New Zealand sea lion/pakake/ whakahao field research report

Auckland Islands 2022/23

CSP POP 2022-09

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New Zealand Government

Cover: Dundas Island New Zealand sea lion colony. *Photo: Kat Manno*

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Contents

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 POP2022-09 'Auckland Islands New Zealand Sea Lions' (DOC 2022).

The field team spent a total of seven weeks at the Auckland Islands (8 December 2022 – 22 January 2023); 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 the colonies. At Dundas Island, the team conducted a mark-recapture experiment to determine the Dundas Island pup production estimate. All live pups (258 total) at Sandy Bay, Enderby Island, were double-flipper tagged and microchipped, and 200 pups were double-flipper tagged at Dundas Island.

Resights of marked (flipper tagged/microchipped) animals of all age and sex classes were collected daily. 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 2022/23 was estimated as **1278 ± 23 pups** (mean ± 1 SE), 24% lower than the pup production estimate from 2021/22 (1686 ± 51 pups; Young & Manno 2022). 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).

These results describe 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.

These results emphasise the need for continued investment in this monitoring programme, with a view to updating the demographic model for New Zealand sea lions as soon as possible. The change in pup production supports a review of the effectiveness of current management strategies to recover the species.

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, unpublished research). 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 commercial trawl-related mortality, *Klebsiella pneumoniae* infection, and limitations on food availability causing nutritional stress (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 (the 2014 pup production estimate) at the Auckland Islands to trigger 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 resights to provide survivorship data for the demographic model (DOC 2022). Additionally, the team was tasked with monitoring terrain traps at the colonies and reinstating ramps to mitigate pup mortality, in support of the NZSL TMP (DOC & MPI 2017). Although the team was mainly occupied with sea lion population research, some hoiho (*Megadyptes antipodes*) and southern royal albatross/toroa (*Diomedia epomophora*) research was undertaken as time allowed.

3 Trip logistics

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

- 6 – 8 December 2022: Transit from Bluff to Enderby Island.
- 9 December 2022 – 18 January 2023: Daily direct counts of all sexes and age classes, tag resights, and terrain trap mitigation at Sandy Bay, and weekly round-the-island surveys, Enderby Island.
- 12 – 15 January 2023: Pup double-flipper tagging and microchip insertion, Sandy Bay, Enderby Island.
- 16 – 18 January 2023: Direct counts of pups, double-flipper tagging, and mark-recapture, Dundas Island.
- 19 January 2023: Direct counts of pups, Figure of Eight Island.
- 20 – 21 January 2023: Double-flipper tagging and microchip insertion, and tag resights, Sandy Bay, Enderby Island.
- 21 – 23 January 2023: Transit from Enderby Island to Bluff.

The field team (Mel Young (DOC), Kat Manno (DOC), Andy Maloney (Contractor), Jordana Whyte (Contractor), Janelle Wierenga (Massey University)) departed Bluff on 6 December 2022 on the *Evohe* sharing passage with Kath Walker and Graeme Elliott, who were bound for Adams Island. Enderby Island was reached on 8 December and provisions were unloaded onto shore that afternoon before the *Evohe* departed again. The following day was spent cleaning and sorting the hut and outbuildings. The field team also prepared a briefing for the DOC Murihiku team to arrange repairs to the huts in January. Starlink was connected successfully and provided high-speed internet for the duration of the trip. The field team began data collection at Enderby Island on 9 December 2022.

The *Evohe* travelled back to Enderby Island on 15 January 2023 delivering the sixth field team member (Lily Pryor Rodgers, Kāi Tahu/Kāti Māmoe), and the DOC Operations team and Hut Inspector.

After considering a suboptimal weather forecast and with the knowledge that the Dundas Island Apple Hut was of questionable integrity, the decision was made to drop the planned Enderby Island mark-recapture on 15-16 January in favour of using the weather window for Dundas Island counts. A team of four (Mel Young, Kat Manno, Andy Maloney, and Jordana Whyte) landed on Dundas Island in the evening of 15 January to commence direct pup counts and tagging operations there. Dundas Island direct counts, pup tagging, and mark-recapture took place on 16-18 January 2023, and the team was uplifted in haste by the *Evohe* before noon on 18 January as the weather closed in again. While the team were on Dundas Island, the door fell off the Apple Hut and issues were identified with the hut's watertightness, anchors, and substructure. The Hut Inspector made some quick repairs to re-hang the door with new hinges, but stressed that the repair was temporary, and that a more robust fix was required. The integrity of the Dundas Island Apple Hut is a significant concern for ongoing New Zealand sea lion research on Dundas Island.

All six team members landed on Figure of Eight Island on 19 January 2023 and undertook direct counts of pups.

4 Methods

All of the fieldwork undertaken followed the Subantarctic Islands New Zealand sea lion fieldwork protocols 2021 to 2023 (DOC-6855381) and New Zealand sea lion and fur seal pup tagging SOP (DOC-5993453).

4.1 Pup production estimates

4.1.1 Enderby Island

Pup production on Enderby Island was determined using two methods: (1) daily direct counts and (2) marking of all known pups using double-flipper tags and microchips.

Daily direct counts were completed at Sandy Bay from 9 December 2022 to 18 January 2023. 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 to avoid disturbing the mass outgoing transit of hoiho across the sward and beach.

Dead animals were counted and marked with Donaghy's Sprayline® paint (Donaghy's Ltd., Christchurch, New Zealand) to ensure that they were not double counted. Dead pups were moved out of the colony to the far end of the beach.

