

# New Zealand sea lion/pakake/ whakahao field research report



Auckland Islands 2023/24

CSP POP 2023-05

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Cover: 2023/24 NZSL field team tagging pups at Sandy Bay, Enderby Island. *Photo: Lydia Uddstrom.*

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# Contents

1	Executive summary.....	5
2	Introduction.....	6
3	Trip logistics.....	7
4	Methods.....	8
4.1	Pup production estimates.....	8
4.1.1	Enderby Island.....	8
4.1.2	Dundas Island.....	9
4.1.3	Figure of Eight Island.....	10
4.1.4	Auckland Islands pup production estimate.....	10
4.2	Pup tagging.....	11
4.2.1	Sandy Bay, Enderby Island.....	11
4.2.2	Dundas Island.....	11
4.2.3	Figure of Eight Island.....	12
4.3	Flipper tag and microchip resightings.....	12
4.4	Terrain trap mitigation.....	13
4.5	Faecal sample collection and processing.....	13
5	Results and Discussion.....	13
5.1	Pup production estimates.....	13
5.1.1	Enderby Island.....	13
5.1.2	Dundas Island.....	15
5.1.3	Figure of Eight Island.....	15
5.1.4	Auckland Islands pup production estimate.....	16
5.2	Pup tagging.....	18
5.2.1	Sandy Bay, Enderby Island.....	18
5.2.2	Dundas Island.....	18
5.2.3	Figure of Eight Island.....	18
5.3	Resightings of tagged individuals.....	21
5.4	Terrain trap mitigation.....	21
5.5	Biodegradable mark-recapture pup cap trial.....	22
5.6	Scat collection.....	23
6	Recommendations.....	24
7	Acknowledgements.....	24
8	References.....	25
9	Appendices.....	27
9.1	Appendix 1: Enderby Island daily direct counts.....	27
9.2	Appendix 2: Dundas Island direct counts and mark-recapture data.....	28
9.3	Appendix 3: Figure of Eight Island direct counts.....	29
9.4	Appendix 4: Auckland Islands pup production estimates, 1994/95 to 2023/24.....	30

# 1 Executive summary

This report summarises fieldwork undertaken by the Department of Conservation Marine Bycatch and Threats team as part of Conservation Services Programme (CSP) project POP2023-05 'Auckland Islands New Zealand Sea Lions' (DOC 2023).

The field team spent a total of seven weeks at the Auckland Islands undertaking the CSP project (9 December 2023 – 22 January 2024); six weeks at Enderby Island, three nights on Dundas Island, and a half day on Figure of Eight Island. Direct counts of pups were undertaken each day that the team were stationed at each of the colonies. At Dundas Island, the team conducted a mark-recapture analysis to determine a pup production estimate. All live pups (297 total) at Sandy Bay, Enderby Island, were double-flipper tagged and microchipped, and 200 pups were double-flipper tagged at Dundas Island.

Resightings of marked (flipper tagged/microchipped) animals of all age and sex classes were collected daily on Enderby Island. Total counts of pups, females, sub-adult males, and adult males were undertaken daily at Sandy Bay, and weekly around Enderby Island.

New Zealand sea lion pup production at the Auckland Islands in 2023/24 was estimated as **1457 ± 19 pups** (mean ± 1 SE), slightly higher than the historic low of 1278 ± 23 pups reported in 2022/23 (Manno & Young 2023). As was the case in the previous season, this year's pup production estimate falls below the minimum level set to trigger reviews of both the [New Zealand sea lion Threat Management Plan](#) (DOC & MPI 2017) and the [Squid 6T Operational Plan](#) (FNZ 2019).

The past two field seasons have reported an unexplained and significant drop from the relatively stable pup production trend over the past decade. This could indicate a temporary reduction in breeding rate, or a decline in adult female survival or fecundity. Further research is needed to determine the cause of the decline and the management implications for the species. The continued lower level of pup production compared to previous seasons supports a review of the effectiveness of current management actions to recover New Zealand sea lions in their subantarctic range.

## 2 Introduction

The New Zealand sea lion/pakake/whakahao (*Phocarctos hookeri*), one of the world's rarest sea lions, is taonga to Ngāi Tahu, and currently classed as Nationally Vulnerable, with a total population estimate of 10,000 individuals breeding on the Auckland Islands/Motu Maha, Campbell Island/Motu Ihupuku, Stewart Island/Rakiura, and the South Island/Te Waipounamu (Baker et al. 2019; Roberts & Edwards 2023).

Approximately 70% of New Zealand sea lions breed at the Auckland Islands, with key populations on Dundas Island, Enderby Island, and Figure of Eight Island. The foraging distribution of New Zealand sea lions at the Auckland Islands overlaps with commercial trawl fishing activity, particularly in SQU6T (the southern squid trawl fishery) and SCI6A (the Auckland Islands scampi fishery), and Fisheries New Zealand (FNZ) report occasional incidental captures of sea lions in these fisheries (Chilvers et al. 2005; Johnston & Childerhouse 2022). The known primary threats to the recovery of Auckland Islands sea lions are *Klebsiella pneumoniae* infection, limitations on food availability causing nutritional stress, and commercial trawl-related mortality (Augé 2010; Large et al. 2019; Meyer et al. 2015; Michael et al. 2019; Roberts & Doonan 2016; Roberts et al. 2018; Roe et al. 2015).

The breeding population of Auckland Islands New Zealand sea lions was estimated to have declined by 40% between the late 1990s and 2008/09, leading to the development of the [New Zealand sea lion Threat Management Plan](#) (NZSL TMP) (DOC & MPI 2017). The NZSL TMP is an initiative led by the Department of Conservation (DOC) in partnership with Te Rūnanga o Ngāi Tahu and FNZ to stabilise and grow the population of New Zealand sea lions until they are classified as "Not Threatened". Both the NZSL TMP and the [Operational Plan to manage the incidental capture of New Zealand sea lions in the southern squid trawl fishery](#) (Squid 6T Operational Plan) (FNZ 2019) set a minimum target of 1575 pups born annually at the Auckland Islands, with values lower than 1575 pups triggering reviews of these documents.

Annual monitoring of New Zealand sea lions at the Auckland Islands includes estimates of pup production, as a proxy for the number of breeding females in the population, and tagging and resighting of marked individuals using flipper tags and microchips for determining survival of specific age and sex classes. The collection of demographic data from the Auckland Islands population is vital to the ongoing assessment of direct and indirect risks to the species from commercial fisheries, as described in fisheries operational plans, and to determine the overall size and vulnerability of the population (Bowen 2012).

Annual pup production at Dundas and Enderby Islands has historically been estimated using a range of methods including aerial and ground-based mark-recapture, marking of all known individuals, and direct counts (Baker et al. 2012; Childerhouse 2012; Chilvers 2012). This year's project objectives were to determine pup production at the Enderby Island, Dundas Island, and Figure of Eight Island colonies, to double-flipper tag, microchip, and measure a subset of pups, and to collect tag resightings to provide survivorship data for demographic modelling (DOC 2023). The team monitored terrain traps at the colonies and reinstated or adjusted ramps to mitigate pup mortality, in support of the NZSL TMP (DOC & MPI 2017). Additionally, the team undertook sea lion scat collection and processing at Sandy Bay as part of a diet study, to support the satellite tracking project undertaken in February 2024 (Uddstrom 2024, [DOC-7597081](#)). Although the team was mainly occupied with sea lion research, some hoiho (*Megadyptes antipodes*) and southern royal albatross/toroa (*Diomedea epomophora*) research tasks were undertaken as time allowed.

