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Monitoring of pinniped populations on Kangaroo Island: 2015/16

Simon D Goldsworthy, Fred Bailleul, Peter D Shaughnessy, Alice I Mackay, Sarah-Lena Reinhold, Melanie Stonnill and Kym Lashmar

SARDI Publication No. F2014/000332-3
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SARDI Aquatic Sciences
PO Box 120 Henley Beach SA 5022

June 2016

Report to the Department of Environment, Water and Natural Resources

PREMIUM FOOD AND WINE FROM OUR CLEAN ENVIRONMENT

Government of South Australia
Department of Environment, Water and Natural Resources

SOUTH AUSTRALIA

Government of South Australia
Primary Industries and Regions SA

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EXECUTIVE SUMMARY

This report provides information on the 2015/16 long-nosed fur seal (LNFS) breeding season in the Cape Gantheaume Wilderness Protection Area (CGWPA), trends in their abundance, and an update on monitoring undertaken on the Australian sea lion (ASL) population at Seal Bay between October 2015 and April 2016.

The total LNFS pup production estimate for the CGWPA was 4,904 (95% CL 4,865 – 4,942), the proportion of marked pups was 0.59 and 3.2% of pups were found dead. The estimate of pup numbers is an increase of 7.8% compared with that for the previous breeding season (4,547, 95% CL 4,504 – 4,589). Since January 1989, pup numbers within the CGWPA have increased by a factor of 10.7 (from 458 to 4,904). Over the last decade, LNFS pup production in the CGWPA has increased by 3.0% per year (range 2.3% to 3.8%), but has declined to 0.2% per year (range -1.3% to 2.1%) over the last five years, indicating that pup production has been relatively stable. Over the last five years, pup production in the three main sub-colonies has been relatively stable at Cape Gantheaume (increasing by 0.6% per year); has declined at Berris Point (-2.7% per year); and increased markedly at Cape Linois from 6 to 246 pups (46.4% per year).

An aerial survey undertaken of the entire CGWPA coastline on 11 April 2016 found a new small LNFS haul-out ~2.4 km east of the Seal Slide. No other new haul-outs or breeding sites were detected on this survey. A follow-up cliff-top survey of the new haul-out indicated the presence of at least five pups, confirming it as a breeding site.

Between 1 October 2015 and 31 April 2016, the ASL population at Seal Bay has been monitored by microchip scanning to estimate survival and reproductive success. Across three bi-monthly scanning sessions (December, February and April) a total of 1,085 individual ASL scans were undertaken. Around two-thirds (67%) of scanned animals had microchips. All data were entered in real-time using an app loaded onto a portable device that enables a user to look up and extract information on all scanned animals from a microchip database. This includes information on sex, cohort, estimated age, resight and reproductive history. These app features provide significant benefits to the program, including confirmation that a scanned animal's microchip has been entered correctly and is in the database; immediate feedback on an animal's age, resight and recent reproductive history; and significant reductions in time required to post-process observations for demographic analyses.

1 INTRODUCTION

Seals are one of the premier tourism attractions on Kangaroo Island (KI) and they underpin a regional multimillion dollar tourism industry, the centrepiece of which is the Australian sea lion (ASL, *Neophoca cinerea*) population in the Seal Bay Conservation Park. Information on the status and trends in abundance of the Seal Bay ASL population is essential for ensuring that ongoing tourism activities and developments are undertaken sustainably and in a way that does not impact natural population processes (Department of Sustainability Environment Water Population and Communities 2013). The information is also needed to provide long-term economic security to the regional tourism industry that is directly or indirectly dependent on Seal Bay (Department of the Environment, Water and Natural Resources (DEWNR), Commercial Tour Operators, regional tourism businesses). Seal Bay forms a critical monitoring site for ASL and is the only location where the species' population vital rates (survival and reproductive rates) are being monitored (Goldsworthy *et al.* 2015). Such data are important to assess the performance of mitigation measures (fishery closures and bycatch trigger limits) introduced by the Australian Government to protect ASL from bycatch in gillnet fisheries (Australian Fisheries Management Authority 2015).

In contrast to ASL, the rapid recovery of long-nosed fur seal (LNFS, *Arctocephalus forsteri*) and recent colonisation and growth of Australian fur seal (*Arctocephalus pusillus dorifierus*) populations has created public concern from some fisheries and ecotourism sectors, and knowledge on their status and trends in abundance is important to assist DEWNR in species management decisions. The last 27 years have seen a 3.5 fold increase in the population of LNFS in South Australia (SA), which now number ~100,000 individuals (Shaughnessy *et al.* 2015). Pup production in the Cape Gantheaume Wilderness Protection Area (CGWPA) on KI has been monitored annually each January since 1989 (Goldsworthy *et al.* 2015, Shaughnessy and Goldsworthy 2015). Over this period pup production has increased from ~450 to 5,300, which is equivalent to a ~10% increase per year (Shaughnessy and Goldsworthy 2015).

This is the third, consecutive three-year program to monitor the status and trends in abundance of Kangaroo Island pinniped populations supported by the DEWNR. The first two extended from 2010 to 2012, and from 2013 to 2015. The current project extends the monitoring from 2015 to 2018. Its aims are to:

1. maintain monitoring of Australian sea lion pup production during the 2016 and 2017/18 breeding seasons at Seal Bay and the Seal Slide, Kangaroo Island;
2. maintain monitoring of population, survival and reproductive success of Australian sea lions between 2015 and 2018 at Seal Bay;

3. provide detailed reports on population dynamics and trends subsequent to the 2016 and 2017/18 breeding seasons;
4. maintain the annual monitoring of long-nosed fur seal pup production in the Cape Gantheaume Wilderness Protection Area over three consecutive breeding seasons (2015/16, 2016/17 and 2017/18), and provide reports on their status and trends in abundance; and
5. provide a final report at the end of the program including an assessment of ongoing seal population monitoring needs for the Kangaroo Island region.

This report provides details on the 2015/16 LNFS survey in the CGWPA, and provides an update on monitoring of the ASL population at Seal Bay since the last breeding, as reported in Goldsworthy *et al.* (2015).

