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Population studies of southern Buller's albatrosses on The Snares

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EXECUTIVE SUMMARY

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This report summarises the results of counts of southern Buller's albatrosses *Thalassarche bulleri bulleri* breeding at The Snares from 1–11 March 2019 and compares these results with those obtained using similar methods, and at a similar time of year, during 1969, 1992, 1997, 2002, and 2014. The results of detailed demographic studies at three study colonies are also presented.

The survey of North East Island was incomplete due to a prolonged period of adverse weather. However, the total of 3557 breeding pairs recorded along the East Coast, North Promontory, and West Coast was very similar to the 3387 breeding pairs estimated in the same areas in 2014. While there was an increase in the size of the breeding population over the period 1969–2002, the present study indicates this has not continued. An additional 621 breeding pairs were estimated on Broughton Island.

Demographic studies at the three study colonies on North East Island have been undertaken annually between 1992 and 2017, and this report incorporates some of these data in the current analysis. Estimates of the numbers of breeding pairs, made by recording the contents of each nest mound, decreased in all three colonies over the numbers recorded during 2017. With the assumption that the combined total number of breeding pairs in the three study colonies was representative of the breeding population on the North East Island as a whole, then the breeding population probably peaked in 2005–2006 and has since undergone marked annual variations.

A total of 269 birds that had been banded previously in the study colonies as breeding adults of unknown age were recaptured. A further 88 breeding birds were banded in the study colonies; these were presumed to be first-time breeders. During the period 1992–2004 all chicks that survived to near-fledging in the study colonies were banded and their survival to return to the study colonies in subsequent years has been monitored. In 2019, 162 of the birds banded as fledged chicks were recaptured, with birds from cohorts banded from 1998 to 2004 recaptured for the first time. This demonstrates the long-term monitoring required to obtain reliable estimates of survival for such known-age birds. Of the 162 known-age birds recaptured, 38 were found breeding for the first time and were therefore recorded as recruited to the breeding population. Three birds, banded as chicks in 1972, were recaptured at 47 years of age.

Incorporation of the 2019 count data and the mark-recapture data from the three study colonies into an updated SeaBird model analysis will provide a more robust estimation of population trends in this species.

1. INTRODUCTION

Southern Buller's albatross *Thalassarche bulleri bulleri* is endemic to New Zealand, breeding only at The Snares (North East Island and Broughton Island) and the Solander Islands (Solander Island and Little Solander Island: Sagar & Stahl 2005).

At The Snares, whole-island counts of the number of breeding pairs of southern Buller's albatrosses have been made in 1969, 1992, 1997, 2002, and 2014 (Sagar & Stahl 2005, Sagar 2014). These counts not only provide information on the population trajectory of this species but can be used to validate population trends observed at three study plots that have been monitored annually from 1992 to 2017.

This report describes the field work carried out at The Snares (under Wildlife Act Authority 52364-FAU and Entry Permit 75248-LND, granted by the Department of Conservation) that centred on completing a whole-island estimate of the numbers of pairs of southern Buller's albatrosses breeding on North East and Broughton islands for comparison with similar previous counts. In addition, further information was obtained regarding the population dynamics of southern Buller's albatross, particularly population size, adult survival, breeding frequency, and recruitment of known-age birds in three long-term study colonies.

This project consisted of one overall objective and one specific objective:

Overall objective:

To collect information on the demographic parameters to reduce uncertainty or bias in estimates of risk for southern Buller's albatross on The Snares.

Specific objective:

To collect information on population size, adult survival, age at first reproduction, and key demographic parameters for southern Buller's albatross on The Snares to reduce uncertainty or bias in estimates of risk.

2. METHODS

2.1 Logistics

Transport to The Snares was provided by *Evohe* (skipper, plus four crew) and the return trip by *Awesome* (skipper, plus four crew). The field team (comprising David Thompson (field leader, NIWA), Paul Sagar (NIWA), and David Sagar (DOC)) were dropped off at Broughton Island on 1 March 2019, where they undertook a count of the number of breeding pairs of southern Buller's albatross. The team departed Broughton Island five hours later and was dropped off at Station Point, North East Island that evening. *Evohe* then departed for Campbell and Auckland islands before returning to Bluff. *Awesome* picked up the field team from Station Point on the morning of 11 March 2019 and returned to Bluff that evening.

