Final Report for CSP Project New Zealand sea lion ground component 2015/16

BPM-16-Final Report for CSP Project NZ sea lion ground component 2015-16 v1.3

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1. Executive Summary

Blue Planet Marine (BPM) was contracted by the Conservation Services Programme (CSP) of the Department of Conservation (DOC) to provide services for the CSP Project New Zealand sea lion (NZSL) ground component 2015/16. The field component of the work was completed on 22 February 2016. This document represents the final report for the project and replaces all previous and preliminary reports. This report also includes components of work that were not directly funded by CSP but separately by DOC and Massey University. They have been included here for completeness.

In summary:

- Pup production was estimated for NZSL colonies at Sandy Bay (n=321), Dundas Island (n=1,347), Figure of Eight Island (n=59) and South East Point (n=0); with total pup production for the Auckland Islands in 2015/16 estimated as **1,727**. The estimate for 2015/16 is 10% higher than for 2014/15 and is 15% higher than the lowest ever estimate for pup production in 2008/09. The steep decline in total pup production seen from 1997/98 until 2008/2009 appears to have leveled off although total pup production is still significantly lower than the peak in 1997/98. Since the lowest ever record of total pup production at the Auckland Islands in 2008/09, pup production has seen annual increases in five of the last seven years and overall production appears to have stabilised at around 1600-1700 pups per annum since 2008/09. While the stabilisation of total pup production is a positive step, it is important to note that pup production in 2015/16 still represents a 43% decline since the peak in 1997/98;
- Estimates of pup mortality to the date of the pup production estimate in mid-January are broadly comparable to previous 'non-epidemic' years. However, these figures do not represent full season surveys and are not directly comparable to data collected prior to 2012/13, and so should be viewed as a minimum. Pup mortality estimates to the date of pup count are: Sandy Bay 4% (to 15 January 2016), Dundas Island 9% (to 18 January 2016) and Figure of Eight Island 10% (to 9 January 2016) and overall for all sites 8%.
- Mean pup weights at Sandy Bay were 13% and 10% higher than 2014/15 for males and females respectively. Mean pup weights at Dundas Island were 8% and 12% lower than 2014/15 for males and females respectively. Mean pup weights at Figure of Eight Island were 2% lower than 2014/15 for both sexes;
- Seven hundred and fifty seven pups were marked at the Auckland Islands including: Sandy Bay – 198 flipper tagged and microchipped, and 110 microchipped only (Note that this was a new protocol implemented in 2014/15 with only approximately 50% rather than 100% of pups being tagged at Sandy Bay); Dundas Island – 400 flipper tagged only; and Figure of Eight Island – 49 flipper tagged only;
- Of the 34 dead pups recovered at Sandy Bay, 33 were in sufficient state for necropsy. Preliminary provisional diagnosis for cause of death includes 61% bacterial infection (suspected with *Klebsiella pneumoniae*), 12% open diagnosis (decomposed, scavenged or no significant findings), 21% starvation, 3% trauma and 3% intestinal perforation. It is important to note that these diagnoses are provisional and will be refined and/or confirmed once full histopathology analysis has been completed at Massey University pending funding;
- Between 11 November 2015 and 20 February 2016, there were a total of 6,667 resights of marked NZSLs of which 6,411 were suitable for use (i.e. contained sufficient information allowing positive identification). Flipper tags were used as the primary form of identification in these resight events (89%), followed by scanning for microchips (7%) and also viewing branded animals (4%). This season represents fewer records than collected in either 2014/15 or 2013/14 collected noting that the 2015/16 field season was shorter by 21% and 42% than 2013/14 and 2014/15 respectively. All resightings were collected on Enderby Island and most (97%) of these

at Sandy Bay. No resights were collected from Dundas Island or Figure of Eight Island due to reduced time available at both these sites;

- In response to previous pup mortality in holes at Sandy Bay, wooden ramps were installed in 2013/14 and 2014/15 in streams and mud holes in order to allow pups to climb out of places where they otherwise would not be able to. This season no dead pups were found in waterways with ramps and from a limited sample of observations at Sandy Bay, 49 pups were observed exiting or were rescued from streams/holes that represented a high or extreme risk of mortality. This was either through the use of active intervention by researchers (n=8) or pups using installed ramps to escape (n=41). Furthermore on Dundas Island, an additional 19 pups were also saved by researchers and/or existing ramps. Overall this programme of work has been very successful and has led to a direct reduction in NZSL pup mortality;
- A considerable amount of additional research was completed including assessment of tag loss, microchip loss, shark scar rates, a preliminary case control study investigating pup mortality and a range of other monitoring projects.

2. Methodology

Blue Planet Marine (BPM) was contracted by the Conservation Services Programme (CSP) of the Department of Conservation (DOC) to provide services for the CSP Project New Zealand sea lion ground component 2015/16.

A full description of methods used in this field study are available in Childerhouse (2015), which is available from DOC. The research outlined here follows almost exactly the same methods as undertaken previously by DOC and as described in Chilvers (2012). Also, dead pups were removed at Sandy Bay whenever possible to allow for autopsy and the determination of cause of death.

Some differences with previous year's research include:

- The mark-recapture estimate on Dundas Island was undertaken one day earlier than in 2014/15 (i.e. 18 January rather than 19 January). The date of the Dundas Island mark-recapture had been set as the 19 January at the request of DOC and agreed to by the CSP Technical Working Group but was moved one day earlier due to limited helicopter availability this year. Prior to 2012/13 the mark recapture at Dundas had been held on 21 January each year;
- While all live pups at Sandy Bay on 16 and 17 January (n=308) were microchipped, only 198 were flipper tagged as well. Prior to 2014/15, all live pups were flipper tagged as well as microchipped. This change was made by DOC, in conjunction with the CSP Technical Working Group, in order to reduce any possible impacts of flipper tagging and is based on an assessment by NIWA that a reduction in the number of individuals tagged is unlikely to reduce the precision of demographic parameters;
- Since 2013/14, detailed records of time spend collecting resighting information have been collected allowing for broad comparison of effort between years; and
- Timing of trips has varied over the 20-year time frame of this long term monitoring project. Since 2012/13, surveys have started in early January in contrast to previous surveys that generally started in early December. The end date of surveys has also varied with 2012/13 ending on 31 January, 2013/14 ending on 11 March, 2014/15 ending on 27 March and 2015/16 ending on 22 February. There were also daily counts undertaken at Sandy Bay from late November 2015. These variations in the timing and length of seasons are likely to influence a range of results including things such as variation in the number of resighting records and estimates of pup mortality.

One researcher was present at Sandy Bay from 11 November 2015. A team of up to six sea lion researchers plus one wildlife vet undertook the counts, tagging, resighting and other work from 9 – 20 January 2016. Three researchers plus a wildlife vet remained on Enderby Island until 22 February 2016 in order to collect resight information and necropsy deceased animals. All dead sea lions found at Sandy Bay from 9 January until 20 February were necropsied and assessed for cause of death whenever possible.

3. Results

3.1 Logistics

The core research team assembled in Invercargill on 3 January 2016 and departed south on 6 January 2016 aboard the *RV Tiama*. A summary of key dates:

- 11 November – One researcher arrived at Enderby Island;
- 6 January – Team of five departed Bluff aboard RV Tiama for the Auckland Islands;
- 8 January – Arrived Enderby Island, Auckland Islands and unloaded all field gear and equipment into the Sandy Bay huts. Reboarded *RV Tiama* for travel to Figure of Eight Island;
- 9 January – Survey & pup count at Figure of Eight Island;
- 10 January – Arrived back at Enderby Island and the team was dropped off;
- 15&16 January – Survey and pup count at Sandy Bay;
- 17&18 January – Survey and pup count at Dundas Island;
- 19 January – Two team members departed for mainland by helicopter;
- 22 February – Remaining four team members departed Enderby Island aboard *RV Tiama*;
- 24 February – Arrived Bluff.

The field work included 46 days on Enderby Island, 3 days on Dundas Island, 1 day on Figure of Eight Island, and no survey effort on any other Island. In addition, there were 58 days of part-time field work at Enderby Island including counts at Sandy Bay and weekly counts/resights around Enderby Island, including South East Point.

The team of researchers undertaking the primary research included: Simon Childerhouse, Chris Muller, Thomas Burns, Rebecca French, Emily Kay. In addition, the following people also provide excellent support in the Auckland Islands: Mark Hindell, Jo Hiscock, Kris Ramm, Richie Robinson and Daniëlle Sijbranda. The data in this report are a credit to the hard work, dedication and expertise of these people.

Figure 1: The New Zealand sea lion research team 2015/16 on Figure of Eight Island. From left to right: Thomas Burns, Mark Hindell (University of Tasmania), Emily Kay, Simon Childerhouse, Rebecca French, Chris Muller

The size of the CSP field team varied throughout the season:

- 11 Dec – 7 Jan: 1 part-time researcher;
- 8 Jan – 19 Jan: 6 researchers; and
- 20 Jan – 22 Feb: 4 researchers.

The team worked very well and achieved all the required tasks.

3.2 General approach and timing of field work

As stated previously, these results follow the methodology previously described in Childerhouse (2015) unless otherwise stated. In order to maintain consistency in data collection, the team planned to conduct work on the same key dates used for previous surveys:

- Figure of Eight Island – the pup census was undertaken on 9 January;
- Sandy Bay, Enderby Island – the mark-recapture was undertaken on 15 (marking) and 16 (recapture) January;
- Dundas Island – the mark-recapture was undertaken on 17 (marking) and 18 (recapture) January. This was one day earlier than 2014/15 and two days earlier than the surveys have been undertaken previously due to a requirement to coordinate with the available helicopter for transport to and from Dundas Island. This change was agreed by the CSP Technical Working Group;
- Sandy Bay – prior to 2014/15 all pups alive at Sandy Bay have been both flipper tagged and microchipped. This year, with a view to investigating and reducing any impacts of research, only approximately half the pups were both flipper tagged and microchipped and the other half were only microchipped.

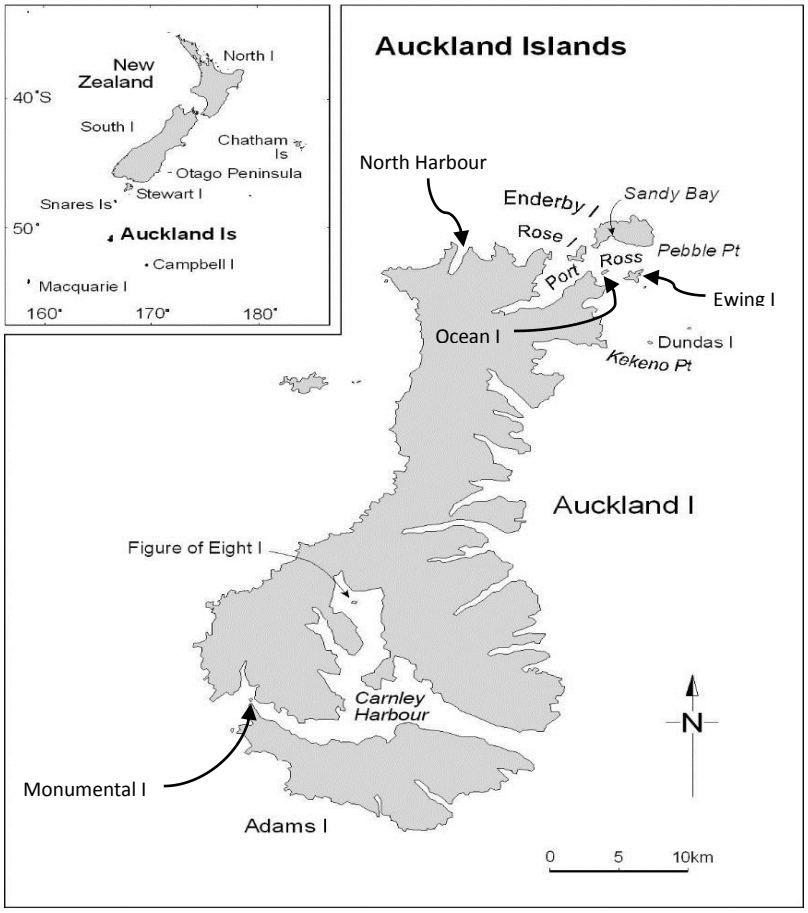

Figure 2: Map of the Auckland Islands showing sites mentioned in the text.

3.3 Estimates of pup production

Annual estimates of pup production for each colony and for total Auckland Islands pup production from 1994/95 until 2015/16 are shown in Appendix 1. Figures showing annual estimates for pup production by colony are shown in Appendix 2.

3.3.1 Sandy Bay, Enderby Island

Table 1: Summary of pup production estimates for Sandy Bay for 2015/16.

Method	Date	No. counts	Start/end time	Estimate (SE)
Mean direct live count	16 Jan 2016	13	08:33/10:15	285 (6)
Cumulative dead count to the day of the mark-recapture	16 Jan 2016	N/A	08:33/10:15	13
Mean mark-recapture estimate	16 Jan 2016	9	08:33/10:15	276 (6)
Total number pups individually marked	15-16 Jan 2016	N/A	N/A	308

Total pup production for Sandy Bay is estimated at **321** (308 live plus 13 dead pups) for 2015/16[1]. This estimate uses the number of live pups tagged on the 16 January rather than the mark-recapture estimate of abundance as it is more accurate. This total is 12% higher than the estimate for 2014/15 which was the lowest total for Sandy Bay since consistent recording began in 1994-95. Figures showing annual estimates for Sandy Bay colony are shown in Appendix 2. Raw data for counts at each of the colonies are provided in Appendix 3.

The estimate of mortality to the 16 January 2016 was 4% which is higher than previous seasons (e.g. ~2%) but noting that this year's estimate represents a complete season count whereas the previous three years were only a count from early January onwards. Ten (78%) of the 13 dead pups counted to 16 January actually died prior to 10 January when the team normally arrives and therefore it is highly unlikely that some of these 10 dead pups would have been unavailable for counting (e.g. lost to decomposition, scavenging, etc.) had the team arrived on 10 January as per usual practice. A preliminary analysis of pup mortality estimates and the start date of field seasons (excluding known mortality event years) gives a mean estimate of pup mortality to 16 January as 5.8% (SE=0.4%) for full season monitoring (2003/04-2011/12; n=9) versus 2.7% (SE=0.7%) for partial season monitoring (2012/13-2014/15; n=3). This suggests that partial season monitoring at Sandy Bay could be underestimating pup mortality to 16 January by at least 50%. While this is not a large number of pups in absolute terms, and therefore will have a small negative impact on total pup production figures, it does appear to provide a negatively biased estimate of mortality.