2 METHODS

2.1 Fur seal surveys

2.1.1 Field sites

The CGWPA contains two large sub-colonies of LNFS: Berris Point and Cape Gantheaume (Figure 1). The Berris Point sub-colony is divided into three sectors referred to as ‘North’, ‘Middle’ and ‘South’ separated by deep channels extending through the schist to the base of the limestone slopes. The Cape Gantheaume sub-colony is also separated into sectors as described by Shaughnessy (2011). In addition, there are several small aggregations of LNFS that form part of the Cape Gantheaume sub-colony: i) 0.5 km west of the Cape Gantheaume headland on small sandy beaches at the base of limestone cliffs, and ii) in the bay immediately north-east of the Cape Gantheaume sub-colony, known locally as ‘Little Weirs Cove’. Finally, there is a third, small but rapidly increasing sub-colony at Cape Linois in the north-east part of the CGWPA (Figure 1).

Figure 1. Main sector boundaries used in the mark-recapture procedures at Cape Gantheaume and Berris Point long-nosed fur seal sub-colonies in the CGWPA.

2.1.2 Direct counting

Numbers of LNFS in small aggregations were counted by one or two members of the survey team while walking through the aggregation; these are referred to as 'direct counts' to distinguish them from the mark-resight estimates.

2.1.3 Mark-resight estimation - marking

LNFS pups were marked by clipping the black natal hair (lanugo) on the top of their heads between the eyes and down toward the nose, with curved surgical scissors to reveal the light grey underfur. This clip provides a temporary mark, in that the natal hair is shed between March and April, when the adult-type pelage emerges. Pups were marked by a team of people with one person acting as scribe to record the number marked. Effort was made to apply marks uniformly throughout each sector of the colony (~50% of pups).

2.1.4 Mark-resight estimation - recapturing

The ‘recapturing’ of pups was undertaken by visual resighting, and did not require physically handling them. Resights were conducted by individuals walking through the colony and visually scanning pups' heads to identify them as either ‘marked’ (clip-marked) or ‘clear’ (unmarked). Information was recorded on tally-counters, one in each hand, with one to record marked and the other to record clear pups. At the completion of each sector, data were recorded in a field notebook and tally-counters were reset to zero. Between 10 and 15 resights were conducted of each colony sector by individuals, typically 10-15 minutes apart. Resights were undertaken between 1-4 days after pups had been marked to enhance the potential for mixing of marked and clear pups.

By distributing marks and conducting resight sessions uniformly throughout each colony sector, the sampling process at resighting is assumed to be random with respect to the marking process. This is an important assumption of mark-recapture estimation (Caughley 1977). The sampling was done without replacement; that is, care was taken to avoid recording pups more than once during each resight session. The percentage of marked pups in a sector or a colony was calculated using the number of pups marked and the mark-resight estimate of live pups.

2.1.5 Dead pups

The number of pups found dead was recorded when pups were marked and also during resight sessions. Dead pups were spray painted or covered in large rocks to indicate that they had already been counted. Dead pups counted during resight sessions were recorded as 'marked' or 'clear'. Dead marked pup were subtracted form the total number of marked pups (*M*) at risk of being resighted (see below).

2.1.6 Calculation of pup abundance using mark-recapture estimates

The estimate of pup numbers (*N*) was calculated using a variation of the Petersen method (Seber 1982), with the formula

$$N = \frac{(M+1)(n+1)}{(m+1)} - 1;$$

where *M* is the number of marked pups available for resighting during recapture sessions (minus any dead marked pups sighted during recapture session), *n* is the total number of pups examined in the recapture (resight) sample, and *m* is the number of marked pups in the recapture sample.

The variance of this estimate was calculated from

$$V = \frac{(M+1)(n+1)(M-m)(n-m)}{(m+1)^2(m+2)};$$

Since there were several mark-recapture estimates (N_j) for each colony, one from each recapture session, they were combined by taking the mean (*N*) for each colony using formulae from White and Garrott (1990, pp. 257 and 268):

$$N = \sum_{j=1}^{q} {N_j}/{q};$$

where *q* was the number of estimates for the individual colony (i.e., the number of recapture sessions). The variance of this estimate was calculated from

$$VarN = \frac{1}{q^2}\sum_{j=1}^{q} Var(N_j) \;\; ;$$

Its standard error (s.e.) was calculated from

$$[Var(N)]^{1/2};$$

(see Chapman 1952, Kuno 1977, Fowler *et al.* 1998). The 95% confidence limits were calculated from

$$N \pm (1.96 \times [Var(N)]^{1/2}).$$

The Cape Gantheaume and Berris Point subcolonies were divided into several sectors, and pup numbers calculated for each sector by the above method. An estimate for the whole subcolony was then obtained by summing the estimates for each sector. The variance of that combined estimate was obtained by summing the variances of each sector, and dividing by the square of the number of recapture sessions. The standard error was calculated by taking the square root of that variance.

For each subcolony, the number of dead pups was added to the estimate of the number of live pups to give the overall estimate of pup numbers in a colony. Means for mark-recapture estimates are presented as ± standard error (s.e.).

2.1.7 Trends in pup abundance

Trends in abundance were calculated using linear regression of the natural logarithm of the mean estimate of pup numbers against year. This gives an exponential rate of increase, which has been demonstrated for LNFS on Kangaroo Island (Shaughnessy *et al.* 1995) and for other species. The intrinsic rate of increase (r) is the slope of the regression line. It can be expressed as a percentage rate of growth (λ) as follows:

$$\lambda = (e^r - 1) \times 100.$$

We also used the method developed by Johnson and Fritz (2014) to estimate tends in abundance of fur seal colonies. The Bayesian modelling approach uses Markov Chain Monte Carlo methods and a hierarchical model to estimate trends in abundance. Analyses were undertaken using the R package ‘agTrend’ (Johnson and Fritz 2014).

2.1.8 Pup weight and length

A sample of pups were weighed using scales (20 kg range) suspended from a surveyors tripod. Pups were sexed, placed in a weighing sling (an adjustable looped rope placed around the neck and under one fore-flipper and) and weighed, their standard length (straight–line distance between tip of nose and tip of tail) was then measursed using a 1 m ruler. A small clip of fur was removed from the rump of the pups to indicate they had been weighted before returning pups to their place of capture.