2.2 Study site

The Snares (48° 02' S, 166° 36' E) comprise North East Island (280 ha) and Broughton Island (90 ha), plus numerous islets and stacks (Figure 1).

2.3 Whole-island counts

The laying period of southern Buller's albatrosses at The Snares extends from late December to the end of February, with most eggs laid by late January (Sagar & Warham 1998). Therefore, the timing of counts was scheduled to occur close to the end of laying, when most birds sitting on a nest were presumed to be incubating. The counts of incubating birds on North East Island and adjacent main islets and stacks were completed between 2 and 10 March 2019, and the count on Broughton Island completed on 1 March 2019. Southern Buller's albatrosses are monogamous, usually nest annually, and do not re-

lay within a season if the single egg laid is broken (Sagar & Warham 1998). Therefore, counts of incubating birds and counts of abandoned and broken eggs were presumed to represent the number of pairs of birds breeding each year.

The islands were divided into sections (see Figure 1), based on maps prepared from aerial photographs, and each section was covered systematically to search for breeding albatrosses. When counting incubating birds, we followed the procedure used in 1992, 1997, 2002, and 2014, which was similar to that used in 1969 (Warham & Bennington 1983; Sagar et al. 1994, 1999; Sagar & Stahl 2005). Two types of counts were employed for both North East Island and Broughton Island: ground counts and vantage-point counts.

Ground counts

Ground counts were completed wherever access to nests was possible. In such situations usually one person used a tally counter to keep a running total of nests counted, with the other members of the field team calling out nests as they were checked. Birds incubating an intact egg (assumed to be all birds sitting tightly on a nest mound) were counted. In addition, abandoned eggs, broken eggs, and eggs which had rolled out of a nest were assumed to represent pairs of albatrosses that had attempted to breed that season, and hence they were also included in the count.

Vantage-point counts

Birds breeding in inaccessible areas were counted using binoculars from vantage points, at distances up to 500 m. In the majority of situations where counts were made from vantage points, counts were made independently by all three observers and averaged. Where vantage-point counts consisted of over 100 occupied nests, the total count from each observer was only included if it was within 10% of the average made by all three observers. Where the average vantage-point count was under 100, the totals had to be within 5%. For both ground and vantage-point counts birds standing on nest mounds were not included in the total counts because the nests were assumed to be empty. Abandoned and broken eggs could not be counted from vantage-point counts, and therefore totals presented here are considered to represent the minimum number of breeding pairs.