As the breeding season progressed and the colony increased in size, each team member conducted two or more daily counts of females and pups, ensuring that multiple counts and triggers to re-count were within those stated in the fieldwork protocols (DOC-6855381). 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.

On days when cruise ships visited Sandy Bay, daily direct colony counts were either reduced or not undertaken.

The round-the-island survey was undertaken by 2-3 observers once per week for six weeks. Total counts of New Zealand sea lions by age-sex class and incidental tag resights were recorded for each segment of the track, according to fieldwork protocols.

A second pup production estimate at Enderby Island was calculated by direct counting of pups as they were tagged at Sandy Bay. Total dead pups tallied from the daily colony counts were added to the tagged pup total to arrive at this second pup production estimate.

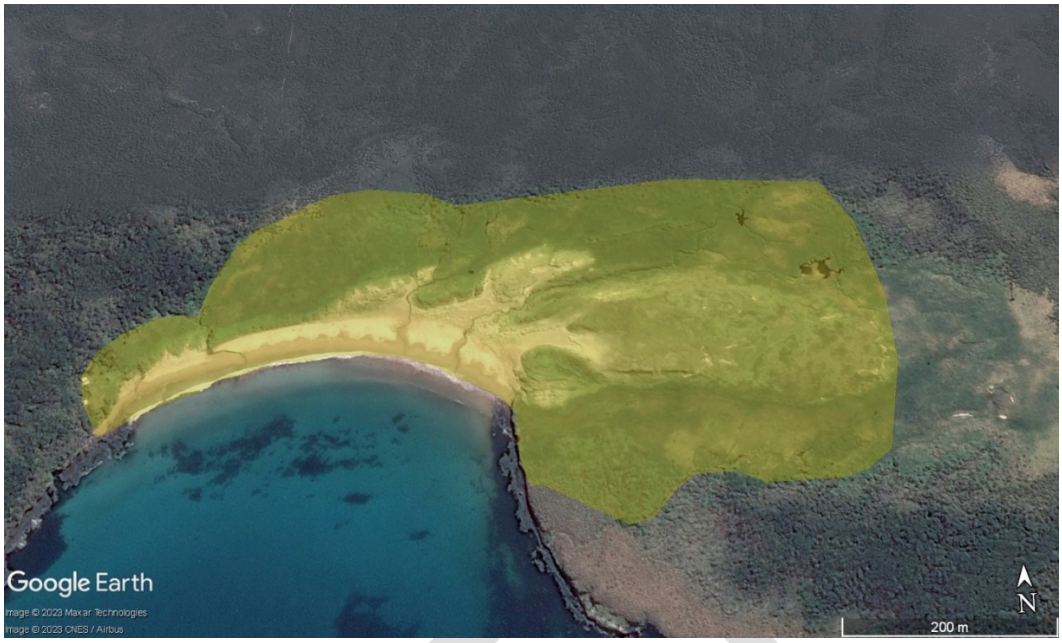

Figure 1. Satellite imagery of Sandy Bay, Enderby Island. Direct counts of defined age-sex classes of New Zealand sea lions (*Phocarctos hookeri*) were undertaken in the yellow shaded area, including the beach and open coastal swardlands.

4.1.2 Dundas Island

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

Direct counts of live pups at Dundas Island were conducted on the morning of 16 January 2023 by three observers, with three repetitions per observer, and on 17 January 2023 with four observers, undertaking one to two repetitions each. Counts were undertaken independently by each observer walking through the colony with hand tally counters. Dead pups at the colony were counted and marked using Donaghy's Sprayline by a single observer on both days to arrive at one cumulative dead count. The mean was taken for all live pup estimates across all observers and was added to the total number of dead pups to arrive at one estimate of total pups determined by direct counts. No other age-sex classes were surveyed at Dundas Island.

Dundas Island pup production was also 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 over two days from 16 to 17 January 2023. The first 200 pups were capped at the same time that they were double-flipper tagged, and a further 100 caps were glued to the heads of untagged pups found throughout the colony on 17 January. One observer walked through the colony at the end of both days to search for lost caps. Due to time limitations and the small size of the Dundas Island colony, the decision was made to reduce the number of caps in the sample from 400 to 300.

Mark-recapture observations were undertaken on the morning of 18 January 2023, 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 (± 1SE) for the Dundas Island colony were calculated using the Lincoln-Petersen estimator (Chapman 1952), as outlined by Chilvers (2012).

Variance between observers was assessed before the mean was taken from all individual mark-recapture estimates. Individual observer variance was assessed, as counts can be inaccurate if observers are distracted during their counts. Variance between each observer was assessed using analysis of variance and Tukey HSD tests, following Young & Manno (2022). Two inexperienced observers undertook trial recaptures the evening before the counts to get their eye in, and these trial counts were not included in the final analysis.

Once the mean of all mark-recapture observations was taken, the total number of dead pups from the direct counts was added to this figure to arrive at the estimate of pup production for the Dundas Island colony.

4.1.3 Figure of Eight Island

The team conducted three colony counts at Figure of Eight Island on 19 January 2023 in teams of 2-3 observers to ensure their personal safety amongst aggressive males. Observers recorded total numbers of live and dead pups; other age classes were not surveyed.

4.1.4 Auckland Islands pup production estimate

The best 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 2022/23.

