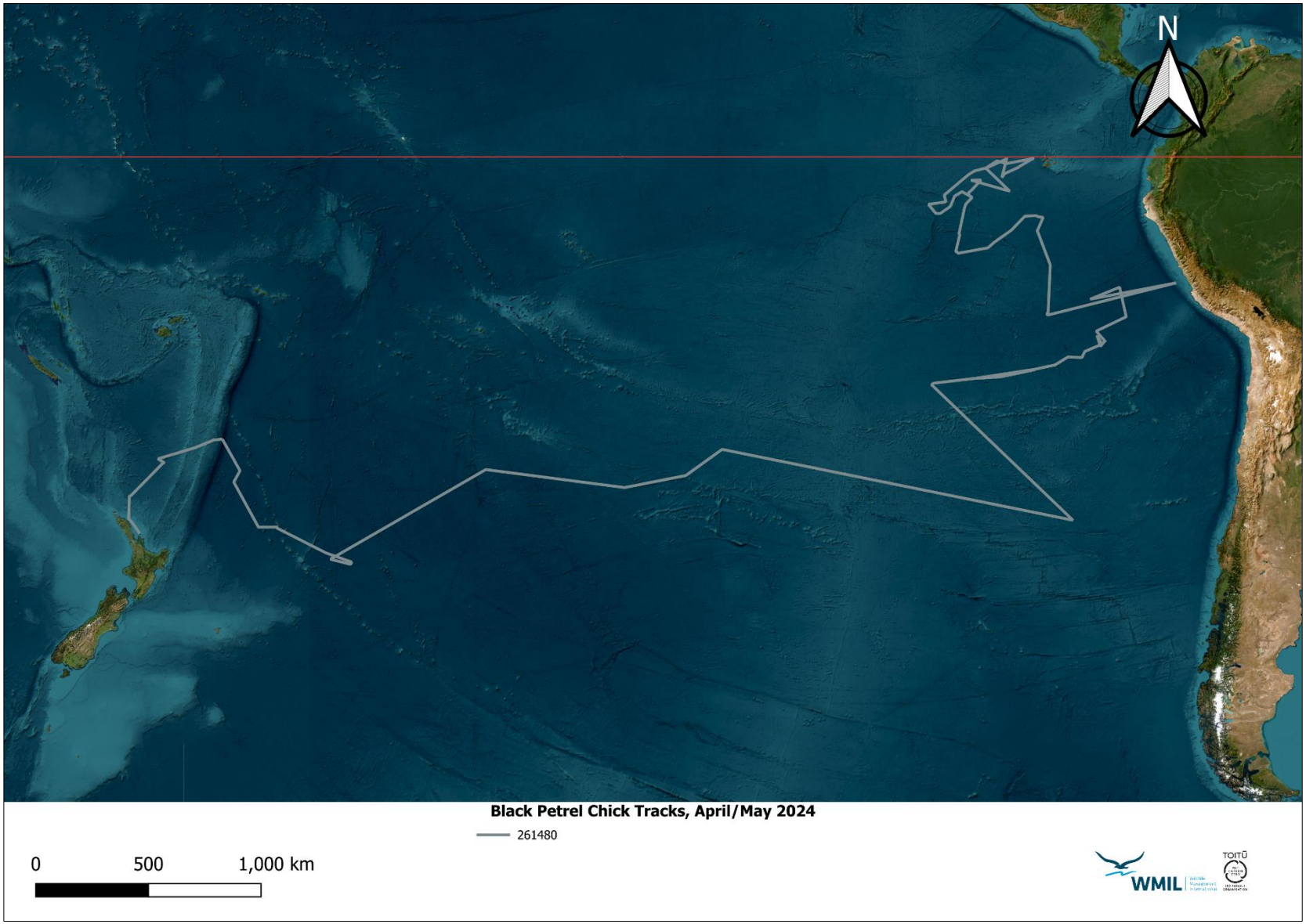


Black Petrel Track Early Chick Rearing, Great Barrier Island, February 2024