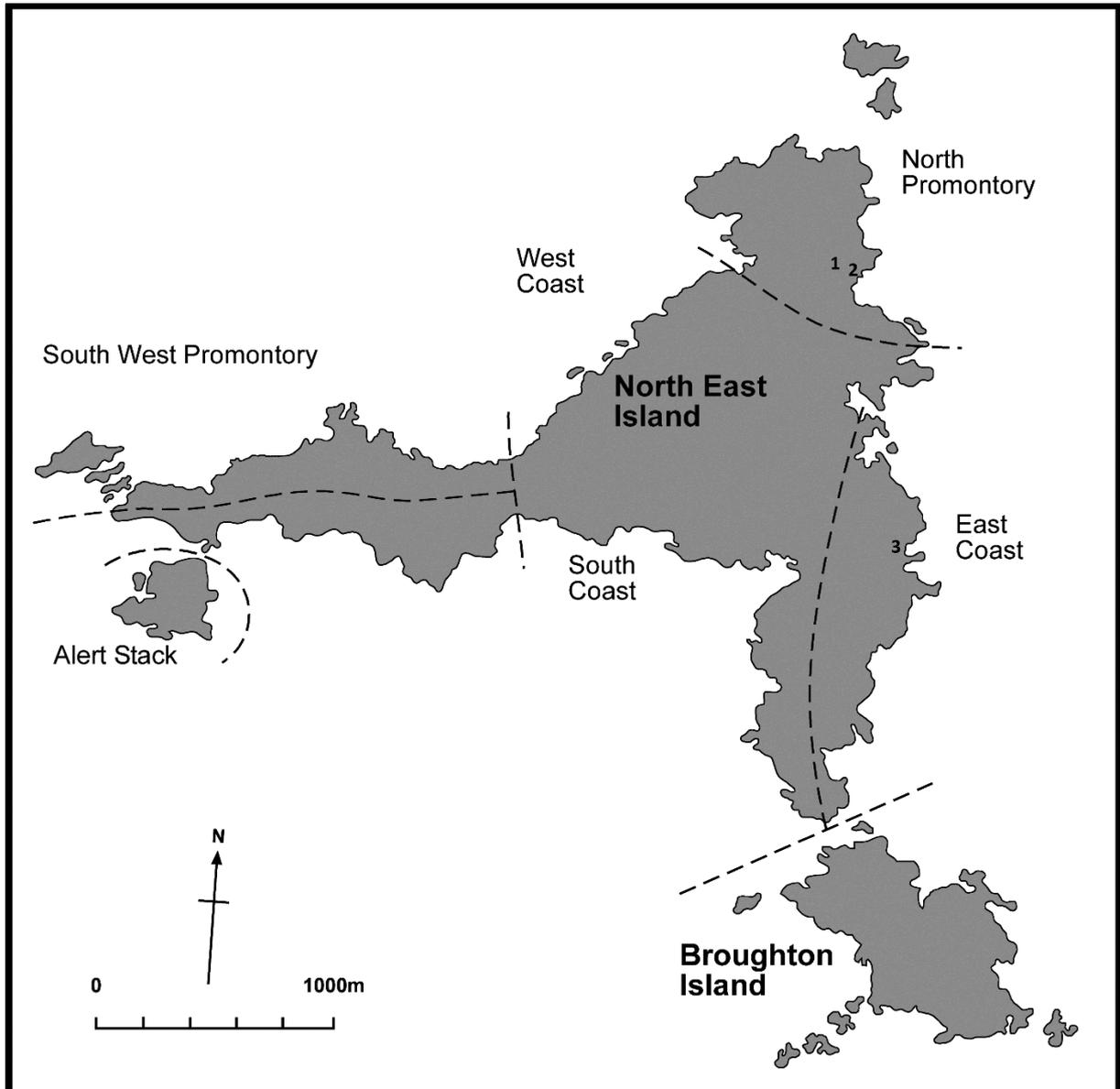


Figure 1: The Snares, showing the boundaries of areas where counts of occupied nests of southern Buller's albatrosses were made. Locations of the study colonies are: 1, Upper Punui Bay; 2, Lower Punui Bay; 3, Mollymawk Bay.

2.4 Study colonies

Each of the three study colonies (Mollymawk Bay, Lower Punui Bay, and Upper Punui Bay) on North East Island was visited 2–3 times; Upper Punui Bay and Lower Punui Bay on 2, 6, and 10 March 2019, and Mollymawk Bay on 3 and 9 March 2019. On the first visit to each colony, all nests were inspected, and the contents recorded. Band numbers of all adult birds associated with these nests were recorded and any unbanded birds incubating were captured and fitted with a uniquely numbered stainless steel leg band. All adult birds recorded on this first visit were marked with blue raddle (a temporary stock marker) so that they were not recaptured on the subsequent visit. On the second visit to each colony, all nests were checked again, and any birds not marked with raddle were captured and either band numbers recorded, or leg bands applied, as appropriate. In addition, on each visit an attempt was made to recapture as many banded non-breeding birds as possible that were loafing in the colonies.

2.5 Banded birds outside study colonies

When completing ground counts of breeding albatrosses outside the study colonies as many birds as possible were checked for leg bands. This information was used to estimate the dispersal rate of birds banded in the study colonies.

3. RESULTS

3.1 Whole-island counts

Adverse weather (gale-force winds and heavy rain) prevented fieldwork on three days, and fog prevented us from making vantage-point counts on another day. Consequently, there was insufficient time to cover all areas of North East Island, and therefore no counts were undertaken on the South Coast and South West Promontory (see Figure 1), because these areas were the most exposed to the prevailing weather.