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 some tagging experience prior to the trip and tagging operations were conducted to maximise training opportunities for all team members. The most experienced tagger (Andy Maloney, Level 3) provided advice and direct supervision for all flipper-tagging and microchipping activities.

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). This was the first year that ID-162C microchips were used, with these microchips being readable by both Trovan LID-575 and Gallagher HR4 and HR5 handheld scanners (Gallagher Group Ltd., Hamilton, New Zealand), but not by the old Trovan GR-250 scanners.

Pup tagging and microchipping at Sandy Bay, Enderby Island started on 12 January 2023 with a comprehensive training session (n = 10 pups) and resumed on 14 and 15 January before the field team relocated to Dundas Island. The pups tagged on 12 and 15 January[1] (a total of 48 males and 41 females) were weighed to the nearest 0.1 kg 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 20 and 21 January 2023.

4.2.2 Dundas Island

The field team double-flipper tagged a total of 200 pups at the Dundas Island colony using laser-printed yellow Allflex® Male-Female 29mm Button tags (Allflex, Palmerston North, New Zealand) using the technique described in the New Zealand sea lion and fur seal pup tagging and sampling SOP (DOC-5993453). The first 50 pups of each sex were weighed to the nearest 0.1kg and measured to the nearest centimetre for total length and axillary girth. Dundas Island pups were not implanted with microchips.

Due to the overall size of the colony and the limited time available, the team reduced the target number of double-flipper tagged pups from 400 to 200. Pups were selected opportunistically for tagging, although the team spread selection effort through the colony as much as possible.

4.2.3 Figure of Eight Island

No pups were tagged at Figure of Eight Island.

4.3 Tag resights

Each day from 9 December 2022 until 15 January 2023, two team members walked the length of Sandy Bay beach from 13:00-16:00 to collect resights of tagged sea lions using binoculars, DSLR cameras, and a Trovan GR-250 microchip scanner. The team walked systematically through the colony, scanning sleeping animals, and photographing and recording tag numbers and colours, tag shape, left/right flipper tagged, and sex and age class for each tagged animal. Opportunistic tag resights were also collected at Dundas Island and Figure of Eight Island.

Photographs and notes were reviewed in the evenings and each tag resight was checked and verified against the Dragonfly Data Science database record before entry into the resight spreadsheet. Where tag and microchip numbers could not be matched with an entry in the database, details were recorded in the resight spreadsheet to ensure data integrity. Where tags were consistently observed and verified at the colony, records were flagged for correction in the database.

1 No measurements were taken on 14 January to replicate the historic Sandy Bay measurement dates as closely as possible.

4.4 Terrain trap mitigation

Terrain traps at Sandy Bay were checked on 11 January 2023. Self-rescue ramps were added where needed, and the status of each terrain trap was documented (DOC-7275892). No pups were found in terrain traps; however, the trip did not overlap the known period of vulnerability during which pups venture into the swardlands.

Self-rescue ramps were not checked at Dundas Island due to time restrictions, but terrain traps at Dundas Island were checked briefly and no pups were found in the traps.

5 Results & Discussion

5.1 Pup production estimates

5.1.1 Enderby Island

Daily counts at Sandy Bay followed historic trends through December 2022 and January 2023, indicating no change in breeding phenology this year. The total number of pups counted at the colony increased to a maximum on 12 January and remained at a plateau through to 17 January 2023 (Figure 2).

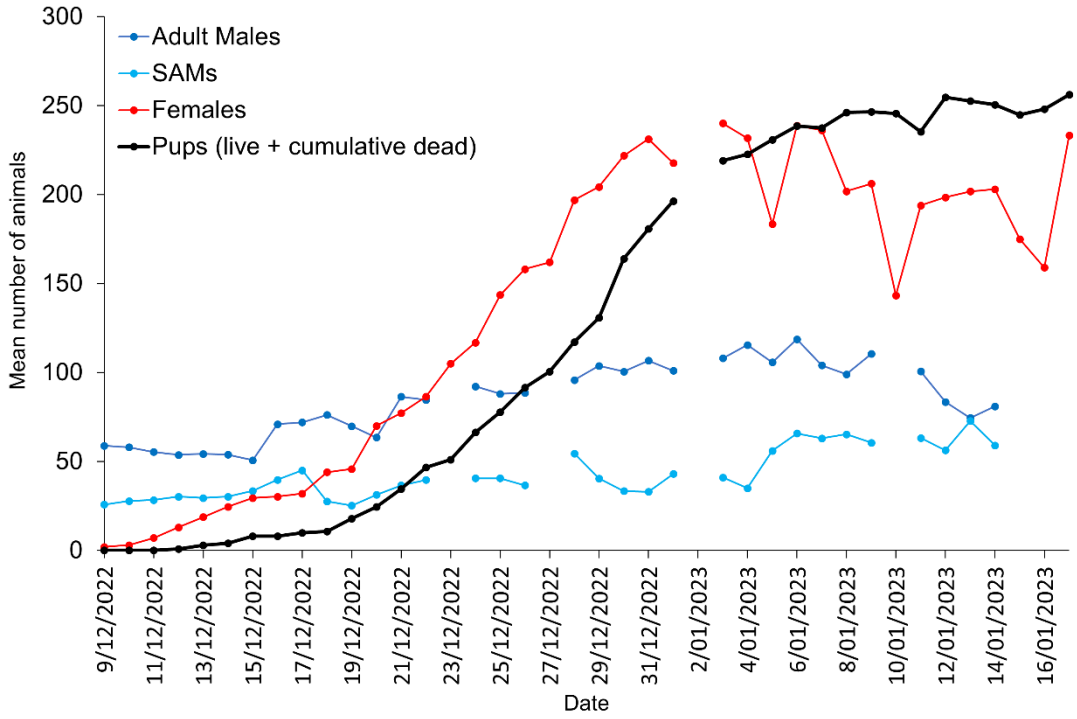

Figure 2. Mean daily counts of each age and sex class of New Zealand sea lions at Sandy Bay, Enderby Island, in 2022/23 (beach and sward combined).

