

Survey and monitoring of black petrels on Great Barrier Island, 2002/03

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ABSTRACT

During the 2002/03 breeding season for black petrel (*Procellaria parkinsoni*), 320 burrows were identified and were intensively monitored over summer; however only 318 burrows were included in the long-term study. There were 199 burrows used by breeding pairs, 81 by non-breeding adults and the remaining 38 were empty. Several factors affecting the black petrel breeding success were noted. By 15 May 2003, 59 chicks were still present in the study burrows and another 78 had already fledged, corresponding to a breeding success of 69%. Nine census grids were also monitored and a total of 132 burrows were located within the grids, with 78 burrows being used for breeding. An extra seven burrows were found in the grids, three of which were newly dug this season and four, previously investigated, were now active. Extrapolating from these grid burrows, we estimate that the black petrel population around the peak of Mt Hobson ranged from 3155 to 4887 birds. There were 18 chicks from earlier breeding seasons recaptured within the Mt Hobson colony area this season. Of these, three have paired and bred (one successfully). 'Dummy' satellite transmitters were placed on 30 adults, each incubating an egg. All transmitters were recovered. We colour-marked 31 adults with fluorescent spray paint. No sightings of these birds at sea were reported.

Keywords: black petrels, *Procellaria parkinsoni*, monitoring, population estimates, breeding success, predation, bycatch, satellite transmitter, colour marked, Great Barrier Island, New Zealand.

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1. Introduction

The black petrel (*Procellaria parkinsoni*) is an endemic seabird which breeds on Little and Great Barrier Islands, New Zealand. The main breeding area on Great Barrier Island is around the summit of Mt Hobson (Hirakimata). Monitoring during the 2002/03 breeding season is a continuation of a study begun in 1995/96 (Bell & Sim 1998a, 1998b, 2000a, 2000b, 2000c, 2002, 2003), and the data collected will be added to existing information on the black petrel population. This study is designed to ensure that any population changes are detected in time to implement appropriate management strategies.

2. Objectives

The main objective of this study was to undertake an annual census of the black petrel population on Great Barrier Island via burrow monitoring and the banding of adults and fledglings to establish adult mortality, breeding success and recruitment. Since this study is a continuation from previous breeding seasons, it will also provide more data to establish current population trends and assist in determining causes and timing of mortality.

In summary, the study objectives were:

- To monitor a sample of black petrel burrows within the main breeding area, band all adults present in the burrows during November/December and January/February and all remaining fledgling chicks during April/May.
- To determine breeding success in the sample of long-term study burrows. Causes of breeding failure, such as predation or disappearance of parents, are to be recorded.
- To monitor and re-survey the census grids and study area for new burrows, and band and recapture as many breeding and non-breeding birds present as possible.
- To determine a population estimate by extrapolating from the grid areas to the main Mt Hobson breeding area.
- To undertake a mark/recapture programme at the beginning of the breeding season (November/December) to determine pre-breeder survival, age of first return and age of first breeding; and to band as many birds as possible.
- To confirm the breeding status of adults during each visit to the colony (i.e. to monitor the study burrows at the beginning, middle and end of the breeding season), and where possible, identify the sex of the resident adult.
- To increase night banding during the entire breeding season.
- To establish which satellite transmitter attachment method (i.e. tape-only or combination of tape, sewing and glue) is the most durable over multiple foraging trips.

3. Methods

3.1 STUDY BURROWS

The study area (30 ha around the summit, Fig. 1) was visited from 4 to 18 December 2002. During this visit the study burrows ($n = 283$) were checked for presence of adults and eggs. Any adult present was removed from the burrow, banded (or the band number recorded if a recapture), sexed by viewing the cloaca (if swollen this indicates the bird is a female; the cloaca is particularly obvious immediately after egg laying), and returned to the burrow. The presence of an egg was noted.

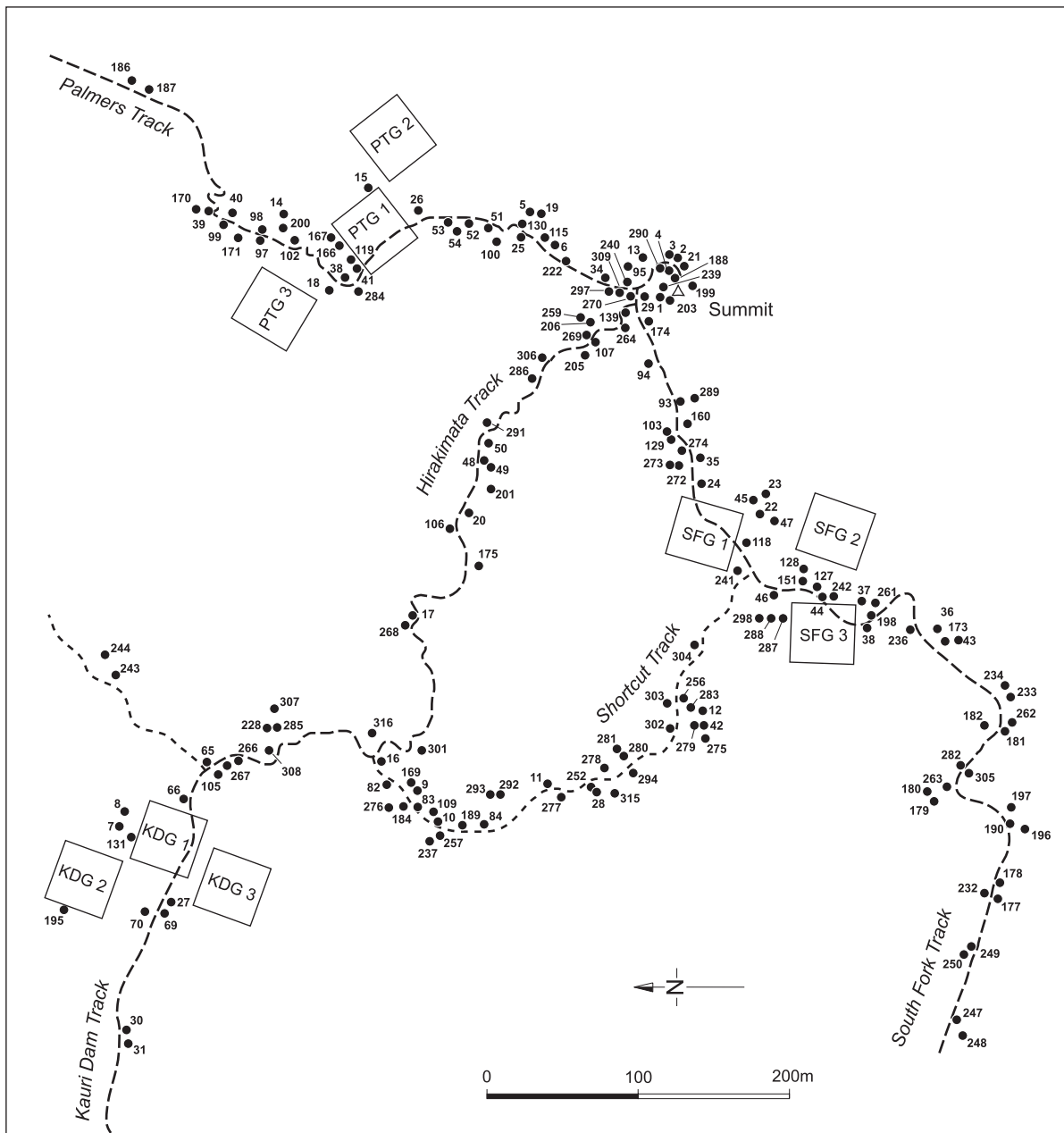
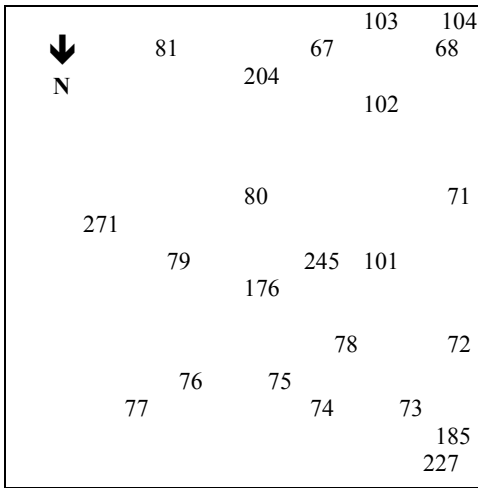
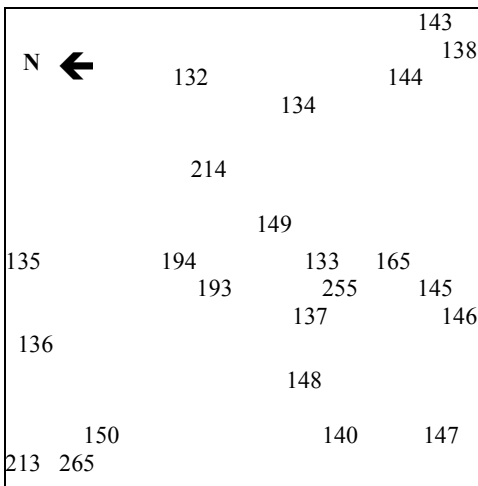