Totals of 3557 and 621 occupied nests (assumed to equate to breeding pairs) were counted on North East Island and Broughton Island, respectively, to give a combined total of 4178 occupied nests (Table 1). The total of 3557 occupied nests in 2019 for North East Island compares with totals of 1419, 2835, 3410, 3580, and 3387 for the same areas covered in 1969, 1992, 1997, 2002, and 2014, respectively. Totals for Broughton Island between 1992 and 2014 show relatively little change (see Table 1).

Table 1: Numbers of occupied nests of southern Buller's albatrosses counted in different areas of The Snares Islands between 1969 and 2019. Values in parentheses assume rates of change on Broughton Island in 1969 and 2002, when no counts (NC) were made, are equal to those in the subtotal for North East Island in those years. Data for 1969–2002 are from Sagar & Stahl (2005) and for 2014 are from Sagar (2014).

* incomplete count.

Area/Year	1969	1992	1997	2002	2014	2019
North Promontory	509	1 108	1 400	1 643	1 508	1 758
West Coast	121	262	317	205	146	193
North side, South-West Promontory	305	785	520	739	427	NC
South side, South-West Promontory	763	1 236	1 410	1 025	1 201	NC
Alert Stack	112	193	223	267	305	NC
South Coast	1 425	2 095	2 161	2 554	2 425	NC
East Coast	789	1 465	1 693	1 732	1 733	1 606
Total North Promontory, West Coast and East Coast	1 419	2 836	3 410	3 580	3 387	3 557
Total North East Island + Alert Stack	4 024	7 144	7 724	8 165	8 047	3 557*
Broughton Island	NC	539	518	NC	657	621
Totals	(4 448)	7 683	8 242	(8 713)	8 704	4 178

The total for North East Island comprised 2686 from ground counts and 871 from vantage-point counts. These totals are similar to those made 1992–2014 (Table 2), showing that although ground-count totals increased over time, the vantage-point totals remained similar from 1992 to 2002, but decreased by 2014 (see Table 2).

Table 2: Counts and % of total (in parentheses) of occupied nests of southern Buller's albatrosses. Ground counts and vantage-point counts, North East Island and Alert Stack, The Snares. * partial count only. Data for 1969–2002 are from Sagar & Stahl (2005) and for 2014 are from Sagar (2014).

Year	Ground-count total	Vantage-point total	Whole-island total
1992	3 779 (53%)	3 365 (47%)	7 144
1997	4 332 (56%)	3 392 (44%)	7 724
2002	4 855 (59%)	3 310 (41%)	8 165
2014	4 971 (62%)	3 076 (38%)	8 047
2019*	2 686 (75%)	871 (25%)	3 557

Vantage-point counts were made by all three observers, with individual totals of 900, 860, and 876 occupied nests. The total for Broughton Island comprised 515 from ground counts and 106 from vantage point counts. On Broughton Island, vantage point counts from all three observers were 108, 108, and 105 occupied nests.

3.2 Study colonies

Numbers of occupied nests

Totals of 133, 58, and 67 nests with an egg were counted in the Mollymawk Bay, Lower Punui Bay, and Upper Punui Bay study colonies, respectively (Figure 2). Included in these totals were four nests in Mollymawk Bay each contained an abandoned egg (= no bird present and egg cold) or had an egg beside the nest mound, assumed to have rolled out of that nest. In Lower Punui Bay one nest contained an abandoned egg and another had the remains of a broken egg, and at Upper Punui Bay one nest contained the remains of a broken egg.

