

Population studies of southern Buller's albatrosses on Tini Heke The Snares

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Executive summary

This report presents a summary of the results of demographic studies at three study colonies of southern Buller's albatrosses *Thalassarche bulleri bulleri* breeding at Tine Heke the Snares from 25 March to 9 April 2023.

Demographic studies at the three study colonies on North East Island have been undertaken annually 1992-2023, with the exception of 2018 and 2021, and so 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 study colonies compared to 2022, when estimated numbers were at an all-time high over the 30 plus years of this study. With the assumption that the combined total number of breeding pairs in the three study colonies was representative of 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 374 birds that had been banded previously in the study colonies as breeding adults of unknown age were recaptured. A further 82 breeding birds were banded in the study colonies - these are presumed to be first-time breeders. Estimates of annual survival of birds banded as breeders improved in 2022 with an estimate of 0.931. 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. This year 139 of these birds were recaptured, with birds from cohorts banded from 1998 to 2004 being recaptured for the first time. This demonstrates the long-term monitoring required to obtain reliable estimates of survival of such known-age birds. Of the 139 known-age birds recaptured in 2023, 11 were found breeding for the first time, and so were recorded as being recruited to the breeding population. In addition, three birds that had been banded as near-fledging in the study colonies during September 2013 and September 2014 were also recaptured for the first time.

In 2020 50 Global Location Sensing (GLS) tags were attached to the metal leg bands of breeding birds in the Mollymawk Bay study colony; of these, 31 were retrieved in 2022 and a further 3 during the 2023 field season.

Twelve trail cameras were deployed at breeding colonies and set to record one photograph every hour during daylight in April 2022. All of these were checked in 2023 when the SD cards were removed and replaced with new cards.

1 Background

This project was funded by the Conservation Services Programme (CSP), Department of Conservation (DOC). The purpose of the project was to continue the demographic study at three study colonies of breeding southern Buller's albatrosses *Thalassarche bulleri bulleri*, which had been initiated in 1992 and continued annually to 2023, with the exception of 2018 and 2021. The specific objectives of the project were to:

1. Establish the numbers of pairs breeding in the three established study colonies,
2. Establish annual survival of banded birds from recapture data, and
3. Retrieve and replace secure digital (SD) cards from 12 trail cameras deployed in breeding colonies to record activities at nests over a further full 12-month period.

This report describes the fieldwork completed at Tine Heke the Snares under contract POP2019-04 to the (DOC) in accordance with Wildlife Act Authority 96049-FAU and Entry Permit 97913-LND.

Fieldwork centred on 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. Demographic data of southern Buller's albatrosses in these study colonies at The Snares were recorded annually 1992-2017 and 2019-20, and 2022-23.

2 Methods

2.1 Logistics

Transport to and from the Snares was provided by the vessel *Awesome* (skipper, plus two crew). The field team (comprising David Thompson (field leader, NIWA), Paul Sagar (NIWA) and David Sagar (DOC)) were dropped off at Boat Harbour, North East Island at 08:00 on 25 March 2023. The pick-up by the *Awesome* was delayed two days by weather and sea conditions and the party was eventually returned to Bluff on 9 April.

The Snares (48°01'S, 166°36'E) comprise North East Island (280 ha) and Broughton Island (90 ha), plus numerous islets and stacks (Figure 2-1). 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). Hatching occurs from mid-March with a peak in the first week of April. Therefore, in 2023 the timing of fieldwork was scheduled to occur close to the end of incubation, when most birds sitting on a nest were assumed to have shorter incubation stints, and so change-overs at the nests were more frequent and allowed a greater proportion of partners to be captured/recaptured. Capturing a greater number of breeding birds reduces the standard errors around estimated mean annual survival rates, and so allows greater confidence in the data.