### 3 Trip logistics

The schedule of New Zealand sea lion fieldwork was as follows:

- 4 – 7 December: Field team 1 arrive in Invercargill; quarantine and biosecurity activities.
- 7 – 9 December 2023: Field team 1 transit from Bluff to Enderby Island.
- 10 December 2023 – 13 January 2024: Daily direct counts of all sexes and age classes, flipper tag/microchip resightings, terrain trap mitigation at Sandy Bay, and weekly round-the-island surveys; sea lion scat collection and processing; Enderby Island.
- 11 January – 13 January 2024: Field team 2 transit from Bluff to Enderby Island.
- 13 – 16 January 2024: Pup double-flipper tagging and microchip insertion; weighing and measuring of 50 male and 50 female pups; biodegradable cap mark-recapture trial (14 – 15 January); opportunistic necropsies; Sandy Bay, Enderby Island.
- 18 – 21 January 2024: Direct counts of pups, double-flipper tagging 100 male and 100 female pups; weighing and measuring 50 male and 50 female pups; mark-recapture; Dundas Island.
- 18 – 21 January 2024: Daily direct counts of females and pups. Daily resightings of females nursing pups; record female and pup IDs to match pairs; opportunistic necropsies; Sandy Bay, Enderby Island.
- 21 – 22 January 2024: Dundas Island team transferred back to Enderby Island. Conducting inventories, cleaning, and shutting down huts; Enderby Island.
- 22 January 2024: Transit to Figure of Eight Island. Direct counts of live and dead pups; Figure of Eight Island.
- 22 – 24 January 2024: Transit from Figure of Eight Island to Bluff.
- 24 – 26 January 2024: Unpacking, sorting, and cleaning gear; Invercargill.

Field team 1 (Jordana Whyte (Team Leader, Contractor), Dr. Andy Maloney (Contractor), and Dr. Oliver Aughton (Contractor)) departed Bluff on 7 December 2023 on the *Evohe*. Enderby Island was reached on 9 December 2023 and provisions were unloaded onto shore in the early morning, with the *Evohe* departing immediately for Adams Island to stay ahead of the poor weather. The field team began data collection at Enderby Island on 10 December 2023, and returned to the mainland with Team 2.

Field team 2 (Lou McNutt (Team Leader, Contractor), Dr. Lydia Uddstrom (DOC), Dr. Annie Pagé (Contractor), Suzi Flack (Kati Huirapa Rūnaka ki Puketeraki), and Koreana Wesley-Evans (Ōtākou Rūnanga)) departed Bluff 11 January 2024 on the *Evohe*, arriving the morning of 13 January 2024. This allowed for flipper tagging to be completed between 13 – 16 January 2024 at Sandy Bay, with all 297 live pups in this colony flipper-tagged and microchipped.

A team of four (Lou McNutt, Jordana Whyte, Dr. Lydia Uddstrom, Dr. Andy Maloney) landed on Dundas Island in the afternoon on 18 January 2024. The Dundas Island team completed the mark-recapture, direct counts, and flipper tagging of 200 pups (100 male, 100 female), including weighing and measuring 50 pups of each sex. The team had planned to conduct a drone survey trial over the colony at Dundas Island, with the intent of comparing mark-recapture estimates with drone-enabled pup counts, but heavy rain and strong wind conditions meant the trial had to be abandoned. The Dundas Island hut is in critical need of replacement to enable field teams to safely and effectively undertake population counts and tagging.

While the Dundas Island field team was away, the remaining team members undertook daily counts and resightings on Enderby Island, as well as confirming tagged pup-



female pairs at Sandy Bay. Dr. Annie Pagé conducted necropsies on freshly dead pups to contribute to the understanding of pup mortality at the colony (Pagé 2024, [DOC-7640470](#)).

The *Evohe* uplifted the Dundas Island field team on the morning of 21 January 2024 and returned to Enderby Island. Final packing, cleaning, and partial shutting-down of the hut was completed in time for a morning pick up on 22 January 2024.

All team members transited to Carnley Harbour. A small team (Lou McNutt, Dr. Lydia Uddstrom, Dr. Andy Maloney, Dr. Annie Pagé) went ashore in the early afternoon of 22 January 2024 at Figure of Eight Island to conduct direct counts of live and dead pups across the island.

The team docked in Bluff the morning of 24 January 2024. Unpacking, cleaning, and sorting gear at the Invercargill Quarantine Store took place from 24 – 26 January 2024.

## 4 Methods

### 4.1 Pup production estimates

#### 4.1.1 Enderby Island

Pup production on Enderby Island was assessed using three methods: (1) daily direct counts, (2) marking of all known pups using double-flipper tags and microchips, and (3) mark-recapture of pups using biodegradable canvas caps.

Daily direct counts were completed at Sandy Bay from 10 December 2023 to 21 January 2024. Direct counts were undertaken by team members walking through the colony (Figure 1) using hand counters to tally the total number of individuals in each of four defined age-sex classes (pups, females, sub-adult males (SAMs), adult males). Counts were conducted between 09:00 – 12:00 NZDT to avoid disturbing the mass outgoing transit of hoiho across the sward and beach. As the breeding season progressed and the colony increased in size, team members conducted two or more daily counts of females and pups. If animals were disturbed during the count, team members repeated the counts until each team members' counts agreed within 10%. Where each team member undertook multiple direct counts of the same defined age-sex class, the mean was taken across all counts of a defined age-sex class. Direct counts of males ceased on 12 January 2024 to prioritise tagging activities. Female and pup counts continued through to 21 January 2024.

On days when cruise ships visited Sandy Bay, daily direct colony counts were sometimes delayed, depending on the number and movement of the visitors. The delay in undertaking counts was necessary for maintaining the health and safety of the field team.

The round-the-island survey was undertaken by two to three observers once per week for each of the six weeks the team were on Enderby Island. Total counts of New Zealand sea lions by age-sex class and incidental tag resightings were recorded for each segment of the track.



A second pup production estimate at Enderby Island was calculated by direct counting of pups as they were flipper tagged at Sandy Bay between 13 – 16 January 2024.

Enderby Island pup production was also estimated using the mark-recapture method as outlined in Chilvers (2012). White 5cm diameter 100% cotton canvas caps were glued to the heads of pups using Loctite® 454™ glue (Henkel AG & Co. KGaA, Düsseldorf, Germany), as per the New Zealand sea lion and fur seal pup tagging SOP ([DOC-5993453](#)). To reduce plastic waste, canvas caps were used as a trial, with 100 caps glued on 14 January 2024 (c. 40% of last season's pup production total, Manno & Young 2023), a day earlier than scheduled, due to weather conditions. A walk through the colony on the morning of 15 January 2024 indicated that two caps had been lost prior to counts. A minimum total of four counts per observer were undertaken, counting the heads of capped and uncapped pups using hand counters. Mark-recapture estimates were determined using the Lincoln-Petersen estimator (Chapman 1952), as outlined in Chilvers (2012).

Dead animals were counted and where possible dead pups were moved out of the colony to the far end of the beach to avoid being double counted. Cumulative dead pup counts from 10 December 2023 to 16 January 2024 were added to pup production estimates for each of the three methods used. Pups that were tagged and died after 16 January were recorded to adjust database records.



Figure 1. Satellite imagery of Sandy Bay, Enderby Island. Direct counts of defined age-sex classes of New Zealand sea lions (*Phocarctos hookeri*) were undertaken in the yellow shaded area, including the beach and open coastal swardlands.

#### 4.1.2 Dundas Island

Pup production on Dundas Island was determined using two methods: (1) mark-recapture and (2) direct counts.