2.2 Australian sea lions

2.2.1 Field site and microchipping and demography program

The Seal Bay site is part of the Seal Bay Conservation Park situated on the south coast of Kangaroo Island, centred on 35.996°S, 137.327°E. A detailed description of the methodology used to survey pup production, and monitor trends in abundance, survival and reproductive success is detailed in Goldsworthy *et al.* (2015)

Briefly, a microchipping program using Passive Integrated Transponder tags (PIT tag: TIRIS™ RFID 23 mm) to monitor survival and reproductive success of ASL was introduced at Seal Bay in 2003. During each breeding season since then, most pups that survive until the end of the breeding have been microchipped. The current microchip scanning program involves scanning of all available animals throughout the Seal Bay colony over three (preferably consecutive) days every two months to monitor survival, in conjunction with targeted scanning of adult females during breeding seasons to monitor recruitment, fecundity and individual reproductive histories. Hand-held RFID scanners (Aleis Model 9030 and Allflex RS320 EID ‘boom’ reader) are used to identify microchips. All scanning data are entered in real time into a custom developed data management app (Seal Bay ASL Monitoring V2) developed using the Fulcrum software (https://web.fulcrumapp.com), and operated on a handheld device.

3 RESULTS AND DISCUSSION

3.1 Fur seal surveys

3.1.1 Pup marking

In the January 2016 survey of LNFS in the CGWPA, a total of 2,868 pups were marked: 133 at Cape Linois, 635 at Berris Point and 2,100 at Cape Gantheaume (Table 1).

3.1.2 Pup abundance estimates

In the Cape Gantheaume sub-colony (which includes Little Weirs Cove), the mean proportion of marked pups was 0.60. The estimated number of pups in the colony was 3,529 (95% CL 3,498 – 3,559). This estimate includes 119 dead pups (3.4%) (Table 1).

At the Berris Point sub-colony, the mean proportion of marked pups in the resight sessions was 0.59. The estimated number of pups in the sub-colony was 1,129 (95% CL 1,107 – 1,151). This estimate includes 32 dead pups (2.8%) (Table 1).

At the Cape Linois sub-colony, the mean proportion of marked pups was 0.56 and the estimated number of pups in the sub-colony was 246 (95% CL 238 – 254). This estimate includes four dead pups (1.6%) (Table 1).

The estimate of pup abundance for the whole CGWPA was 4,904 (95% CL 4,865 – 4,942), the proportion of marked pups was 0.59 and 3.2% of pups were found dead (Table 1). The estimate represents an increase of 7.8% compared with the previous breeding season (4,547, 95% CL 4,504 – 4,589).

3.1.3 Trends in pup abundance

At Cape Gantheaume, estimates of pup numbers increased from January 1989 to January 2015 throughout the sub-colony (Table 2, Figure 2). Growth rates in the subcolony have declined from 2.3% per year over the last decade to just 0.6% over the last five years (Table 3).

The Berris Point sub-colony was established in 1996/97and grew at a fast rate throughout the 2000s, peaking at 1,344 pups in the 2013/14 breeding season. Much of this increase is likely to have been sustained through immigration from the Cape Gantheaume sub-colony. Average

growth in the Berris Point subcolony has declined from 4.8% per year over the previous 10 years, to -2.7% per year over the last five years (Table 3).

The first breeding record at the Cape Linois sub-colony was in 2001/02 when a single pup was sighted. Over the last five years, pup numbers have increased from 6 to 246, at a rate of 46.4% per year (Table 3).

Since January 1989, pup numbers within the CGWPA have increased by a factor of 10.7 (from 458 to 4,904). Overall, this increase has been at an average exponential rate of r = 0.088, equivalent to 9.2% per annum (n = 28 seasons, r^2 = 0.87). There are two apparent phases to the recovery of fur seals in the CGWPA, the first between January 1989 and 1998 when the population increased at an average exponential rate of r = 0.159, equivalent to 17.2% per annum (r^2 = 0.99); the second between January 1999 and 2016 when the population increased at the lower exponential rate of r = 0.061, equivalent to 6.3% per annum (r^2 = 0.83) (Figure 3). However, regression models fitted to data over the last full decade indicate that pup production in the CGWPA increased by only 3.0% per year, which has declined to just 0.2% per year over the last five years (Table 3). These results indicate that LNFS pup production has been relatively stable over the last five years in the CGWPA (Figure 4).

3.1.4 Pup mortality

The number of pups found dead was recorded when pups were marked and also during resight sessions a few days later. In January 2016, a total of 155 dead fur seal pups were recorded at colonies in the CGWPA. This represents 3.2% of the 4,904 pups estimated at these sites (Table 1). These estimates of pup mortality should all be considered underestimates because some of the dead pups would have been overlooked, including some that might have been washed out to sea or into rock pools, or taken by scavengers (Shaughnessy and Goldsworthy 2015).

3.1.5 Pup weight and length

A total of 110 pups were weighed at Cape Gantheaume on 27 January 2016 (Table 4): males and females weighed 6.97 kg and 6.82 kg, and were 69.7 cm and 67.8 cm in length, respectively. Fluctuations in the mass of male and female pups over 28 consecutive years are presented in Figure 5. Both show a steady decline in mass since the late 1990s; pups were heavier in 2016 relative to recent years.

3.1.6 Survey for potential new breeding sites within the CGWPA

A helicopter aerial survey of the CGWPA coastline was undertaken between Bales and D'Estrees Bays on 11 April 2016 to search for new or emerging LNFS haul-outs or breeding sites. One new site was detected ~1 km east of the current eastern end of the Berris Point breeding colony (~2.4 km south-west from the Seal Slide). About 20 fur seals were sighted on a small rock platform (Figure 6a). No other sites outside the existing known haul-out and breeding sites were detected during the aerial survey. A cliff-top survey of the new site was undertaken on 3 May 2016, when ~25 fur seals were observed, including five pups, confirming the location as a breeding site for the species (Figure 6b). As this was a qualitative survey done outside the of breeding season, these pup numbers were not added to the total estimate for the CGWPA in this year. A quantitative pup survey of the site is planned to be undertaken as part of the January 2017 CGWPA fur seal survey.

Table 1. Estimates of abundance of long-nosed fur seal pups at breeding colonies in the CGWPA, Kangaroo Island in January 2016. Survey methods: count = direct count; MR = mark-resight estimate; CL = confidence limits.