Estimates of pup production at Sandy Bay were completed successfully. A description of the breeding area searched during pup counts at Sandy Bay is provided in Appendix 4. Nine mark-recapture counts by three people were undertaken and 14 direct counts by four people were undertaken) of live pups (Appendix 3). In addition, a single direct count of live pups was undertaken daily between 11 November 2015 and 22 January 2016 (Appendix 5), but counts of dead pups continued until the team left for the mainland on 22 February 2016.

One hundred and ten caps were used as marks for the mark-recapture and were put out on 15 January (between 08:30 and 16:30) following standard methodology (see Childerhouse 2015). One cap was recovered from the ground prior to starting the mark-recapture counts on the 16 January. The number of marked pups was, therefore, considered to be 109 for the purposes of the mark-recapture estimation (Appendix 3).

[1] Please note that the estimate of pup production at Sandy Bay has always been derived from the estimate from the mark-capture for live pups plus the number of dead pups to that date. This year we have started using the most accurate estimate which is the total number of live pups tagged plus the cumulative number of dead pups to the date of the mark-recapture.

The methodology for estimating the number of dead pups has varied over the years. Prior to 2012/13, all dead pups were counted daily (generally starting early December) and removed from the beach for autopsy throughout the season. This therefore represents a cumulative and complete seasonal count of dead pups. In 2012/13, all dead pups were left on the beach to allow for helicopter aerial surveys to be undertaken to count both live and dead pups, and the first dead counts were made on January 11 when the team arrived with no counts prior to this. Between 2013/14 and 2014/15, all dead pups found on the beach during the first survey on 8 January were counted and removed. Therefore, between 2012/13 and 2014/15, these counts represent incomplete season counts. This year, 2015/16, there was a cumulative and complete count from 11 November 2015 until the team left on 22 February 2016. Overall, it is important to be aware of the different timing and methods used to estimate the number of dead pups at Sandy Bay as incomplete season counts will be underestimates.

3.3.2 Dundas Island

Table 2: Summary of pup production estimates for Dundas Island for 2015/16.

Method	Date	No. counts	Start/end time	Estimate (SE)
Mean direct live count	18 Jan 2016	3	08:49/09:54	1135 (23)
Mean direct dead count	18 Jan 2016	3	09:54/11:05	126 (0.0)
Mean mark-recapture estimate	18 Jan 2016	9	08:54/10:41	1221 (19)
Total number pups tagged	17-18 Jan 2016	N/A	N/A	400

Total pup production for Dundas Island is estimated at **1347** (1221 live plus 126 dead pups). The estimate for 2015/16 was 10% higher than the estimate for 2014/15. Figures showing annual estimates for Dundas Island colony are shown in Appendix 2. Pup mortality to 19 January was estimated as 9%, higher than the 5% recorded in 2014/15. The full data series for pup production at Dundas Island is shown in Appendix 1 and Appendix 2. Raw data for counts at Dundas Island are provided in Appendix 3.

Estimates of pup production at Dundas Island were completed successfully. Nine mark-recapture counts were undertaken by three different people and three direct counts by three different people were undertaken for live pups. Three direct counts of dead pups were undertaken by the whole six-person team working together and all dead pups found were marked with spray paint in order to confirm they had been counted.

Four hundred mark-recapture caps were put out on pups on 17 January on Dundas Island. The approximate location of the pups that were capped is shown in Appendix 6. The aim was to mark approximately 20-25% of the live pups on the day of marking, therefore, caps were put out amongst pups in that approximate ratio (i.e. 1 cap for every 4-5 pups) across the whole area where pups were present. Four hundred caps were put out on 17 January but four caps were recovered from the ground prior to starting the mark-recapture counts on 18 January. The number of marked pups was, therefore, considered to be 396 for the purposes of the mark-recapture estimation (Appendix 3).

3.3.3 Figure of Eight Island

Table 3: Summary of pup production estimates for Figure of Eight Island for 2015/16.

Method	Date	No. counts	Estimate (SE)
Mean direct live count	9 Jan 2016	3	53 (1.2)
Mean direct dead count	9 Jan 2016	3	6 (0.0)
Total number pups tagged	9 Jan 2016	N/A	49

Total pup production for Figure of Eight Island is estimated at **59** (53 live plus 6 dead pups). The estimate for 2015/16 was exactly the same as for 2014/15. Pup mortality to 9 January was estimated as 10% which is lower than recorded for the previous two years (i.e. 22% and 14% for 2014/15 and 2013/14 respectively). The full data series for pup production at Figure of Eight Island is shown in Appendix 1 and Appendix 2. Raw data for counts at Figure of Eight Island are provided in Appendix 3. Figures showing annual estimates for Figure of Eight Island colony are shown in Appendix 3.

Estimates of pup production at Figure of Eight Island were completed successfully. Three direct live counts were undertaken by three different people and three direct dead counts were undertaken by the whole team.

3.3.4 South East Point, Enderby Island

Table 4: Summary of pup production estimates for South East Point for 2015/16.

Method	Date	Estimate (SE)
Direct live count	12 Jan 2015	0
Direct dead count	12 Jan 2015	0
Total number pups tagged	12 Jan 2015	0

Total pup production for South East Point is estimated at **0** (0 live plus 0 dead pups). The estimate for 2015/16 is the same as for 2014/15. The full data series for pup production at South East Point is shown in Appendix 1 and Appendix 2. There was a small group of 14 adult females recorded at South East Point on 23 November but no pups were seen to be born there. The beach at South East Point has changed considerably since there were pups being born – specifically most of the sand that used to be there has been washed away and left small stones and rocks substrate which is a less desirable substrate for NZSL pupping. While these changes have been seen at South East Point, no such changes have been seen at any of the other Auckland Islands colonies.

3.3.5 Total pup production for the Auckland Islands

Overall, total pup production for the Auckland Islands in 2015/16 was estimated to be **1727** pups (1582 live pups and 145 dead pups). This total represents an overall increase of 10% from the 2014/15 estimate. The estimate for 2015/16 is 15% higher than the lowest ever estimate for pup production of 1501 pups estimated in 2008/09. Overall pup production for the Auckland Islands since 1994/95 is shown in Figure 3.

The long term pattern in total Auckland Island pup production shows some clear inflection points in the series with a maximum recorded in 1997/98 and a minimum recorded in 2008/09 (Figure 3). There was a significant increase in the series from when consistent records started in 1994/95 until a peak in 1997/98, followed by a period of significant decline from 1997/98 until a low point in 2008/09. Between 2008/09 and 2015/16, total pup production has varied between 1550 and 1940 with no significant trend either upward or downward over this period (e.g. linear regression: 2007/08-2015/2016, df=7, t=0.34, p=0.74).

The steep decline in total pup production seen from 1997/98 until 2008/2009 appears to have ended. Since the lowest ever record of total pup production at the Auckland Islands in 2008/09, pup production has seen annual increases in five of the last seven years and overall production appears to have stabilised at around 1600-1700 pups per annum since 2008/09 (i.e. mean ± SE: 1671 ± 57 pups (Figure 4). While the stabilisation of total pup production is a positive step, it is important to note that pup production in 2015/16 is still 43% lower than the peak in 1997/98.

While total pup production at the Auckland Islands has been stable since 2008/09, independent modelling work suggests that the total Auckland Island population of mature females is projected to decline over the next 20 years based on recent demographic rates (Roberts & Doonan 2016).

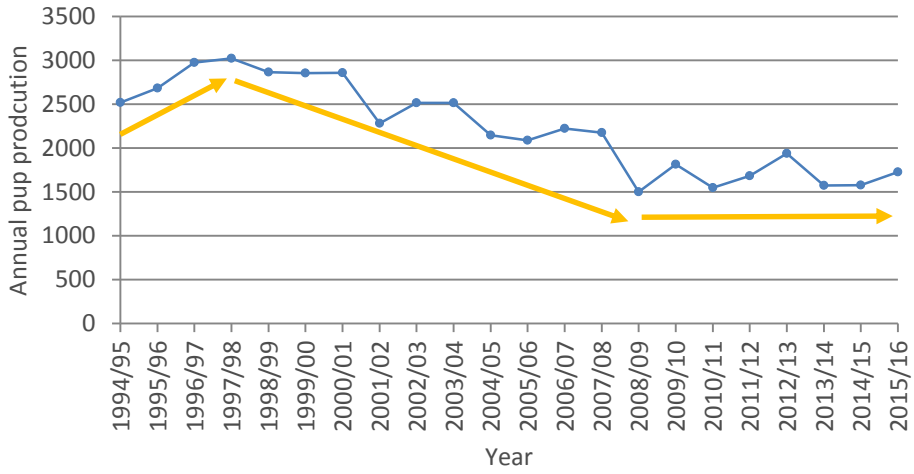

Figure 3: Total estimated pup production for New Zealand sea lions at the Auckland Islands 1994/95 – 2015/16. Yellow arrows provide indicative rates of change in total annual pup production (Data prior to 2012/13 from Chilvers (2012)).

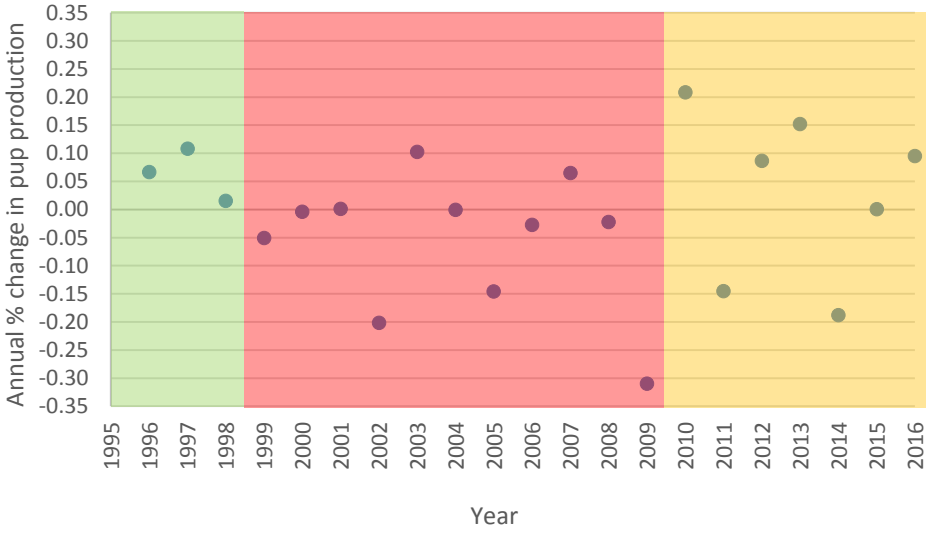

Figure 4: Percentage change in Annual total pup production for the Auckland Islands. Shaded sections represent mean change for that period: green – increase, red – decrease, yellow - stable

3.4 Pup weights

Table 5: Summary of mean pup weights for the Auckland Islands for 2015/16

Location	Mean female weight			Mean male weight		
	n	kg (SE)	Change from 2014/15	n	kg (SE)	Change from 2014/15
Sandy Bay	50	11.7 (1.9)	10%	50	12.5 (1.9)	13%
Dundas Island	50	10.0 (1.7)	-12%	50	11.3 (2.0)	-8%
Figure of Eight Island	27	10.2 (1.1)	-2%	22	11.0 (1.4)	-2%

A random sample of 100 pups (50 of each sex) were weighed at both Sandy Bay and Dundas Island on the same day of the mark-recapture count (16 and 18 January 2016 respectively). For the second year, pup weights were also collected from pups (n=49) at Figure of Eight Island. Mean pup weights from previous surveys at Sandy Bay, Dundas Island and Figure of Eight Island are shown in Figure 5, Figure 6 and Figure 7.

Figure 5: Mean pup weights for Sandy Bay colony by sex 1994/95 – 2015/16

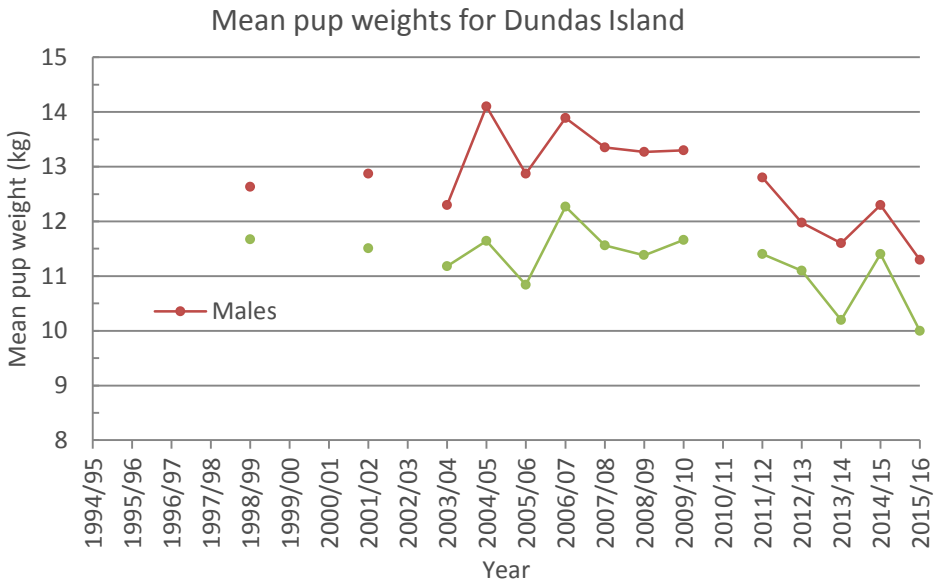

Figure 6: Mean pup weights for Dundas Island colony by sex 1994/95 – 2015/16

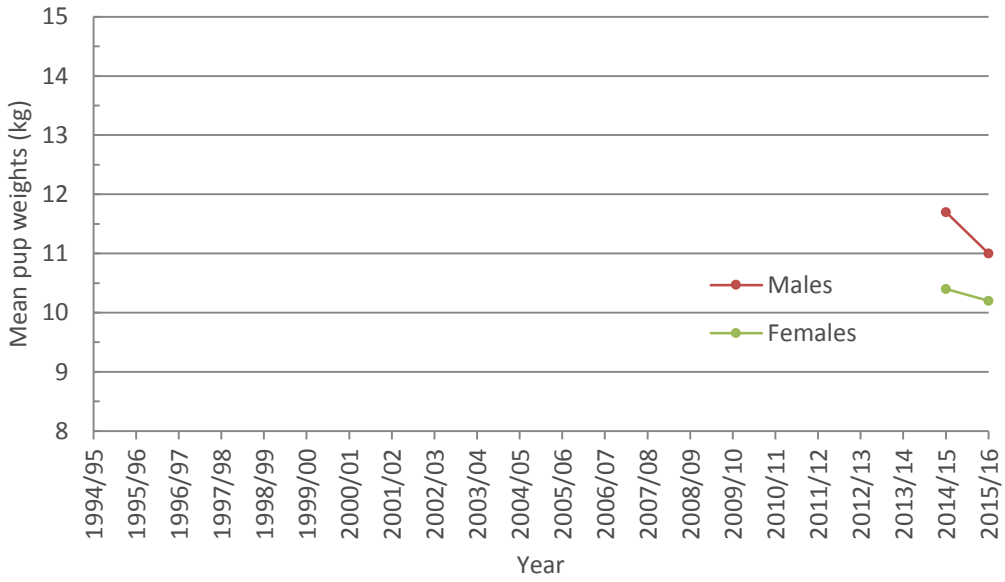

Figure 7: Mean pup weights for Figure of Eight colony by sex 2014/15 – 2015/16.