Dundas Island pup production was estimated using the mark-recapture method as outlined in Chilvers (2012). A total of 300 white 5cm diameter vinyl caps (Canvasland, Levin, New Zealand) were glued to the heads of pups using Loctite® 454™ glue (Henkel

AG & Co. KGaA, Düsseldorf, Germany), as per the New Zealand sea lion and fur seal pup tagging SOP ([DOC-5993453](#)). Pup capping was undertaken on the evening of 18 January 2024. The decision to distribute caps as a stand-alone activity was made due to poor weather forecast for the following day, and in case of an unexpected early uplift from the island. The caps were distributed on the heads of pups around the entire island. One observer walked through the colony on the morning of 19 January 2024 to search for lost caps prior to the mark-recapture counts, with two caps found.

Mark-recapture observations were undertaken on the morning of 19 January 2024 in alignment with previous counts, with each observer counting capped and uncapped pups with hand tally counters three times (n = 12 counts total). Only pups with heads fully visible were counted. Mark-recapture estimates and standard error ( $\pm 1SE$ ) for the Dundas Island colony were calculated using the Lincoln-Petersen estimator (Chapman 1952), as outlined by Chilvers (2012).

Direct counts of live pups at Dundas Island were conducted on the morning of 19 January 2024 by three observers, with three repetitions per observer. Counts were undertaken independently by each observer walking through the colony with hand tally counters.

Dead pups were counted and marked by two observers using Donaghy's Sprayline® (Donaghy's Ltd., Christchurch) on the afternoon of 19 January 2024 to arrive at one cumulative dead pup count. For both the mark-recapture estimate and the direct count estimate, the total number of dead pups counted were added to the live estimates derived to indicate total pup production for Dundas Island using both methods.

No other age-sex classes were surveyed at Dundas Island.

#### **4.1.3 Figure of Eight Island**

The team conducted total direct counts of pups at Figure of Eight Island on 22 January 2024. A single team of four observers completed counts together to ensure their personal safety amongst aggressive males and in wet, slippery conditions. Observers recorded total numbers of live and dead pups.

No other age-sex classes were surveyed at Figure of Eight Island.

#### **4.1.4 Auckland Islands pup production estimate**

Estimates of pup production for each of the colonies were added together to arrive at the total estimate of New Zealand sea lion pup production for the Auckland Islands for 2023/24.

Standard error in the difference of means ( $SEDM = \sqrt{((SE_1)^2 + (SE_2)^2)}$ ) was used to calculate overall standard error for pup counts summed across islands, as outlined by Chilvers (2012).

## 4.2 Pup tagging

### 4.2.1 Sandy Bay, Enderby Island

The field team had a mix of tagging experience prior to the trip, and tagging was conducted to maximise training opportunities for all team members. The most experienced tagger (Dr. Andy Maloney, Level 3) provided advice and direct supervision for all flipper-tagging and microchipping activities. Two team members were considered Level 2 (Jordana Whyte, Lou McNutt), two team members had a significant amount of parallel veterinary experience (Dr. Lydia Uddstrom, Dr. Annie Pagé), and the remainder had no previous tagging experience, although both had some experience with pup restraint (Suzi Flack, Koreana Wesley-Evans, Dr. Oliver Aughton).

The team followed the methods described in the New Zealand sea lion and fur seal pup tagging and sampling SOP ([DOC-5993453](#)) to double-flipper tag and microchip all pups on the beach and sward at Sandy Bay using orange Dalton SuperFlexi® 45mm coffin tags (Dalton Tags, Newark-On-Trent, United Kingdom) and Trovan® ID-162C FDX-B 11.5mm microchips (Trovan Ltd., United Kingdom). All microchips were scanned before and after implantation, using a Gallagher HR5 V2 EID handheld reader (Gallagher Animal Management, Hamilton). Gallagher readers were fully charged each day to ensure optimal operation in the field.

Pup tagging and microchipping was completed at Sandy Bay, Enderby Island, from 13 – 16 January 2024. Tagging on 13 January 2024 was set up as a training session for all staff (n = 31 pups tagged). Some pups tagged on 14 – 15 January (a total of 50 males and 50 females) were weighed to the nearest 0.2kg and measured to the nearest centimetre for total length and axillary girth. The remaining pups were double-flipper tagged and microchipped, but not weighed or measured, on 15 – 16 January 2024. Tagging was completed the morning of 16 January 2024.

Daily sweeps of the colony for untagged pups took place between 17 – 21 January 2024, but no further untagged pups remained. A total of 297 pups were tagged and microchipped at the Sandy Bay colony.

Three tagged pups were subsequently found dead between 16 – 21 January 2024. These pups were not counted in the dead pup cumulative tally as the deaths occurred after 16 January. Post-mortem results for these tagged pups are included in Pagé (2024).

### 4.2.2 Dundas Island

The field team double-flipper tagged a total of 200 pups at the Dundas Island colony on 20 January 2024 using laser-printed yellow Allflex® [Male-Female 29mm Button](#) tags (Allflex, Palmerston North) using the technique described in the New Zealand sea lion and fur seal pup tagging and sampling SOP ([DOC-5993453](#)).

A re-design of the Allflex tagging applicator significantly improved the overall physical effort required to attach flipper tags, speeding up the process, and resulting in less team fatigue compared to the 2022/23 season. Pups were selected opportunistically for tagging, although the team spread this selection effort through the colony as much as possible. The first 50 pups of each sex were weighed to the nearest 0.2kg and measured to the nearest centimetre for total length and axillary girth. Dundas Island pups were not implanted with microchips.

### 4.2.3 Figure of Eight Island

No pups were tagged, microchipped, or measured at Figure of Eight Island.

## 4.3 Flipper tag and microchip resightings

Each day from 10 December 2023 – 21 January 2024, field team members walked the length of Sandy Bay beach to collect resightings of tagged sea lions using binoculars and DSLR cameras, and microchip resightings using a Trovan GR-250 microchip scanner. A Trovan GR-252 scanner was also brought to the island, but a manufacturing defect rendered it unusable, and the team reverted to the GR-250 for the entirety of the field season. The GR-250 scanner was charged daily to ensure optimal performance.

The team walked systematically through the colony each day, scanning sleeping animals for microchips, and photographing and recording flipper tag numbers and colours, tag shape, left/right flipper tag presence, sex, and age class for each tagged animal. Multiple sessions of resightings were conducted on most days, depending on other fieldwork obligations, cruise ship presence, and weather conditions, as well as the activity in the colony. Resighting sessions spanned throughout the day, from as early as 10am to as late as 8pm.

The priority for resightings this field season was to identify females in the colony. The team therefore did their first resighting session of the day as a holistic whole-colony effort of all sea lions regardless of age/sex class. All resighting sessions following focused largely on females. If weather/visitor conditions meant a restricted window for resightings on a given day, then female resightings were prioritised.

For health and safety reasons, the field team did not move through the colony when cruise ship visitors were present on the island. Cameras and binoculars were used from the sward or edges of the colony for these times. Once visitors departed the island for the day, the field team were able to carry out late afternoon or evening resighting sessions in the colony.

Weather conditions also impacted resighting efforts. Rain coupled with strong winds tended to result in highly alert and active sea lions, making it difficult to scan sleeping animals. Wet sand prevented identification of flipper tags, making tag resightings very challenging in these conditions.

Photographs and field notes were reviewed after every resighting session, and to prevent erroneous data, each flipper tag/microchip resight was checked and verified against the Dragonfly Data Science New Zealand sea lion [database](#) record before entry into the resightings spreadsheet. Where flipper tags/microchips were consistently observed in the colony and verified, but did not match existing records in the database, the entries were flagged for correction in the database.

Once tagging was completed on Enderby Island, the resighting effort was focused on confirming female-pup pairings as outlined in New Zealand sea lion fieldwork protocols. Field team members prioritised identification of females actively nursing pups. Additional observation time was required for confidence that females were knowingly nursing their own pups. Microchip or flipper tag numbers of the females were recorded, along with the flipper tag numbers of nursing pups. This specific resight effort took place from 16 – 21 January 2024.