Site (& survey method)	Date marked or counted	Date of resight	Live count	No. pups marked	No. pups dead	No. resight estimates	Overall Estimate	95% CL	% pups marked	% pups dead
Cape Linois										
Cape Linois (MR)	22-Jan-16	26-Jan-15	-	133	3	10	240	232-248	56.1	1.3
Cape Linois East (count)	26-Jan-15		5		1	-	6	-	-	-
Subtotal Cape Linois			-	**133**	**4**		**246**	**238-254**	**54.1**	**1.6**
Berris Point										
North (MR)	22-Jan-16	24-Jan-16	-	266	13	14	506	489-522	54.3	2.6
Middle (MR)	22-Jan-16	24-Jan-16		191	10	12	341	330-352	57.6	2.9
South (MR)	22-Jan-16	24-Jan-16		178	9	13	283	274-292	65.0	3.2
Subtotal Berris Point				**635**	**32**		**1129**	**1107-1151**	**59.3**	**2.8**
Cape Gantheaume										
Little Weirs East (count)	26-Jan-16	-	10		1	-	11	-	-	-
Little Weirs East (MR)	23-Jan-16	26-Jan-16	-	77	6	11	145	138-151	55.4	4.1
Little Weirs West (count)	26-Jan-16	-	1		0	-	1	-	-	-
West of Beach (count)	4-Feb-16	-	17	-	2	-	19	-	-	-
Cave (count)	25-Jan-14*	-	15	-	0	-	15	-	-	-
Sector Beach (MR)	22-Jan-16	24-Jan-15	-	395	16	15	715	699-731	56.6	2.2
Sector A, B (MR)	23-Jan-16	25-Jan-16	-	92	14	13	159	154-164	63.4	8.8
Sector C, D, E (MR)	23-Jan-16	25-Jan-16	-	221	16	13	342	334-350	67.8	4.7
Sector F, G, H (MR)	23-Jan-16	25-Jan-16	-	237	12	13	413	401-424	59.3	2.9
Sector I, J (MR)	23-Jan-16	25-Jan-16	-	471	26	11	808	792-823	69.3	3.2
Sector K, L (MR)	23-Jan-16	25-Jan-16	-	607	26	12	902	889-916	56.3	2.9
Subtotal Cape Gantheaume				**2100**	**119**		**3529**	**3498-3559**	**59.5**	**3.4**
Total				**2868**	**155**		**4904**	**4865-4942**	**59.1**	**3.2**

* Not able to be surveyed in 2016. Most recent survey from 2014 (Goldsworthy *et al.* 2014).

Table 2. Numbers of long-nosed fur seal pups in sectors of the Cape Gantheaume sub-colony, Kangaroo Island in 28 breeding seasons to 2015-16. Dead pups are included, but the sectors Little Weirs and West of Beach are not included. Data for breeding seasons from 1990-91 to 2005-06 may differ from those of Shaughnessy *et al*. (2006, Table 13) because they have been revised. Data for 2015-16 are from Table 3 of this report.

	Sectors					
Year	Beach	Cave	A, B	C, D, E[a]	F to L[b]	Overall
1988-89[c,d]	0	0	233	205	19	457
1989-90[c]	0	0	237	234	54	525
1990-91	0	0	279	238	89	606
1991-92	2	0	312	310	112	736
1992-93	2	0	370	313	179	864
1993-94	22	0	380	311	225	938
1994-95	92	0	350	409	263	1114
1995-96	211	6	337	426	425	1405
1996-97	341	0	275	478	485	1579
1997-98	548	12	270	408	694	1932
1998-99	623	0	201	402	822	2048
1999-2000	590	8	132	408	994	2132
2000-01	523	5	73	222	832	1655
2001-02	633	22	71	289	1117	2131
2002-03	618	33	71	310	1138	2170
2003-04	692	45	85	370	1443	2635
2004-05	750	41	92	394	1704	2980
2005-06	731	41	106	360	1883	3120
2006-07	690	41	100	314	1817	2963
2007-08	635	9	100	293	1782	2819
2008-09	804	-	107	347	2079	3337
2009-10	548	28	72	261	1671	2580
2010-11	707	28	100	319	2177	3324
2011-12	792	22	115	320	2260	3509
2012-13	723	20	116	355	2113	3327
2013-14	882	15	118	387	2353	3755
2014-15	668	-	134	317	2083	3217
2015-16	715	-	159	342	2122	3353

[a] Includes sector Ew each year, but did not include sector Ee until 1995-96.
[b] Includes sector Ee until 1995-96; data have been adjusted to include sector K from 1996-97 and sector L from 1999-2000.
[c]From Goldsworthy (1990, Table 8).
[d] All tagged.

Table 3. Trend estimates of growth in LNFS pup production for the three main sub-colonies (Cape Gantheaume, Berris Point and Cape Linois) and all breeding sites combined within the CGWPA calculated using the hierarchical modelling and Bayesian inference methodology (see Johnson and Fritz 2014). Trend estimates are given for the posterior median, and lower and upper 90% highest probability density credible intervals (CI) (in parentheses) of λ by year for the last five (2010/11-2015/16) and ten (2005/06 to 2015/16) year periods.

Site	Growth rate last 10 years (λ/yr)	Growth rate last 5 years (λ/yr)
Cape Gantheaume	2.3 (1.4 - 3.4)	0.6 (-1.5 - 3.3)
Berris Point	4.8 (3.8 - 5.7)	-2.7 (-4.7 - -0.4)
Cape Linois	48.5 (23.1 - 74.4)	46.4 (-2.6 - 97.8)
Total Cape Gantheaume WPA	3.0 (2.3 - 3.8)	0.2 (-1.3 - 2.1)

Table 4. Mass (kg) and standard length (cm) of long-nosed fur seal pups at Cape Gantheaume sub-colony, Kangaroo Island on 27 January 2016.

	2016	
	Male	Female
Mass (kg)		
Mean	6.97	6.82
(min-max)	(4.30 -9.80)	(4.10-9.95)
Standard deviation	1.44	1.40
SL		
Mean	69.7	67.8
(min-max)	(59 -79)	(51-76)
Standard deviation	4.5	4.6
Sample size	51	59