Direct counts of pups at Enderby Island yielded an estimate of 251 ± 2 live pups (mean ± 1SE) over 12-18 January 2023, and a total of 258 pups were tagged at Sandy Bay. A cumulative total of 10 untagged dead pups found at Sandy Bay was added to the tagged pup total to arrive at the **pup production estimate of 268 for Enderby Island**.

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").

From daily direct counts, the total number of pups counted at the Sandy Bay colony on 12 January 2023 (255 ± 6 pups) was the lowest ever recorded in the history of this

monitoring programme. The second-lowest count of pups at Sandy Bay on 12 January was recorded in January 2009 (301 ± 12 pups, Chilvers 2009) (Figure 3).

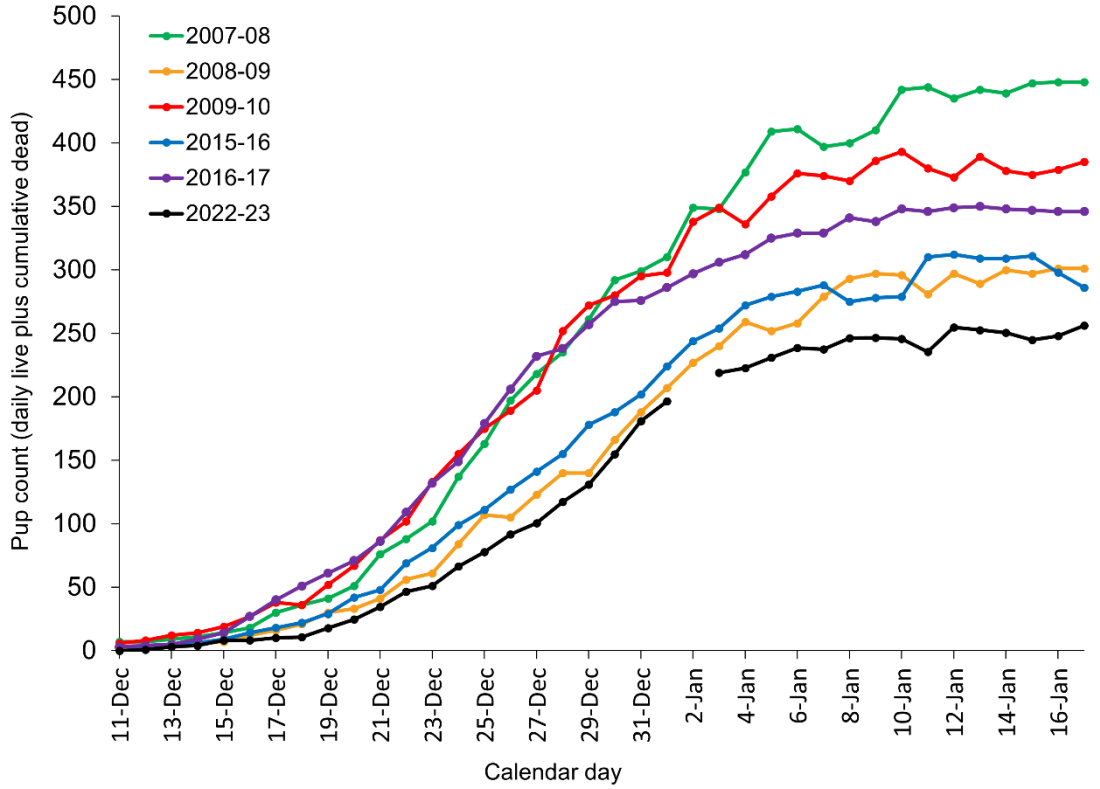

Figure 3. Daily mean count of New Zealand sea lion pups (live plus cumulative dead) at Sandy Bay, Enderby Island, in 2007/08[2], 2008/09, 2009/10, 2015/16, 2016/17 and 2022/23 (2007 – 2010 data from Louise Chilvers, Department of Conservation; 2015 – 2017 data from Simon Childerhouse, Blue Planet Marine).

When compared with previous years, the number of females counted in daily counts in 2022/23 at Sandy Bay, Enderby Island, was also low. 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 second 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).

2 All available data from years with daily counts from December through January in the past 15 years are graphed here; earlier data are omitted for clarity.

Table 1. Mean, minimum, and maximum number of females counted daily at Sandy Bay, Enderby Island between 27 December (mean pupping date) and 2 January, 1997/98 to 2002/23 (1997 – 2012 data from Louise Chilvers, Department of Conservation; 2015 – 2017 data from Simon Childerhouse, Blue Planet Marine).

Season	*Mean # females at Sandy Bay*	*Minimum*	*Maximum*
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
2022/23	206	162	231

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 794 ± 9 pups (mean ± 1SE) and the **mark-recapture yielded an estimate of 960 ± 23 pups**. The team did not find any caps fallen off on the beach or dead capped pups on the morning of the count. One of the observers was concerned that one of their counts was spurious, however, 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 & A2.2).