Opportunistic tag resightings were collected at Dundas Island, although opportunity was limited due to time and task constraints.

Additional resighting effort was undertaken on a subsequent trip to Enderby Island in February 2024 (Uddstrom 2024, [DOC-7597081](#)). These resightings were added to the raw resighting data ([DOC-7644973](#)) and are presented in this report.

#### **4.4 Terrain trap mitigation**

Terrain traps at Sandy Bay were surveyed and assessed on 6 January 2024. Self-rescue ramps were added where needed, and the status of each terrain trap was documented. No pups were found in terrain traps; however, the trip did not overlap the known period of vulnerability during which pups venture onto the sward.

Self-rescue ramps were not checked at Dundas Island due to time restrictions. Several pups were found dead in bogs and other wet areas on Dundas Island, but it was unclear if the deaths were due to being trapped, or the pups simply died while in wet areas.

#### **4.5 Faecal sample collection and processing**

Throughout December 2023 and January 2024, Field Team 1 collected and processed faecal samples from the Sandy Bay colony. These samples are being retained to be analysed as part of a future diet study. Most samples were taken from the sward area above and adjacent to the main colony activity on the beach.

Sample collection and processing were scheduled each week to allow for maximum efficiency for the small team, and to allow for adequate soaking time of the samples prior to final processing and storage. A subsample from each scat was collected for DNA metabarcoding, stored in labelled cryotubes, and placed at  $-13^{\circ}\text{C}$  in the LPG freezer on Enderby Island, and then at  $-20^{\circ}\text{C}$  in Invercargill. Hard part remains were retained for each scat sample to allow for identification, quantification, and frequency of occurrence.

## **5 Results and Discussion**

### **5.1 Pup production estimates**

#### **5.1.1 Enderby Island**

Daily counts at Sandy Bay followed historic trends through December 2023 and January 2024, indicating no apparent change in breeding phenology this season. The total number of pups counted at the colony increased to a maximum on 12 January 2024, and remained at a plateau through to 17 January 2024 (Figure 2), whereas the number of females plateaued on 28 December 2023 (Figure 2).

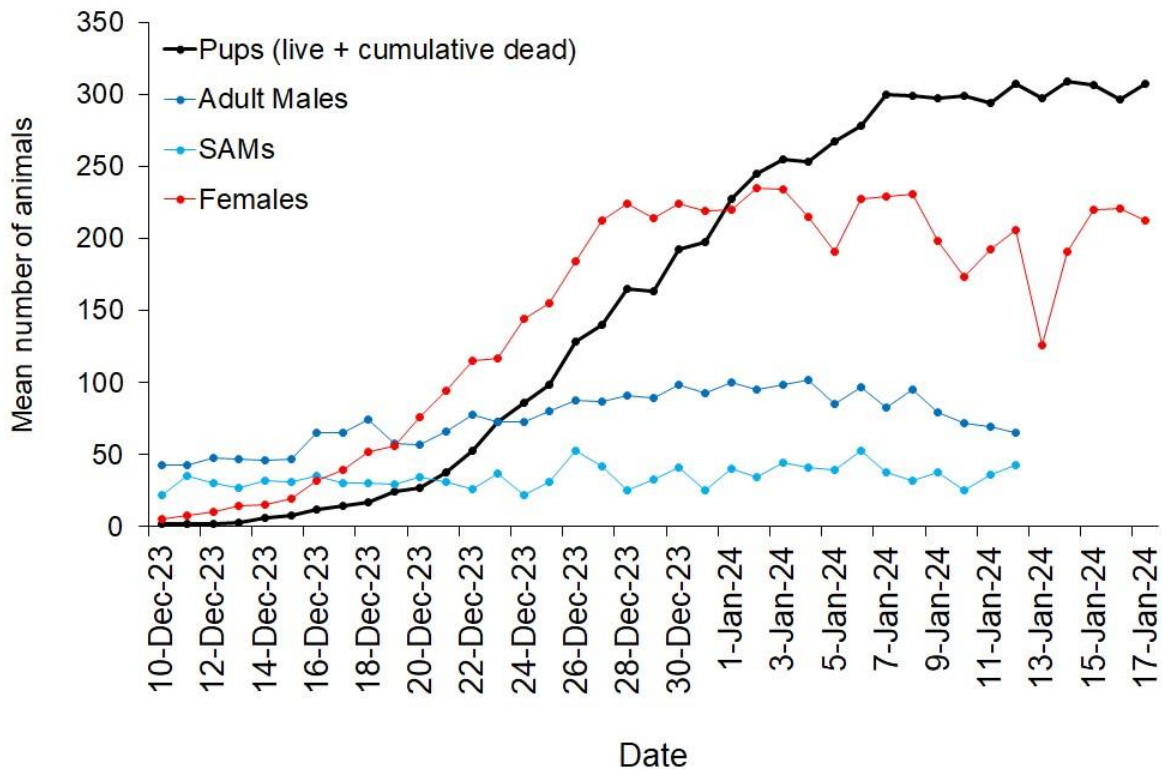


Figure 2. Mean daily counts of each age and sex class of New Zealand sea lions at Sandy Bay, Enderby Island, in 2023/24 (beach and sward combined).

Direct counts of pups at Enderby Island yielded an estimate of  $284 \pm 3$  live pups (mean  $\pm$  1 SE; range = 274 – 290 pups) over 12 – 17 January 2024.

A mark-recapture experiment was undertaken, primarily to assess the effectiveness of biodegradable pup caps as an alternative to PVC, and to familiarise team members with protocols prior to completing a mark-recapture on Dundas Island. The Enderby Island mark-recapture completed at Sandy Bay, with the addition of the cumulative tally of dead pups, yielded an estimate of  $309 \pm 3$  pups.

A total of 297 pups were tagged at Sandy Bay, and the extensive deployment time gave high confidence that all pups at Sandy Bay were tagged. A cumulative total of 21 untagged dead pups found at Sandy Bay was added to the tagged pup total to arrive at the pup production estimate of 318 pups for Enderby Island. As the total number of tagged pups was higher than the mean total count, results derived from tagging were accepted as being closer to the true number of pups born at Sandy Bay.

No pups were found on the weekly round-the-island surveys, although the occasional lone female was sighted outside Sandy Bay (at Derry Castle Reef, Bones Bay, East Bay, and Teal Lake). No females or pups were observed at Pebble Point (“Southeast Point”).

When compared with previous years, the daily counts of females ashore in 2023/24 at Sandy Bay, Enderby Island, remained low, as was observed during 2022/23 (Manno & Young 2023; Table 1). During the peak pupping period, at which time the maximum number of females are found ashore (27 December – 2 January, Chilvers et al. 2007), the mean number of females counted at Sandy Bay this year was the fourth lowest ever recorded in the history of this data set (Table 1).



The raw data from Enderby Island counts are available in Appendix 1 (Table A1.1).

*Table 1.* Mean, minimum, and maximum numbers of females counted daily at Sandy Bay, Enderby Island, between the mean pupping period from 27 December – 2 January, 1997/98 to 2023/24 (1997 – 2012 data from Louise Chilvers, Department of Conservation; 2015 – 2017 data from Simon Childerhouse, Blue Planet Marine; 2018 data from Sarah Michael, University of Sydney).