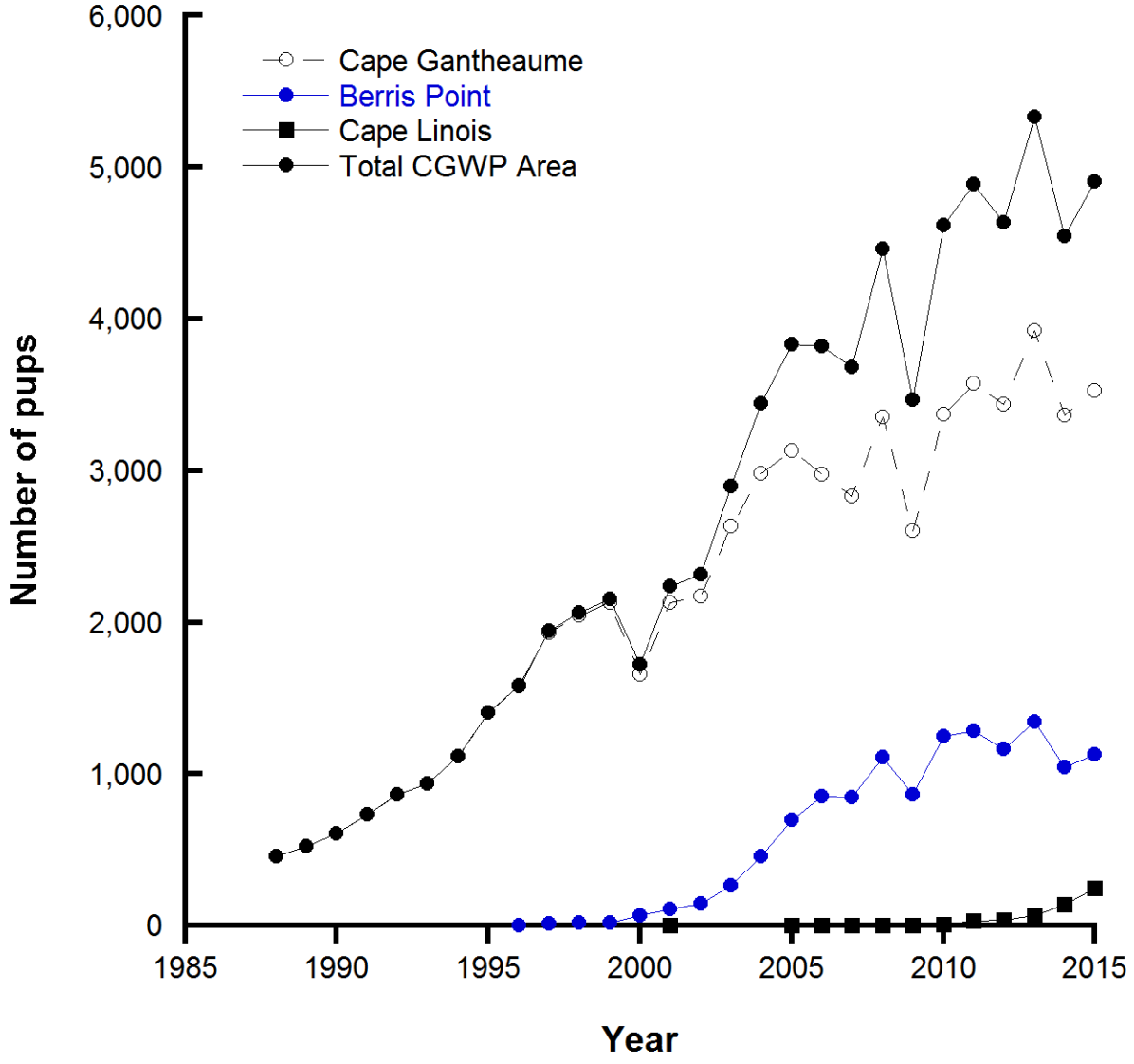


Figure 2. Annual change in long-nosed fur seal pup production in the entire CGWPA, and at the Cape Gantheaume, Berris Point and Cape Linois sub-colonies, monitored each January between 1989 and 2016.

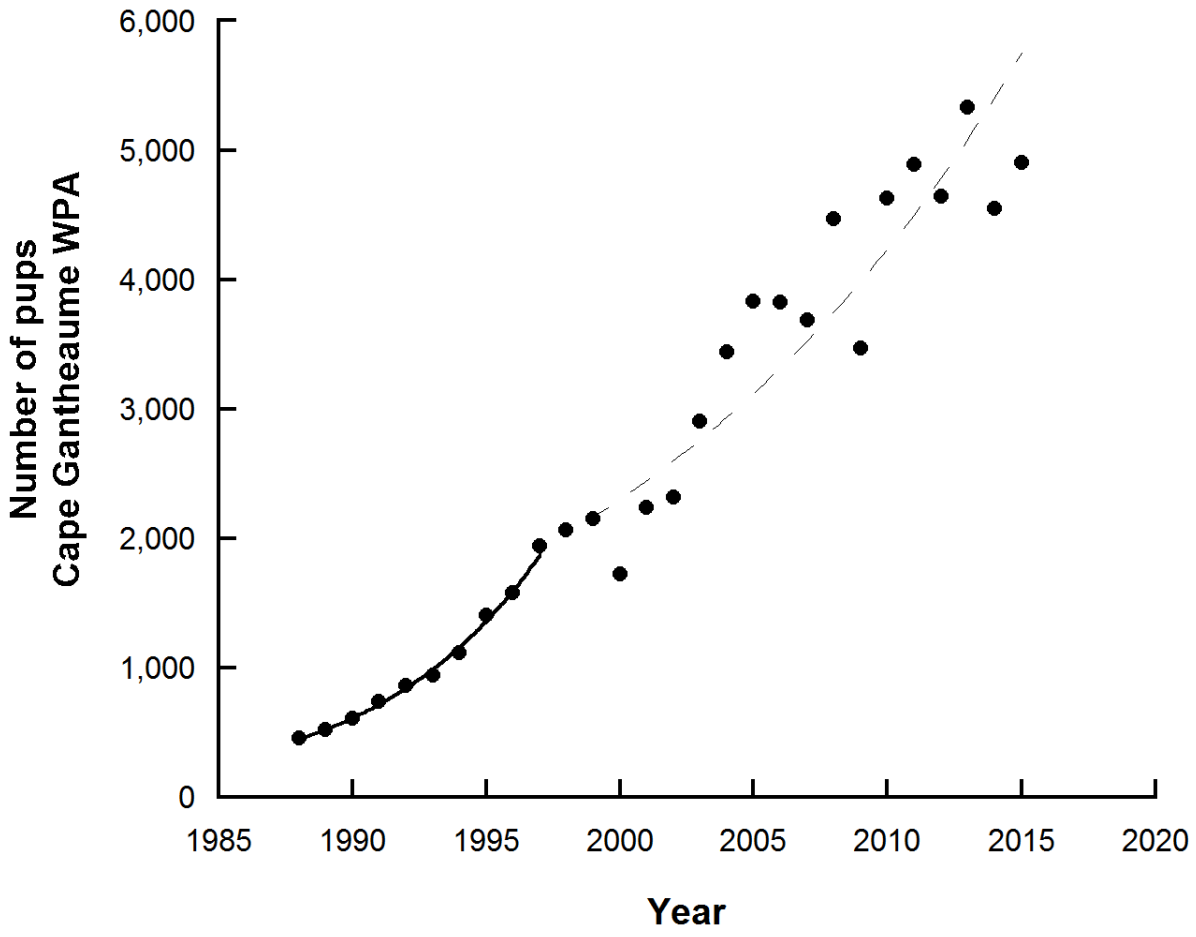


Figure 3. Annual change in long-nosed fur seal (LNFS) pup production in the entire CGWPA, between two recovery periods: January 1989 to 1998 (16.9% per annum); and January 1999 to 2016 (6.7% per annum).