3.5 Direct counts at Sandy Bay

Direct counts of live and dead pups, adult females, adult and sub-adult males were made at Sandy Bay from 11 November to 22 January 2016 (Figure 8). This is the first year since 2011/12 that there has been a complete count at Sandy Bay since the beginning of the breeding season which includes a cumulative count of dead pups.

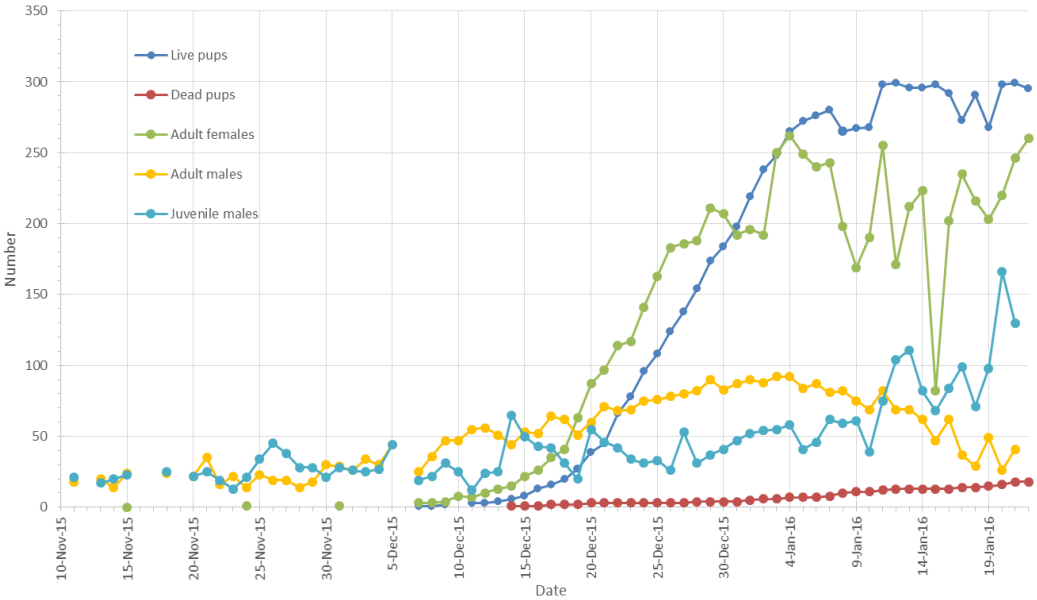

Figure 8: NZ sea lion counts at Sandy Bay, Enderby Island 2015/16

3.6 Tagging and micro-chipping

3.6.1 Number of individuals marked

Flipper tagging and subcutaneous micro-chipping were also undertaken. Summary of pup tagging was:

- Dundas Island – 400 pups tagged (comprising 100 males and 300 females);
- Figure of Eight Island – 49 pups tagged (as many as could be tagged in the time available); and
- Sandy Bay – All live pups on 16 January. 198 pups both tagged and micro-chipped and a further 110 pups micro-chipped only. This is the second time since 1998 that all pups at Sandy Bay have not been tagged although they were all micro-chipped.

3.6.2 Tagging and microchipping review

As part of research this year, we undertook a review of our tagging and micro-chipping covering three main areas.

1. *Microchip retention*: we recaptured a subsample of pups at Sandy Bay that had been microchipped to review microchipping retention rates. From 108 pups recaptured 6 days after chipping, 14 (13%) were found to have lost their chip. This is an area that requires further consideration and we **recommend** that future teams allocate more time and training to microchipping to reduce this loss rate. Given that about 50% of pups at Sandy Bay were microchipped but not tagged this season, this loss represents a significant proportion of the 2015-16 age cohort which is now unidentifiable. We therefore **recommend** returning to both microchipping and tagging of all pups at Sandy Bay, at least until microchip loss rates can be minimised.

2. *Tagging rates amongst population*: We undertook three surveys estimating the proportion of individuals (males and females) at Sandy Bay that had been tagged previously. Only those individuals for which both pectoral flippers could be clearly seen were included in the survey. Results are shown below and represent the number of NZSL counted in each category. Overall,

on average, 58% of all individuals on Sandy Bay had tags or had been tagged previously. It is possible that some individuals that had been tagged and lost both tags may have healed cleanly so that no tag scar was visible but we consider that this is likely to be rare as, in general, tag scars are quite distinctive. Furthermore, we have assumed that our sample represents a random sampling of NZSL but as the sample was collected at a breeding colony during a breeding season, our sample is likely to be biased towards breeding males and females. It is not known if this rate varies amongst the wider non-breeding population and it is likely to be considerably lower at other breeding colonies as the proportion of individuals tagged at those colonies is significantly lower than at Sandy Bay.

Table 6: Summary of all New Zealand sea lions (e.g. tagged, lost tags, never tagged) observed on Sandy Bay for tagging rate and tag loss rate assessment

Survey	Never tagged	Tagged – lost 0	Tagged – lost 1	Tagged – lost 2	Totals
1	155	80	45	65	345
2	124	104	56	63	347
3	98	44	28	38	208
Total	377 (42%)	228 (25%)	129 (14%)	166 (18%)	900

3. *Tag loss rates*: During the same surveys described above, we also investigated what proportion of individuals that had been tagged previously had retained one or more of their tags. Results were that of individuals that had been tagged (n = 523), 228 (44%) had retained both tags, 129 (25%) had lost one tag and 166 (32%) had lost both tags. Overall, 69% of tagged individuals were still identifiable from one or more tags.

   There was a relatively small proportion of tagged animals present (i.e. 39% with either 1 or 2 tags) despite all the pups born at Sandy Bay being double flipper tagged in previous years. The recent practice begun in 2014/15 and continued this year of tagging only 50% of pups at Sandy Bay is likely to result in a significant reduction in the number of tagged animals present in the colony once these age cohorts reach breeding age. Given that tag resights represent 89% of all individual resights, this is likely to result in a significant decline in the number of individuals available for resighting in the future. We therefore **recommend** recommencing tagging 100% of pups born at Sandy Bay beginning in the 2016/17 season.

   When the number of animals with 2 lost tags is considered along with the untagged individuals this represents a significant proportion of the population which is not visually identifiable. We therefore **recommend** investigation of an additional electronic tagging/tracking method to identify individuals at a distance. This would also help to alleviate difficulties caused as tags become worn and unreadable with age.

3.7 Resighting and management of mark data

A total of 6,667 individual flipper tag, brand and microchip resightings were made during the field season. These records do not represent different individuals but rather the total number of all resights collected and includes multiple resights of some individuals. Of these, 256 did not contain sufficient information to identify an individual (e.g. one or more digit missing from the recorded tag number), which left 6,411 records suitable for uploading into the NZSL database.

Of these 6,411 records, most of the resighting records were from flipper tags (n=5,721; 89%) with microchip resighting comprising 7% (n=433) and brands 4% (n=257). Of those individuals for which sex could be determined (91% of all sightings), 67% were records from females and 33% from males.

This season represents fewer records than were collected in previous years, noting that the 2015/16 field season was shorter by 21% and 42% than 2013/14 and 2014/15 respectively. All resightings were collected on Enderby Island and most (97%) of these at Sandy Bay. No resights were collected from Dundas Island or Figure of Eight Island due to reduced time available at both these sites.

Table 7: Summary of New Zealand sea lion resightings for 2015/16 for which identification was possible

Resight type	No.	No. of different individuals	No. of times individuals resighted
Flipper tags	5,721	1,018	1-36
Brands	257	32	1-29
Microchips	433	195	1-10
Total	6,411	1,177[2]	1-36

Some other summary statistics include:

- Mean number of resights per individual sea lion = 5.4 (SE = 0.1);
- Maximum number of resighting per individual sea lion = 36;
- Number of individuals only resighted once = 337;
- Number of individuals identified from 3 methods (i.e. microchip, brand, flipper tag) = 0; and
- Number of individuals identified from 2 methods (i.e. microchip, brand, flipper tag) = 68.

3.8 Resighting effort

Detailed effort information was collected during resighting surveys. Collection of information including start and end of effort, personnel undertaking it, location and weather conditions. A sample of these data is available in Appendix 7. Figure 9 shows the number of sea lion resighting records collected by the whole team per day and Figure 10 the total number of hours of resighting effort undertaken by the whole team per day. Figure 11 is the number of resighting records collected in a day weighted by the total number of hours of resighting effort on that day.

Interpretation of these data can be complex and data will be influenced by a range of factors such as:

- The size of the field team which can vary through the season (e.g. for 2015/16: 11 November – 9 January: 1 part-time person; 10-19 January: 5 people; 20 January – 20 February: 4 people), which should be accounted for when considering relative effort;
- Experience of the field team which can vary across the field season;
- Gaps in these data series generally coincide with either very bad weather days (when resighting is not possible) or days when other research is being undertaken (e.g. mark-recaptures, tagging);
- Sea lion behaviour will also influence the ability to collect resights (e.g. early in the season adult males are strongly territorial and it is difficult to get close to collect resights; later in the season, once breeding has ceased, young sea lions that are generally more approachable return and are easily resighted);
- Location of resighting effort (e.g. when resighting during peak breeding season there could be 800 individuals on the beach available for resighting but during a 6 hour walk around the Island at the same time to search other areas may only yield a handful of resighting records but the effort is the same); and

[2] Note that this total isn't the sum of the total number of individuals identified by each method as some individuals were identified from more than one method but are only counted once towards the total number of unique individuals recorded.

- Relevant work priorities can vary both within and between seasons meaning that more or less effort is allocated to resighting.

The number of resights collected per day is therefore a function of and range of variables including effort (i.e. time spent) but is also a function of other factors including weather, colony density (e.g. tightly packed on the beach versus spread out on the sward and forest), number of marked individuals available for sighting and individual animal behaviour (e.g. territorial versus dispersed). These additional factors are difficult to assess and therefore the interpretation of sighting data should not be confined to resighting effort alone.

Figure 12 is a summary of the cumulative number of resighting records collected through the season and is provided with similar data collected during previous years. Given the caveats above, it is important to bear in mind differences between seasons when making direct comparisons.

A key element of this research was to ensure that data were collected in an accurate and robust fashion and that they are provided in an electronic format suitable for upload into the NZSL database. All of the groomed and reviewed data have been uploaded into the NZSL database and are available online[3] as open access information.