<i>Season</i>	<i>Mean # females at Sandy Bay</i>	<i>Minimum</i>	<i>Maximum</i>
1997/98	368	355	388
1998/99	342	300	393
1999/00	390	374	413
2000/01	320	303	352
2001/02	316	303	352
2002/03	363	326	388
2003/04	372	335	389
2004/05	294	226	337
2005/06	325	253	355
2006/07	307	289	337
2007/08	308	283	340
2008/09	209	190	225
2009/10	290	264	317
2010/11	318	285	358
2011/12	290	259	325
2015/16	196	186	211
2016/17	258	193	282
2017/18	259	244	278
2022/23	206	162	231
2023/24	221	212	235

### 5.1.2 Dundas Island

After addition of the dead pup tally, mean direct counts at the Dundas Island colony produced a total estimate of  $1133 \pm 8$  pups (mean  $\pm 1$  SE). These results were similar to the mark-recapture, which yielded an estimate of  $1107 \pm 19$  live and dead pups, which was considered the more accurate of the two count methods. For mark-recapture estimates, variance between each operator was assessed using analysis of variance and Tukey HSD tests, and no significant differences between observers were found ( $F(3, 8) = 2.073$ ,  $p = 0.182$ ). The raw data from Dundas Island counts are available in Appendix 2 (Tables A2.1 and A2.2).

### 5.1.3 Figure of Eight Island

Three separate counts were averaged to arrive at a total of  $32 \pm 1$  pups (mean  $\pm 1$  SE) at the Figure of Eight Island colony. This number included six dead pups. The raw data from Figure of Eight Island are available in Appendix 3 (Table A3.1).



#### 5.1.4 Auckland Islands pup production estimate

The total New Zealand sea lion pup production estimate for the Auckland Islands in 2023/24 was **1457 ± 19 pups** (mean ± 1SE, Table 2), which was approximately 13% lower than the pup production estimate from 2021/22 (1686 ± 51 pups, Young & Manno 2022).

Table 2. Auckland Islands pup production estimates for 2023/24 including standard error (± 1SE).

Location	Method	Date	Number of counts (observers)	Cumulative dead pups prior to counts	Live pup production estimate ± 1 SE
Sandy Bay, Enderby Island	Total pups tagged	13 - 16 Jan	1 (8)	21	297
Enderby Island (other)	Mean direct count	9 Dec - 17 Jan	6 (2 - 7)	0	0
Dundas Island	Mark-Recapture	19 Jan	12 (4)	111	996 ± 19
Figure of Eight Island	Mean direct count	22 Jan	12 (4)	6	26 ± 1
Dead and live estimates				138	1319 ± 19
<b>Total pups</b>				<b>1457 ± 19 pups</b>	

For the second season in a row, the Auckland Island pup production estimate fell below the trigger value for review of both the [New Zealand sea lion Threat Management Plan](#) (1575 pups, DOC & MPI 2017) and the [Squid 6T Operational Plan](#) (FNZ 2019) (Figure 3).

Table A4.1 in Appendix 4 summarises the historic pup production estimates from the Auckland Islands since 1994/95. Raw count data from 2023/24 are stored in [DOC-7645557](#).

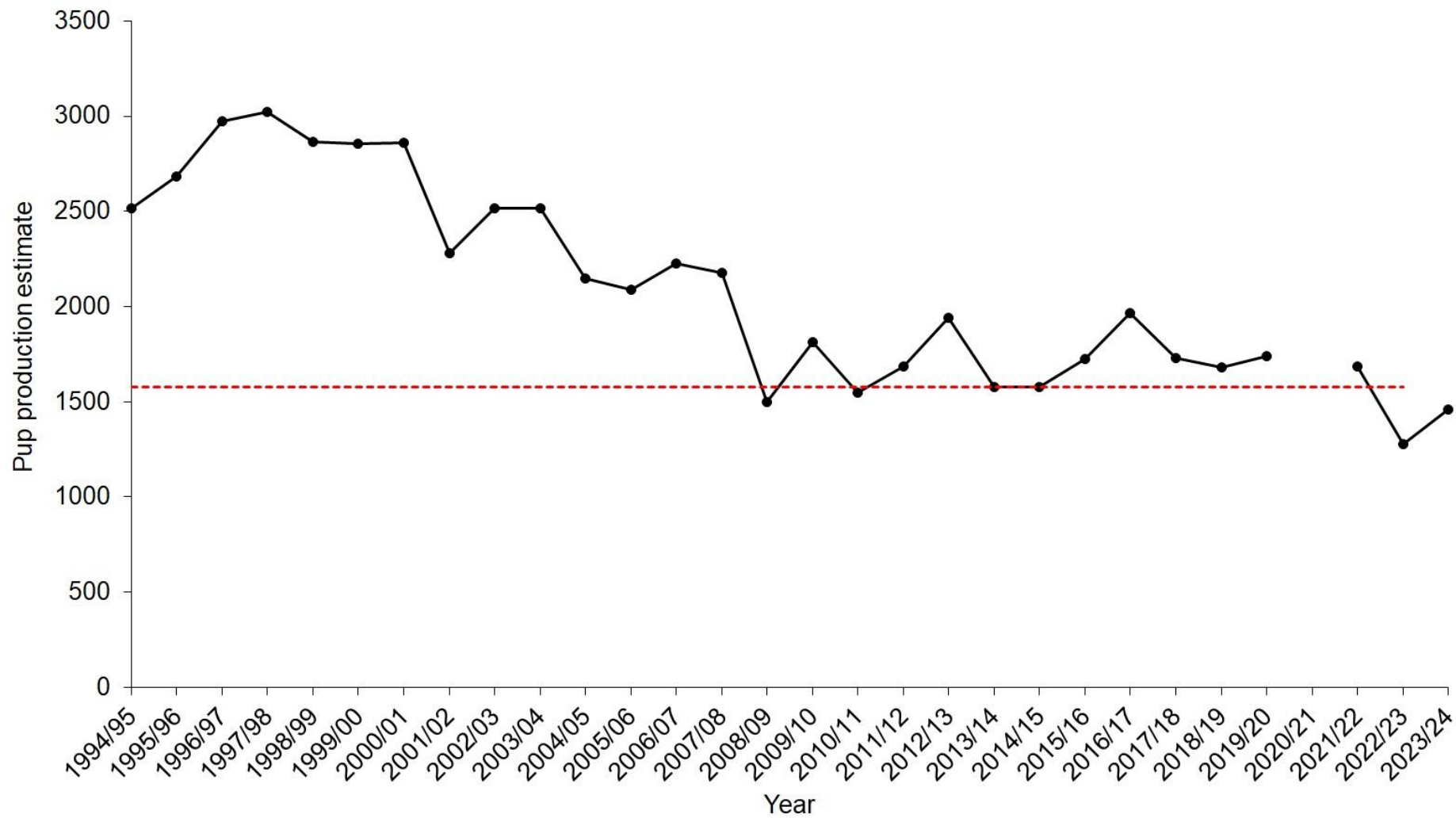


Figure 3. Auckland Islands total New Zealand sea lion pup production estimates 1994/95 - 2023/24. The red dashed line represents the minimum count of 1575 pups set to trigger reviews of the New Zealand sea lion Threat Management Plan (DOC & MPI 2017) and Squid 6T Operational Plan (FNZ 2019).

## 5.2 Pup tagging

All 2023/24 pup tagging data are stored in [DOC-7644637](#).

### 5.2.1 Sandy Bay, Enderby Island

A total of 297 pups were double-flipper tagged and microchipped at Sandy Bay, Enderby Island, between 13 – 16 January 2024 (148 female : 149 male). All live pups found at the colony were tagged. On 14 – 15 January 2024, a total of 53 females and 50 males were weighed and measured at the time of tagging (Table 3). The mean mass of pups and the difference between male and female pup mass were similar to historic measurements taken at this colony, with male pups being approximately one kilogram heavier than females at tagging (Table 3; Figure 4).