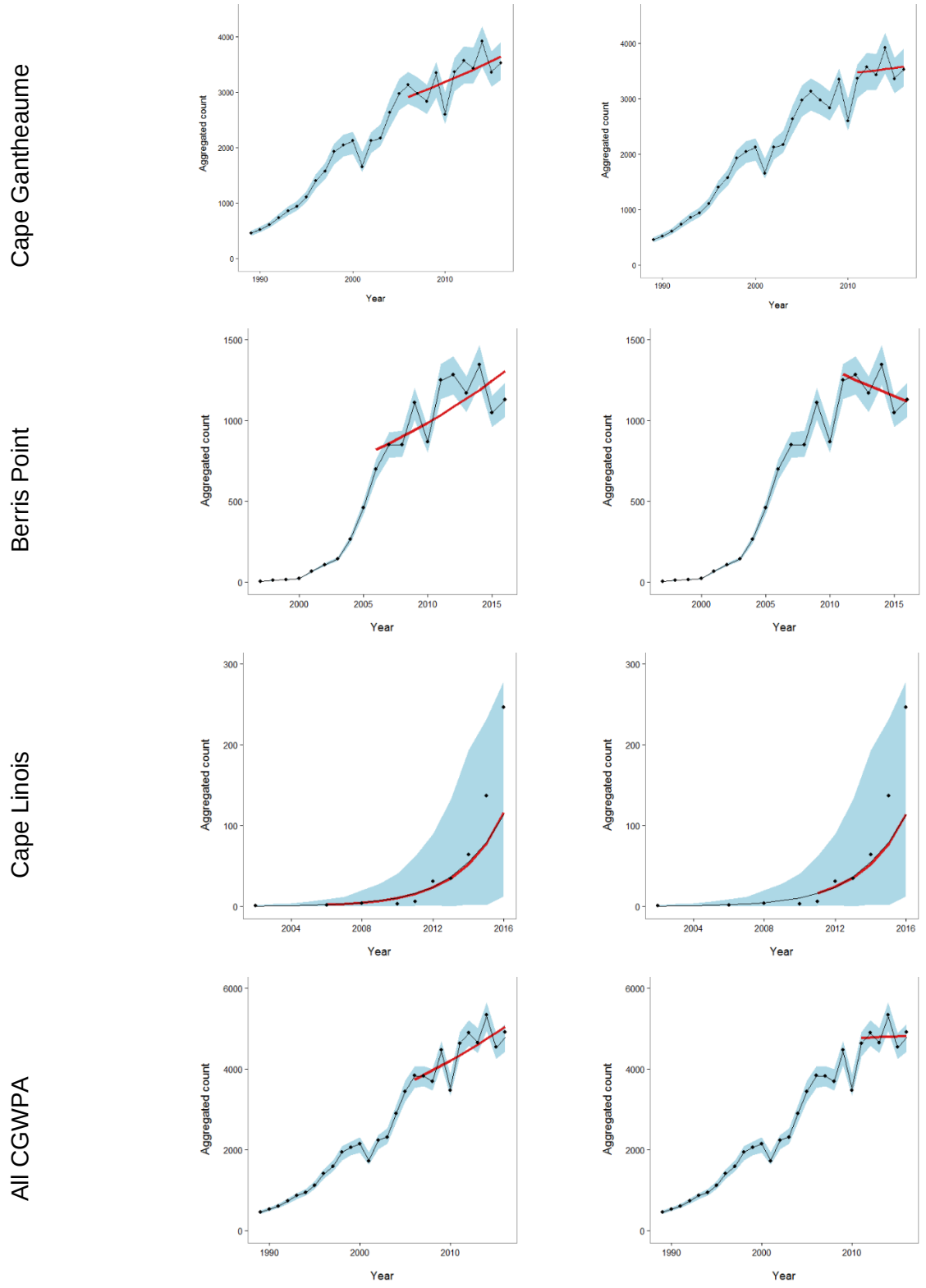


Figure 4. Estimates of growth in LNFS pup production (aggregated count of individual pups (x) counted per year (y)) for the three main sub-colonies (Cape Gantheaume 1988/89-2015/16, Berris Point 1996/97 – 2015/16 and Cape Linois 2001/02 – 2015/16) and all breeding sites combined within the CGWPA (1988/89-2015/16), calculated using the hierarchical modelling and Bayesian inference methodology (see Johnson and Fritz 2014). The blue envelope is the 90% highest probability density credible intervals. The red line is the fitted least-squares predictive trend for the last 10 (left) and 5 (right) years.