[3] http://data.dragonfly.co.nz/nzsl-demographics/

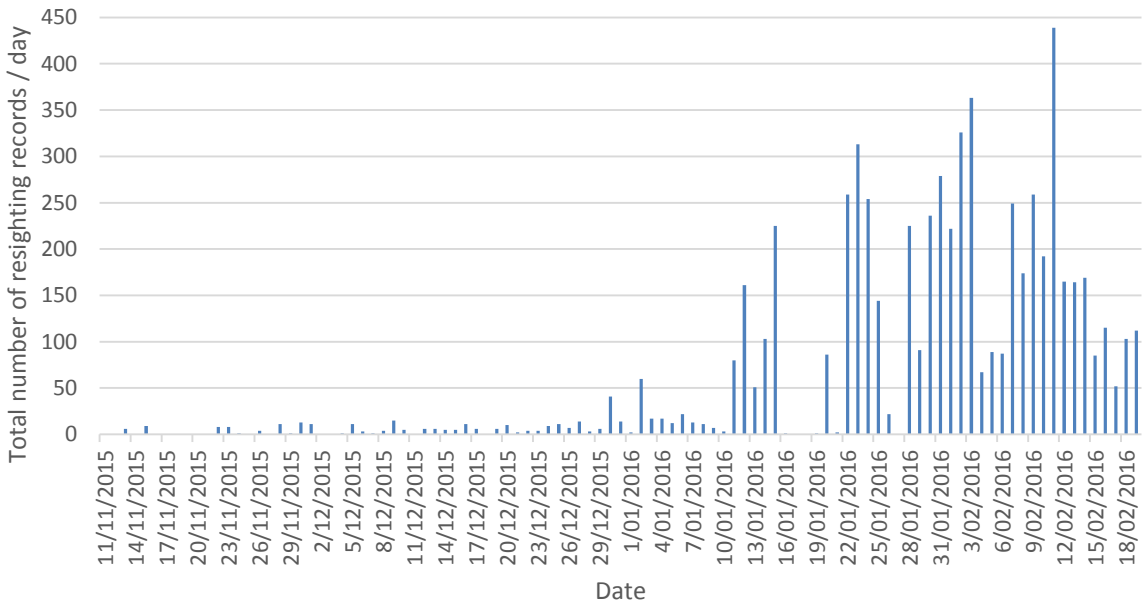

Figure 9: Number of individual resighting records collected per day in 2015/16

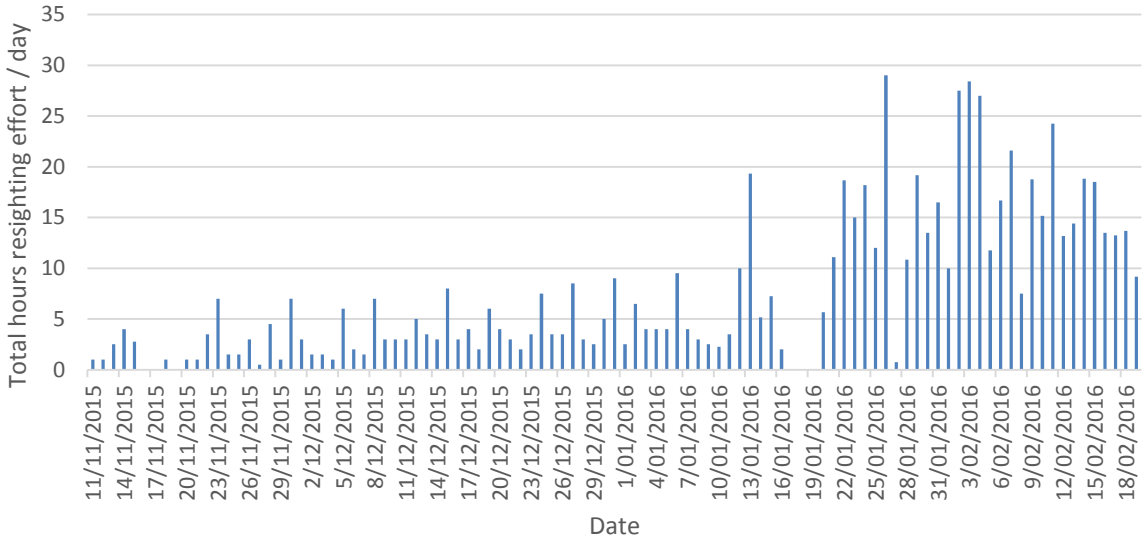

Figure 10: Total number of hours of resighting effort per day in 2015/16

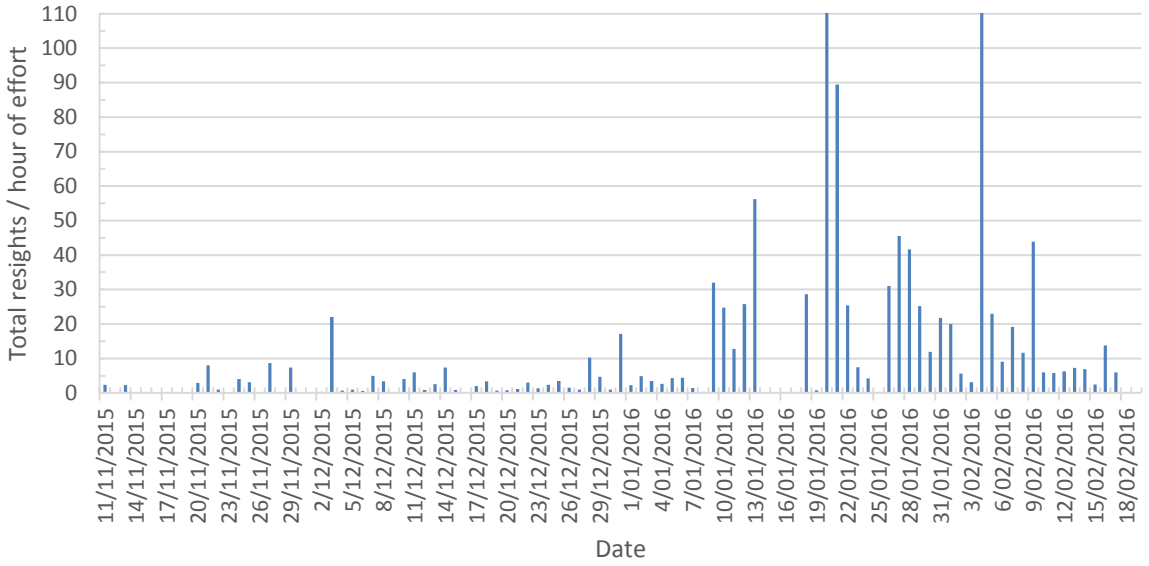

Figure 11: Total number of resights by total resight effort per day in 2015/16

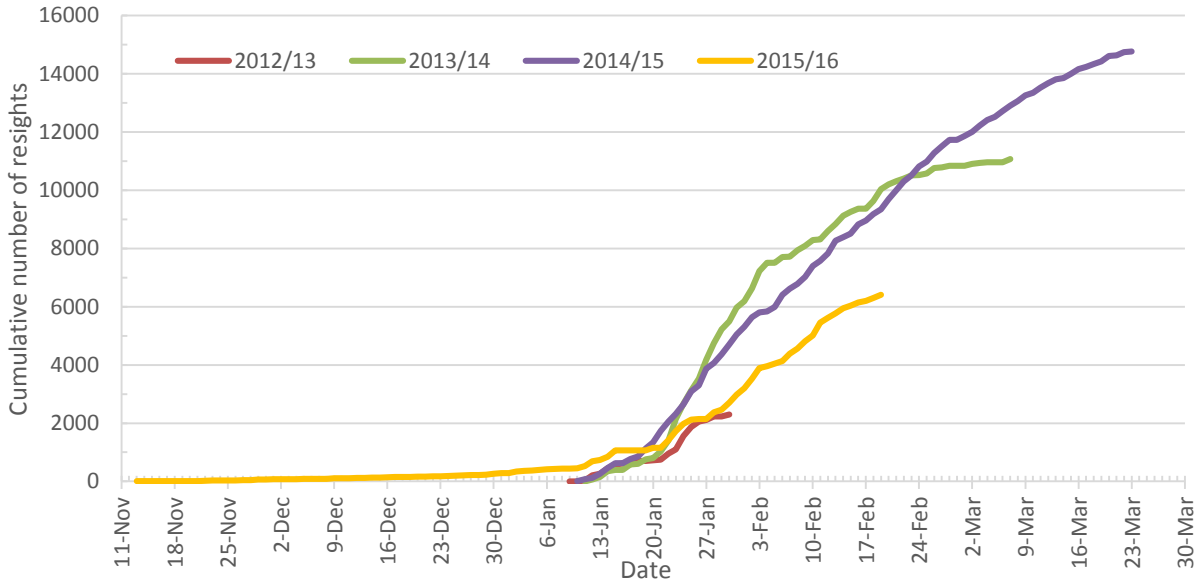

Figure 12: Cumulative number of resights by year

3.9 Mitigation of pup mortality in holes

Death of NZSL pups in holes has been identified as a significant source of mortality. Since 2013/14, researchers have been monitoring the situation directly and using cameras to estimate the level of mortality and have installed a series of ramps to allow pups to escape from holes from which they otherwise wouldn't be able to (Childerhouse et al. 2014, 2015). During the 2014/15 field season, a total of two pups were found dead in mud holes, however 65 were physically rescued by researchers prior to ramp installation and 45 were seen exiting on ramps on review of GoPro and trail camera photos (Childerhouse et al. 2015). This research and intervention was continued during the 2015/16 field season.

The 2015/16 season saw the continuation of the ramp program previously funded by WWF and DOC that again proved a valuable method for reducing pup mortality. The natural geography of the Auckland Islands lends itself to the creation of steep sided sink holes, mud pools and undercut streams that can prove inescapable to pups. It is possible that the historic human disturbance at some sites, such as Sandy Bay may have exacerbated this problem as there is less vegetation and therefore limited natural escape routes such as roots or branches. Wooden ramps have therefore previously been installed in some of the problem waterways to provide an ongoing method of escape to these trapped pups which otherwise may die from drowning or starvation

With the NZSL population at a critically low level, the continued use of ramps and implementation of new ramps (where necessary) is an extremely valuable management tool for demonstrably reducing pup mortality while having a minimal impact on the surroundings and other wildlife. From a limited sample of observations at Sandy Bay, 49 pups exited streams/holes that represented a high and extreme risk of mortality through the use of active intervention by researchers (n=8) and pups using installed ramps to escape (n=41). Furthermore, on Dundas Island, an additional 19 pups were also saved by researchers and/or existing ramps. At least 10 pups died in bogs on Dundas (e.g. bodies recovered only on the two days we visited so this is an underestimate), therefore we **recommend** increased monitoring effort and a review of existing pup ramps at Dundas Island.

3.10 Preliminary assessments of cause of death in pups in 2015/16

The New Zealand Sea Lion pup mortality was monitored daily throughout the research season at Sandy Bay, and sporadically across other sites around Enderby Island. The total pup mortality recorded between 10 January and 21 February was 34 pups. The daily and cumulative totals of dead pups at Enderby Island are described below in Figure 13.

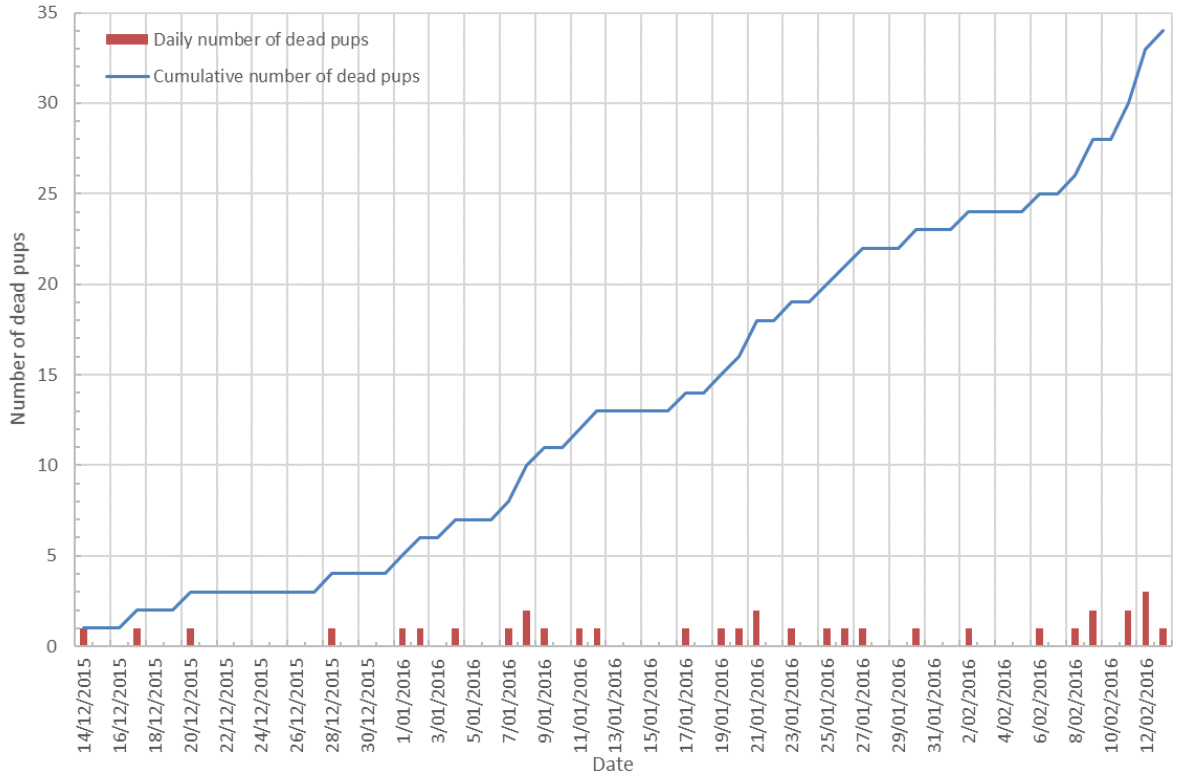

Figure 13: Daily and cumulative New Zealand sea lion pup mortality at Sandy Bay, Enderby Island 2015/16.

Post mortem examination was performed on all 33 dead pups found at Sandy Bay after 10 January when the main research team arrived and samples were collected for further testing at Massey University. One pup was also found at Teal Lake on 15 February. The pup found at Teal Lake was not in a sufficient state for necropsy due to severe decomposition of all tissues. An additional 9 pups were recorded at Sandy Bay before the main field season but a post-mortem was not carried out on these.

A preliminary diagnosis of the cause of death for the pups found at Sandy Bay was made based on the gross necropsy examination. The preliminary provisional diagnosis of mortality for pups on Enderby Island this season is as follows: 61% bacterial infection (suspected with *Klebsiella pneumoniae*), 12% open diagnosis (decomposed, scavenged or no significant findings), 21% starvation, 3% trauma, and 3% intestinal perforation (Figure 7). Severe haemorrhagic enteritis caused by hookworms was identified on examination of 4 pups this season. However, all 4 of these pups also had severe gross lesions of the brain consistent with *Klebsiella pneumoniae* infection, which would have been the cause of the mortality for these pups acutely. It must be noted that all of these diagnoses are provisional, and will be altered and/or confirmed based on microbiology and histopathology analysis that is to be completed at Massey University (funding dependent).

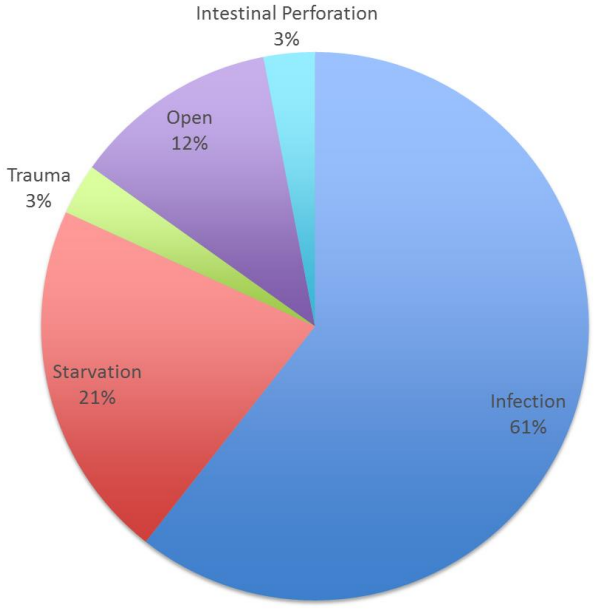

Figure 14: Preliminary and provisional diagnosis (%) of cause of death of New Zealand sea lion pups at Sandy Bay, Enderby Island 2015/16 (n=33) from 10th January to 21st February 2016.

The pattern of pup mortality attributed to bacterial infections at Sandy Bay differed this season compared to recent years, in particular, the apparent timing and rate of mortality caused by *Klebsiella pneumoniae*. Firstly, there was no dramatic peak in the pup mortality due to bacterial infections seen during this season of research at Sandy Bay. In previous seasons there has been a "spike" in the mortality attributed to a provisional diagnosis of *Klebsiella pneumoniae* infection (Childerhouse et al. 2015, 2014; Roe et al. 2015). Figure 15 demonstrates the mortality "spike" that was observed in 2014 and 2015, compared to the 2016 pattern with no major peak. As this season of research ended five weeks earlier than 2014/15, it is possible that the peak in mortality occurred after the end of the study period which is consistent with an apparent trend of the "spike" in mortality moving later in the season.

It must be noted that a climbing level of mortality due to bacterial infection occurred in the last 2 weeks of the study season. Therefore, it is possible that this slight rise in mortality observed was the only "spike" in mortality for the season, or that the mortality continued to peak after the end of the research period. Secondly, lesions consistent with *Klebsiella pneumoniae* infection were also observed

earlier, and throughout the season in 2016, compared to last year in which they predominated the mid to late season of research. The first dead pup with a provisional diagnosis of *Klebsiella pneumoniae* infection in 2014/2015 was identified on 29 January, compared to this season in which the first provisional cases were observed on the 11 and 12 January (Childerhouse et al. 2015).