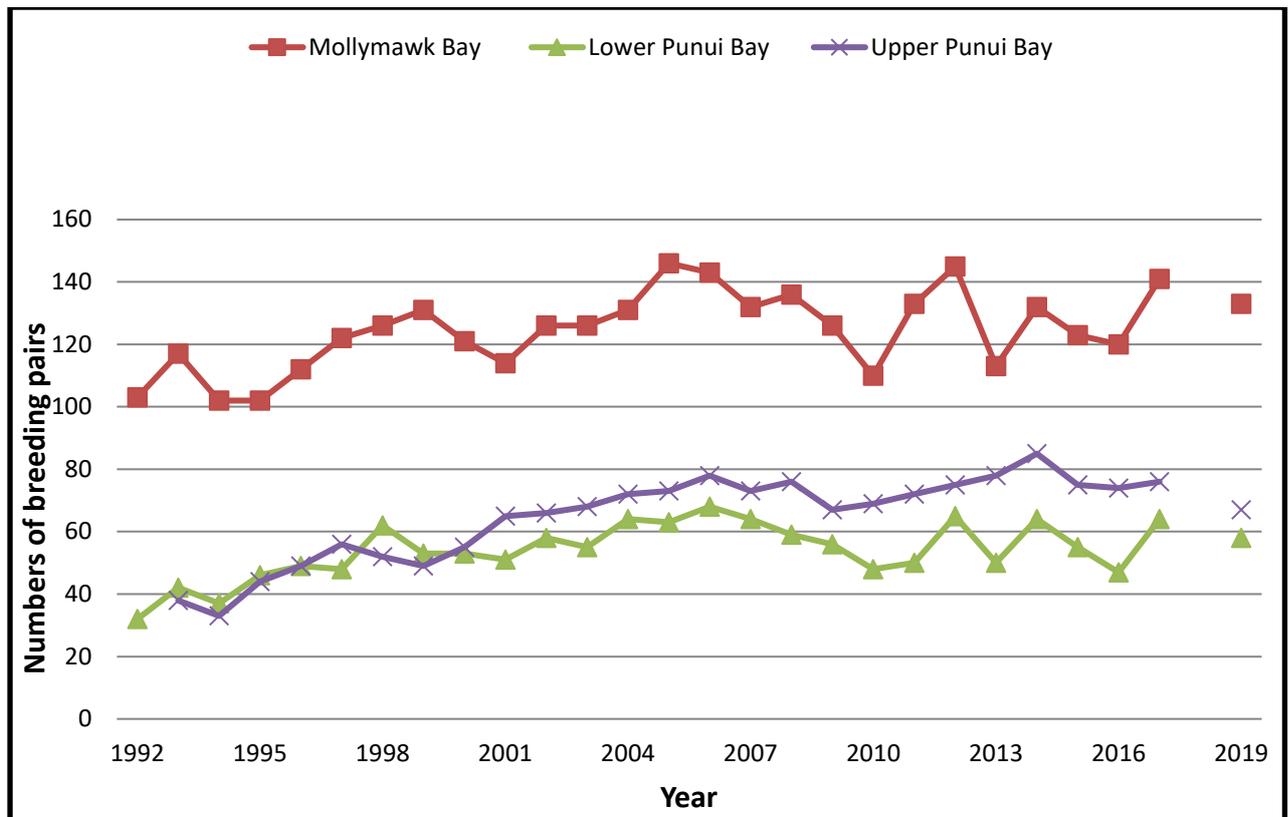


Figure 2: Numbers of breeding pairs of southern Buller's albatrosses counted annually at three study colonies (Mollymawk Bay, Lower Punui Bay, and Upper Punui Bay) on The Snares between 1992 and 2019. No check was made of the study colonies in 2018, hence the gap in the data points.

The 2019 totals represent decreases, relative to numbers counted in April 2017, in the Mollymawk Bay, Lower Punui Bay, and Upper Punui Bay of 5.7%, 9.4%, and 11.8%, respectively.

Adult Survival

A total of 269 birds that had been banded previously as breeding adults of unknown age were recaptured. This total comprised breeding birds, non-breeding birds, and failed breeders. In addition, a further 88 breeding birds (i.e., birds that were incubating) were banded within the study colonies. Because birds breeding in the study colonies have been checked annually, and any new birds banded since 1992, we assumed that any birds captured that are not banded are first-time breeders, and so likely to be 10–12 years old, the average age of first breeding (Francis & Sagar 2012).