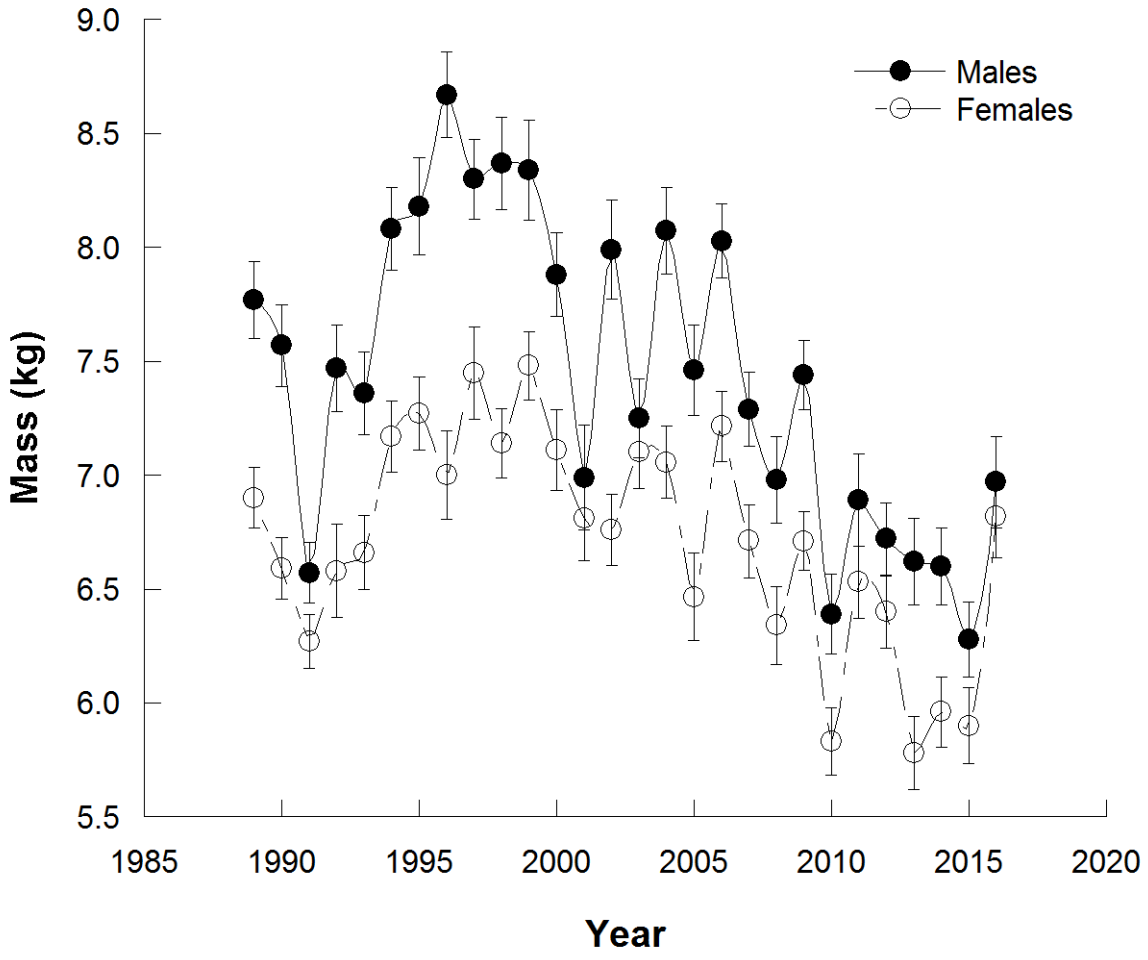


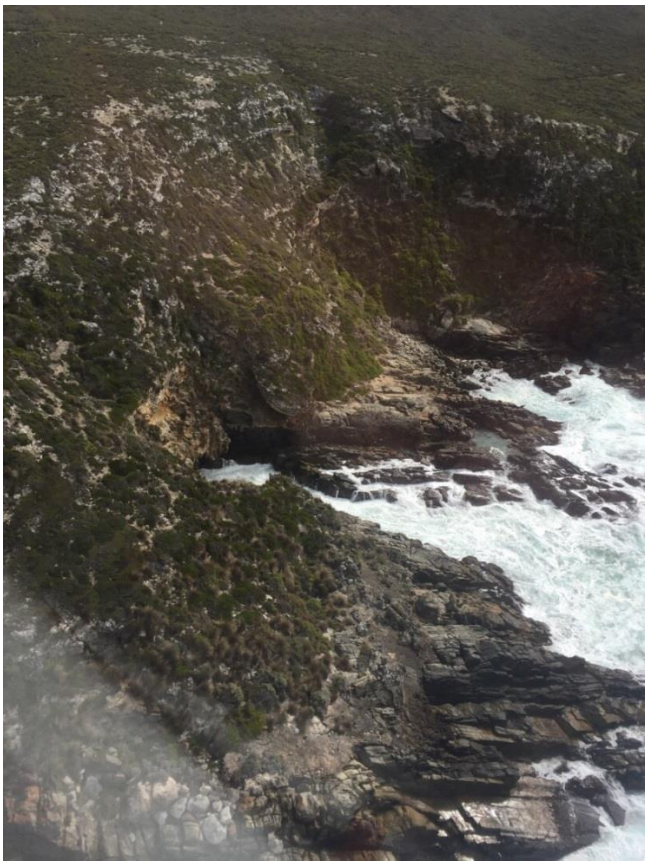
Figure 5. Changes in the mean mass (±SE) of male and female long-nosed fur seals pups weighed at Cape Gantheaume between January 1989 and 2016.

3.2 Seal Bay

3.2.1 Seal Bay – microchipping and demography program

Between 1 October 2015 and 31 April 2016 (since last report, Goldsworthy *et al.* 2015), 1,085 individual ASL scans were undertaken at Seal Bay (Figure 8). Approximately 235 (range 219-245) animals were scanned during each of the bi-monthly three-day scaning sessions (December, February and April) (Figure 7). Around two-thirds (67%) of the animals scanned had microchips.

A new feature in the Fulcrum App enables users to look up information on all scanned animals from a microchip database, including their sex, cohort and estimated age (date of scan minus the median pupping date for the cohort) (Figure 8). A summary of the resight (number of times scanned per year over the previous five years) and reproductive history over the previous three breeding seasons (for females, pups or juveniles nursed and their microchip numbers if known) is also extracted from the database (Figure 8). These new app features provide significant benefits to the program, including confirmation that a scanned animal's microchip has been entered correctly and is in the database; immediate feedback on an animal's age, resight and recent reproductive history; and reductions in the time required to process data for demographic analysis.

a. 

b. 

Figure 6. Aerial (a.) and coastal (b.) views of new long-nosed fur seal breeding and haul-out site discovered on 11 April 2016 to the east of Berris Point, CGWPA.