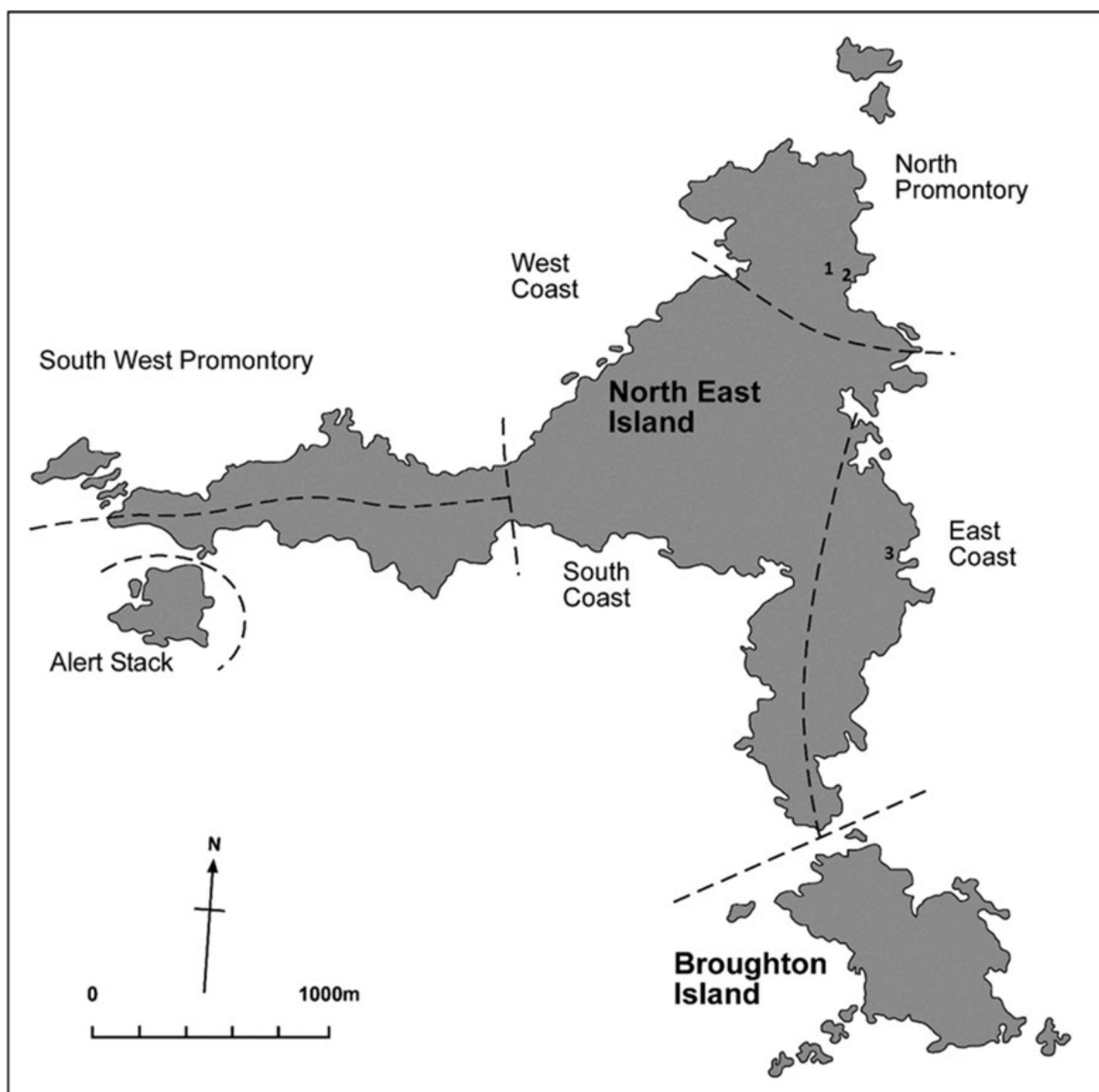


Figure 2-1: Tini Heke The Snares, showing locations of study colonies on North East Island. 1, Upper Punui Bay; 2, Lower Punui Bay; 3, Mollymawk Bay. Dashed lines indicate boundaries of areas for whole-island counts of breeding pairs of southern Buller's albatross (although such counts were not undertaken in 2023).