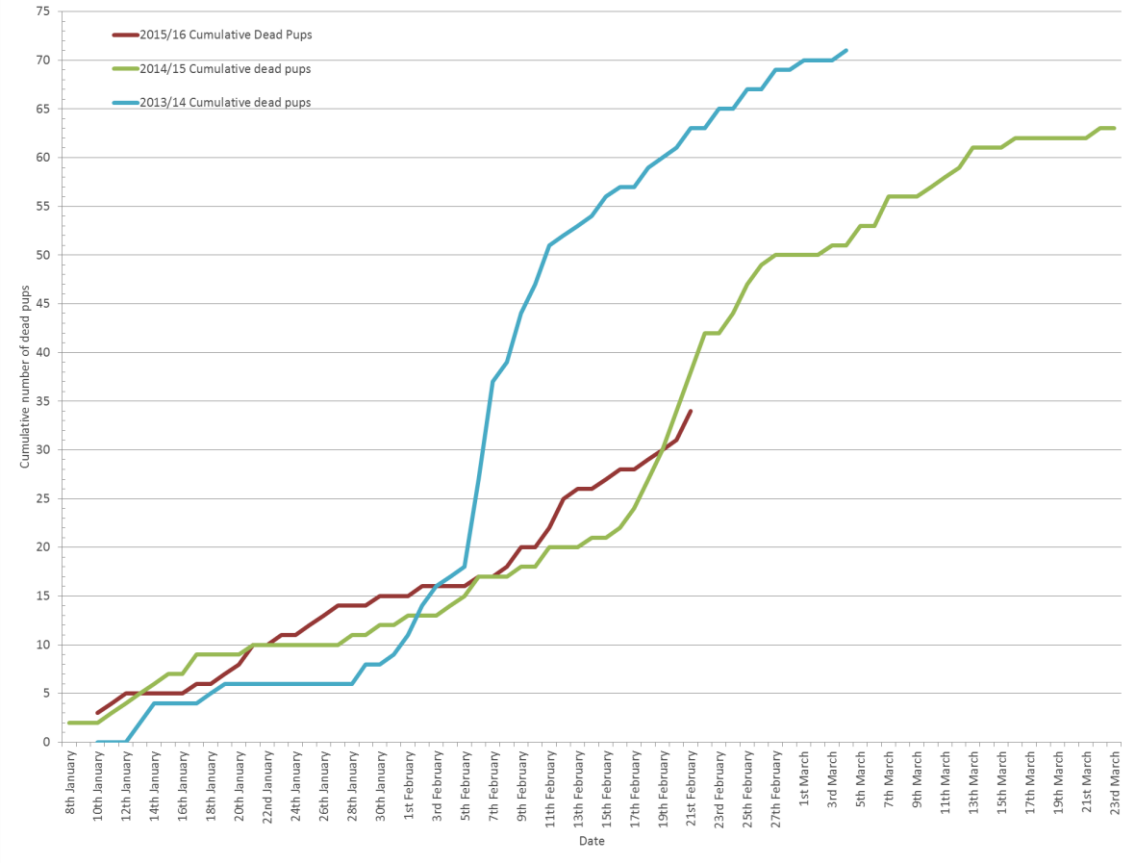

Figure 15: Comparison of the cumulative mortality patterns seen across the 2014, 2015 and 2016 field seasons at Sandy Bay

Adult NZ sea lion mortality was also monitored at Sandy Bay throughout the season, and post mortem examinations were performed on all dead adults found. Three adult females and one adult male were necropsied, and samples were gathered for analysis in the future at Massey University. The following provisional diagnoses were made based on the gross examination findings: open diagnosis (scavenging, and no significant findings) for one female adult, two females had fatal shark bite injuries, and the adult male had lesions consistent with bacterial infection. Interestingly, the adult male and one of the females with shark bite wounds, both had lesions consistent with *Mycobacterium pinnipedii* infection. All of the aforementioned preliminary provisional diagnoses will be confirmed by further analysis at Massey University (funding dependent).

The mortality of pups at Sandy Bay was monitored closely throughout the field season this year, allowing further monitoring and investigation into mortality patterns of the endangered NZSL. Of the 34 pups found dead after 10 January, only 13 were tagged, and there was only dead one pup with evidence of a flipper tag wound infection. The sex of the dead pups was able to be determined in 32 animals (2 were too heavily scavenged), with 13 of the dead pups being female, and 19 male. Unfortunately, no post mortem examinations could be performed on Dundas Island this season due to the shorter time period spent on the island. The field season on Enderby Island allowed pup mortality in the NZ sea lion to be closely monitored, with a provisional diagnosis for the cause of death identified in 88% of the dead pups found. As no peak in mortality was observed during this shorter field season, it may be necessary to consider further extended expeditions such as 2013/14, and

2014/15, to truly document the pattern and extent of the mortality in pups at Sandy Bay. If the pattern of mortality due to *Klebsiella pneumoniae* has changed from the previously observed "spikes", then this is an important variation to investigate in future field seasons.

Another issue relates to the timing of surveys for pup mortality. Average pup mortality to 16 January at Sandy Bay is negatively biased if monitoring starts in early/mid-January in contrast to full season monitoring. For example, estimates of pup mortality (as a percentage of the total estimated pup production) is 5.7% (SE=0.5) for full season monitoring (i.e. Dec onwards; n=2003/04-2011/12 and 2015/16) versus 2.7% (SE=0.8) for partial season monitoring (i.e. 9 Jan onwards; n=2012/13-2014/15). This is because pups that die early in the season (e.g. December) are not available for counting when surveys start in early/mid-January due to them being scavenged, washed away and/or buried. While this negative bias is small, it does negatively impact on both the estimate of pup mortality and also on the estimate of total pup production.

In addition, environmental sampling of water and soil for the presence of *Klebsiella* was also undertaken to assess background/baseline levels around the Auckland Islands.

3.11 Preliminary trial investigating new aspects of pup mortality

For the first time, the team undertook a preliminary trial investigating new aspects of the causes of pup mortality. The aim of this preliminary project was to trial an experimental-design for the assessment of pup mortality with a view to using it to develop a more comprehensive project (i.e. case-control study) for the 2016/17 season. This project is led by Massey University with support and/or funding from DOC, Massey University and Blue Planet Marine. A full description of the methodology is provided in Appendix 8.

Replicate samples (i.e. controls) were taken for 19 dead pups providing data on 38 additional live pups. The results and data will be worked up by Massey University and provide information that will be useful for the development of a future comprehensive case control study next season.

3.12 Shark bite scars

During the surveys reported in Section 3.6.2, data was also collected on the presence of shark scars on individuals for which their whole body could be reliably viewed. Over the three surveys, a total of 42 (5%) individuals were seen with shark bite scars of a total of 900 individuals viewed. Photos of each individual were also collected following a protocol provided by DOC for previous shark bite scar analysis. We were unable to analyse the photos due to lack of time while in the field but these photos will be made available to DOC for analysis when time and funds allow.

3.13 Summary of other work

A range of other work has been undertaken alongside the normal NZSL CSP work programme including:

Task	**Requested by:**
Forty-four southern royal albatross nests were identified around Enderby Island	DOC CSP for ACAP reporting
Giant Petrel nest survey and mapping (96 live chicks on Enderby, 32 on Dundas)	DOC CSP for POP2015-03
NZSL hair sampling	Otago University for ecosystem study
Yellow-eyed penguin count	Annual one-day survey for DOC
Auckland Island Shag nest photo points (weekly)	DOC Southern Islands / Massey University
Track monitoring including photo points (monthly) and track counter monitoring	DOC Southern Islands (standard for all field teams)
NZSL faecal sample collection and processing	Annual NZSL diet monitoring for DOC
NZSL canine tooth collection from dead adults	NIWA diet research

Task	Requested by:
Weed monitoring survey	DOC Southern Islands (standard for all field teams)
Rodent monitoring survey	DOC Southern Islands (standard for all field teams)

4. HSE

There were no notable HSE incidents. A post-trip de-brief has been held with the field team and a report will be made available to DOC following completion.

5. Issues for Future Consideration

Based on the experience of the 2015/16 team, we would recommend the following issues be reviewed for any 2016/17 field season:

- *Euthanasia* - If a vet is present on the Island, consideration should be given to prior approval for injectable humane euthanasia of moribund individuals. When performed correctly, this would not significantly impact on post mortem findings and would prevent prolonged suffering of individuals. These individuals would need to be buried in order to prevent scavenging. We **recommend** that a clear set of criteria for determinations be developed including decision making responsibilities and is approved by DOC prior to the next season;
- *Pup flipper tagging at Sandy Bay* – in 2014/15 and 2015/16, the number of pups flipper tagged at Sandy Bay was reduced from 100% to 50% although all of them were still microchipped. We **recommend** that all pups should be flipper tagged in future as 89% of all individual resight records this year were from flipper tags and reducing the number of tags in the population is likely to significantly impact on resighting rates and potentially on the estimation of vital life history rates;
- *Confidence intervals for total pup production estimates* – confidence intervals for estimates of total pup production have never been provided. A total pup production estimate is comprised of several different estimates generated from different techniques, some of which have no estimates of variance associated with them. We **recommend** the development of a standardised method for the estimation of confidence intervals for pup production and one that could also be used for all previous data;
- Pup and adult body condition have been implicated in the decline of pup production at the Auckland Islands. It would be useful to assess how this information could be collected in future in order to provide an insight into future trends. For example, it would be possible to catch and measure adult females (as was done in 1999-2001) or use photogrammetry from an aerial platform, to provide a comparative data set on both adult body condition and also age structure;
- *Active management* – some sources of pup mortality could be mitigated through active management. This includes such things as:
    - The number of pups dying in holes could be reduced by filling in holes or building new ramps at all problem locations so they could get out;
    - Veterinary treatment of sources of mortality such as injury (e.g. relocation of dislocated flippers);

- Hookworm or disease (e.g. immunisation drug treatment); and/or
- Supplementary feeding (e.g. in cases a pup may not be getting sufficient food from its mother).

This is a very complex issue and would require careful consideration before any actions are agreed. Active management may offer the most promising avenue for conservation management to make a positive contribution to survivorship of individual pups and potentially yield positive flow-on benefits for the species as a whole. Elements of active management such as those identified here should be reviewed as a minimum, as part of the development of a Threat Management Plan, but also perhaps as a wider issue that could lead to immediate changes to the research programme for the 2016/17 season.

- *Surveys of other islands* – Last season was the first year for several years that surveys were undertaken in known sea lion areas away from the main colonies including Ewing Island, Rose Island, Ocean Island and the main Auckland Island. These surveys are generally undertaken late in the season (e.g. March) when pups were assumed to have dispersed from Dundas Island and Sandy Bay but it would be useful to survey these areas both early and later in the season to confirm that there are in fact no pups being born there and help confirm that the pups seen later in the season are actually immigrants. Other possible sea lion breeding areas could also be surveyed including North Harbour, Ranui Cove and Kekeno Point. This would aid in confirming that pup production is still limited to the existing breeding colonies.
- *Tagging and microchipping* – The tagging and chipping programme are fundamental to the NZSL monitoring programme but we are still using the same methods that were originally started in 1998. There have been some significant advances in both tagging and chipping technologies and it would be useful to review where we are, the aims of the programme, and what options exist to improve what we do. There are some significant technological advances in microchips that could lead to increased retention, improved read range and even automatic detection systems. An assessment of what we are doing now and how it stacks up to modern systems would be useful in exploring other options. We **recommend** that a review of tagging and microchipping systems is undertaken to make recommendations about the best system for NZSLs.
- *Counts of dead pups at Sandy Bay* - these is good evidence that estimates of both pup mortality and pup production are negatively biased when monitoring starts in mid-January compared to early December. During future full season monitoring, it would be useful to leave pups that die in December on the beach but mark them and see how many are available for counting in mid-January. This will aid in trying to estimate what proportion of pups that die early are not available for counting in mid-January.
- *General recommendations from the main text*:
    - 3.6.2 - We **recommend** that future teams allocate more time and training to microchipping to reduce this loss rate.
    - 3.6.2 - We **recommend** returning to both microchipping and tagging of all pups at Sandy Bay, at least until microchip retention rates can be minimised.
    - 3.6.2 - We **recommend** recommencing tagging 100% of pups born at Sandy Bay beginning in the 2016/17 season.
    - 3.6.2 - We **recommend** investigation of an additional electronic tagging/tracking method to identify individuals at a distance.

- 3.9 - We **recommend** increased monitoring effort and a review of existing pup ramps at Dundas Island.

6. Acknowledgements

This project is funded by the Department of Conservation's Conservation Services Programme through levies on the commercial fishing industry. This research would not have been possible without the support of many people, and for which we are very grateful:

- Professor Mark Hindell from University of Tasmania for excellent support and advice;
- Henk Haazen, master of the *RV Tiama*, and his crew were extremely professional and accommodating and the *RV Tiama* was an excellent vessel for the work;
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- The Auckland Islands helicopter team of Barry Baker, Jo Hiscock, Kris Ramm and Mark Deaker for excellent support and good company;
- Danielle Sijbranda and Richie Robinson; and
- Members of the CSP Technical Working Group who provided useful feedback on this project.