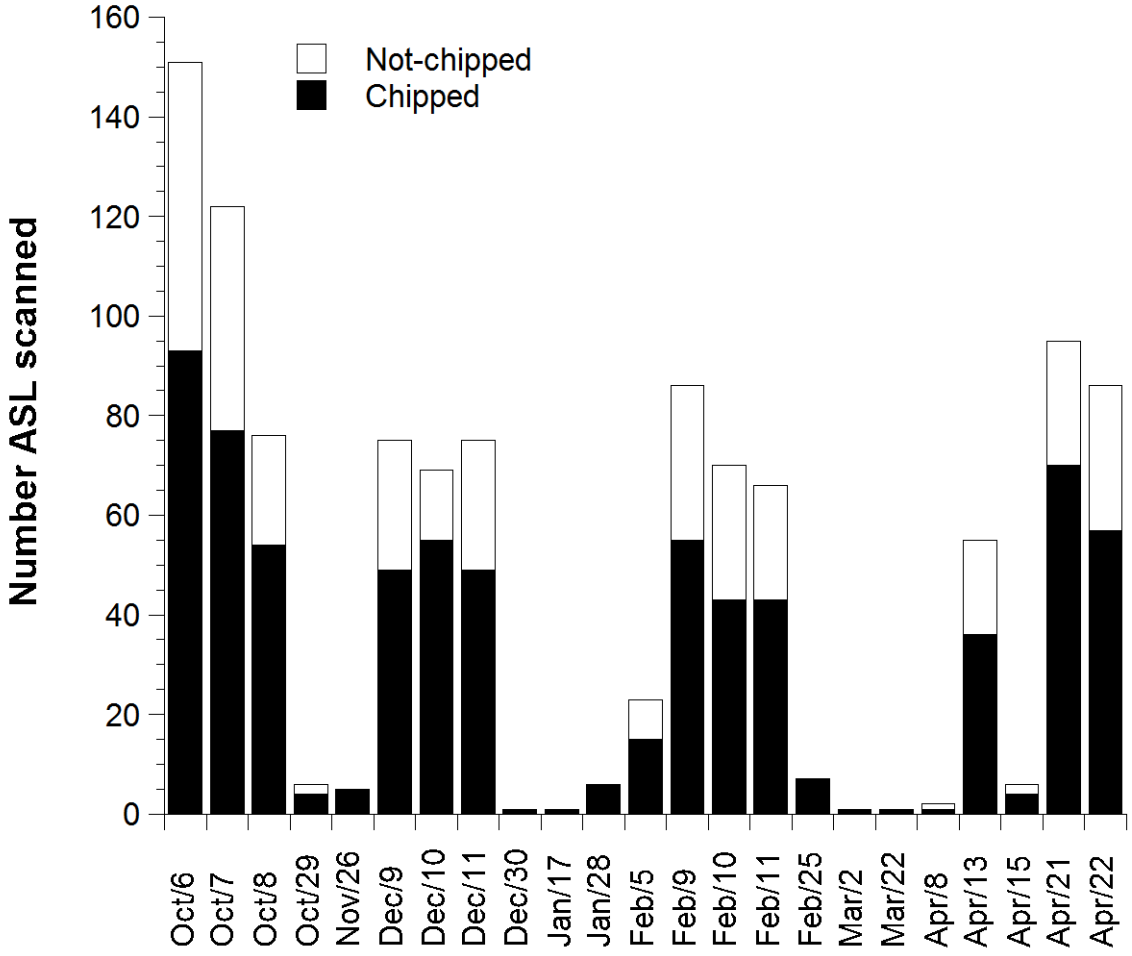


Figure 7. Histogram of Australian sea lion scanning effort at Seal Bay between October 2015 and April 2016. The total number of individual scans, and those with (closed sections) and without microchips (open sections) is indicated.

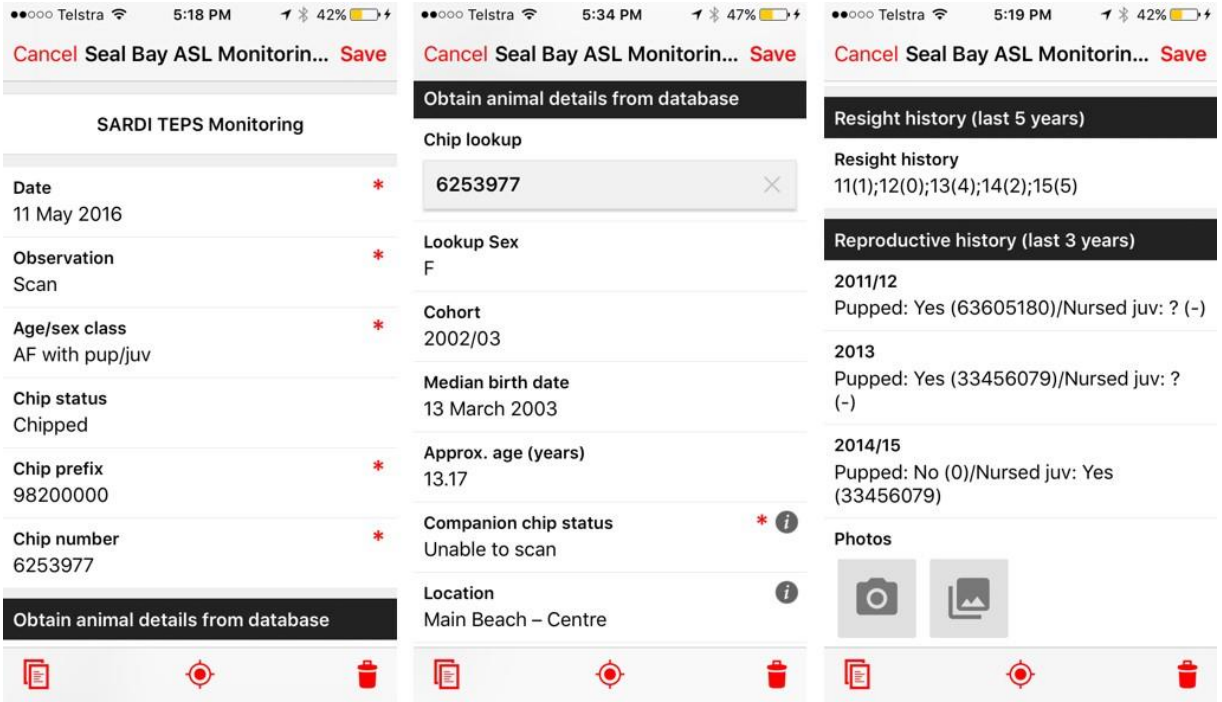


Figure 8. Example of data entry using the 'Seal Bay ASL Monitoring V2' Fulcrum app. In this example an adult female with a juvenile is scanned. Once the michrochip is entered, a Chip lookup window appears and when selected, provides details on the sex, cohort, median birth date, and approximate age (extracted from a microchipping database). Information on the resight history over the last five years (number of times scanned by year), and reproductive history over the last three years is also extracted.

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