Figure 1. Location of the burrows and census grids around the summit area of Great Barrier Island. Figs 2–4 show the burrow numbers within each of the nine census grids.

Kauri Dam grid one (KDG1)



Kauri Dam grid two (KDG2)



Kauri Dam grid three (KDG3)

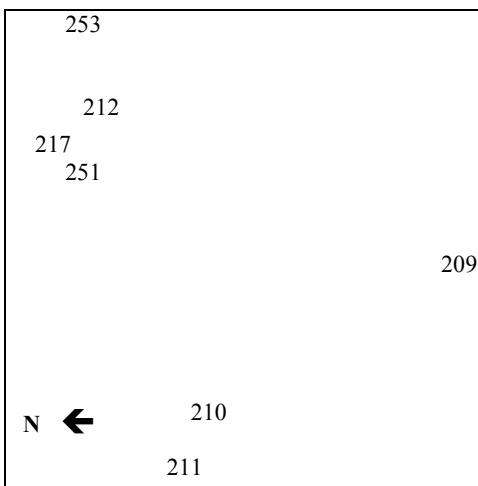


Figure 2. Location of Kauri Dam grid sites (each grid is 40 × 40 m).

During the next visit to the colony (15 January to 3 February 2003), the number of study burrows was increased from 283 to 318 (Figs 1–4). To ensure accurate monitoring, the study burrows were accessible either through the main entrance or via an opening that had been excavated through the burrow roof into the chamber. This opening was covered by a piece of plywood, with soil and debris camouflaging the cover.

As in the first visit, any adult present in the burrow was removed, banded (or the band number recorded if a recapture), and returned to the burrow. Eggs or chicks were noted if present; the lack of eggs or chicks identified non-breeding birds. The study burrows were monitored again (15–18 May) and all remaining fledgling chicks were banded. This information was used to determine breeding success.

3.2 CENSUS GRIDS

The three original grids were selected in areas that had historical presence of black petrels, different strata, vegetation types and topography and were near known launch sites (Bell & Sim 1998a, 2000a). These original grids were replicated to determine whether burrow density was similar in each area and to increase the accuracy of the population estimate (Bell & Sim 2000a, 2000b).

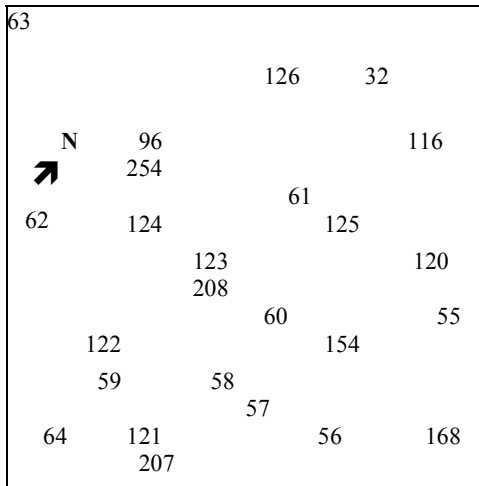
The nine census grids (each 40 × 40 m) set up around Mt Hobson were systematically searched (at 1 m intervals) to locate any new burrows and to determine this season's occupancy (Figs 1–4). Any birds present in a burrow within the census grids were dealt with as explained in Section 3.1.

3.3 SATELLITE TRANSMITTERS

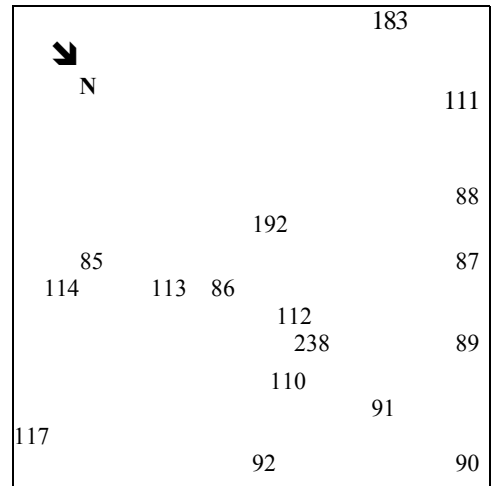
After a successful preliminary satellite transmitter trial in 2001/02 season using three attachment methods, the two best methods (tape-only or combination of tape, sewing, glue) were selected to trial for long-term endurance (over multiple foraging trips). The transmitters were attached to the birds during the December visit to the colony and removed during the January trip.

Thirty 'dummy' transmitters were attached to breeding birds incubating eggs (15 attached with tape-only and 15 by the combination method). The transmitter design was identical to that used in the 2001/02 season (weighed 22 g, streamlined, measuring 20 mm × 66 mm × 13 mm with a 'battery' (16 mm × 25 mm × 7 mm) protruding from the right side and 200 mm wire to represent the antenna; Bell & Sim in press). Eleven

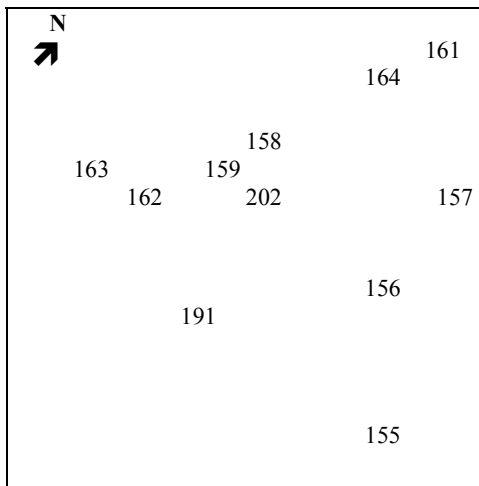
Palmers Track grid one (PTG1)



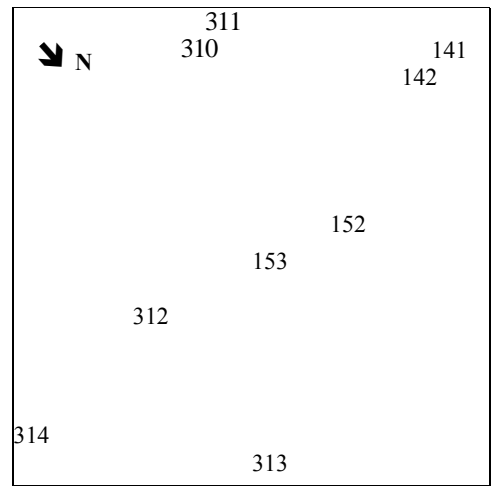
South Fork Track grid one (SFG1)