Subsequent monitoring from 17 – 21 January 2024 indicated that three tagged pups had died; these deaths were not included in cumulative totals presented in Table 2 as they occurred after the annual pup count on 16 January 2024. Post-tagging pup deaths were investigated as part of a separate necropsy study (Pagé 2024, [DOC-7640470](#)).

Table 3. Mean mass (mean  $\pm$  1 standard deviation) of pups tagged at Enderby and Dundas Islands in January 2024.

<i>Island</i>	<i>Female pup mass in kg (mean <math>\pm</math> 1SD)</i>	<i>Number of female pups measured</i>	<i>Male pup mass in kg (mean <math>\pm</math> 1SD)</i>	<i>Number of male pups measured</i>
Sandy Bay, Enderby Island	10.8 $\pm$ 1.7	53	11.7 $\pm$ 2.0	50
Dundas Island	10.9 $\pm$ 1.8	50	12.1 $\pm$ 2.1	50
<b>Auckland Islands</b>	<b>10.9 <math>\pm</math> 1.8</b>	<b>103</b>	<b>11.9 <math>\pm</math> 2.1</b>	<b>100</b>

### 5.2.2 Dundas Island

A total of 200 pups (100 females : 100 males) were double-flipper tagged at Dundas Island on 20 January 2024, and the first 50 pups of each sex were weighed and measured at the time of tagging (Table 3). The mean mass of pups and the difference between male and female pup mass were similar to historic measurements taken at this colony (Figure 5).

### 5.2.3 Figure of Eight Island

No tagging, microchipping, or measuring took place on Figure of Eight Island in 2023/24.

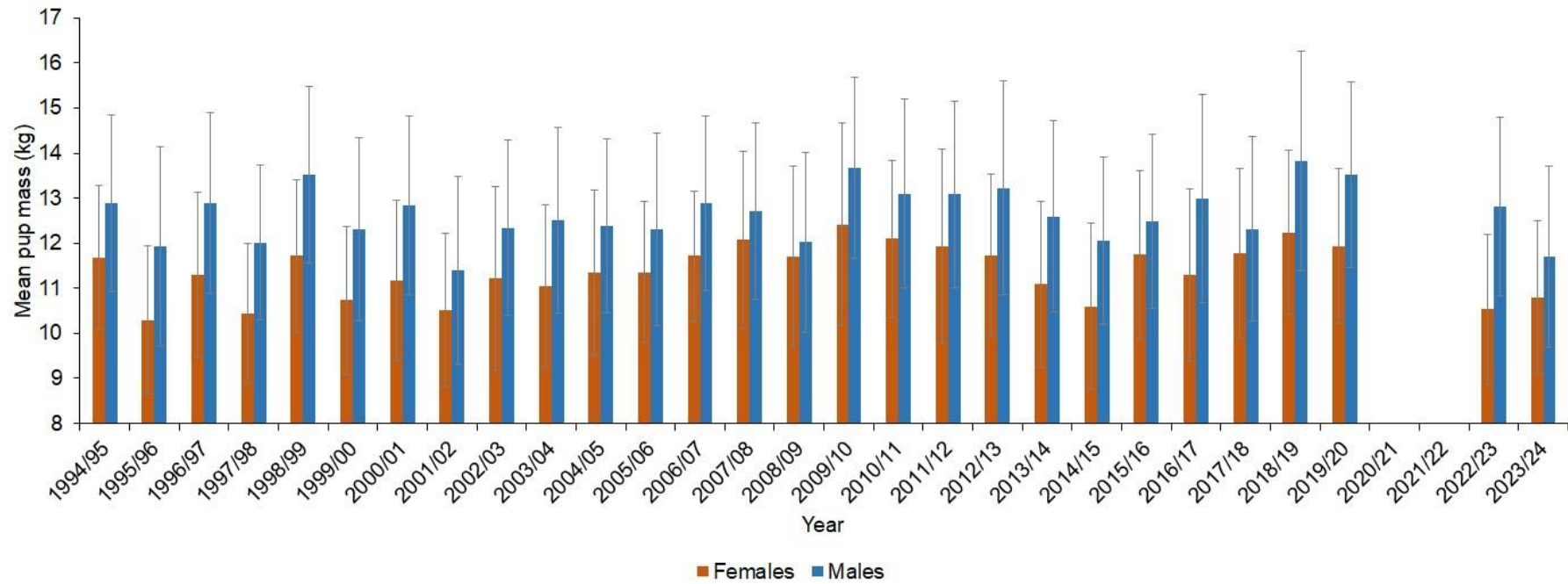


Figure 4. Mean pup mass at tagging (kg) for Sandy Bay, Enderby Island female and male pups (1994/95 – 2023/24). Error bars represent the standard deviation of the mean.

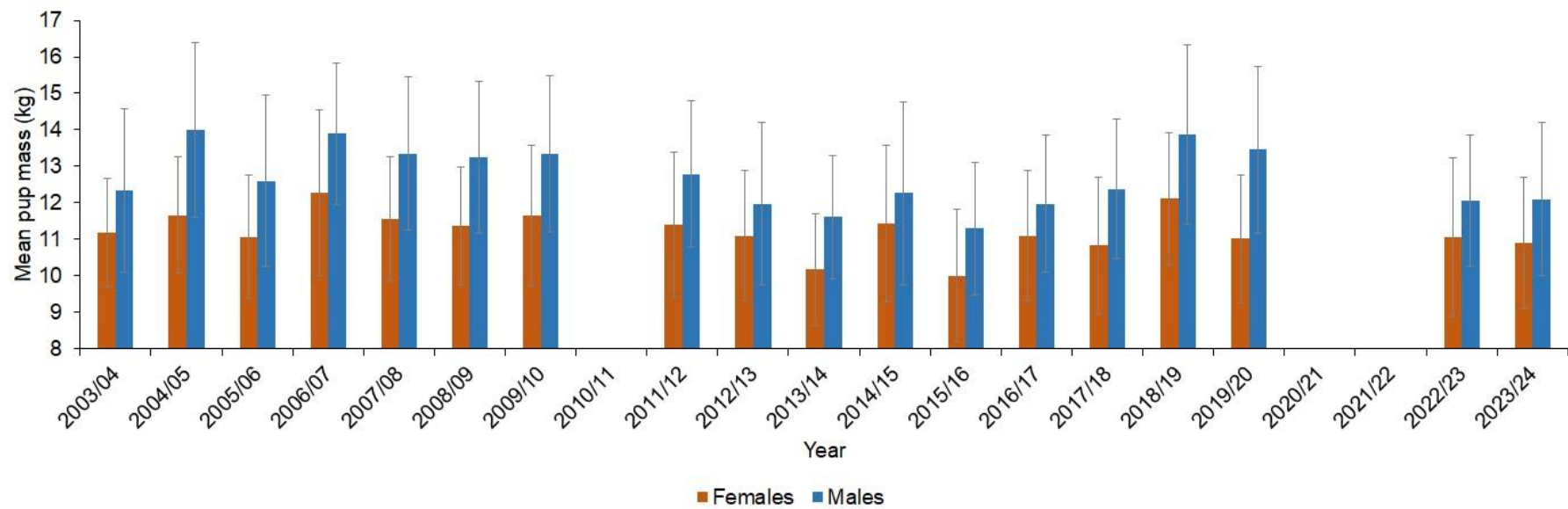


Figure 5. Mean pup mass at tagging (kg) for Dundas Island female and male pups (2003/04 - 2023/24). Error bars represent the standard deviation of the mean.