5.1.3 Figure of Eight Island

Three separate counts were averaged to arrive at a total of **50 ± 1 pups** (mean ± 1SE) at the Figure of Eight Island colony. This number included two dead pups found on the slope below the aggregation of females.

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 2022/23 was **1278 ± 23 pups** (mean ± 1SE, Table 2), which was approximately 24% lower than the pup production estimate from 2021/22 (1686 ± 51 pups, Young & Manno 2022).

Table 2. Auckland Islands pup production estimates for 2022/23 including standard error (± 1SE).

Location	Method	Date	Number of counts (observers)	Cumulative dead pups	Pup production estimate ± 1SE
Sandy Bay, Enderby Island	Total pups tagged	12-21 Jan	1 (6)	10	268
Enderby Island (other)	Round-the-island surveys	9 Dec - 6 Jan	5 (2)	0	0
Dundas Island	Mean Mark-Recapture	18 Jan	12 (4)	49	960 ± 23
Figure of Eight Island	Mean direct count	19 Jan	3 (3)	2	50 ± 1
Total pups				61	**1278 ± 23**

This year's pup production estimate is the lowest ever recorded for this island group and falls below the trigger for review of both the New Zealand sea lion Threat Management Plan (DOC & MPI 2017) and the Squid 6T Operational Plan (FNZ 2019) (Figure 4).

Table A4.1 in Appendix 4 summarises the historic pup production estimates from the Auckland Islands since 1994/95. Raw count data from 2022/23 are stored in DOC-7275706.

New Zealand sea lions of all age and sex classes seen at the Auckland Islands colonies appeared to be in good health this year, and there were no obvious external signs of illness or starvation in adults or pups by the time the field team left in late January. The weather was unusually warm and dry for the duration of the field season and there was only one significant storm event, near the end of the trip.

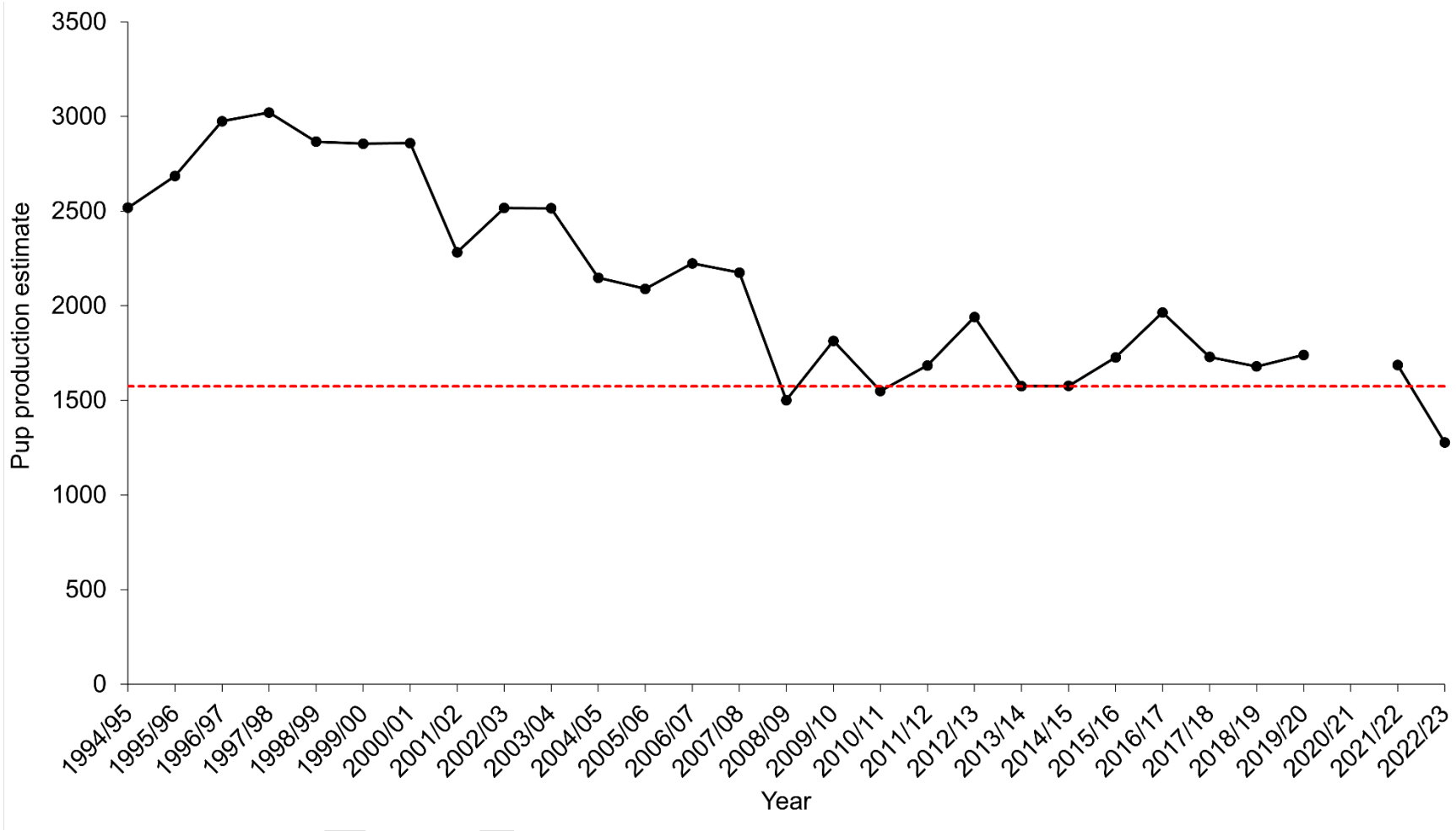

Figure 4. Auckland Islands total New Zealand sea lion pup production estimates 1994/95 – 2022/23. The red dashed line represents the minimum count of 1575 pups set to trigger reviews of the New Zealand sea lion Threat Management Plan (DOC & MPI 2017) and Squid 6T Operational Plan (FNZ 2019).