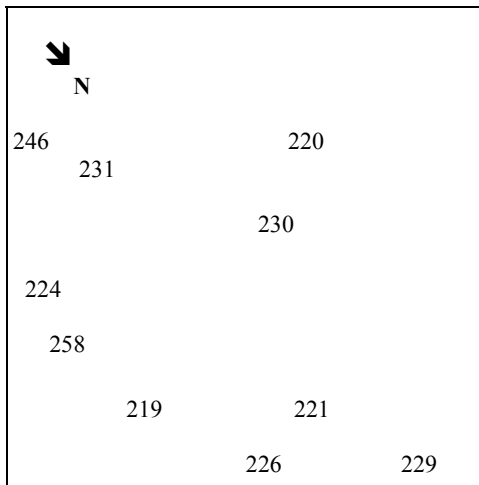
Palmers Track grid two (PTG2)



South Fork Track grid two (SFG2)



Palmers Track grid three (PTG3)



South Fork Track grid three (SFG3)

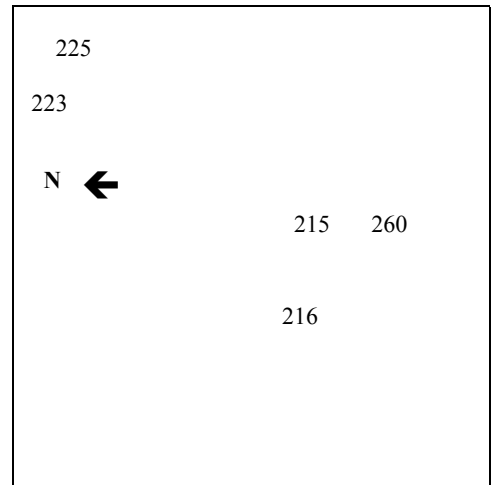


Figure 3. Location of Palmers Track grid sites (each grid is 40 x 40 m).

Figure 4. Location of South Fork Track grid sites (each grid is 40 x 40 m).

transmitters were attached on 6 December 2002 and the remaining 19 on 9 December 2002. Twenty-three (10 tape only and 13 combination) were placed on known males and seven (4 tape only and 3 combination) on females.

Transmitters were recovered during the January visit to the colony. The burrows were monitored daily and as soon as the parent returned, the transmitter was removed. Twenty transmitters were removed on 17 January 2003, one on 19 and 20 January 2003, two on 23 January 2003, one on 25, 26, 28, 30 and 31 January 2003, and one on 2 February 2003.

3.4 COLOUR MARKING

A trial of colour marking a selection of adult black petrels was undertaken this season. Fluorescent Dazzle™ pink or green spray paint was used. The birds were sprayed on the centre of the back, between the wings and towards the tail (stopping short of the preening gland). With a pillowcase placed over their heads to reduce drift and fumes, the birds were held by one team member and sprayed by another. After five minutes, allowing the paint to dry, the birds were returned to their burrows. A total of 31 birds were colour-marked (5 breeding adults and 26 non-breeding adults).

3.5 NIGHT BANDING

In both the December 2002 and January/February 2003 visits to the study area, night banding was undertaken. This involved searching the study area by walking the track system and capturing any adult on the surface. Several nights were also spent at known launch sites and birds were captured while taking off or landing. All birds were banded or had their band numbers recorded. During the December 2002 visit sex was determined if possible (by cloacal inspection).

4. Results

4.1 NUMBER OF BURROWS IN THE CENSUS GRIDS

A total of 132 burrows were found in the nine census grids (Table 1, Figs 2–4). Of these, 78 burrows were used by breeding pairs, 37 were used by non-breeding adults and 17 burrows were empty. There were also several ‘potential’ burrows within the grids, which are not included in any burrow estimate. We define ‘potential’ burrows as those which have been investigated and/or preliminarily dug out, but are not yet being used by breeding or non-breeding petrels.

TABLE 1. TYPE AND NUMBER OF BURROWS WITHIN THE CENSUS GRIDS ON GREAT BARRIER ISLAND.

AREA AND BURROW TYPE	GRID ONE									GRID TWO					GRID THREE			
	95/ 96	96/ 97	97/ 98	98/ 99	99/ 00	00/ 01	01/ 02	02/ 03	98/ 99	99/ 00	00/ 01	01/ 02	02/ 03	99/ 00	00/ 01	01/ 02	02/ 03	
Kauri Dam grid																		
Empty	1	1	1	1	3	1	4	2	0	0	0	1	2	2	1	1	1	
Breeding	8	10	8	12	11	12	11	16	15	16	13	16	17	3	3	4	3	
Non-breeding	5	5	7	6	8	9	8	5	4	5	9	6	4	0	3	2	3	
TOTAL	14	16	16	19	22	22	23	23	19	21	22	23	23	5	7	7	7	
Palmers Track grid																		
Empty	3	0	0	1	1	0	1	3	0	0	0	0	2	0	2	3	2	
Breeding	7	13	13	15	18	16	19	15	10	9	10	10	8	9	6	6	6	
Non-breeding	3	6	7	6	5	9	5	7	1	2	1	1	2	0	2	1	3	
TOTAL	13	19	20	22	24	25	25	25	11	11	11	11	12	9	10	10	11	
South Fork Track grid																		
Empty	2	1	1	0	1	3	4	4	1	1	1	0	0	1	0	0	1	
Breeding	5	12	11	11	10	10	8	6	2	1	3	3	3	3	3	4	4	
Non-breeding	2	1	3	5	6	4	5	7	1	2	0	1	6	0	1	1	0	
TOTAL	9	14	15	16	17	17	17	17	4	4	4	4	9	4	4	5	5	
ANNUAL TOTALS	36	49	51	57	63	64	65	65	34	36	37	38	44	18	21	22	23	

4.2 STUDY BURROWS

Within the 318 study burrows (those burrows that can be accessed out of the 320 numbered burrows), 199 contained breeding birds, 81 contained non-breeding birds and 38 were empty. There were 68 failures due to various factors (loss of eggs, infertile, predation, etc., Table 2). This corresponds to a breeding success of 69% (Table 2).

Both parents were identified in 173 of the breeding study burrows, 24 where only one parent was identified and two burrows where no parents were identified (Appendix 1). Of the non-breeding burrows, there were 41 burrows where two or more birds were identified, 19 where one was identified and 21 where no birds were present during the day, but the burrows were active at night (Appendix 1).

Three male pre-breeders on first return to the colony were found in their natal burrows (H31366 in burrow 64, H31527 in burrow 119 and H31495 in burrow 89, Appendix 1). Two of these birds were evicted by the resident pair when they returned to breed, and the other attracted a partner to this now vacant burrow.

TABLE 2. BREEDING SUCCESS AND CAUSES OF MORTALITY IN THE STUDY BURROWS ON GREAT BARRIER ISLAND.

		96/97	97/98	98/99	99/00	00/01	01/02	02/03
Number of study burrows		118	137	197	248	255	283	318
Eggs	laid	92	95	142	178	168	192	199
	predation (rat)	6	1	2	9	6	5	1
	crushed ^a	5	0	1	10	6	5	14
	abandoned	2	1	5	1	3	9	7
	infertile	6	4	12	6	8	3	2
	dead embryo (at various stages)	0	8	6	13	9	14	19
	disappeared egg ^b	0	0	0	0	0	11	3
	unknown ^c	0	0	0	0	0	0	5
Chicks	hatched	73	81	116	139	136	145	148
	predation (rat)	0	0	2	0	0	0	0
	predation (cat)	0	0	2	2	1	2	3
	died (disease)	1	0	0	0	0	0	0
	died (starvation)	0	1	0	0	0	0	0
	died (unknown causes)	0	0	3	6	7	8	8
	fledged ^d	72	80	109	131	128	135	137 ^e
Overall breeding success (%)		78	84	77	73.5	76	70	69

^a These eggs have been crushed by the parents or during fighting with interloping birds and only shell fragments were recovered from the burrow. Some may have been predated by rats, infertile or contained an embryo which died.

^b These eggs were present in November/December, but were gone when first checked in January. Many of the burrows had been cleaned out and the adults were not caught again.

^c There were five burrows not located in May 2003 and as a result it is not known if the eggs hatched successfully. To determine overall breeding success we have been cautious and assumed that they failed.

^d All chicks still present at the end of the April trip. It is assumed all will fledge safely.