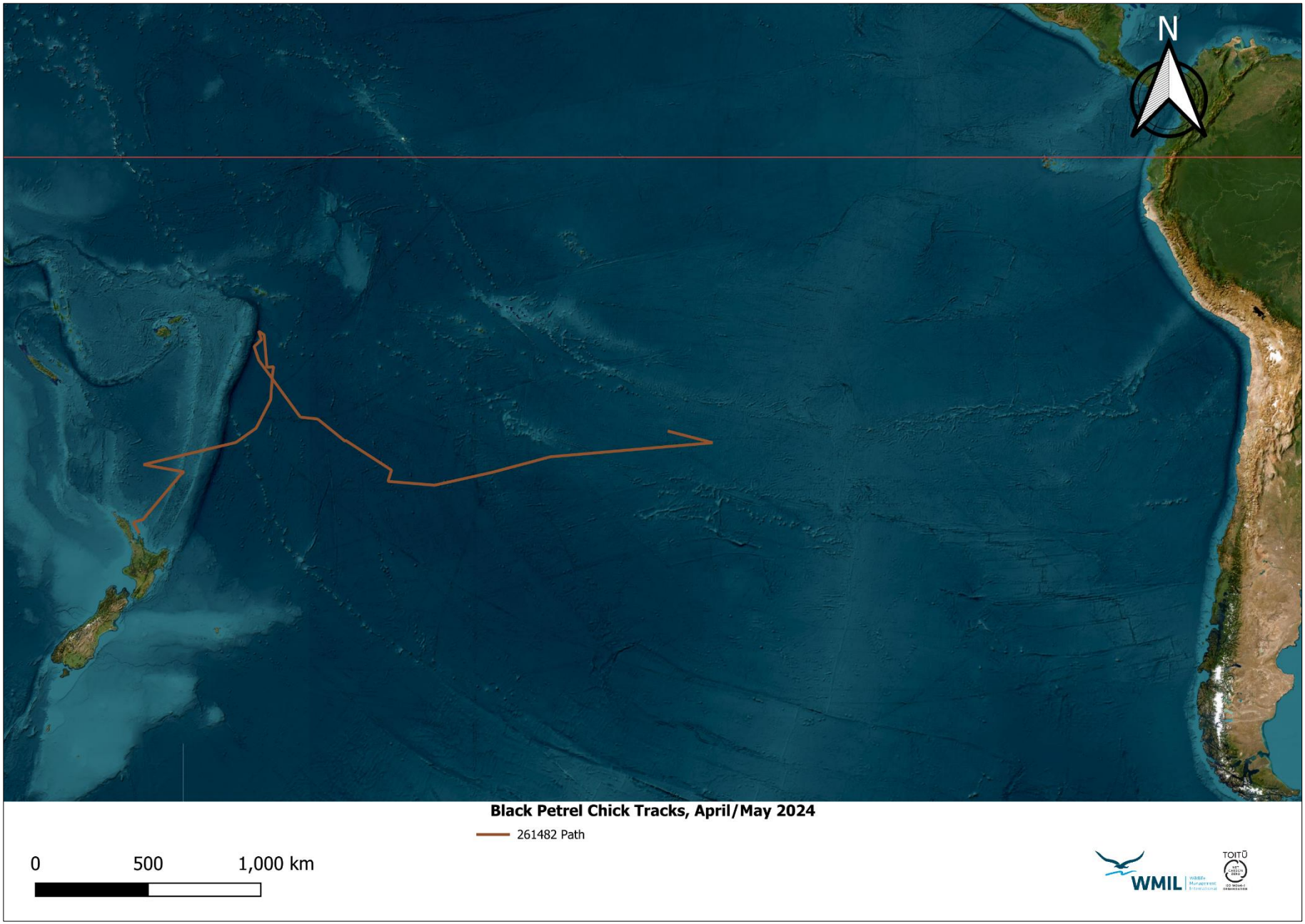
Black Petrel Track Early Chick Rearing, Great Barrier Island, February 2024