5.2 Pup tagging

5.2.1 Sandy Bay, Enderby Island

A total of 258 pups were double-flipper tagged and microchipped at Sandy Bay, Enderby Island, on 12-21 January 2023 (117 female : 141 male). All live pups found at the colony were tagged. On 12 and 15 January, a total of 41 females and 48 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 (Figure 5).

Table 3. Mean mass (mean ± 1 standard deviation) of pups tagged at Enderby and Dundas Islands in January 2023.

Island	*Female pup mass in kg (mean ± 1SD)*	*Number of female pups measured*	*Male pup mass in kg (mean ± 1SD)*	*Number of male pups measured*
Sandy Bay, Enderby Island	10.5 ± 1.7	41	12.8 ± 2.0	48
Dundas Island	11.1 ± 2.2	50	12.1 ± 1.8	50
Auckland Islands	**10.8 ± 2.0**	**91**	**12.4 ± 1.9**	**98**

5.2.2 Dundas Island

A total of 200 pups (87 females : 113 males) were double-flipper tagged at Dundas Island on 16-17 January 2023, 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 6).

Pups tagged at Enderby Island had a male-biased sex ratio, and Dundas Island pups, although not a random sample, showed a male bias as well (female: male ratios: Sandy Bay 0.83:1, Dundas 0.77:1).

All 2022/23 pup tagging data are stored in DOC-7275707.

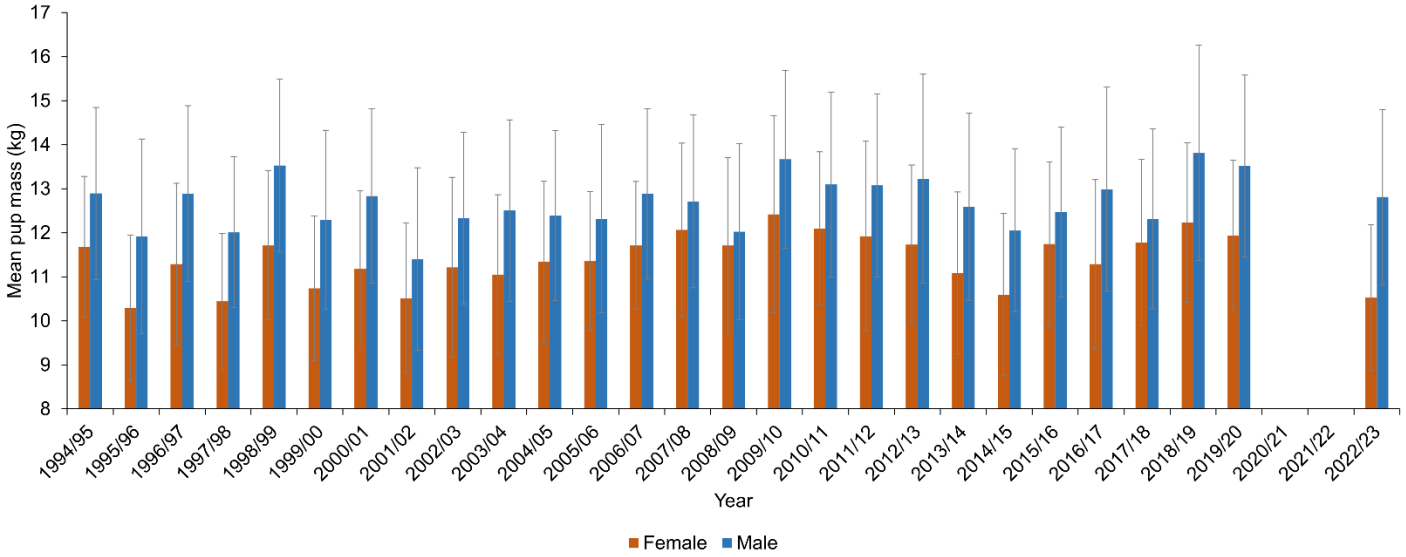

Figure 5. Mean pup mass at tagging (kg) for Sandy Bay, Enderby Island female and male pups (1994/95 – 2022/23). Error bars represent the standard deviation of the mean.