^e Of these, 78 chicks had already fledged prior to the banding visit, only 59 chicks were banded.

4.3 BANDING DATA

There were 549 adults identified during the 2001/02 season (Table 3), of which 370 had already been banded and 179 were banded this season. There were 59 chicks still present in the study burrows and three chicks in non-study burrows that were also banded (Table 3).

Since the first chick was recaptured in the 1999/00 season, 23 'chicks' have been recaptured as pre-breeders, non-breeders or breeding adults (Table 4). Four of these 'chicks' have bred over three seasons (2000/01 to 2002/03; Bell & Sim 2002; in press), with three successfully raising chicks of their own. This means the age at first breeding is 5-6 years and upwards (Table 4). The remaining chicks have not bred, although several were recaptured while calling to attract a mate.

TABLE 3. BANDING, RECAPTURE AND RECOVERY DATA FOR BLACK PETRELS FROM GREAT BARRIER ISLAND.

	95/96	96/97	97/98	98/99	99/00	00/01	01/02	02/03
Recaptures of birds banded prior to 1995	19	31	24	23	29	27	27	27
Recaptures of birds banded in 1995/96	-	14	14	14	16	14	11	12
Recaptures of birds banded in 1996/97	-	-	113	86	84	73	63	57
Recaptures of birds banded in 1997/98	-	-	-	32	32	30	28	24
Recaptures of birds banded in 1998/99	-	-	-	-	95	82	71	64
Recaptures of birds banded in 1999/00	-	-	-	-	-	86	75	66
Recaptures of birds banded in 2000/01	-	-	-	-	-	-	51	52
Recaptures of birds banded in 2001/02	-	-	-	-	-	-	-	68
Total recaptures	19	45	151	155	256	312	326	370
Number of new adults (banded that season)	41	179	60	129	145	97	114	179
Total adults	60	224	211	284	401	409	440	549
Number of chicks (banded that season)	59	69	85	116	137	137	160	62
Total number of birds	119	293	296	400	538	546	600	611
Number of chicks recaptured alive (returned to colony)	-	-	-	-	1	2	11	18
Band recoveries from dead birds	-	1	1	-	2	1	2	2

TABLE 4. NUMBER OF RECAPTURES, AGE AT FIRST RECAPTURE AND AGE AT FIRST BREEDING FOR RECAPTURED 'CHICKS' BANDED ON MT HOBSON.

BIRD	BAND NO.	NO. OF RECAPTURES	AGE AT FIRST RECAPTURE (years)	AGE AT FIRST BREEDING (years)
1	H25664	1	3	-
2	H30924	1	7	-
3	H30908	2	6	6
4	H30930	4	4	5
5	H31076	1	5	-
6	H31080	1	4	-
7	H31081	2	4	-
8	H31082	1	4	-
9	H31089	1	5	-
10	H31194	1	5	5
11	H31366	1	5	-
12	H31370	1	5	-
13	H31377	1	4	-
14	H31382	2	4	5
15	H31405	1	6	-
16	H31406	1	5	-
17	H31424	1	6	-
18	H31473	1	4	-
19	H31474	1	4	-
20	H31490	1	4	-
21	H31495	1	4	-
22	H31527	1	4	-
23	H31542	1	4	-
MEAN		1.26 ± 0.14	4.6 ± 0.2	5.25 ± 0.25

4.4 FLEDGING AGE

As the banding trip was delayed until May 2003, several chicks had already fledged within a day of our arrival. This was obvious from the pin shafts present at the entrance (fall off when the chicks practise flying) and old down feathers. Many of the burrows still had a strong smell of petrels. This gave an excellent opportunity to determine approximate fledging date for some of the chicks (Table 5). As we knew the hatching date and approximate fledging date of ten chicks we could also determine maximum age at fledging (Table 5). This ranges from 105 to 121 days (Table 5).

TABLE 5. PIPPING DATE, APPROXIMATE FLEDGING DATE AND MAXIMUM AGE AT FLEDGING FOR TEN CHICKS ON MT HOBSON.

BURROW	DATE AT PIPPING	APPROX. DATE OF FLEDGING	MAX. AGE AT FLEDGING (days)
22	1 Feb 03	16 May 03	106
29	19 Jan 03	16 May 03	118
41	18 Jan 03	18 May 03	121 [*]
46	19 Jan 03	16 May 03	118
48	18 Jan 03	16 May 03	119
52	27 Jan 03	16 May 03	109
146	29 Jan 03	15 May 03	109
164	24 Jan 03	17 May 03	114
166	18 Jan 03	17 May 03	120
307	2 Feb 03	16 May 03	105

^{*} This is an exact fledging age as the chick left the burrow the day after it was banded.

4.5 POPULATION ESTIMATE

Extrapolating from the census grid data to the 30 ha area around the summit area of Mt Hobson, the black petrel population is estimated between 3155 and 4887 adults birds (4021 ± 866 birds, Table 6), consisting of 771 (± 148) non-breeding adults and 3250 (± 718) breeding adult (i.e. approximately 1600 breeding pairs). Over the past four seasons when the nine census grids have been monitored, the population estimates have been very similar (ranging from 3500 to 4000 birds ($\pm 860-900$, Table 7).

4.6 SATELLITE TRANSMITTERS

Thirty dummy transmitters were attached using two different attachment methods. Once the transmitters were attached, they stayed on the birds for between 39 and 56 days.

Placement of the transmitters did not affect breeding outcome. All birds continued to incubate their eggs as normal, both after the transmitters were

TABLE 6. 2002/03 POPULATION ESTIMATE OF BLACK PETRELS IN THE 30 ha SUMMIT AREA AROUND MT HOBSON, GREAT BARRIER ISLAND.

	DENSITY (no./ha)		POPULATION (30 ha)	
	Breeding adults	Non-breeding adults	Breeding adults	Non-breeding adults
Grid One (KDG1)	200	31.3	6000	937.5
Grid Two (KDG2)	212.5	25	6375	750
Grid Three (KDG3)	37.5	18.75	1125	562.5
Grid Four (PTG1)	187.5	43.75	5625	1312.5
Grid Five (PTG2)	100	12.5	3000	375
Grid Six (PTG3)	75	18.75	2250	562.5
Grid Seven (SFG1)	75	43.75	2250	1312.5
Grid Eight (SFG2)	37.5	37.5	1125	1125
Grid Nine (SFG3)	50	0	1500	0
Mean	108.3	25.7	3250 ± 718	771 ± 148
Total population			4021 ± 866	
Range			3155-4887	

TABLE 7. ANNUAL MEAN POPULATION ESTIMATE SINCE 1999/2000 BREEDING SEASON FOR BLACK PETREL USING THE 30 ha AREA AROUND MT HOBSON, GREAT BARRIER ISLAND.

YEAR	BREEDING ADULTS	NON-BREEDING ADULTS	TOTAL POPULATION	RANGE
1999/2000	2938 ± 800	583 ± 186	3521 ± 986	2535-4507
2000/01	2792 ± 676	792 ± 235	3584 ± 911	2673-4495
2001/02	3375 ± 699	625 ± 168	4000 ± 867	3133-4867
2002/03	3250 ± 718	771 ± 148	4021 ± 866	3155-4887

attached in December 2002 and after they were removed in January or February 2003. Twenty-two chicks fledged, one chick died (aged two weeks) and five embryos died in the egg. This equates to a breeding success rate of 73% (chicks fledged from eggs laid), which is better than the colony as a whole (68%, Section 4.2).

Twenty-nine transmitters were recovered. All birds were recaptured; however one of the combination transmitters has fallen off at sea. The tape, sewing and glue part was still on the bird's back. It appeared the seawater had leaked between the epoxy casing and the wax transmitter, which caused it to fall off.

The transmitters were easily attached and removed. The tape-only method was the most successful for long-term attachment and was the easiest to manage in the field. Both methods were quick to attach; however, the tape-only method took only a maximum of five minutes and the combination method could vary up to 10 minutes.