2.2 Study colonies

Each of three study colonies (Mollymawk Bay, Lower Punui Bay and Upper Punui Bay) on North East Island was visited 3-8 times; Upper Punui Bay on 25, 26, 28, 30 March and 2, 3, 5 and 7 April 2023, Lower Punui Bay on 26, 30 and 31 March and 2, 3, 5 and 7 April 2023, and Mollymawk Bay on 27 and 31 March and 6 April 2023. 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 a temporary blue stock marker so that they were not recaptured (and disturbed) on subsequent visits. On the second and subsequent visits to each colony, all nests were checked again, and any birds not marked with blue stock marker were captured and band numbers recorded, or leg bands applied, as appropriate. In addition, on

each visit an attempt was made to recapture as many as possible of the banded non-breeding birds that were loafing in the colonies.

Global location sensing (GLS) data-logging tags were deployed on 50 breeding birds in the Mollymawk Bay study colony on 15 March 2020. During fieldwork in 2022, 31 GLS were retrieved and seven noted as lost from recaptured birds. During the present visit further checks were made for GLS devices.

Additionally, and also during the 2022 visit, 12 trail cameras were deployed with each camera attached to either a warratah or a suitable branch so that it overlooked 4-6 breeding birds. During the present visit all these cameras were checked and the SD cards and batteries replaced. Where necessary the position of cameras was changed to allow coverage of more active nests.

2.3 Banded birds outside study colonies

When transiting around the island to and from 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.

2.4 Survival estimation

Survival was estimated from banded birds, using the mark-recapture programme Mark 10.1 (White & Burnham 1999) and a relatively simple Cormack-Jolly-Seber model. The model was run using data from 1992 to 2023, noting that 1993 was the first year for which a survival estimate was calculated. Estimates from 2018 and 2021 have not been presented in this report. No field visit was made to the island in both of these years. Overall, this data set comprised 1819 birds banded across all years (1992-2023).

As well as estimating the annual survival of the adult population as a whole, where possible the sex of each bird was assigned, using measurements of minimum bill depth and tarsus width (Sagar et al. 1998), with cross-referencing with the partner of each bird, so allowing the estimation of annual survival by sex.

3 Results

3.1 Occupied nests in the study colonies

Totals of 132, 55 and 82 nests with an egg were counted in the Mollymawk Bay, Lower Punui Bay and Upper Punui Bay study colonies, respectively (Figure 3-1). Included in these totals were eight nests in Mollymawk Bay each containing and abandoned (cold) egg or egg fragments indicating an egg that had been laid but broken earlier that season. In Lower Punui Bay there were no indications of abandoned or broken eggs. At Upper Punui Bay there were seven broken or abandoned eggs.