All banding data for newly banded birds have been submitted to the Banding Office, Department of Conservation, Wellington.

Survival and Recruitment of Known-age Birds

Return rate of known-age birds

The return rate of known-age southern Buller’s albatrosses is the proportion of a cohort of chicks that is recaptured several years after banding. Of the 2765 birds banded as chicks near fledging in the study colonies and adjacent areas between 1992 and 2004, 162 were recaptured during March 2019. The oldest known-age birds recaptured in the three study colonies for the first time were from the 1998 cohort and, therefore, are 21 years old. This indicates that many more years of recapture effort are required to obtain reliable estimates of the survival of these known-age birds.

Of the 1991 birds banded as chicks near fledging in the study colonies during the period 1992–2004 (which would now be at least 10 years old), 561 (28.2%) have been recaptured. The lowest rate of return (13.1%, 14 recaptured from 107 banded birds) is for the 2003 cohort in Punui Bay (Lower and Upper Punui Bay study colonies combined) and the highest rate of return (44.3%, 27 recaptured from 61 banded birds) from the 1995 cohort in these same colonies (Table 3).

Table 3: Number (% of total banded) of southern Buller's albatrosses, banded as well-grown chicks in 1992–2004, that returned to The Snares. Data are presented by colony of provenance, with Punui Bay colonies combined.

Colony /cohort	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Molly mawk Bay	19 (27.1)	28 (31.8)	26 (37.1)	6 (26.1)	19 (22.4)	20 (21.0)	32 (39.5)	34 (38.6)	25 (28.1)	17 (21.0)	22 (23.2)	31 (32.6)	27 (27.3)
Punui Bay	20 (43.5)	12 (20.7)	18 (41.9)	27 (44.3)	21 (32.3)	26 (34.7)	20 (26.0)	10 (19.6)	21 (25.0)	18 (21.9)	20 (21.3)	14 (13.1)	28 (31.5)

With no new birds recaptured in the three study colonies during March 2019, from the 1992 to 1997 banded cohorts, it is unlikely that any further birds from these cohorts will be recorded. A plot of the overall return rate (all three study colonies combined; Figure 3), shows that from these cohorts the percentage of banded known-age birds returning varied from 26.7% (1993 and 1996 cohorts) to 39.3% (1995 cohort) for the cohorts banded between 1992 and 1999. Currently, the return rate of cohorts banded between 2000 and 2004 varies from 12.4% (2003 cohort) to 22.0% (2000 cohort) and this indicates that more birds from these cohorts have yet to be recaptured.

A bird banded as a chick at Punui Bay in 1998 was found occupying an empty nest on Broughton Island (about 1.0 km from the banding site) on 1 March 2019. This is the first record of a banded southern Buller’s albatross on Broughton Island.