4.7 COLOUR MARKING

Thirty-one adults were colour marked (five breeding adults and 26 non-breeding adults). It did not have any effect on breeding success (all five chicks successfully fledged) and non-breeding birds continued to try to attract a partner (calling from the burrow at night). Two non-breeding birds were recaptured over one week after spraying and the colour was still highly visible.

It was hoped that the colour-marked birds would be sighted by the public, fishers and/or observers to give basic foraging data. To date, no sightings have been recorded.

5. Discussion

The black petrel population on Great Barrier Island has been monitored since the 1995/96 breeding season (Bell & Sim 1998a, 1998b, 2000a, 2000b, 2000c, 2002, 2003).

5.1 CENSUS GRIDS

Nine grids were intensively monitored during the three periods of 2002/03 breeding season, 4 to 18 December 2002, 15 January to 3 February 2003 and 15 to 18 May 2003. Seven new burrows were located in the grids (one in PTG2 and PTG3, and 5 in SFG2). Three of these were occupied by breeding pairs and the others by non-breeding birds. As this study has continued, the number of burrows found within the grids has risen each year. It appears that pre-breeding and non-breeding birds are returning to their natal area and are starting to excavate new burrows. This is confirmed by the recapture of three male pre-breeders returning to their natal burrows (Section 4.3, Appendix 1).

Using the past four breeding seasons, the ratio of non-breeding burrows to breeding burrows have been very similar ($1:2 \pm 0.6$) to previous seasons (1:3 or 1:2, Bell & Sim 2000a, 2000b, 2000c, 2002, 2003). This may be explained by a consistent numbers of birds returning to the colony to breed each season.

5.2 STUDY BURROWS

A further 35 study burrows were added to the 283 previously identified. There were 137 breeding successes and 69 breeding failures this season, equating to an overall breeding success rate of 69%. This breeding success is slightly lower than in previous years (Table 2), but still higher than reported in the earlier research by Imber (1987) in 1977 (50%) and 1978 (60%) and Scofield (1989) in 1988/89 (62%). The similar success rates for 2001/02 and 2002/03 may be due

to recording eggs laid in December. In previous seasons any egg that may already have failed, and been removed from the burrow by the time we visited the colony in January, could not be noted. In the case of this season, three eggs had disappeared by the return visit in January (1.5%). It will be interesting to continue this monitoring stage to enable a 'correction' factor to be added to the earlier seasons.

Unfortunately, during the final check (May 2003), five burrows were missed. Each of these burrows had an egg present in February 2003. It is unknown whether the eggs hatched successfully and the resulting chick fledged. To enable breeding success to be calculated, we have assumed the eggs failed. However, if all eggs hatched and chicks fledged, the breeding success rate would have been 71%. Both success rates fall within the usual range over the entire study (Table 2).

5.3 RAT AND FERAL CAT PREDATION

There were three incidents of cat predation (1.5%) on chicks, while rats predated 0.5% of the eggs laid within the study burrows this season. Predation by cats occurred in three different areas - Palmers Track, Kauri Dam, and the Summit. Juvenile petrels are vulnerable to feral cat predation as soon as they leave the burrows to strengthen wings and practise flying (Warham 1996). Ten chicks have been predated by cats over the past five seasons (Table 2). It is important to continue cat trapping in the area.

5.4 CHICKS

In May 2003, 59 chicks were still present in the study burrows. In comparison with previous seasons, most chicks were in very good condition, and because of the later date, were about to fledge. Only two chicks were small or in poor condition. The overall improvement on chick condition this season suggests that food quality (or quantity) may have improved in the foraging areas. If chick condition continues to vary annually, it would be worthwhile to determine if this was dependent on the amount of food available, distance from the colony, or the nutritional quality in their diet.

One banded chick appeared to have been attacked, and may not survive due to a damaged bill and eye. Although poor condition may not prevent fledging, it would mean that it could be unlikely that the bird would make its first flight to South America, which in turn, would reduce juvenile survival estimates.

The chick-banding trip was later than expected, which meant some chicks had already fledged, but this situation provided information to calculate and verify approximate fledging age for some birds. This ranged from 105 to 121 days (Table 5). This is within the range 96-122 days (mean 107 days) recorded in Robertson & Heather (1996).

5.5 POPULATION ESTIMATE

Extrapolating from the census grids to the Mt Hobson summit area (30 ha), the population of the Great Barrier Island black petrels is estimated at 4021 ± 866 adults (ranging from 3155 to 4887, Table 6). This estimate is similar to those for 1999/2000 and 2000/01 seasons, but less than for earlier years (Table 7)—a direct result of increasing the number of census grids from three to nine. Replicating the grids gives a better idea of burrow density within each distinct area and, as a result, gives a statistically sounder population estimate for the entire study area.

To expand this population estimate to Great Barrier Island as a whole, further census grids would have to be established in other areas on the island. Black petrels are known to nest in the Northern Block (Tataweka), other high points around the summit area, in small pockets of private land, and more recently towards the southern end of the island. Census grids or further intensive surveys in these areas would give a better idea of density and range around the island. Increasing the number of census grids using other areas around the summit would give more accuracy to the population estimate, and might enable extrapolation to the entire island. These grids could be established on or near the Hogs Back, Mt Heale, and Mt Matawhero. It may be noted that a pair of black petrels (which are successful breeders) have been found well below 300 m asl (pers. obs.). So it is possible that other birds are also breeding at lower elevations than previously thought, and this should be investigated further.

5.6 BANDING DATA

A total of 611 birds were identified this season (Table 3). Of these, 549 were adults and 62 were fledglings (Table 3). There were 370 recoveries of previously banded birds, and an additional 18 that were returned chicks (Table 3); of these, two were female, ten were males and six were of unknown sex. These chicks had been banded in the 1995/96 (3), 1996/97 (2), 1997/98 (6), 1998/99 (6) and 1999/2000 (1) breeding seasons. This means the minimum age at first return is now three years (compared to four years recorded in 2000/01; Bell & Sim 2003).

Ten chicks were recaptured in their natal area (less than 20 metres from their 'hatching' burrow) and three were recaptured in their natal burrows. The other chicks were caught over 200 m away from their natal areas.

Since the first chick was recaptured in the 1999/00 season, 23 'chicks' have been recaptured. Four of these 'chicks' have bred during this period, and ages of first recorded breeding have been five years (3) and six years (1) (Table 4). It is important to check for more returned chicks and maintain intensive burrow monitoring where returned 'chicks' have been present.

5.7 SATELLITE TRANSMITTERS

The transmitter trial was very successful. All the transmitters were easily attached and removed, using both tape-only method and the combination method (tape, sewing and glue) of attachment. Of the 30 applied (15 of each attachment method), 29 were recovered (although all the birds were recaptured).

The transmitters were present on the black petrels for between 39 and 56 days. This would correspond to approximately 5-8 foraging trips (assuming the average foraging trip was 7 days, Robertson & Heather 1996). The transmitters did not affect the outcome of breeding, with 22 chicks fledging successfully (breeding success of 73% compared to the whole colony at 69%). Unlike the sooty shearwater *Puffinus griseus* (Söhle et al. 2000), black petrels appear to be able to carry satellite transmitters long-term without it affecting behaviour, survivorship or attendance at the colony.

The quicker method was tape-only (less than five minutes), whereas the combination method took up to ten minutes. The combination method was the more awkward, requiring tape, needles, strong cotton and glue. The tape-only transmitter attachment method was easier to manage in the field (both attaching and removing), as only a roll of tape was required. It is recommended that if actual satellite transmitters are to be used on black petrels, they should be attached by the tape-only method.

At present, satellite transmitters can be placed on larger birds such as sooty shearwaters and Westland petrels (*Procellaria westlandica*). As technology progresses, the development of transmitters small enough for black petrels would allow foraging data to be collected for this species. In this trial the transmitters weighed 22 g, which is just over 3% of a black petrel weight (the average weight is 700 g for a breeding adult). This is within the recommended range for size and weight of transmitters (5% of the bird's body weight), but at present most transmitters weigh more (approximately 34 g; C.J.R. Robertson, pers. comm.). Given that this, and the previous trial, were so successful, with little to no effect on black petrel behaviour, survivorship or breeding success, it should not be necessary to repeat these trials. We hope for future development of satellite transmitters appropriate for black petrels, which would allow for collection of important foraging information.