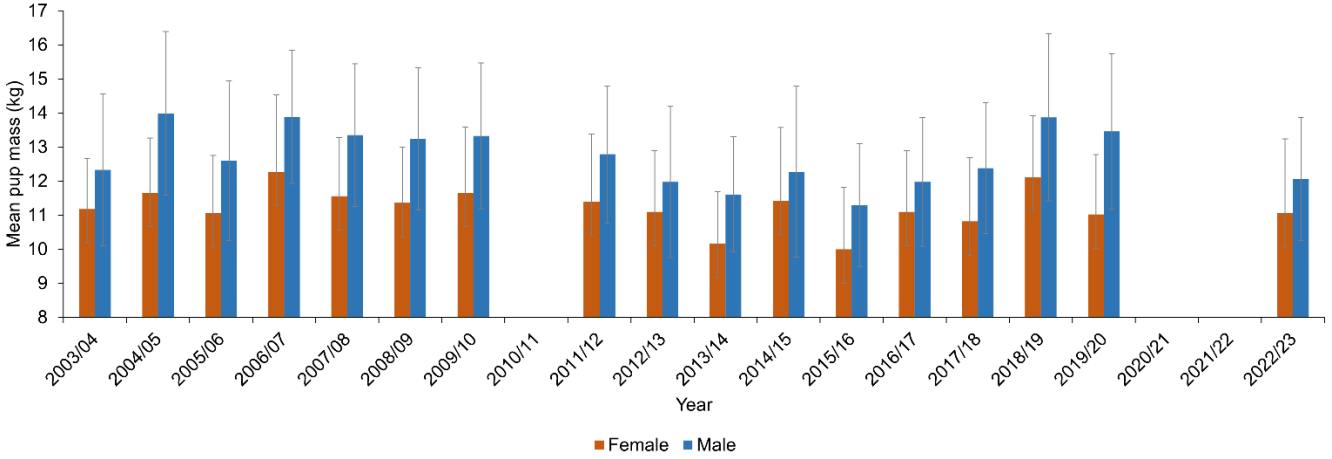

Figure 6. Mean pup mass at tagging (kg) for Dundas Island female and male pups (2003/04 – 2022/23). Error bars represent the standard deviation of the mean.

5.3 Resights of tagged individuals

A total of 1467 unique resighting events of 508 individual New Zealand sea lions were recorded during this trip. The internet connection at Enderby hut increased confidence in the accuracy of resight data, as tag numbers were able to be verified daily against the New Zealand sea lion database records. The team found a total of 15 unique tagged or microchipped animals that could not be matched to records in the database. These errors will be investigated, and records will be corrected in the database as required.

Resight data will be uploaded to the New Zealand sea lion database hosted by Dragonfly Data Science and stored in DOC-7275710.

Of note was a resighting of a 25-year-old female with no tags, microchip# 00-01C0-91A2, originally tagged at Sandy Bay, Enderby Island, in 1998.

5.4 Terrain trap mitigation

Terrain trap assessment and mitigation are described in a separate report (DOC-7275892).

5.5 Biodegradable pup caps

Although the field team had a supply of biodegradable canvas caps, 5cm white vinyl caps were used for the Dundas Island count to ensure maximum retention and visibility over the two-day period, especially considering the poor weather conditions. The canvas caps will be stored for use next season.

6 Recommendations

- Review the New Zealand sea lion Threat Management Plan (DOC & MPI 2017) and Squid 6T Operational Plan (FNZ 2019).
- Analyse tag resight data from 2022/23 to investigate any changes in breeding rate or demographics of female New Zealand sea lions observed at Sandy Bay.
- Repeat this survey in 2023/24, with an increased emphasis on tag resights 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 observed decline in 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, to provide insight into the observed decline in pup production.

- Incorporate new information on population size and trajectory into assessment of threats and threat mitigation measures for New Zealand sea lions.

7 Acknowledgements

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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 ± 1SE) for all age-sex classes of New Zealand sea lions counted at Sandy Bay, Enderby Island.