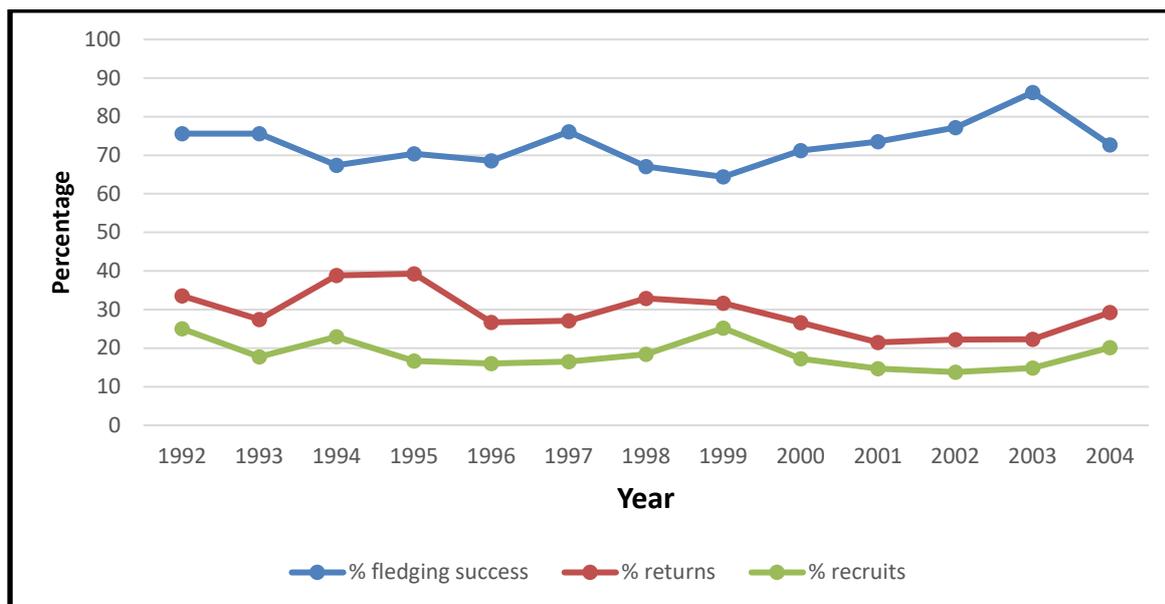


Figure 3: Fledging success, return rate, and recruitment rate (%) of southern Buller's albatrosses banded as chicks in three study colonies at The Snares from 1992 to 2004.

Recruitment of known-age birds

The recruitment rate of known-age southern Buller's albatrosses is the proportion of a cohort of chicks that is recaptured as breeding adults several years after banding. The recruitment rate is invariably less than the return rate because of mortality in the years between returning and the first breeding attempt.

In March 2019, 38 known-age birds, banded as chicks in the study colonies between 1992 and 2004, were found breeding for the first time (i.e., they had recruited to the breeding population). Of these, 14 were aged 15 years (banded as chicks in 2004), eight were aged 16 years (banded as chicks in 2003), seven were aged 17 years (banded as chicks in 2002), one was aged 18 years (banded as a chick in 2001), four were aged 19 years (banded as chicks in 2000), one was aged 20 years (banded as a chick in 1999), one was aged 25 years (banded as a chick in 1998), and two were aged 27 years (banded as chicks in 1992).

A plot of recruitment rate, by cohort, of birds banded as chicks between 1992 and 2004 (see Figure 3) shows an apparent decline throughout most of this period. However, given that the mean age of first breeding of southern Buller's albatrosses at The Snares is 10–12 years (Francis & Sagar 2012), more birds from the later cohorts are likely to be recorded breeding in future. Therefore, it is probably prudent to estimate recruitment only for the 1992–99 cohorts, i.e., birds aged 20–27 years. Currently, these range from 8.7% for the 1995 cohort from Mollymawk Bay to 30.4% for the 1992 cohort from Punui Bay (Table 4). In addition, there is considerable variation in the recruitment rate both between years and between colonies in the same year (see Table 4).

Table 4: Numbers (% of total banded) of known-age southern Buller's albatross recruits (i.e., returning to breed) to The Snares. For cohorts banded in 1992–99, by colony of provenance (with Punui Bay colonies combined).

Colony/cohort	1992	1993	1994	1995	1996	1997	1998	1999
Mollymawk Bay	15 (21.4)	18 (20.5)	15 (21.4)	2 (8.7)	10 (11.8)	8 (8.4)	14 (17.3)	26 (29.5)
Punui Bay	14 (30.4)	8 (13.4)	11 (25.6)	12 (19.7)	14 (21.5)	20 (26.7)	15 (19.5)	9 (17.7)

A plot of the overall recruitment rate (all three study colonies combined; see Figure 3) shows that the percentage of banded known-age birds from the 1992 to 1999 cohorts that returned and survived to breed varied from 16% (1996 cohort) to 25.2% (1999 cohort). Currently, the recruitment rate of known-age birds banded between 2000 and 2004 varies from 13.8% (2002 cohort) to 20.2% (2004 cohort), with more birds likely to be recorded from these cohorts in future.

Despite searches for banded birds in other colonies adjacent to the three study colonies, some birds, particularly females, will have settled to breed elsewhere on North East Island (Sagar et al. 1998), and thus the percentage returns from each cohort should be considered as a minimum.