5.8 CONSERVATION

As in previous seasons, large numbers of the public continue to visit Mt Hobson and this still has little or no direct impact on the breeding success of the black petrel. As stated in earlier reports (Bell & Sim 2000a, 2000b, 2000c, 2002, 2003), the construction of raised walkways around the summit has decreased damage to the overall environment, and to the burrows. However, serious erosion continues to occur along the summit ends of the South Fork and Palmers Tracks (pers. obs.). Extended walkway construction in these areas is recommended. This should be done with full consultation with the authors and DOC staff on the island to prevent the accidental destruction of burrows

(certain places along these tracks have high burrow densities) and important plant species around the summit area.

New signs at the summit have increased awareness of the black petrel breeding area, but signs at the entrances to the track systems which lead to the summit still need to be replaced (most are illegible). With the high number of visitors to the island, this is an excellent opportunity to increase public awareness of endemic species and conservation issues that affect them. This is particularly important in relation to littering and public fouling, which continues to be a problem in the summit area.

Although only three black petrels have been caught as bycatch on domestic longline vessels in the previous fishing year (1 October 2001 to 30 September 2002; Robertson et al. in press), there have been a total of nine caught over the past ten years, including a pre-breeder banded by the authors as a chick in 1996/97 (C.J.R. Robertson, pers. comm.; Robertson et al. 2003, Robertson et al. in press). All of these birds have been caught on domestic pelagic longline vessels between November and April, which means all may have been adults either returning to breed or already incubating an egg and/or feeding a chick (Robertson et al. 2003, Robertson et al. in press). Not only would this result in a breeding failure, reducing overall productivity and recruitment, but also it would directly decrease adult survivorship. Black petrels have delayed maturity, low reproduction rates and high adult survivorship, and any change in adult survivorship, however small, will affect the population greatly (Murray et al. 1993). If breeding adults continue to be caught on longlines, this species could be drastically affected. It is important to continue to monitor the Great Barrier Island black petrel population. Long-term population data can be used to develop an accurate population model to assess adult survivorship, recruitment, mortality, and productivity. A good population model will assess factors affecting the black petrel population and help to determine the overall effects of bycatch in the longline fishing industry.

6. Recommendations

Monitoring of the black petrel population (using the study burrows) should continue at Great Barrier Island up to and including the 2008/09 breeding season. This will ensure ten years of comparative data are collected from which to determine the population dynamics of black petrels, and in particular to develop a population model to determine survivorship, mortality and the effects of predation, longline fishing and other environmental factors.

The November/December visits to the study area should be continued. This would allow a large number of birds to be banded or recaptured easily, as the birds are generally outside the burrows at this time. It would also enable a mark-recapture programme to be established. At the same time, the study burrows could be checked for breeding status, to give a more accurate estimate of breeding success and to determine sex. This would also provide a chance to recapture returning birds banded as chicks.

The January/February visit should also continue. This would still enable the study burrows to be monitored intensively, allow the adults to be identified and determine breeding status in the burrows. The April/May visit should also continue. This would allow time to band the surviving chicks.

A sample of 50 birds should be colour-marked (dazzle spray) to determine foraging locations using sightings from MOF/DOC observers and the public.

The Northern Block (Tataweka) should be visited in November to survey the black petrel population to gain a more accurate estimate of the population in that area.

Census grids need to be established on other high points around the Mt Hobson area (e.g. Mt Heale, Mt Matawhero, Hogs Back). This would ensure that a better estimate for the black petrel population on Great Barrier Island could be made. These sites should be monitored as long as the study continues.

Cat trapping should be established over the black petrel breeding season, November–June, especially during pre-laying (November) and the fledging period (May–June).

The walkway system down Palmers Track (Windy Canyon) and South Fork Track should be continued. Construction should be completed between July and October, when the chicks have fledged and before the adults return. Known petrel burrows could be identified for the construction team to avoid.

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Appendix 1

Results from the burrows around Mt Hobson (Hirakimata)

Note that bold entries are non-study burrows (i.e. cannot reach the resident birds) and those study burrows within census grids have the location noted (PTG1, 2, 3; SFG1, 2, 3 or KDG1, 2, 3).

BURROW	BAND	OUTCOME
1		Empty
2	H25408	Chick H33238
	H32008	
3	H31382	Chick (fledged before banding)
	H31109	
4	H23017 (M)	Abandoned egg
5	H31161 (M)	Abandoned egg
6	H31291 (M)	Chick H33242
	H33610 (F)	
7	H31272 (M)	Dead embryo
	H30854 (F)	
8	H31103 (M)	Chick H33207
	H31273 (F)	
9		Empty
10	H32901 (M)	Non-breeder
	H29680 (F)	
11		Empty
12	H33612 (M)	Non-breeder
	H33695 (F)	
13	H31575 (M)	Non-breeder
	H25418 (F)	
14	H31284 (F)	Non-breeder
	H31202 (M)	
15		Empty
16	H31004 (F)	Chick (fledged before banding)
	H32002 (M)	
17	H31108 (M)	Chick (fledged before banding)
	H28009 (F)	
18	H33724	Non-breeder
19	H31971 (F)	Chick H33243
	H31162 (M)	
20	H25696 (M)	Non-breeder
21	H31235	Crushed egg
	H33726	
22	H31214 (F)	Chick (fledged before banding)
	H25492 (M)	
23		Empty
24	H31405	Non-breeder
	H33773	
25	H25487	Dead embryo
	H31217	
	H33703[Interloper]	

BURROW	BAND	OUTCOME
26	H23014 (M)	Non-breeder
	H31218 (F)	
	H33709 (F)	
27		Empty
28		Empty
29	H31210 (F)	Chick (fledged before banding)
	H28004 (M)	
30	H25446 (M)	Non-breeder
	H33677 (F)	
31	H31101 (M)	Chick (fledged before banding)
	H33678 (F)	
32(PTG1)	H25480 (M)	Chick H33733
	-	
	H33665 (M) [Interloper]	
33	H31244 (F)	Chick (fledged before banding)
	H28076 (M)	
34	H31121	Chick (fledged before banding)
	H31248	
35	H33654 (M)	Non-breeder
	H32040 (F)	
36	H31129	Non-breeder
	H25573	
	H33653	
37	H31107 (M)	Chick H33232
	H28036 (F)	
38		Empty
39	H25426 (M)	Cat predation
	H31578 (F)	
40	H31122 (F)	Crushed egg
	-	
41	H31112 (M)	Chick H33741
	H31029 (F)	
42	H29676 (M)	Chick H33222
	H32004 (F)	
43	H31016	Non-breeder
	H31586	
44	H31130 (M)	Chick (fledged before banding)
	H25424 (F)	
45	H31995	Non-breeder
46	H28813	Chick (fledged before banding)
	-	
47	H33786 (F)	Non-breeder
	H31018 (M)	