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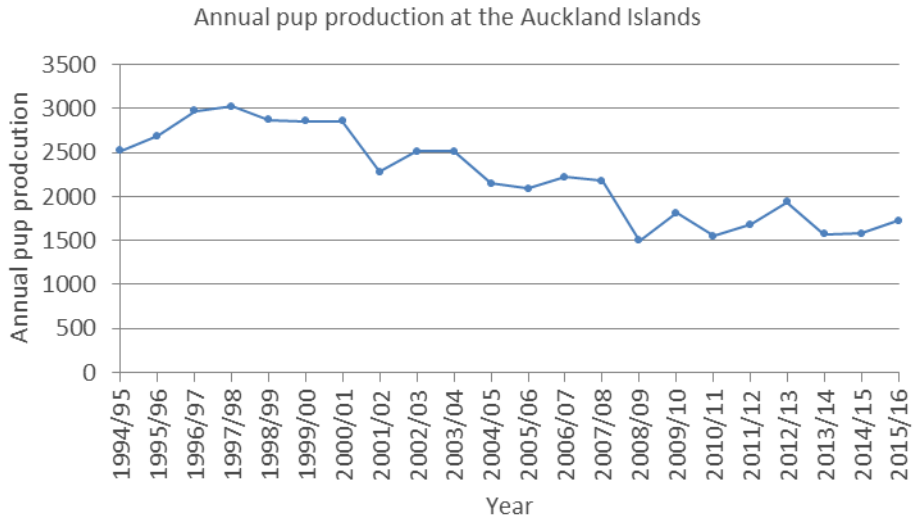
Appendix 1: Annual estimates of live, dead and total pup production for each colony and for total Auckland Islands pup production 1994/95 – 2015/16

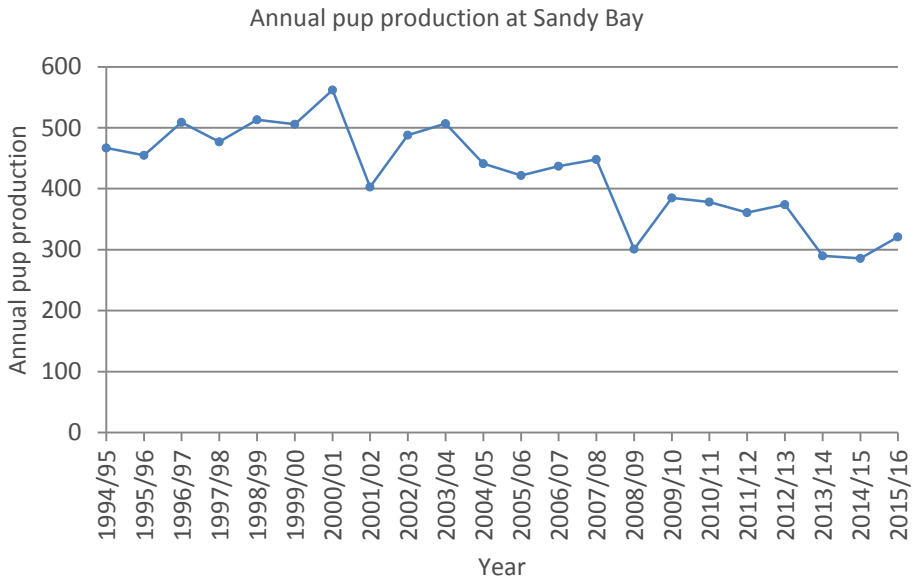
(NB. Data prior to 2012/13 from Chilvers (2012))

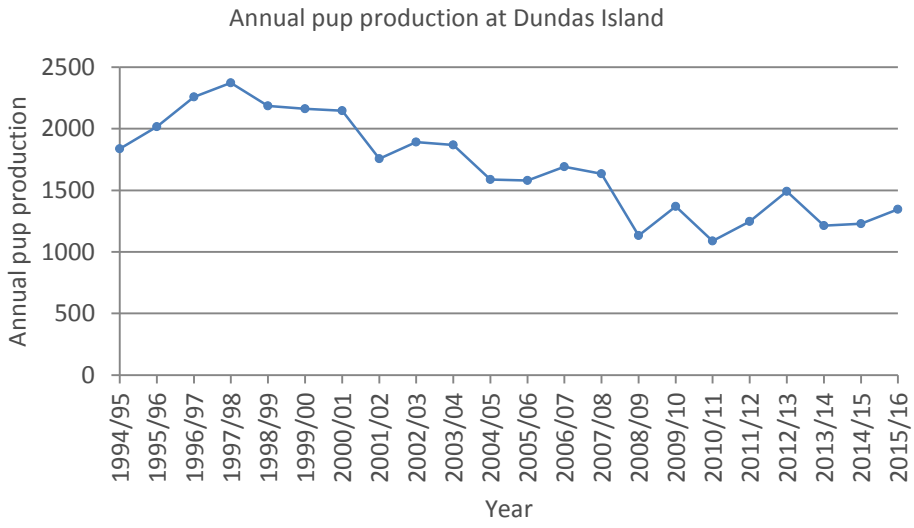
Year	Sandy Bay			Dundas Island			Figure of Eight Island			South East Point			Total Auckland Islands		
	Total	Live	Dead	Total	Live	Dead	Total	Live	Dead	Total	Live	Dead	Total	Live	Dead
1994/95	467	421	46	1837	1603	234	143	123	20	71	59	12	2518	2206	312
1995/96	455	417	38	2017	1810	207	144	113	31	69	49	20	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	488	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	441	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**

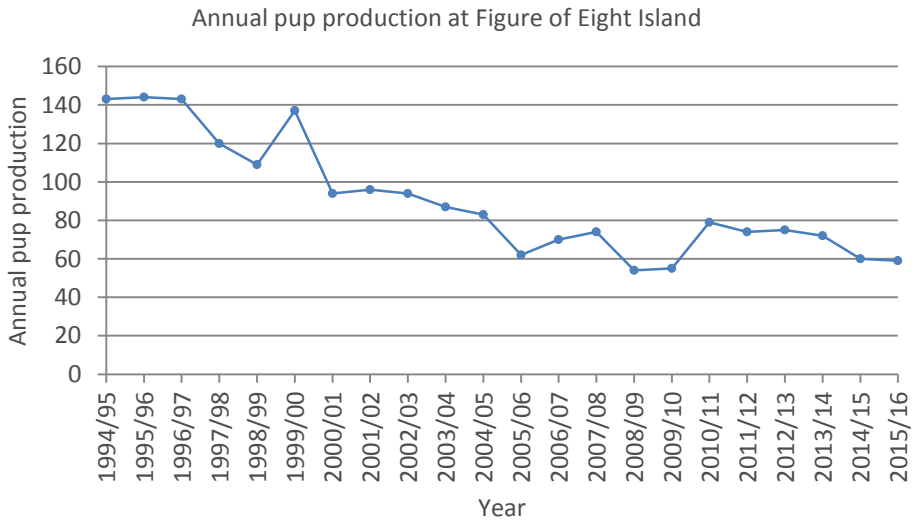
Appendix 2: Annual estimates of total pup production for each colony and for total Auckland Islands pup production

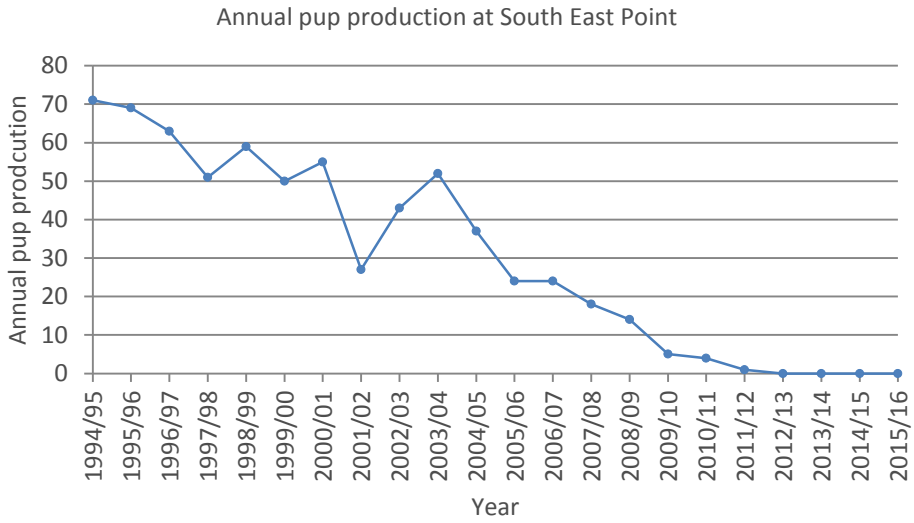
(NB. Data prior to 2012/13 from Chilvers (2012))






Annual pup production at Dundas Island
Annual pup production
2500
2000
1500
1000
500
0
1994/95
1995/96
1996/97
1997/98
1998/99
1999/00
2000/01
2001/02
2002/03
2003/04
2004/05
2005/06
2006/07
2007/08
2008/09
2009/10
2010/11
2011/12
2012/13
2013/14
2014/15
2015/16
Year


Annual pup production at Figure of Eight Island
Annual pup production
160
140
120
100
80
60
40
20
0
1994/95
1995/96
1996/97
1997/98
1998/99
1999/00
2000/01
2001/02
2002/03
2003/04
2004/05
2005/06
2006/07
2007/08
2008/09
2009/10
2010/11
2011/12
2012/13
2013/14
2014/15
2015/16
Year


Annual pup production at South East Point
Annual pup prodcution
80
70
60
50
40
30
20
10
0
1994/95
1995/96
1996/97
1997/98
1998/99
1999/00
2000/01
2001/02
2002/03
2003/04
2004/05
2005/06
2006/07
2007/08
2008/09
2009/10
2010/11
2011/12
2012/13
2013/14
2014/15
2015/16
Year

Appendix 3: Raw data for pup production estimates for Sandy Bay, Dundas Island and Figure of Eight Island[4]

Mark recapture individual counts for Sandy Bay, 16 January 2016		
No. of animals marked = 109 (i.e. 1 cap found (i.e. fell off) before MR)		
	Number marked counted	**Number unmarked counted**
Counter 1-1	65	110
Counter 1-2	73	113
Counter 1-3	80	128
Counter 2-1	69	97
Counter 2-2	67	104
Counter 3-1	69	117
Counter 3-2	46	58
Counter 4-1	47	65
Counter 4-2	50	88
Direct live pups counts for Sandy Bay, 16 January 2016		
	Number counted	
Counter 4-1	258	
Counter 4-2	262	
Counter 4-3	258	
Counter 4-4	319	
Counter 4-5	302	
Counter 2-1	302	
Counter 5-1	315	
Counter 5-2	284	
Counter 5-3	290	
Counter 5-4	283	
Counter 6-1	262	
Counter 6-2	284	
Counter 6-3	289	
Cumulative dead pup counts for Sandy Bay to 16 January 2016		
	Cumulative number counted	

[4] The identity of the individual counters is indicated by "Counter 1" being the first person, "Counter 2" being the second, etc. This identifier is used throughout all the counts in this Appendix but is not consistent with previous years. Details of counters is available from DOC.

Cumulative count	13

Mark recapture estimates for Dundas Island, 18 January 2016

No. of animals marked = 396 (i.e. 4 caps found (i.e. fell off) before MR)

	Number marked counted	Number unmarked counted
Counter 1-1	281	599
Counter 1-2	288	575
Counter 1-3	294	586
Counter 2-1	312	639
Counter 2-2	305	650
Counter 2-3	270	619
Counter 3-1	234	441
Counter 3-2	228	449
Counter 3-3	196	454

Direct counts for number of live pups for Dundas Island, 18 January 2016

	Number counted
Counter 5-1	1104
Counter 4-2	1120
Counter 6-1	1180

Direct counts for number of dead pups for Dundas Island, 18 January 2016

	Number counted
Count 1	126
Count 2	126
Count 3	126

Direct counts for number of live pups for Figure of Eight Island, 9 January 2016

	Number counted
Counter 1-1	51
Counter 2-1	55
Counter 3-1	53

Direct counts for number of dead pups for Figure of Eight Island, 9 January 2016

	Number counted
Counter 1-1	6
Counter 2-1	6
Counter 3-1	6

Appendix 4: Description of breeding area searched during pup counts at Sandy Bay, Enderby Island

The following figure provides a graphical presentation of the "entire breeding area" searched during pup counts at Sandy Bay, Enderby Island. All of the beach and surrounding sward (e.g. green, grassy area adjacent to the beach) constitutes the "entire breeding area" but the forested area is excluded. On 16 January, when the mark-recapture counts are undertaken, pups are almost exclusively restricted to the beach area, although sometimes a few pups have moved up onto the sward but no more than 20-30 m from the beach itself.

This image is taken from Baker B, Jensz J and Chilvers L (November 2012). Aerial survey of New Zealand sea lions – Auckland Islands 2011/12. Report prepared for Ministry of Agriculture and Forestry, Deepwater Group Limited and Department of Conservation. 11 p.

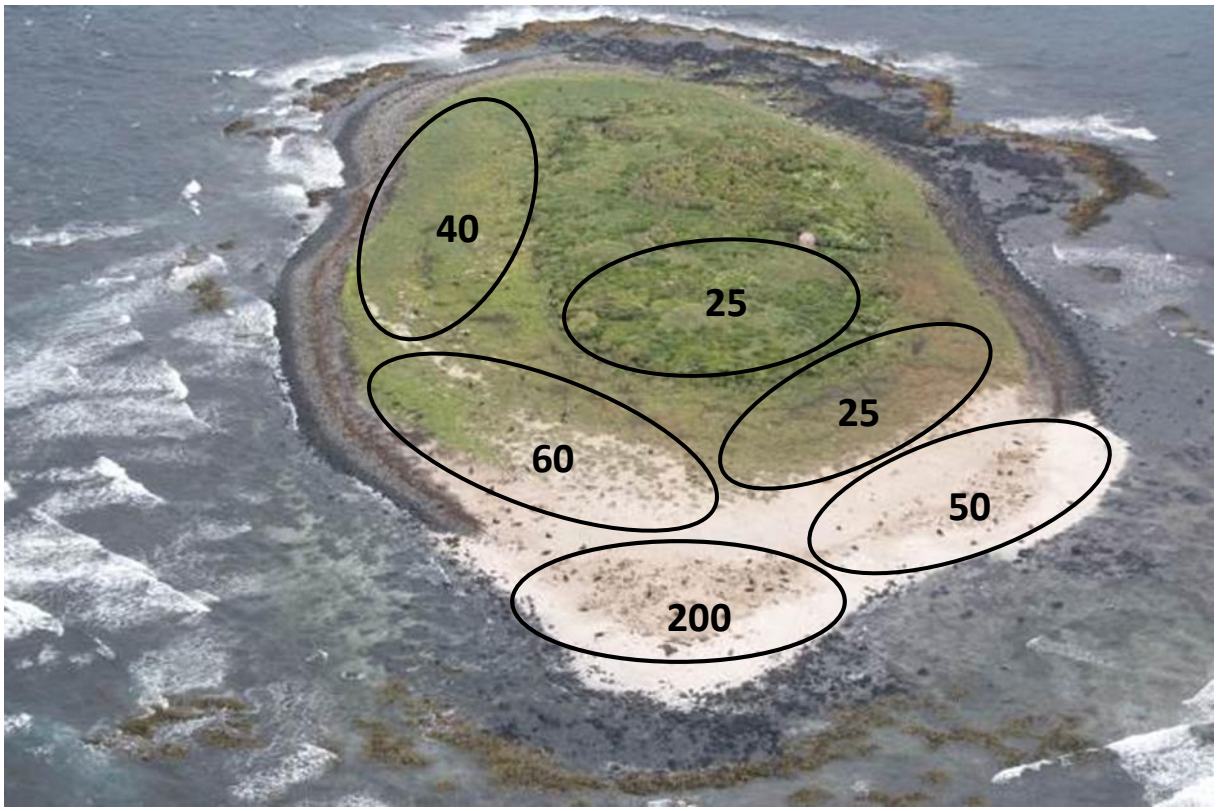
Appendix 5: Direct counts made at Sandy Bay, Enderby Island