### 5.3 Resightings of tagged individuals

Resightings were undertaken between 10 December 2023 and 22 January 2024 at Sandy Bay, Enderby Island. A second period of resightings, when females had moved off the beach onto the sward, occurred between 17 – 25 February 2024, when adult females were caught for satellite tag deployments (Uddstrom 2024, [DOC-7597081](#)), and these resightings were added to the raw data. Resighting data will be uploaded to the [New Zealand sea lion database](#) hosted by Dragonfly Data Science and are stored in [DOC-7644973](#).

A total of 1,960 resighting events of 537 individual New Zealand sea lions aged 1+ years (193 males, 344 females) were recorded on Enderby Island. Flipper tag and microchip numbers were able to be verified daily against the Dragonfly Data Science New Zealand sea lion database records. In addition, two adult females were marked during satellite tag deployments; one female had no prior marks, while the other had LO,RO tag loss (Uddstrom 2024, [DOC-7597081](#)).

The total number of resightings was 25% higher than the previous season (1,467 events), resulting in c. 6% more unique animal identifications than in 2022/23 (Manno & Young 2023). The heightened focus on resighting females resulted in a 30% increase in unique female resightings from the previous season (243 unique females sighted in 2022/23, DOC unpublished data), whereas the numbers of males resighted were comparable (cf. 190 males, DOC unpublished data).

Only three animals were resighted on Dundas Island in 2023/24.

On Enderby Island, this season's harems were clustered slightly further from the grassy bank edge that borders the beach. This was advantageous as it allowed field team members a safer buffer to move along the inside of the colony, providing better and closer access to scan females for microchips or to resight tags. The relocation of the harems may in part be related to rainwater draining off the sward and keeping the first metre or so of sand wet. Females and pups seemed wary of resting on the wet sand, and instead inhabited the edge of the colony which tended to be on the dry sand, located more than one metre from the bank.

Resightings in February 2024 allowed for a higher proportion of microchip resightings from females, as they were able to be approached singularly or in smaller groups on the sward. This period was optimal for determining relationships between tagged pups and their dams.

DSLR cameras with large lenses were a valuable tool for flipper tag resightings. Increasingly, flipper tags are wearing and warping, and binoculars are no longer adequate for reading some tags in the field.

### 5.4 Terrain trap mitigation

Terrain trap assessment and mitigation actions are described in a separate report ([DOC-7672396](#)).

## 5.5 Biodegradable mark-recapture pup cap trial

The field team trialled biodegradable mark-recapture pup caps at Sandy Bay on Enderby Island. The caps, made of a white 100% cotton canvas material cut into 5cm diameter caps, had been prepared in 2022/23 but not trialled due to time constraints.

A mark-recapture event is not strictly required for the population on Enderby Island when there is high confidence that 100% of live pups have been tagged. However, trialling the biodegradable pup caps at a suitable site is required so that their efficacy can be monitored. The rationale for using biodegradable pup caps is to reduce pollution from using PVC caps.

The canvas caps were comparable to PVC caps in terms of application technique and approach to pups, however, being less rigid than the PVC caps, this made the application of glue in windy conditions more logistically challenging. A small piece of cardstock was used as a firm base to protect from the wind mitigated this issue. A comparable amount of glue was required for the canvas caps to adhere well to pups' heads as is normally used for the PVC caps. Only two caps were found detached prior to counts, which was attributed to a lack of glue during application rather than an issue with the canvas. Discolouration occurred after several days, changing from white to a tan colour (Figure 6), presumably due to contact with sand, moisture, and other sea lions. This in some ways acted to camouflage the cap close to the pups' natural fur colour and thus it is unclear whether this impacted the team's ability to fully see and count capped pups the day after application. Not all caps were discoloured by the morning of the mark-recapture counts, however, so it was not a uniform effect. The PVC caps used on Dundas Island this season were also white, but did not discolour overnight prior to the counts.



*Figure 6.* This photo, taken at 9:42am on 15 January 2024, shows the discolouration of the white cloth M-R caps after being applied to a pup's head for less than 24 hours. Photo: J. Whyte.



The field team noted that a mix of caps that were fully adhered to pup heads, and some that had significant lifting on the edges (Figure 7). Only three of the eight team members involved in distributing the caps had prior experience in doing so, which may be a factor in poor placement or not utilising enough glue, potentially leading to cap loss or edge lifting. It is unclear if premature lifting of the caps from pups' heads was the result of poor application (i.e. not holding the cap on the pup's head until the glue is set), using less glue than other caps, or due to the canvas caps themselves. Despite these observations, the remainder of the lifting cap surface appeared to be well adhered and not at imminent risk of falling off which might compromise counts.

Some caps were still noted on 21 January 2024, suggesting that, if adhered properly in the first instance, the canvas caps are effectively retained. However, there is typically only a need for the caps to remain adhered for approximately 24 hours.



*Figure 7.* This photo, taken at 9:41am on 15 January 2024, shows the significant edge lift on the pup sitting up. It appears the remainder of the cap is well adhered. The second red arrow pointing to the sleeping pup shows a cap that is fully adhered. Photo: J. Whyte.

## 5.6 Scat collection

A total of 44 scat samples were collected, processed, and returned to the mainland for future analysis. The scat samples were collected on the sward during the harem period, which will bias the samples almost exclusively to adult and subadult males. Female sea lions were largely confined to the beach in their harem groups during this portion of the breeding season, where samples could not be collected safely. Further, the samples will be biased towards non-territorial males for the same reasons.

A further 20 faecal samples were collected exclusively from adult females on the sward in February 2024. These samples have not been processed but have been stored at -20°C for future analysis.

## 6 Recommendations

- Review and implement a new iteration the New Zealand sea lion Threat Management Plan with Te Rūnanga o Ngāi Tahu and Fisheries New Zealand as partners (DOC & MPI 2017).
- Analyse tag resight data from 2022/23 and 2023/24 to investigate any changes in breeding rate or demographics of female New Zealand sea lions observed at Sandy Bay.
- Repeat this population survey in 2024/25, with an increased emphasis on tag resightings to provide quality data for an updated demographic model.
- Update the demographic model for the Auckland Islands New Zealand sea lion population in 2024, including quality resight data from 2022 – 2024.
- Investigate links between the continued low levels of pup production this year with oceanographic conditions and fisheries patterns.
- Conduct tracking of female New Zealand sea lions at Auckland Islands in winter and summer 2024/25, to provide insights into the observed decline in pup production. Determine evidence for nutritional stress from samples collected during tracking.
- Incorporate new information on population size and trajectory into assessment of threats and threat mitigation measures for New Zealand sea lions.

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# 9 Appendices

## 9.1 Appendix 1: Enderby Island daily direct counts

Table A1.1. Mean daily direct count data and standard error (mean  $\pm$  1SE) for all age-sex classes of New Zealand sea lions counted at Sandy Bay, Enderby Island. Mean values were calculated from 1 - 3 observers undertaking multiple counts at the site.