8.3 Appendix 3: Individual tākoketai/black petrel chick tracks



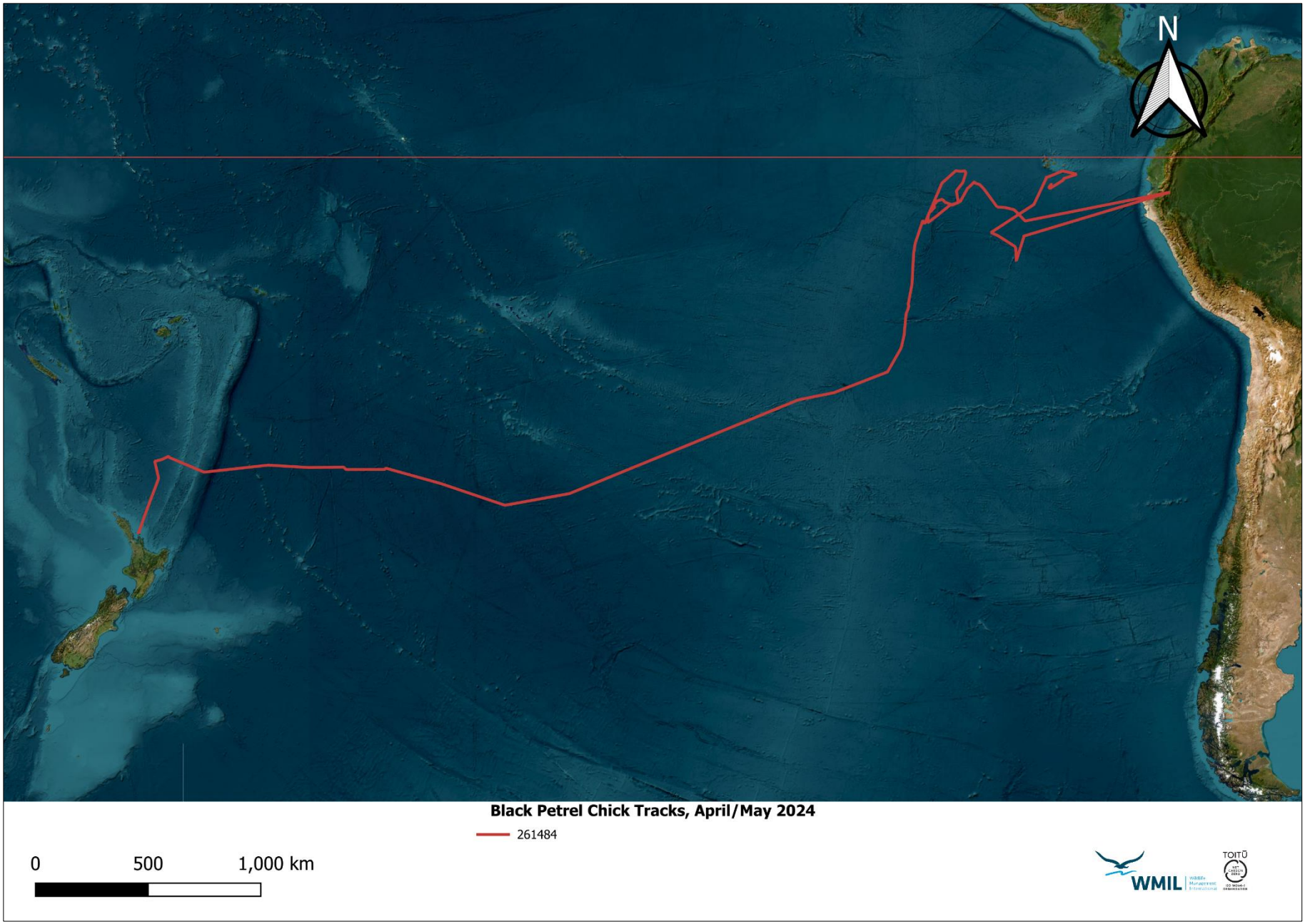
Bell, et al. 2024

Bell, et al. 2024