Date	Live pups	Daily dead pups	Cumulative dead pups	Adult females	Adult males	sub-Adult males	Comment
11-Nov-15	0	0	0	0	18	21	
12-Nov-15	0	0	0	0			
13-Nov-15	0	0	0	0*	20	17	1 female arrived after count
14-Nov-15	0	0	0	0*	14	20	
15-Nov-15	0	0	0	0	24	23	1 female arrived after count
18-Nov-15	0	0	0	0	24	25	
20-Nov-15	0	0	0	0	22	22	
21-Nov-15	0	0	0	0	35	25	
22-Nov-15	0	0	0	0	16	19	
23-Nov-15	0	0	0	0	22	13	
24-Nov-15	0	0	0	1	14	21	
25-Nov-15	0	0	0	0	23	34	
26-Nov-15	0	0	0	0	19	45	
27-Nov-15	0	0	0	0	19	38	
28-Nov-15	0	0	0	0	14	28	
29-Nov-15	0	0	0	0	18	28	
30-Nov-15	0	0	0	0	30	21	
1-Dec-15	0	0	0	1	29	28	
2-Dec-15	0	0	0	0	26	26	
3-Dec-15	0	0	0	0	34	25	
4-Dec-15	0	0	0	0	30	27	
5-Dec-15	0	0	0	0	44	44	
7-Dec-15	1	0	0	3	25	19	
8-Dec-15	1	0	0	3	36	22	
9-Dec-15	2	0	0	4	47	31	
10-Dec-15		0	0	8	47	25	
11-Dec-15	3	0	0	7	55	12	
12-Dec-15	3	0	0	10	56	24	
13-Dec-15	4	0	0	13	51	25	
14-Dec-15	6	0	0	15	44	65	
15-Dec-15	8	0	1	22	53	50	
16-Dec-15	13	0	1	26	52	43	
17-Dec-15	16	1	2	35	64	42	
18-Dec-15	20	0	2	41	62	31	
19-Dec-15	27	0	2	63	51	20	
20-Dec-15	39	1	3	87	60	55	
21-Dec-15	45	0	3	97	71	46	
22-Dec-15	66	0	3	114	68	42	
23-Dec-15	78	0	3	117	69	34	
24-Dec-15	96	0	3	141	75	31	
25-Dec-15	108	0	3	163	76	33	
26-Dec-15	124	0	3	183	78	26	
27-Dec-15	138	0	3	186	80	53	
28-Dec-15	154	1	4	188	82	31	
29-Dec-15	174	0	4	211	90	37	
30-Dec-15	184	0	4	207	83	41	

Date	Live pups	Daily dead pups	Cumulative dead pups	Adult females	Adult males	sub-Adult males	Comment
31-Dec-15	198	0	4	192	87	47	
1-Jan-16	219	1	5	196	90	52	
2-Jan-16	238	1	6	192	88	54	
3-Jan-16	248	0	6	250	92	55	
4-Jan-16	265	1	7	262	92	58	
5-Jan-16	272	0	7	249	84	41	
6-Jan-16	276	0	7	240	87	46	
7-Jan-16	280	1	8	243	81	62	
8-Jan-16	265	2	10	198	82	59	
9-Jan-16	267	1	11	169	75	61	
10-Jan-16	268	0	11	190	69	39	
11-Jan-16	298	1	12	255	82	75	
12-Jan-16	299	1	13	171	69	104	
13-Jan-16	296	0	13	212	69	111	
14-Jan-16	296	0	13	223	62	82	
15-Jan-16	298	0	13	241	47	68	
16-Jan-16	285	0	13	224	62	84	
17-Jan-16	273	0	13	235	37	99	
18-Jan-16	291	0	13	199	59	112	
19-Jan-16	268	0	13	203	69	114	

Appendix 6: Approximate location of where mark-recapture caps were put out on pups on Dundas Island

The following figure identifies the approximate number and location of where 400 mark-recapture caps where put out on Dundas Island for the mark phase of the mark-recapture. Please note that this aerial image of Dundas Island was provided by Barry Baker (Latitude 42) but is from 2011/12 and therefore the location of pups shown on this image does not reflect the location of pups in 2015/16 but has been used here for illustrative purposes.



Appendix 7: Recording of effort data for resightings

The following table provides a example of the effort data that were collected for all the resighting work during 2013/14. Data from 2015/16 follows the same format.

Date	Location	Person	Start time	End time	Total effort	Wind	Cloud Cover	Weather	Notes
9/01/2014	F8	AM	10:30	11:30	1:00	SW20	8/8	Overcast	
9/01/2014	F8	DMD	10:02	11:30	1:28	SW20	8/8	Overcast	
9/01/2014	F8	NTS	10:30	11:30	1:00	SW20	8/8	Overcast	
9/01/2014	F8	SAM	10:30	11:30	1:00	SW20	8/8	Overcast	
9/01/2014	F8	SC	10:02	11:30	1:28	SW20	8/8	Overcast	
11/01/2014	SEP	AM	10:02	14:30	4:28	W25	8/8	Overcast	
11/01/2014	SB	DH	17:25	18:08	0:43	W15	8/8	Overcast	
11/01/2014	SB	DH	21:05	21:21	0:16	W15	8/8	Overcast	
11/01/2014	SB	DH	21:23	21:41	0:18	W15	8/8	Overcast	
11/01/2014	SB	SC	21:13	21:44	0:31	W15	8/8	Overcast	
12/01/2014	SB	AM	9:00	15:00	6:00	W20	5/8	Showers	
12/01/2014	SB	DH	9:00	9:34	0:34	W10	6/8	Overcast	
12/01/2014	SB	DMD	9:07	15:21	6:14	SW20	5/8	Overcast	
12/01/2014	SB	NTS	9:07	15:21	6:14	SW20	5/8	Overcast	
12/01/2014	SB	SAM	9:00	15:20	6:20	W10	6/8	Overcast	

Appendix 8: Preliminary case control study for the investigation of the causes of pup mortality

Report by Rebecca French

Introduction

For the first time a preliminary case control study was undertaken as part of a wider study into the investigation of the causes of pup mortality. The aim of this preliminary project was to trial an experimental-design for the assessment of pup mortality with a view to using it to develop a more comprehensive project for the 2016/17 season. This project is led by Massey University with support and/or funding from DOC, Massey University and Blue Planet Marine.

Method of Pup selection

As soon as possible after the discovery of a dead pup (e.g. within 24 hours), two live pups were selected as randomly as possible from the Sandy Bay population. This was done using a random number table, and walking the length of the bay counting all the pups until the selected number was reached. In order to ensure each pup had an equal opportunity for selection as efficiently as possible the methodology needed to be altered during the season depending on the location and spread of the colony, and the available information on total pup numbers, as explained below:

Early season methodology (10-24 January 2016):

Early in the season pups were all located on sandy bay beach, and a count was undertaken each morning of pup numbers until the 16 January when all the pups had been tagged or chipped. A random number was selected from a random number table between 1 and the total count of pups taken that morning. After 16 January when all the pups had been tagged or chipped (and thus it was known exactly how many pups were on the beach) this number was used instead of a morning count. Pup 1 was the pup closest to Sandy Bay hut. The pups were then counted along the beach from this pup away from the hut until the selected number was reached.

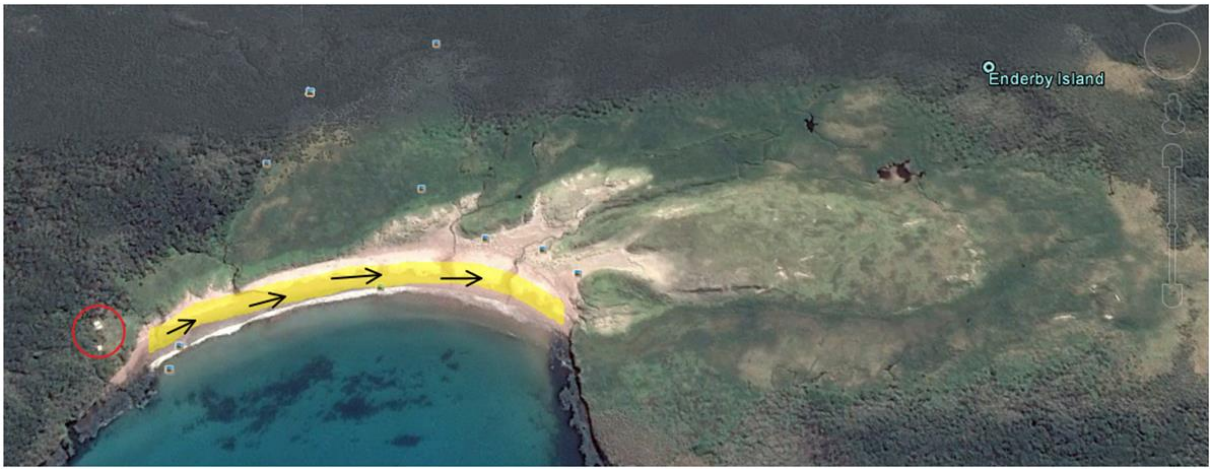


Figure 1: The hut is shown in red. The yellow zone shows the area surveyed when counting pups early in the season, and the arrows show the direction.

Mid-season methodology (25 January – 9 February 2016):

In the middle of the season the pups were spread on both the beach and the grassy area (known as the sward). These areas could not both be counted at once, so they were counted separately. If the first number selected from the table was odd the count was started from the sward. If even, it was started on the beach. The pups were then counted from the hut along the beach/sward until the

selected number was reached, curving back towards the hut at the end of the bay. So if we started on the beach and had a large number we may end on the sward and vice versa. The number selected was between 1 and the total number of tagged pups minus the dead.

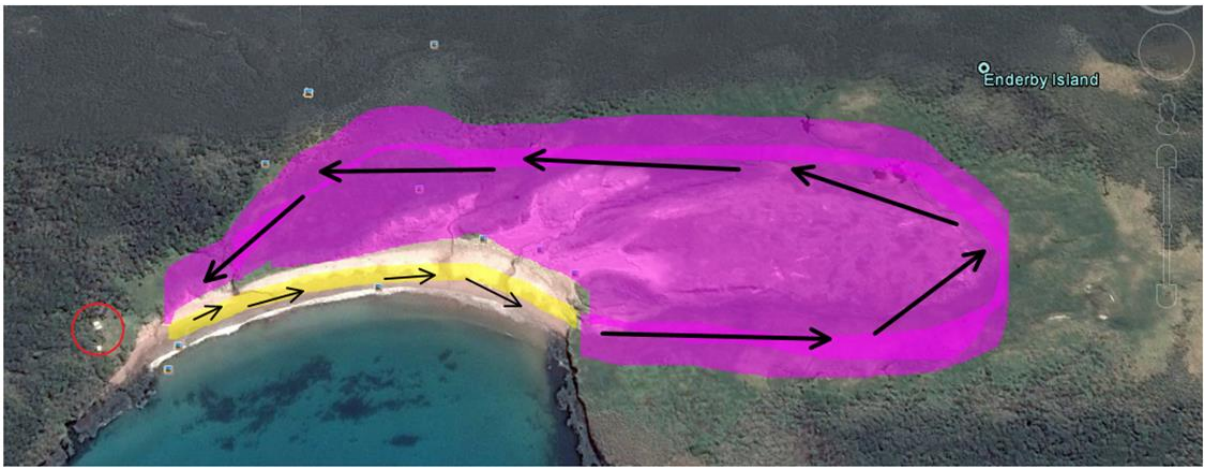


Figure 2: The hut is shown in red. The yellow zone shows the beach area surveyed and the purple zone shows the sward area surveyed, when counting pups in the mid-season. The arrows show the direction when starting on the beach. If the count started on the sward the survey proceeded in the opposite direction than is shown in the arrows.

Late-season methodology (10 – 18 February 2016):

In the late season almost all pups were on the sward. The count then proceeded as in early season, but starting with the pup nearest the hut on the sward. As the count was done on the sward another person checked the beach so they were counted as one sweep. During this period, the total or estimated number of pups was no longer used in calculations due to the increased likelihood of immigration/emigration occurring.

Data collection

From each control pup the following data was collected:

- Weight;
- Length;
- tag number and/or chip number;
- tag / chip of mother if seen (female was determined to be mother if suckling);
- Any injuries or physical observations;
- GPS location;
- Substrate (sand or grass); and
- Anal / oral swab.

For cases a full post-mortem was undertaken by the vet and the GPS location of the pup was recorded.

Limitations and ideas for next year

Pup location: As the season progressed the pups moved from the beach up onto the sward becoming more spread and difficult to locate. By the end of the season pups were moving into large pools and up into the bush. The boundary of the sampling area was set as the bush line, as once in the bush pups are impossible to reliably count. In order to sample pups in the bush some sort of marking method (caps, paint etc.) would need to be used in order to ensure they were not being double-counted. The amount of time invested per pup would be considerably increased as the bush area was large and

dense. To search this area thoroughly takes at least 2 hours. Some sort of tracking technology could also be useful for locating pups hidden in the bush areas.

Available information: At the beginning of the season pup counts were undertaken each day, so the approximate number of pups was always known. Once the pups had been tagged or chipped on the 16th of January the exact number of pups was known. This number decreased in accuracy towards the end of the season as pups were swum away by their mothers, and pups from Dundas Island appeared on Sandy Bay. Randomizing where the survey started perpendicular to the tideline (beach or sward) in the mid-season was introduced to try to reduce bias that may be introduced by an over or under estimation of pup numbers. Randomizing where the survey started along the bay (near the hut or at the other end of the bay) would further reduce potential for bias.

To better avoid this decrease in accuracy a count would need to be undertaken each morning throughout the season. Alternatively, a method that does not require the total number of pups to be known could be developed, such as selecting a random co-ordinate. However, this may be time-consuming as the pups had a very clumped distribution, with large areas devoid of pups.

Dundas pups: The first sighting of a pup born on Dundas on Enderby Island was on the 27 of January (marked by a yellow cap on Dundas Island during our mark-recapture study), although unmarked pups may have arrived prior to this date. This further reduces the accuracy of the total pup number estimate (as explained above), and also introduces non-tagged/chipped pups into the sample population. This means information about the mothers of these pups cannot be collected, and the pups cannot be identified as cases at a later date. One non-tagged/chipped pup was selected in this study, and a number of untagged/chipped pups were cases.

Transmitters: In order to be able to relocate the pups once they have been sampled, transmitters could be used. You could then have a treatment cohort and a control cohort which you could follow throughout the season. Without transmitters it would be difficult to relocate them even if they were marked when they move up into the bush and become much more mobile.

Searching for dead: Searching for dead pups would need to be more frequent than our schedule allowed if sampling of controls needs to be immediately after the case has died. We searched for dead pups morning and evening. If a dead pup was found in the evening (which may be up to 5-6 hours old), pups for the case control study were not be selected until the next morning.