Date	Males	Subadult males	Females	Live pups	Cumulative dead pups	Daily counts # observers (# counts)
10/12/2023	42	22	5	2	0	3 (3)
11/12/2023	43	35	8	2	0	2 (1)
12/12/2023	48	30	10	2	0	2 (1)
13/12/2023	47	27	14	3	0	1 (1)
14/12/2023	46	32	15	6	0	2 (1)
15/12/2023	47	31	19	8	0	1 (1)
16/12/2023	65	35	32	12	0	2 (1)
17/12/2023	65	30	39	14	0	2 (1)
18/12/2023	74	30	52	17	0	2 (1)
19/12/2023	58	29	56	24	0	2 (1)
20/12/2023	57	34	76	27	0	3 (1)
21/12/2023	66	31	94	38	0	3 (1)
22/12/2023	78	26	115	53	0	3 (1)
23/12/2023	73	37	117	73	0	2 (1)
24/12/2023	73	22	144	83	3	3 (1)
25/12/2023	80	31	155	95	3	3 (1)
26/12/2023	88	53	184	124	4	2 (1)
27/12/2023	87	42	212	136	4	3 (1)
28/12/2023	91	25	224	160	5	2 (1)
29/12/2023	89	33	214	158	5	2 (1)
30/12/2023	98	41	224	186	6	2 (1)
31/12/2023	93	25	219	190	7	3 (1)
1/01/2024	100	40	220	220	7	3 (1)
2/01/2024	95	34	235	238	7	3 (1)
3/01/2024	98	44	234	247	8	3 (1)
4/01/2024	102	41	215	245	8	3 (1)
5/01/2024	85	39	191	258	9	2 (1)
6/01/2024	97	53	227	267	11	2 (1)
7/01/2024	83	38	229	289	11	3 (1)
8/01/2024	95	32	231	288	11	2 (1)
9/01/2024	79	38	198	285	12	2 (1)
10/01/2024	72	25	173	287	12	1 (1)
11/01/2024	69	36	192	278	16	3 (1)
12/01/2024	65	43	206	290	17	1 (1)
13/01/2024	n/a	n/a	126	279	18	1 (1)
14/01/2024	n/a	n/a	191	290	19	1 (1)
15/01/2024	n/a	n/a	220	286	20	1 (1)
16/01/2024	n/a	n/a	221	274	22	1 (1)
17/01/2024	n/a	n/a	212	285	22	3 (1)
18/01/2024	n/a	n/a	228	278	22	2 (2)
19/01/2024	n/a	n/a	137	256	22	2 (2)
20/01/2024	n/a	n/a	232	243	23	2 (2)
21/01/2024	n/a	n/a	226	259	24	2 (2)

## 9.2 Appendix 2: Dundas Island direct counts and mark-recapture data

Table A2.1 Dundas Island direct counts of New Zealand sea lion pups on 19 January 2024.

<i>Date</i>	<i>Live pups</i>	<i>Cumulative dead pups</i>	<i>Observer # (count #)</i>
19/01/2024	991		1 (1)
19/01/2024	1044		1 (2)
19/01/2024	993		1 (3)
19/01/2024	1008		2 (1)
19/01/2024	1041		2 (2)
19/01/2024	1051		2 (3)
19/01/2024	1004		3 (1)
19/01/2024	1046		3 (2)
19/01/2024	1024		3 (3)
19/01/2024		111	1 (4)
19/01/2024		111	4 (1)

Table A2.2 Mark-recapture count data for New Zealand sea lion pups from the four observers at Dundas Island on 19 January 2024. A total of 300 pups were capped on 18 January 2024.

<i>Date</i>	<i>Capped</i>	<i>Uncapped</i>	<i>Observer # (count #)</i>
19/01/2024	226	581	1 (1)
19/01/2024	194	484	1 (2)
19/01/2024	185	472	1 (3)
19/01/2024	167	385	2 (1)
19/01/2024	217	474	2 (2)
19/01/2024	184	437	2 (3)
19/01/2024	194	398	3 (1)
19/01/2024	164	323	3 (2)
19/01/2024	153	344	3 (3)
19/01/2024	203	522	4 (1)
19/01/2024	239	527	4 (2)
19/01/2024	228	602	4 (3)

### 9.3 Appendix 3: Figure of Eight Island direct counts

Table A3.1 Figure of Eight Island direct counts of New Zealand sea lion pups from one team of four observers on 22 January 2024.

<i>Date</i>	<i>Live pups</i>	<i>Cumulative dead pups</i>	<i>Total pups</i>	<i>Team # (count #)</i>
22/01/2024	25	5	30	1 (1)
22/01/2024	25	6	31	1 (2)
22/01/2024	27	6	33	1 (3)
22/01/2024	27	6	33	1 (4)



## 9.4 Appendix 4: Auckland Islands pup production estimates, 1994/95 to 2023/24

Table A4.1 Pup production estimates for Auckland Islands New Zealand sea lion colonies 1994/95 - 2023/24. Table copied from Melidonis & Childerhouse (2020). Data prior to 2012/13 from Chilvers (2012), data prior to 2018 from Childerhouse et al. (2018); 2018 - 2023 data from the Conservation Services Programme.

Year	<i>Sandy Bay Enderby Island</i>			<i>Dundas Island</i>			<i>Figure of Eight Island</i>			<i>Enderby Island (other)</i>			<i>Auckland Islands</i>		
	<i>Total pups</i>	<i>Live</i>	<i>Dead</i>	<i>Total pups</i>	<i>Live</i>	<i>Dead</i>	<i>Total pups</i>	<i>Live</i>	<i>Dead</i>	<i>Total pups</i>	<i>Live</i>	<i>Dead</i>	<i>Total pups</i>	<i>Live</i>	<i>Dead</i>
1994/95	467	421	46	1837	1603	234	143	123	20	71	59	12	2518	2206	312
1995/96	455	417	38	2017	1810	207	144	113	31	69	49	20	2685	2389	296
1996/97	509	473	36	2260	2083	177	143	134	9	63	39	24	2975	2729	246
1997/98	477	468	9	2373	1748	625	120	97	23	51	37	14	3021	2350	671
1998/99	513	473	40	2186	1957	229	109	100	9	59	42	17	2867	2572	295
1999/00	506	482	24	2163	2039	124	137	131	6	50	37	13	2856	2689	167
2000/01	562	527	35	2148	1802	346	94	92	2	55	47	8	2859	2468	391
2001/02	403	320	83	1756	1395	361	96	90	6	27	21	6	2282	1826	456
2002/03	489	408	80	1891	1555	336	94	89	5	43	26	17	2516	2078	438
2003/04	507	473	34	1869	1749	120	87	86	1	52	39	13	2515	2347	168
2004/05	411	411	30	1587	1513	74	83	79	4	37	31	6	2148	2034	114
2005/06	422	383	39	1581	1349	232	62	55	7	24	20	4	2089	1807	282
2006/07	437	414	23	1693	1587	106	70	67	3	24	19	5	2224	2087	137
2007/08	448	425	23	1635	1512	123	74	72	2	18	13	5	2175	2022	153
2008/09	301	289	12	1132	1065	67	54	48	6	14	8	6	1501	1410	91
2009/10	385	364	21	1369	1218	151	55	48	7	5	1	4	1814	1631	183
2010/11	378	359	19	1089	952	137	79	71	8	4	2	2	1550	1384	166
2011/12	361	343	18	1248	1189	59	74	72	2	1	0	1	1684	1604	80
2012/13	374	357	17	1491	1364	127	75	70	5	0	0	0	1940	1791	149
2013/14	290	284	6	1213	1141	72	72	62	10	0	0	0	1575	1487	88
2014/15	286	279	7	1230	1163	67	60	47	13	0	0	0	1576	1489	87
2015/16	321	308	13	1347	1221	126	59	53	6	0	0	0	1727	1582	145
2016/17	349	328	21	1549	1415	134	67	52	15	0	0	0	1965	1795	170
2017/18	332	309	23	1397	1340	57		NA	NA	0	0	0	1729	1649	80
2018/19	319	312	7	1295	1240	55	65	60	5	0	0	0	1679	1612	67
2019/20	289	285	4	1398	1353	45	53	27	26	0	0	0	1740	1665	75
2020/21	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
2021/22	341	336	5	1284	1253	31	61	52	7	1	1	0	1686	1643	43
2022/23	268	258	10	960	911	49	51	50	1	0	0	0	1278	1218	60
2023/24	318	297	21	1107	996	111	32	26	6	0	0	0	1457	1319	138