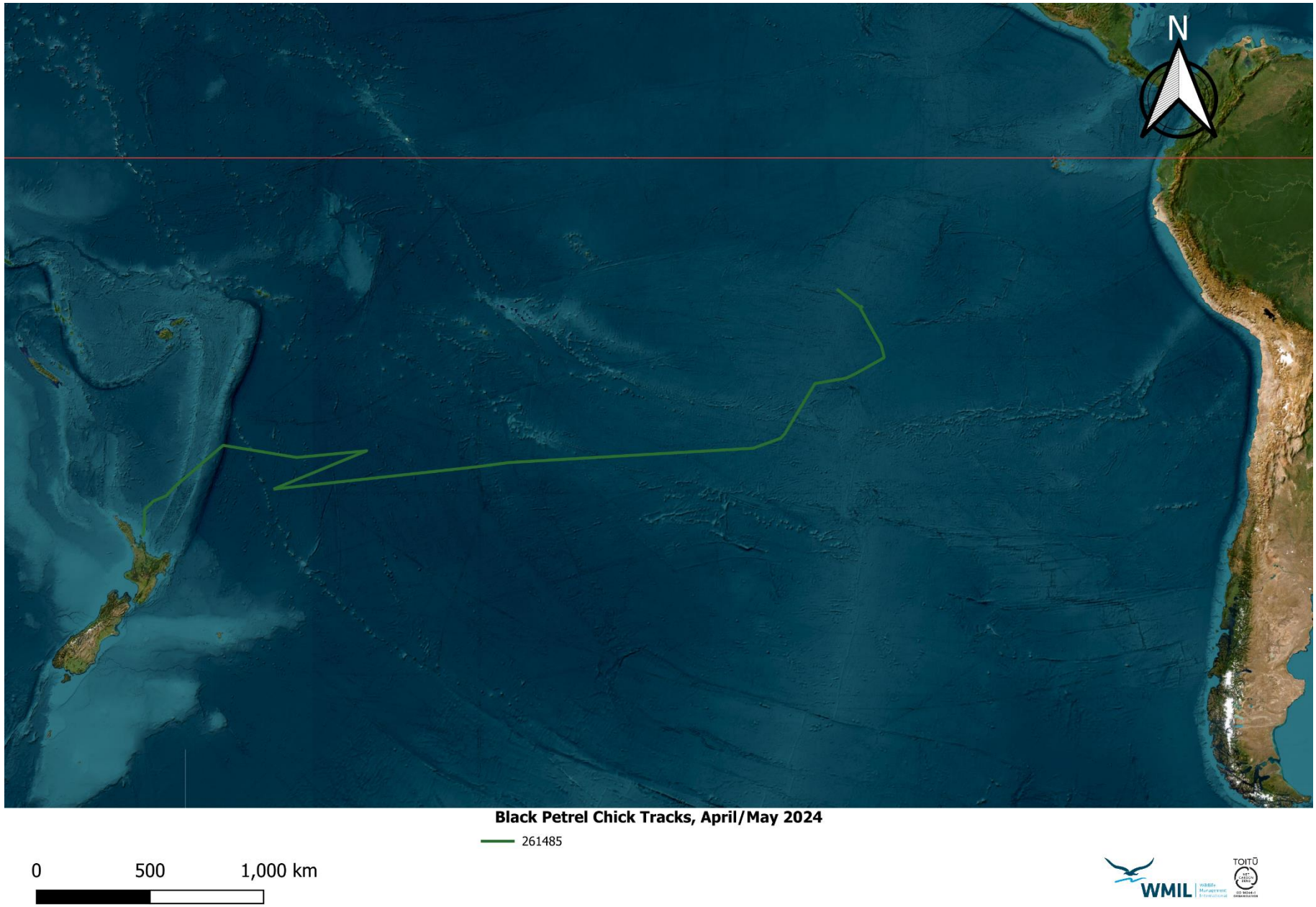


Bell, et al. 2024

Bell, et al. 2024



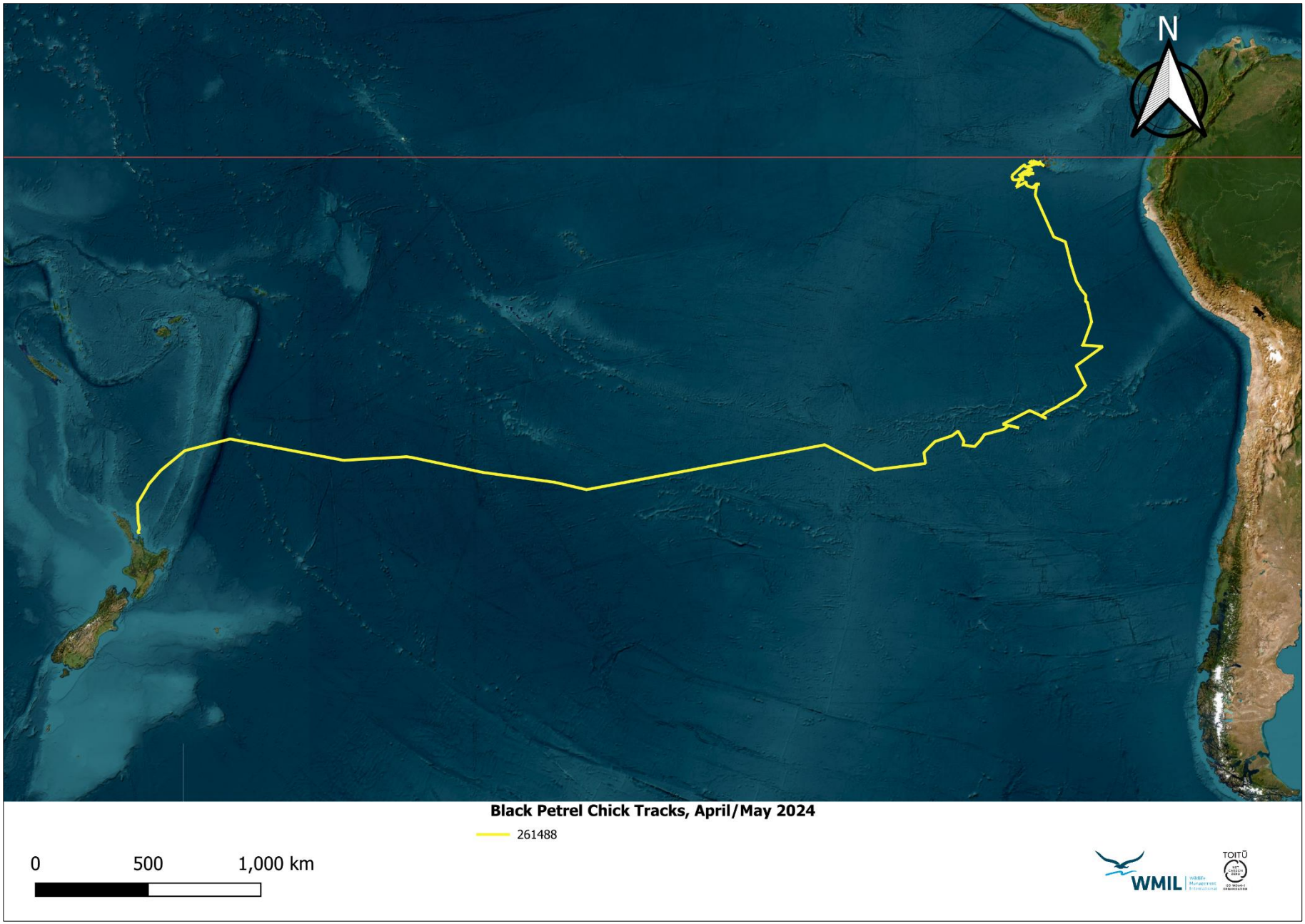