Date	*Males*	*Subadult males*	*Females*	*Live pups*	*Total pups (live plus cumulative dead)*
9/12/2022	59 ± 1.6	26 ± 0.7	2 ± 0	0 ± 0	0
10/12/2022	58 ± 3.4	28 ± 1.5	3 ± 0	0 ± 0	0
11/12/2022	55 ± 2.5	28 ± 2.3	7 ± 0	0 ± 0	0
12/12/2022	54 ± 4.1	30 ± 1.8	13 ± 0	1 ± 0.3	1
13/12/2022	54 ± 3.1	30 ± 2.2	19 ± 0.3	3 ± 0	3
14/12/2022	54 ± 1.7	30 ± 1	25 ± 0.2	4 ± 0	4
15/12/2022	51 ± 5	34 ± 2	30 ± 0.3	8 ± 0	8
16/12/2022	71 ± 1.3	40 ± 2.1	30 ± 0.3	8 ± 0	8
17/12/2022	72 ± 1.8	45 ± 1.1	32 ± 0	10 ± 0	10
18/12/2022	76 ± 2.7	28 ± 1.6	44 ± 0	10 ± 0.2	11
19/12/2022	70 ± 2.1	25 ± 1.9	46 ± 0.2	17 ± 0.2	18
20/12/2022	64 ± 1.3	31 ± 1.5	70 ± 1.2	24 ± 0.3	25
21/12/2022	86 ± 2.4	37 ± 2.3	77 ± 0.2	34 ± 0.4	35
22/12/2022	85 ± 2.6	40 ± 1.8	86 ± 0.7	46 ± 0.2	47
23/12/2022	No count	No count	105 ± 0	50 ± 0	51
24/12/2022	92 ± 2.6	41 ± 2.2	117 ± 1.8	65 ± 1.2	66
25/12/2022	88 ± 2.3	41 ± 2	144 ± 2	76 ± 1.7	78
26/12/2022	89 ± 1.3	37 ± 1.2	158 ± 3.6	90 ± 1.6	92
27/12/2022	No count	No count	162 ± 2.1	99 ± 2.4	101
28/12/2022	96 ± 3.5	55 ± 5.4	197 ± 1.6	115 ± 1.7	117
29/12/2022	104 ± 4	41 ± 3.8	204 ± 1.9	129 ± 3.3	131
30/12/2022	101 ± 2	33 ± 2.9	222 ± 3.3	162 ± 3.4	164
31/12/2022	107 ± 4.3	33 ± 2.2	231 ± 2	179 ± 2.8	181
1/01/2023	101 ± 0	43 ± 0	218 ± 4.4	194 ± 2.2	196
2/01/2023	No count	No count	No count	No count	
3/01/2023	108 ± 2	41 ± 1	240 ± 3	217 ± 2.3	219
4/01/2023	116 ± 3.6	35 ± 2.1	232 ± 0.3	221 ± 2.3	223
5/01/2023	106 ± 3.1	56 ± 2.8	183 ± 1.3	228 ± 3.8	231
6/01/2023	119 ± 5.1	66 ± 5.8	239 ± 2.3	236 ± 1.2	239
7/01/2023	104 ± 3.2	63 ± 2.6	236 ± 2.7	234 ± 7.5	237
8/01/2023	99 ± 4.6	65 ± 1.4	202 ± 0.7	243 ± 1.4	246
9/01/2023	111 ± 6.5	61 ± 2.5	206 ± 1.5	244 ± 2.5	247
10/01/2023	No count	No count	143 ± 2.3	243 ± 2.8	246
11/01/2023	101 ± 2.1	63 ± 0.8	194 ± 4	231 ± 2.8	235
12/01/2023	84 ± 3.3	56 ± 4.6	199 ± 6.6	250 ± 2.8	255
13/01/2023	75 ± 3.3	73 ± 3.8	202 ± 2	248 ± 3.3	253
14/01/2023	81 ± 0	59 ± 0	203 ± 1.7	245 ± 1.4	251
15/01/2023	No count	No count	175 ± 1.2	239 ± 1.5	245
16/01/2023	No count	No count	159 ± 1.6	241 ± 1.7	248
17/01/2023	No count	No count	233 ± 1.3	245 ± 5.5	256

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

Table A2.1 Dundas Island direct pup counts from four observers on 16-17 January 2023.

Date	*Live pups*	*Cumulative dead pups*	*Total pups*	*Observer (count #)*
16/01/2023	718	44	762	1 (1)
16/01/2023	684	44	728	1 (2)
16/01/2023	786	44	830	1 (3)
16/01/2023	747	44	791	2 (1)
16/01/2023	735	44	779	2 (2)
16/01/2023	700	44	744	2 (3)
16/01/2023	801	44	845	3 (1)
16/01/2023	759	44	803	3 (2)
16/01/2023	747	44	791	3 (3)
17/01/2023	811	49	860	1 (4)
17/01/2023	701	49	750	1 (5)
17/01/2023	749	49	798	2 (4)
17/01/2023	759	49	808	2 (5)
17/01/2023	723	49	772	3 (4)
17/01/2023	769	49	818	3 (5)
17/01/2023	777	49	826	4 (1)

Table A2.2 Mark-recapture count data from Dundas Island on 18 January 2023. A total of 300 pups were capped on 16-17 January 2023. An analysis of variance indicated no significant difference in the variance between observers, however one observer was concerned that their count was inaccurate (indicated with an asterisk*).

Date	*Capped*	*Uncapped*	*Observer*
18/01/2023	115	200	1 (1)
18/01/2023	114	232	1 (2)
18/01/2023	144	274	1 (3)
18/01/2023	116	201	2 (1)
18/01/2023	113	213	2 (2)
18/01/2023	121	267	2 (3)
18/01/2023	131	292	3 (1)
18/01/2023	113	305	3 (2)*
18/01/2023	155	319	3 (3)
18/01/2023	194	355	4 (1)
18/01/2023	205	417	4 (2)
18/01/2023	167	367	4 (3)

9.3 Appendix 3: Figure of Eight Island direct counts

Table A3.1 Figure of Eight Island direct pup counts from two teams of observers on 19 January 2023.

Date	*Live pups*	*Cumulative dead pups*	*Total pups*	*Team (count #)*
19/01/2023	49	2	51	1 (1)
19/01/2023	47	2	49	1 (2)
19/01/2023	47	2	49	2 (2)

9.4 Appendix 4: Auckland Islands pup production estimates, 1994/95 to 2022/23

Table A4.1 Pup production estimates for Auckland Islands New Zealand sea lion colonies 1994/95 – 2022/23. 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.

	Sandy Bay, Enderby Island			*Dundas Island*			*Figure of Eight Island*			*Enderby Isl (other)*			*Auckland Islands*		
Year	*Total pups*	*Live*	*Dead*	*Total pups*	*Live*	*Dead*	*Total pups*	*Live*	*Dead*	*Total pups*	*Live*	*Dead*	*Total pups*	*Live*	*Dead*
1994/95	467	421	46	1837	1603	234	143	123	20 5	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		NA	NA		NA	NA		NA	NA		NA	NA		NA	NA
2021/22	341		5	1284		31	61	52	7	1	1	0	1686		43
2022/23	**268**	**258**	**10**	**960**	**911**	**49**	**51**	**50**	**1**	**0**	**0**	**0**	**1278**	**1218**	**60**