Dundas Island: It would be interesting to do a similar study on Dundas Island where there is a higher mortality rate. This way you would have a larger dataset.

Appendix 9: Summary of pup mortality in waterways and the use of ramps to aid pup exit

Report by Thomas Burns

Introduction

Death of NZSL pups in holes has been identified as a significant source of mortality. Since 2013/14, researchers have been monitoring the situation directly and using cameras to estimate the level of mortality and have installed a series of ramps to allow pups to escape from holes from which they otherwise wouldn't be able to (Childerhouse et al. 2014, 2015). During the 2014/15 field season, a total of two pups were found dead in mud holes, however 65 were physically rescued by researchers prior to ramp installation and 45 were seen exiting on ramps on review of GoPro and trail camera photos (Childerhouse et al. 2015). This research and intervention was continued during the 2015/16 field season.

The 2015/16 season saw the continuation of the ramp program previously funded by WWF and DOC that again proved a valuable method for reducing pup mortality. The natural geography of the Auckland Islands lends itself to the creation of steep sided sink holes, mud pools and undercut streams that can prove inescapable to pups. It is possible that the historic human disturbance at some sites, such as Sandy Bay may have exacerbated this problem as there is less vegetation and therefore limited natural escape routes such as roots or branches. Wooden ramps have therefore previously been installed in some of the problem waterways to provide an ongoing method of escape to these trapped pups which otherwise may die from drowning or starvation (Figure A9.1).

Figure A9.1 Pup climbing out of muddy hole on Dundas Island using an existing wooden ramp.

The ramps are constructed out of wood and nails with the main ramp leading out of the waterway and perpendicular crossbars allowing the NZSL pups to grip the ramp even if it becomes slick. The ramps are either fixed in place with stakes or use an unstaked design with a long crossbar at the top which keeps the ramp in place. If a hole was deemed to be an ongoing hazard and it was appropriate for the situation, then a ramp was installed. Only one new hole in the 2015/16 season was rated as such and was considered inescapable without intervention and a ramp (Ramp K595) was put in to remedy this (Figure A9.2).

Figure A9.2 Single new ramp (K595) installed in 2015/16 at Sandy Bay on Enderby Island

Methodology

In addition to the use of ramps to mitigate pup mortality the waterways were monitored by researchers at least daily to determine if new ramps were needed and if any pups needed rescuing. A protocol was established which could be easily used in the field to determine whether a pup needed rescuing. Specifically:

Mortality risk to pup	Description of risk	Action
0 (Low)	No risk. Pup exhibiting natural behaviour in stream/hole with easy access to one or more possible exits.	Continue regular monitoring
1	Low risk. Exit from stream/hole is available but not immediately obvious but reasonably accessible to pups.	Increase monitoring of the location and continue to assess risk.
2	High risk. Pup may be able to exit the stream/hole unaided but the exit is difficult to find or use (e.g. steep and/or slippery, exit distant from location of pup) and the pup is highly unlikely to be able to successfully exit. Pup can be trapped for a substantial period of time. Without intervention, mortality is highly likely.	Remove pup and install ramp if appropriate. Increase monitoring of the location until ramp confirmed as effective exit
3 (High)	Extreme risk. Pup is unable to leave the stream/hole without intervention. Either the banks are too steep and/or high with no natural ramps or the mud is too	Remove pup and install ramp if appropriate. Increase monitoring

	thick and the pup is too exhausted and or cold to escape on its own. Without intervention, mortality is certain.	of the location until ramp confirmed as effective exit

Monitoring of pups that were scored as 0 and 1 was done during a morning and evening survey. A score of 2 or 3 would result in an immediate rescue, a score of 1 would be identified and monitored for a short time (up to an hour where practical) and left to try and make its own way out of the waterway and be specifically checked on during the next survey. Only pups scored 2 or 3 were recorded.

Ramp monitoring and rescues at Sandy Bay, Enderby Island

Pups started reaching the risk areas of streams and holes on the 27 January 2016 which coincided with the first rescue.

Over the 2015/16 season, 460 hours of ramp monitoring was performed by motion activated trail cameras across six ramps that had been installed in previous years. The footage indicated eight pups using ramps to escape waterways where they would have died without a ramp. A further 20 pups were filmed using ramps to escape waterways where there was a high probability that they would have died without a ramp. It was not possible to monitor all ramps all the time and therefore actual numbers of pups using the ramps to escape is likely to be higher. However, the actual number of individual pups that were saved is also difficult to assess as pups may fall into holes more than once and climb out, but it was not possible to assess this from video.

During routine direct observations of streams/holes with ramps installed previously, 13 pups were observed to have escaped using a ramp from holes in which they otherwise would have had a high chance of dying (n=10) or an extreme change of dying (n=3). An additional eight pups were found in waterways without ramps that were considered to have a very high (n=2) or extreme (n=6) chance of mortality without the intervention (i.e. scored as a 2 or 3) were rescued. The Sandy Bay pup mortality mitigation data is summarised in Table A9.1 below.

Mortality risk	Rescued	Researcher – seen escaping using a ramp	Trail Cam - seen escaping using a ramp	Total
2	2	10	20	32
3	6	3	8	17
Total	8	13	28	49

Table A9.1. Summary of management intervention for pups in holes in the 2015/16 season at Sandy Bay, Enderby. Events scored 2 are pups with a high risk of mortality without the intervention and events scored 3 had an extreme risk of mortality without intervention. Events scored 0 and 1 do not lead to intervention but increased monitoring in some cases.

Pup mortality monitoring – Dundas Island

During the research trip to Dundas Island to undertake pup tagging, 14 pups were rescued from mud holes on 17 January and a further five pups were rescued on 18 January. In addition, on 18 January a total of 10 pups were found dead in mud holes indicating a minimum of 10 pups had already died over the season. The mud in these holes was thick and many of the banks were steep and unclimbable for pups.

There was very limited time available on Dundas Island this season but all previously installed ramps were checked and were found to be in reasonable condition but some maintenance would be useful

next season. A full list and description of ramps on Dundas Island is available in Appendix 9 of Childerhouse et al. (2015).

Figure A9.3 Pups being removed from a muddy hole on Dundas Island

Trouble shooting of ramps and monitoring

Large waterways can be problematic because adult female NZSL have been observed calling their pups and encouraging them to get out of waterways at the end or edge of a waterway where the sides are too steep and/or high for a pup to exit. Pups can eventually get out but some large or long waterways may benefit from an additional ramp to allow pups to exit quickly. Another possible option for future ramps, are that they could be designed to have a wider top portion so that puppies can go to either bank and are less likely to fall back down (see Figure A9.4).

The use of motion activated trail-cams allows a much longer period of observation of a given hole than direct observation by researchers but still requires time to review footage. There were some problems with the field of view of the cameras and the wind moving the camera or grass near the camera and setting it off. This meant much more time was required when reviewing the footage. The lowest sensitivity rating on the trail camera is recommended to help combat this. In addition, it is recommended future use of these trail cameras are put in place using tripods which are pegged or weighted and mounted using ball heads to ensure that the field of view is correct and that the wind can't move the angle of the camera.

Ramp (P913; see Figure A9.4) had been installed the previous season with the top leading up against a small waterfall. Over the course of the year the natural passage of the water and worn away some of the substrate moving the waterfall away from the ramp top. The result was that now pups could get behind the ramp and had the potential to get stuck. To monitor whether this was a problem, a trail camera was installed and found that while pups could move past the ramp at the base from within the stream, they were finding it difficult. The ramp was therefore redesigned so that its base was positioned at a wider point within the stream. This allowed pups to move past the base in either

direction easily. The ramp also used a 'T' design which is prevented from falling in to the stream by the cross bar at the top and is not secured by stakes. This means there is some movement allowed in the ramp making the passage of pups past it at the base easier.

Figure A9.4 Ramp P913 at Sandy Bay, Enderby Island before alteration (left panel) and following alteration (right panel)

The deep holes at the eastern end of Sandy Bay had no pup movement near them for most of the season and they were therefore not significant hazards this season. However, one pup was rescued by the alteration of an existing ramp from one of these holes (Ramp K597; see Figure A9.5). Another of these holes had the ramp repositioned as it was submerged (Ramp K598; see Figure A9.6). These holes represent a high risk for the mortality of pups in the area and should be reassessed next season. While there were few pups in this area this season, the holes are inescapable without intervention while the depth, vegetation and underground component make them very difficult to monitor with an observer. Much longer ramps with a shallower incline are recommended for these holes particularly, Ramp K598.


K597

Figure A9.5 Ramp K597 at Sandy Bay, Enderby Island before alteration (left panel) and following alteration (right panel)

Figure A9.6 Ramp K598 at Sandy Bay, Enderby Island before alteration (left panel) and following alteration (right panel)

As water levels in streams/holes can fluctuate dramatically depending on rainfall, ramps are not necessarily required throughout the season. Ramp P915 is an example of this, at first the ramp was necessary as the pool would have been extremely difficult or impossible to escape without its use. However, a combination of the water rising and the vegetation on the sides of the holes being flattened down as pups entered the stream meant that towards the end of the season, it was no longer necessary. This ramp will likely be needed next season and was therefore left in. Ramp 4 was completely submerged this season and became covered in a thin layer of silt and overgrown. This ramp will be reviewed next year and removed if it is still not considered useful or repositioned. See Appendix B for photos of both these ramps.

Impact on wildlife and the environment

The ramps appeared to have no detrimental effects on any other wildlife in the area and in fact were utilised by other animals such a teal or yellow-eyed penguins (as observed on the trail cameras). The impact of the existing ramps on their surrounds was also assessed during the season. The ramps have a low profile and in an undisturbed area are difficult to find, providing little visual disturbance to the site. Once large numbers of pups move into the area, then ramps get more frequent use and the vegetation around them is flattened making them more obvious to an observer.

There is a small potential for the stream ramps to cause blockages flooding or altering the waterway. Ramps P913 and P917 were considered to cause only a small obstruction of the waterway. Ramp 4 was thought to only have a minimal obstruction to water flow while P916 was thought to cause a moderate obstruction to the waterway. In times of large water flow, these ramps would restrict some water flow past them although this is not thought to be a major problem. The habitat that surrounds the area where these ramps are situated is largely open grassland, and the temporary flooding of these waterways in time of very high rainfall is unlikely to have any significant negative impacts.

Conclusion

With the NZSL population at such a critically low level the continued use of ramps and implementation of new ramps (where necessary) is an extremely valuable management tool for demonstrably reducing pup mortality while having a minimal impact on the surroundings and other wildlife. From a limited sample of observations at Sandy Bay, 49 pups exited streams/holes that represented a high

and extreme risk of mortality through the use of active intervention by researchers (n=8) and pups using installed ramps to escape (n=41). Furthermore, on Dundas Island, an additional 19 pups were also saved by researchers and/or existing ramps.

Summary of installed ramps at Sandy Bay, Enderby Island. February 2016

New Name	Old Name	Latitude Longitude	Condition	Current Usefulness	Environmental Impact	Notes
P919	Ramp 8	50°29'56.1"S 166°17'17.5"E	Good	Very Important	No ongoing impact	
P918	Ramp 7	50°29'57.8"S 166°17'15.4"E	Good	Useful	No ongoing impact	
P917	Ramp 2	50°29'56.0"S 166°17'07.5"E	Good	Important	Small obstruction of water flow	
P916	Ramp 3	50°29'56.6"S 166°17'03.8"E	Good	Important	Moderate blockage of waterway at base	Review next year as the base may cause too much of blockage to the passage of water or puppies moving along it. No puppies in the area anymore so could not be monitored to determine if this were so. No signs it was backing up water.
P915	Ramp 5	50°29'55.8"S 166°17'05.8"E	Good	Important	No ongoing impact	Initially very useful but by 10.2.16 the water level of the pool had risen substantially and the vegetation surrounding the pool had been flattened down by sea lions in to a natural ramp meaning the ramp was no longer essential for this pool at this part of the season. Left in for next season.
P914	Ramp 1	50°29'56.5"S 166°17'05.9"E	Good	Important	No ongoing impact	
P913	Ramp 6	50°29'57.6"S 166°17'04.6"E	Altered	Important	Small obstruction of water flow	Altered in 2016. The stream had changed slightly and pups could fall in front of ramp and get temporarily stuck. New design is not fixed with stakes and uses a wide crossbar at the top and a wider space at the base for pups to move past in the stream. Could be improved next season by making this ramp and other like this wider at the top. As pups have been observed falling off when they get near the top and try to get to nearest bank.
K598	Mud hole 3	50°30'032"S 166°17'37.1"E	Altered	Should be replaced with a longer ramp next season	no ongoing impact	In 2016 this ramp was repositioned as it was underwater and had a new top rung added due to degradation. It was not considered a priority initially as pups were only present near this hole the day before the trip ended. Advise that next season this ramp should be elongated and have a lesser incline to aid pups.
K597	Mud hole 2	50°30'032"S 166°17'36.2"E	Altered	Very Important	No ongoing impact	This ramp was elongated and had new rungs added in 2016 as it was not functional due to degradation and water level. Will need checking next year. The substrate between the top of the ramp and top of the hole is soft and may become unclimbable.
K596	Ramp 9	50°29'56.6"S 166°17'17.5"E	Good	Useful	No ongoing impact	Very small ramp, bank collapsed 1m upstream. Check next year to see if still needed/should be moved
K595	N/A	50°29'55.3"S 166°17'19.0"E	New	Very Important	No ongoing impact	New ramp for 2016, not secured with stakes. Sinkhole with no way out, small opening to hole about 75cm x 40 cm, around 60cm deep with undercut banks. No way of escape
K594	Ramp 11	50°30'05.2"S 166°17'21.6"E	Good	Useful	No ongoing impact	
K593	Ramp 10	50°30'04.7"S 166°17'21.2"E	Good	Useful	No ongoing impact	
K592	Ramp 10B	50°30'05.0"S 166°17'21.3"E	Good	Useful	No ongoing impact	

New Name	Old Name	Latitude Longitude	Condition	Current Usefulness	Environmental Impact	Notes
N/A	Ramp 4	50°29'56.2"S 166°17'05.8"E	Overgrown	Not useful at present	Minimal obstruction of water	Water in pool has risen, the ramp is not needed in this pool this season and covered with a thin layer of silt, overgrown and largely underwater.

Photos of previously installed ramps at Sandy Bay, Enderby Island. February 2016

P919

P918

P917

P916

P915

P914

P913

K598

K597

K596

K595

K594

K593

K592

Ramp 4

Photos of selected previously installed ramps at Dundas Island. January 2016