BURROW	BAND	OUTCOME
48	H31003 (M) H26991 (F)	Chick (fledged before banding)
49	H31243 (M) H31010 (F)	Chick H33249
50	H31282 (M) H25476 (F)	Chick (fledged before banding)
51	H29670 (F) H22169 (M)	Chick H33245
52	H31289 (M) H31255 (F)	Chick (fledged before banding)
53	H31021 H31022	Chick H33246
54		Empty
55 (PTG1)	H23635 (M) H33638 (F)	Chick (fledged before banding)
56 (PTG1)	H31977 (F) H31152 (M)	Abandoned
57 (PTG1)	H33635 H31153 (M) H33644 H33725	Non-breeder
58 (PTG1)	H28029 H31205	Chick H33736
59 (PTG1)	H31125 (M) H31220 (F)	Chick H33735
60 (PTG1)	H33659 (M) H31286 (F)	Chick (fledged before banding)
61 (PTG1)	H25456 (F) H30878 (M)	Non-breeder
62 (PTG1)	H31257 (M) H25486 (F)	Chick (fledged before banding)
63 (PTG1)	H31268 (F)	Non-breeder
64 (PTG1)	H33713 (F) H31366 (M)	Non-breeder
65	H31460 (F) H27548 (M)	Chick H33202
66	H31990 (F) H31999 (M)	Dead chick
67 (KDG1)	H31270 (F) H31271 (M)	Chick (fledged before banding)
68 (KDG1)	H32005 (F) H31172 (M)	Chick H33215
69	H27604 (M) H31240 (F)	Chick (fledged before banding)
70	H31992 (F) H27665 (M)	Chick (fledged before banding)
71 (KDG1)	H31023 (F) H31242 (M)	Chick (fledged before banding)
72 (KDG1)	H32907 (M) H33707 (F)	Dead embryo
73 (KDG1)	H28572 (M) H31300 (F)	Cat predation
74 (KDG1)	H31974 (F) H29693 (M)	Chick (fledged before banding)

BURROW	BAND	OUTCOME
75 (KDG1)		Empty
76 (KDG1)	H33758 H31089	Non-breeder
77 (KDG1)	H25407 (F) H30870 (M)	Chick (fledged before banding)
78 (KDG1)	H25512 (F) H30867 (M)	Chick H33206
79 (KDG1)	-	Non-breeder
80 (KDG1)	H29682 (F) H25404 (M) H31474 (M)[Interloper]	Infertile
81 (KDG1)	H31155 (F) H28046 (M)	Chick H33201
82	H31978 (F) H30889 (M)	Dead embryo
83	H25413 (F)	Non-breeder
84	H 29677(M) H31179 (F)	Chick (fledged before banding)
85 (SFG1)	H33762 H31118 (M)	Non-breeder
86 (SFG1)		Empty
87 (SFG1)	H32023 (F) H32033 (M)	Abandoned egg
88 (SFG1)		Empty
89 (SFG1)	H30910 (F) - H31495 (M)[Interloper]	Non-breeder
90 (SFG1)	H32935 (F) -	Chick (fledged before banding)
91 (SFG1)	-	Non-breeder
92 (SFG1)	H33660 (F) H32928 (M)	Non-breeder
93	H33655 (F) H30856 (M)	Non-breeder
94	H23018 (M) H31028 (F)	Dead embryo
95	H30880 (M) H25425 (F)	Chick (fledged before banding)
96 (PTG1)		Empty
97	H30872 (M) H31263 (F)	Dead embryo
98		Empty
99	H31262 (M) H31201 (F)	Non-breeder
100	H29660 (M) H29667 (F)	Chick H33244
101 (KDG1)	H25692 (F) H25588 (M)	Chick (fledged before banding)
102 (KDG1)	H25511 (M) H30866 (F) H33676 (F)[Interloper] ¹	Chick H33204
103 (KDG1)	H31588 (M) H29690 (F)	Chick H33216

¹ Laid egg (infertile) in December, adult kicked out when original pair returned.

BURROW	BAND	OUTCOME
104 (KDG1)		Empty
105		Empty
106	H31038 (M) H25458 (F)	Chick (fledged before banding)
107	H33656 (M) H33764 (M) H33799	Non-breeder
108	H25417 (F) H25452 (M)	Chick (fledged before banding)
109	H31052 (F) H25428 (M)	Chick H33219
110 (SFG1)	H31008 (M) H31007 (F)	Chick (fledged before banding)
111 (SFG1)	H28033 (F) -	Abandoned egg
112 (SFG1)	-	Non-breeder
113 (SFG1)	H25409 (F) H31987 (M)	Chick (fledged before banding)
114 (SFG1)	H25453 (M) H31142 (F)	Chick (fledged before banding)
115	H31031 (M) H32022 (F)	Chick (fledged before banding)
116 (PTG1)	H25411 (F) H25435 (M)	Dead embryo
117 (SFG1)	H29675 (M) H33693	Non-breeder
118	H31985 (M) -	Chick H33234
119	H25454 (F) H31055 (M) H31527 (M)[Interloper]	Chick H33740
120 (PTG1)		Empty
121 (PTG1)	H25455 H31032	Chick H33737
122 (PTG1)	H31051 H31050	Chick H33734
123 (PTG1)	H31053 (M) H31246 (F)	Chick (fledged before banding)
124 (PTG1)	H28032 (M) -	Chick (fledged before banding)
125 (PTG1)	-	Breeder
126 (PTG1)	H25577 (M) H29658 (F) H33723[Interloper]	Abandoned egg
127	H25415 (M) H31128 (F)	Disappeared egg
128	H31054 (M) H25495 (F)	Chick (fledged before banding)
129		Empty
130	H28212 (M) H25457 (F)	Chick (fledged before banding)
131	H25421 (M) H33694 (F)	Dead chick

BURROW	BAND	OUTCOME
132 (KDG2)	H29681 (M) H31568 (F)	Chick H33208
133 (KDG2)	H25430 (M) H32027 (F)	Chick (fledged before banding)
134 (KDG2)	H25401 (F) H32001 (M)	Chick H33209
135 (KDG2)	H25463 H25447	Chick H33211
136 (KDG2)	H29691 (F) H29699 (M)	Chick H33212
137 (KDG2)	H25494 (M) H31572 (F)	Chick (fledged before banding)
138 (KDG2)	H25448 (M) H31565 (F)	Chick (fledged before banding)
139	H14012 (F) H23035 (M)	Chick (fledged before banding)
140 (KDG2)	H33711 H32010	Non-breeder
141 (SFG2)	-	Breeder
142 (SFG2)	H28026 (M) H28027 (F)	Non-breeder
143 (KDG2)	H25469 H28021	Dead embryo
144 (KDG2)	H25459 (M) H31566 (F)	Dead embryo
145 (KDG2)	H25474 H25504	Chick H33213
146 (KDG2)	H25460 (M) H25473 (F)	Chick (fledged before banding)
147 (KDG2)	H28023 (M) H25482 (F)	Non-breeder
148 (KDG2)	H27534 (M) H25483 (F)	Dead chick
149 (KDG2)		Empty
150 (KDG2)	H25471 (F) H25493 (M)	Chick (fledged before banding)
151	H25593 (M) H29674 (F)	Chick H33233
152 (SFG2)	H31983 (M) H33761 (F)	Non-breeder
153 (SFG2)	-	Non-breeder
154 (PTG1)	H31542	Non-breeder
155 (PTG2)	H33639 (F) H33792 (M)	Non-breeder
156 (PTG2)	H31558 -	Chick H33739
157 (PTG2)		Empty
158 (PTG2)	H25440 (F) H31451 (M)	Dead embryo
159 (PTG2)	H25441 (F) H31557 (M)	Chick H33738
160	H25690 (M) H29671 (F)	Chick (fledged before banding)

BURROW	BAND	OUTCOME
161 (PTG2)	H25500 (F) H25488 (M)	Crushed egg
162 (PTG2)	H25442 (M) H25489 (F)	Disappeared egg
163 (PTG2)	H32910 (M) H33658 (F)	Disappeared egg
164 (PTG2)	H33606 (M) H31151 (F)	Chick (fledged before banding)
165 (KDG2)	H29661 (F) H29700 (M)	Chick H33214
166	H25437 (M) H32015 (F)	Chick (fledged before banding)
167	H28012 (M) H33657 (F)	Dead embryo
168 (PTG1)	-	Non-breeder
169		Empty
170	H33770 -	Dead embryo
171	H31110 (F) H28006 (M)	Chick (fledged before banding)
172	H31048 -	Dead embryo
173	H31143 (M) H28018 (F)	Chick H33231
174	H28071 (M) H33772 (F)	Chick (fledged before banding)
175	H25503 (M) H28001 (F)	Chick (fledged before banding)
176 (KDG1)	H27702 H25693	Dead chick
177	H31462 -	Chick (fledged before banding)
178		Empty
179	H29694 (M) H29697 (F)	Chick H33228
180	H31560 (M) H33729 (F)	Chick H33227
181	H31463 (M) H31561 (F)	Chick (fledged before banding)
182	H25514 (M) H33785 (F) H33691	Non-breeder
183 (SFG1)		Empty
184	H33710 (F) H32916 (M)	Dead chick
185 (KDG1)	-	Non-breeder
186	H31577 (M) H29665 (F) H33605 (M)[Interloper]	Chick H33744
187	H31047 (M) -	Unknown (egg alive at last check)
188	H26956 (F) H28100 (M) H33771[Interloper]	Dead chick