Bell, et al. 2024



Bell, et al. 2024

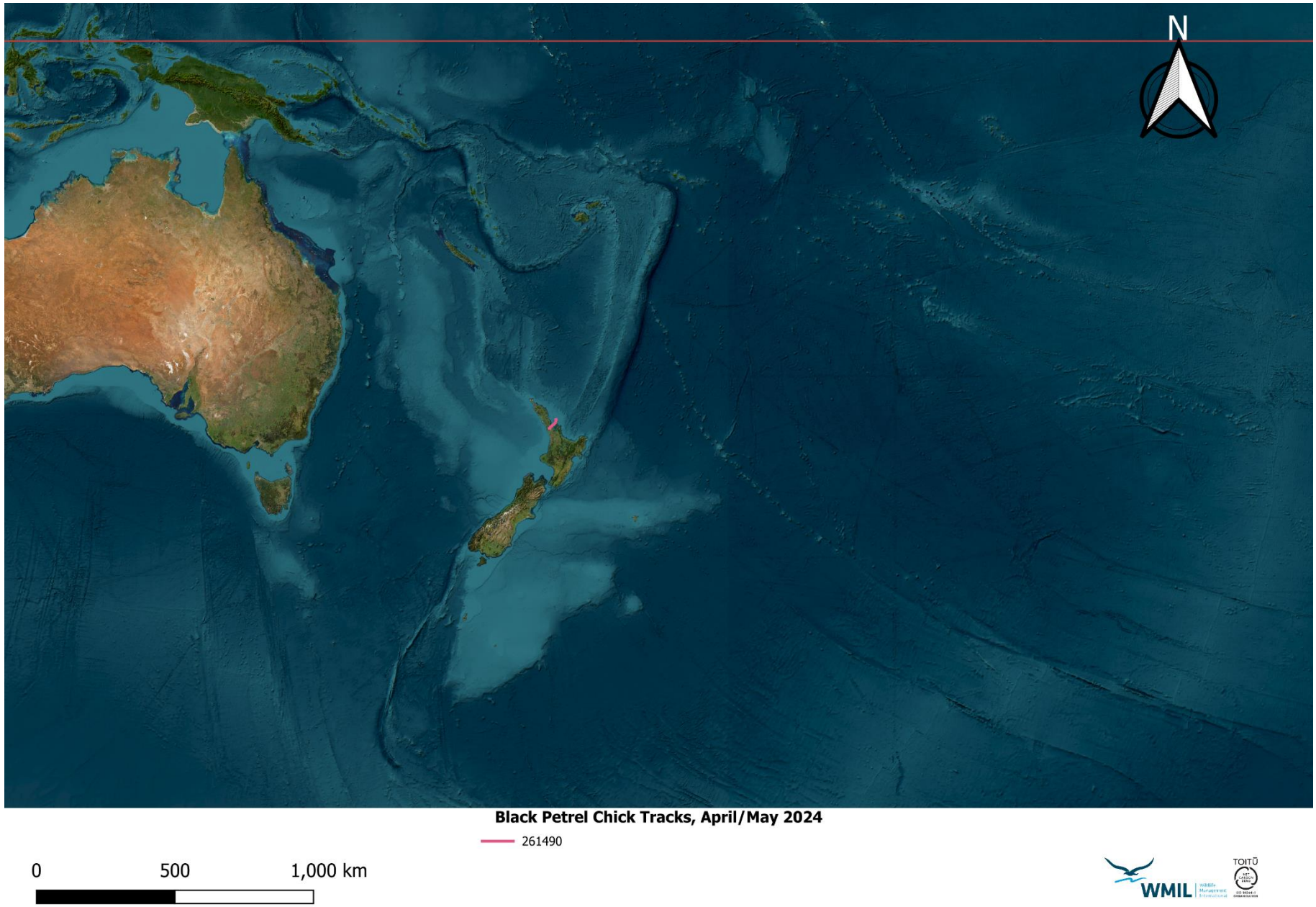
Bell, et al. 2024

Bell, et al. 2024



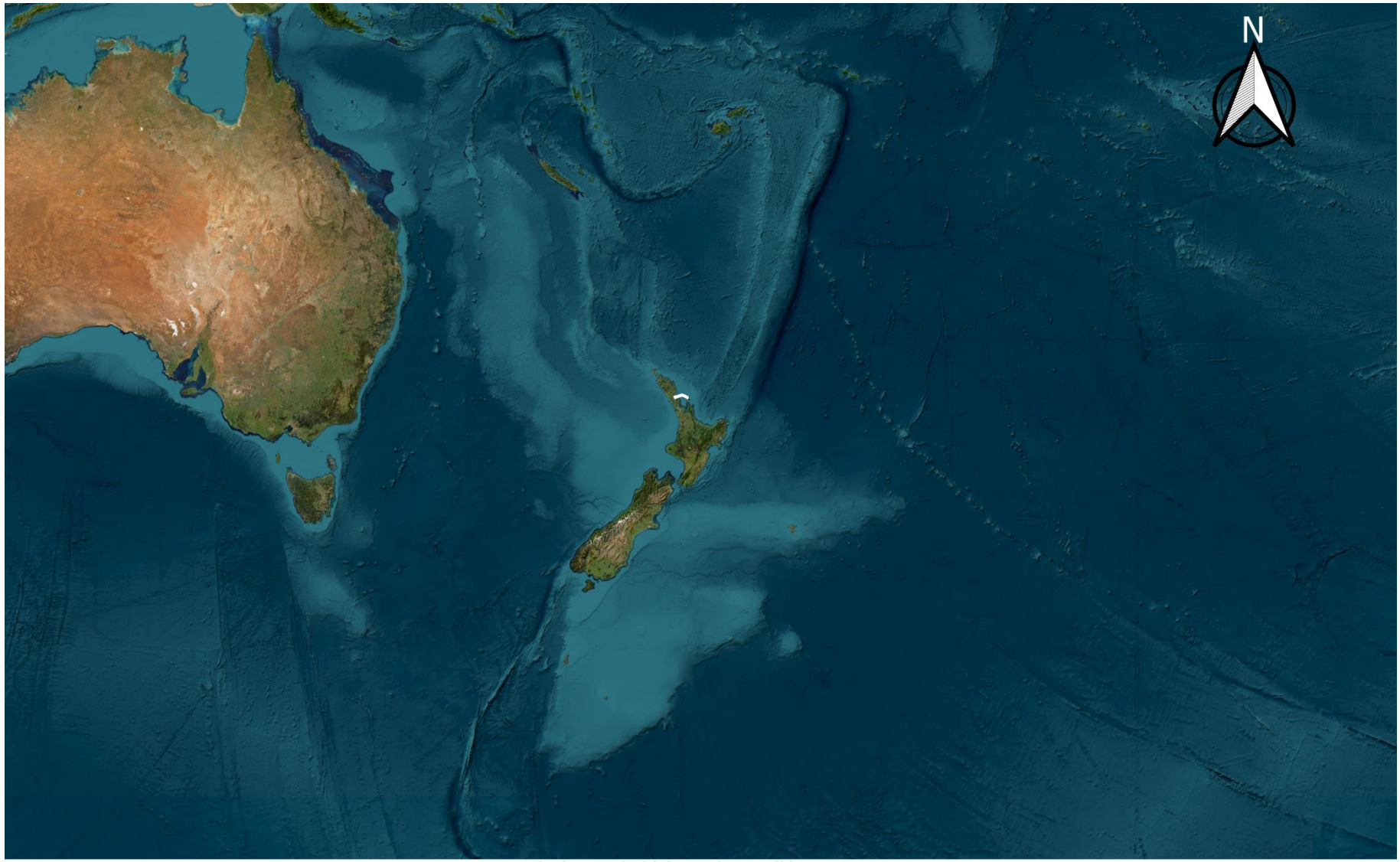
Bell, et al. 2024

Bell, et al. 2024



Bell, et al. 2024

Bell, et al. 2024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Black Petrel Chick Tracks, April/May 2024
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Bell, et al. 2024

Bell, et al. 2024