At The Snares, breeding birds were banded during studies in 1948, 1961, and during most years between 1967 and 1977 (Sagar & Warham 1998). None of these birds were recorded in 2019. In addition, 859 well-grown chicks were banded at a large number of colonies distributed over much of North East Island during August 1972 (Sagar et al. 1998). Three of these birds were recorded during March 2019: one incubating and two on empty nests. At 47 years, these are the oldest known-age southern Buller's albatrosses.

All recapture data have been submitted to the Banding Office, Department of Conservation, Wellington.

4. DISCUSSION

Despite adverse weather resulting in incomplete coverage of North East Island, the results indicate that the breeding population of southern Buller's albatrosses at The Snares in 2019 was similar to that estimated using the same methods in 2002 and 2014. In addition, information from annual counts of the numbers of southern Buller's albatrosses breeding in three study colonies collected between 1992 and 2019 indicates that such annual counts provide a useful index of trends in the whole-island population.

4.1 Whole-island counts

A comparison of the total numbers of breeding pairs counted in comparable areas in the six counts completed between 1969 and 2019 indicated that numbers have remained relatively similar since 1997, with total numbers of breeding pairs recorded in the East Coast, North Promontory, and West Coast of 3410 in 1997, 3580 in 2002, 3387 in 2014, and 3557 in 2019. This followed a period of rapid population growth from 1419 pairs in 1969 and 2835 pairs in 1992.

Previously, Sagar & Stahl (2005) showed that ground counts were both accurate and precise, and so the trend of increasing numbers over time recorded by this method is assumed to be real. On North East and Broughton islands most nests counted from vantage points were on ledges of steep cliffs. In 1992, such ledges were already fully occupied by albatross nests, unlike the breeding colonies under the forest and accessible to ground counting. Consequently, there appears to be scope for expansion of breeding colonies under the forest, unlike those sited on ledges.

The proportion of occupied nests recorded from ground counts increased between 1992 and 2014, while the proportion recorded by vantage-point counts decreased over the same period (Sagar 2014). The results of the 2019 count indicate a sharp increase in the proportion of nests recorded by ground counts compared with vantage-point counts. However, this does not indicate a large expansion of nesting southern Buller's albatrosses into accessible forest areas, but rather reflects the geography of The Snares. For example, the South West Promontory and South Coast provide greater areas of inaccessible cliffs for the nesting albatrosses than are available on the East Coast and North Promontory where the counts were completed in 2019.

4.2 Study colonies

Information from the three study colonies suggests that the breeding population peaked during 2005–06, then trended downward until 2010. Since this time, the breeding population size has been variable in the Lower Punui Bay and Mollymawk Bay study colonies with marked annual increases and decreases, whilst numbers in the Upper Punui Bay colony have tended to increase in most years. The numbers of breeding pairs in all three study colonies in 2019 were broadly similar to those recorded in 2002 and 2014, the years of the previous whole-island counts. This indicates that the annual counts of pairs breeding in the study colonies provide an index of numbers breeding on North East Island as a whole.

The trends in the numbers of pairs breeding in the study colonies until 2007 broadly reflect changes in annual adult survival (Sagar et al. 2000; Francis & Sagar 2012), with higher annual adult survival rates recorded between 1992 and 2004 (Sagar et al. 2000) followed by declines through to 2016 (Francis & Sagar 2012; Sagar et al. 2017). Since 2012, the recruitment rate (calculated from the numbers of newly banded birds and recaptures of known-age birds) increased from 10–11% to 16–21%, which led Sagar et al. (2017) to suggest that this level of recruitment is required to sustain the breeding population and without it the population would decline.

The return and recruitment rates of known-age birds banded between 1992 and 2004 shows considerable variation both within colonies between years and between colonies within the same year. Although future field work is likely to increase both return and recruitment rates for the cohorts between 2000 and 2004, few new birds are likely to be recaptured from the cohorts banded between 1992 and 1999.

Inputting breeding bird annual survival data combined with 2019 count data and mark-recapture data from the three study colonies 2008–19 into an updated SeaBird (Francis & Sagar 2012) model analysis will provide a more robust estimation of population trend in this species.

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