BURROW	BAND	OUTCOME
189	H28015 (F) H31994 (M)	Dead embryo
190	H32036 (F) H32048 (M)	Chick (fledged before banding)
191 (PTG2)		Empty
192 (SFG1)		Empty
193 (KDG2)		Empty
194 (KDG2)	H31569 (M) H31570 (F)	Chick (fledged before banding)
195	-	Non-breeder
196	H28016 (F) H29951 (M)	Chick (fledged before banding)
197	H25518 (M) H29685 (F)	Chick H33226
198	H25699 (F) H31593 (M)	Dead embryo
199	H32009 (F) H29696 (M)	Chick H33237
200	H32006 (F) H28073 (M)	Chick (fledged before banding)
201	H31581 (M) H28002 (F)	Chick (fledged before banding)
202 (PTG2)	H31556 (F) H28031 (M)	Chick (fledged before banding)
203	H29668 (F) H30930 (M)	Cat predation
204 (KDG1)	H31965 (F) H28008 (M)	Chick (fledged before banding)
205	H25697 H29664	Dead embryo
206	-	Non-breeder
207 (PTG1)	H31137 (M)	Non-breeder
208 (PTG1)	H31034 (M) H25505 (F)	Crushed egg
209 (KDG3)	H31424	Non-breeder
210 (KDG3)	H25691 (M) H33601 (F)	Non-breeder
211 (KDG3)	H28812 (M) H29689 (F)	Chick (fledged before banding)
212 (KDG3)	H28040 (F) H30869 (M)	Chick (fledged before banding)
213 (KDG2)	-	Non-breeder
214 (KDG2)	H25687 H25595	Chick H33210
215 (SFG3)		Empty
216 (SFG3)	H28051 (M) H29673 (F)	Dead embryo
217 (KDG3)	H31991 H32903	Chick H33218
218	H33636	Non-breeder
219 (PTG3)		Empty
220 (PTG3)	H33637 (M) H31970 (F)	Chick (fledged before banding)

BURROW	BAND	OUTCOME
221 (PTG3)	H29695 (M) H33704 (F)	Chick (fledged before banding)
222	H28049 (M) -	Dead chick
223 (SFG3)	H31598 H28068	Chick H33224
224 (PTG3)	H32011 (M) H25564 (F) H33756 (M)	Non-breeder
225 (SFG3)	H31600 (F) H13634 (M)	Crushed egg
226 (PTG3)	H27058 (M) H28041 (F)	Chick (fledged before banding)
227 (KDG3)	H25509 (M) H33702 (F)	Non-breeder
228	H33633 (M)	Non-breeder
229 (PTG3)	H28042 (M) H25565 (F)	Chick (fledged before banding)
230 (PTG3)	-	Non-breeder
231	H25568 (M) H32014 (F)	Chick (fledged before banding)
232		Empty
233	H29698 (M) H25558 (F)	Chick H33230
234	H25559 (F) H25571 (M)	Crushed egg
235	H25566 (F) H28044 (M)	Dead chick
236		Empty
237	H25575 H29953	Crushed egg
238 (SFG1)	H28037 (M)	Non-breeder
239	H32013 (M) H25700 (F)	Dead embryo
240	H31973 H33777	Non-breeder
241	H33790 H33673	Non-breeder
242	H28099 (M) H31998 (F)	Chick (fledged before banding)
243	-	Non-breeder
244	H33701 H33757 H33800	Non-breeder
245 (KDG1)	H33732	Non-breeder
246 (PTG3)	H25586 (M) H32026 (F)	Chick H33743
247		Empty
248	H33727 (F) H28067 (M)	Chick (fledged before banding)
249	H33760 (M) H33728 (F)	Non-breeder
250	H31168 (F) H30924 (M)	Crushed egg

BURROW	BAND	OUTCOME
251	-	Non-breeder
252	H25695 (F) H28058 (M)	Chick H33220
253		Empty
254		Empty
255	-	Non-breeder
256		Empty
257	H30877 (M) H33615 H33759 (F)	Non-breeder
258 (PTG3)		Empty
259	H32025 (M) H32018 (F)	Chick H33248
260(SFG3)	H32020 H32034	Chick H33225
261	H32021 (M) H33789 (F)	Chick (fledged before banding)
262	H32902 (F) H32922 (M)	Chick (fledged before banding)
263	H31980 (M) H33603 (F)	Chick H33229
264		Empty
265 (KDG2)	-	Non-breeder
266	H31975 (M) H25444 (F)	Crushed egg
267	H31989 (M) H33784 (F)	Crushed egg
268	H33779 (M)	Non-breeder
269	H32031	Non-breeder
270	H33669 (M) H33791 (F)	Chick H33247
271 (KDG1)	H32913 H32920	Dead embryo
272	H30908 (M)	Non-breeder
273	H33708 -	Chick H33235
274	H23034 (M) H33706 (F)	Chick (fledged before banding)
275	H32037 (M) H32046 (F)	Crushed egg
276		Empty
277	H33619 H33620	Non-breeder
278	H32035 (M) H32042 (F)	Unknown (egg pipping at last check)
279	-	Non-breeder
280	H32929 (M) H33604 (F) H33712 (F)[Interloper]	Rat predation
281	H33602 (M) H25413	Non-breeder
282	H33652 (M) H33643 (F)	Chick (fledged before banding)

BURROW	BAND	OUTCOME
283		Empty
284	H32904	Chick H33742
	-	
285	-	Dead embryo
	-	
286	H33614 H33700	Non-breeder
287	H33670 (F) H33699 (M)	Chick H33223
288	H33705 (F) H33671 (M)	Chick (fledged before banding)
289	H33621 H33650	Non-breeder
290	H27543 (F) H28038 (M)	Chick H33236
291	H33618 (F) H33690 (M)	Chick H33250
292	H33675 (M)	Dead embryo
	Dead female (unbanded) ² H33670 (F)[Interloper]	
293	-	Non-breeder
294	H32931 (M)	Non-breeder
295	H33649 (F)	Unknown (egg pipping at last check)
	H33630 (M)	
296	H28054 (F) H33682 (M)	Chick H33241
297	H33755 (F)	Unknown (egg pipping at last check)
	H28034 (M)	
298	H33646 H25579	Chick (fledged before banding)
299	H32012 H33793 (M)[Interloper] H33794 (F)[Interloper]	Crushed egg
300	H33716 -	Chick (fledged before banding)

BURROW	BAND	OUTCOME
301	H28060 H33768 H25427 (M)	Non-breeder
302	H33686 H33787	Chick H33221
303	H33797 (M) H33781 (F)	Chick (fledged before banding)
304	H33624 (M)	Non-breeder
305	H33645 (M) H33788 (F)	Chick (fledged before banding)
306	H33685 H33782	Abandoned egg
307	H33796 -	Chick (fledged before banding)
308	H33769 (M) H33783 (F)	Non-breeder
309	H28020 -	Chick H33240
310	-	Non-breeder
311	-	Infertile
	-	
312	-	Non-breeder
313	H33795 -	Chick (fledged before banding)
314	H25664	Non-breeder
315	H33714 -	Chick (fledged before banding)
316	H33712 (M) H33750 (F)	Chick (fledged before banding)
317	-	Non-breeder
318	-	Non-breeder
319	H31966 H33722	Unknown (egg alive at last check)
320	H33766 (M) H33721 (F)	Non-breeder

² Unbanded female, found dead in burrow, died while laying egg (not incubated).