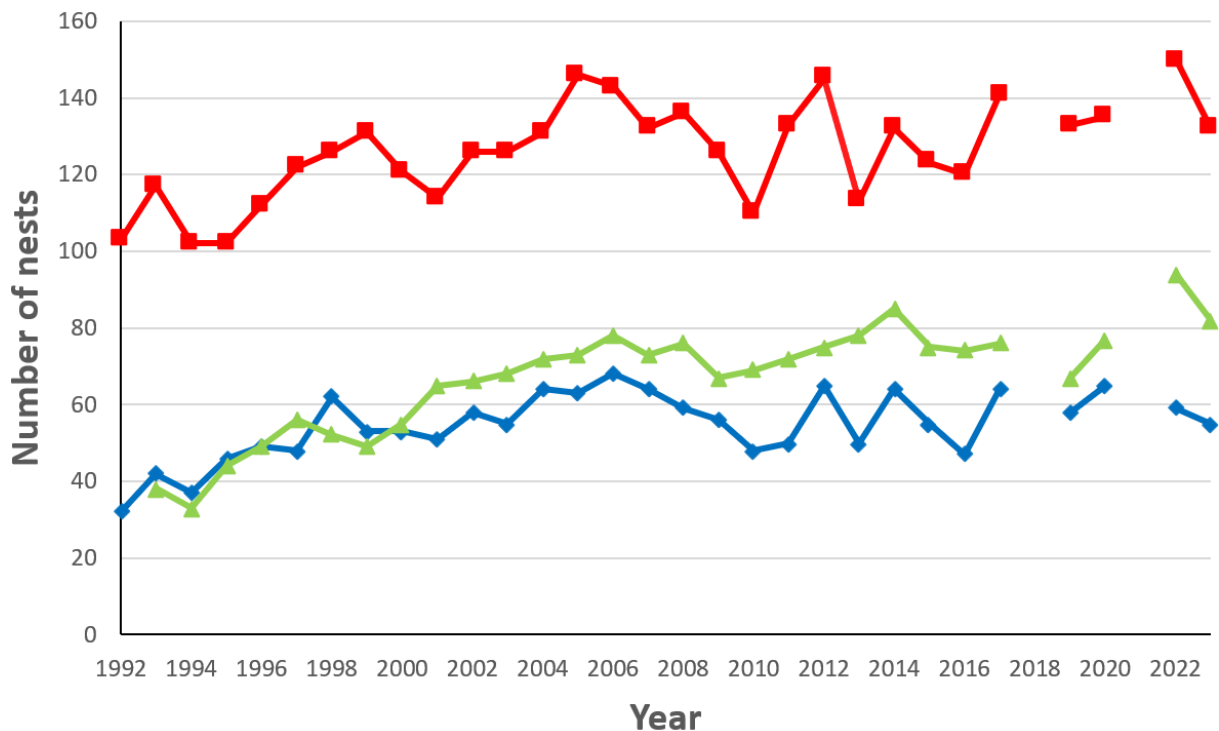


Figure 3-1: Numbers of breeding pairs of southern Buller's albatrosses counted annually at three study colonies, The Snares 1992-2023. Mollymawk Bay - red squares and line, Lower Punui Bay - blue diamonds and line, and Upper Punui Bay - green triangles and line. The study colonies were not visited in 2018 and in 2021.

The 2023 totals represent decreases, relative to numbers counted in March 2022, in the Mollymawk Bay, Lower Punui Bay and Upper Punui Bay study colonies of 12.0%, 6.8% and 12.8%, respectively.

3.2 Adult survival

A total of 374 birds that had been banded previously as breeding adults of unknown age in the study colonies were recaptured. This total comprised breeding birds, non-breeding birds, and failed breeders. In addition, a further 82 breeding birds (i.e., birds that were incubating or brooding a chick) 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 (newly banded birds plus recaptures) have been submitted to the Banding Office, Department of Conservation, Wellington.

Estimates of annual survival are presented in Table 3-1 and plotted in Figure 3-2. Annual survival was relatively high prior to 2012, with values generally in excess of 0.95, from which point estimates tended to decline and were generally less than 0.93 through to 2022 (Table 3-1, Figure 3-2).

Table 3-1: Estimates of annual survival, with one standard error, for southern Buller's albatross at The Snares, 1993 to 2023.

Year	Survival Estimate	Standard Error
1993	0.972	0.01
1994	0.976	0.01
1995	0.928	0.01
1996	0.981	0.01
1997	0.957	0.01
1998	0.971	0.01
1999	0.974	0.01
2000	0.959	0.01
2001	0.934	0.01
2002	0.941	0.01
2003	0.957	0.01
2004	0.956	0.01
2005	0.944	0.01
2006	0.934	0.01
2007	0.920	0.02
2008	0.956	0.02
2009	0.943	0.02
2010	0.913	0.02
2011	0.951	0.02
2012	0.907	0.02
2013	0.936	0.02
2014	0.919	0.02
2015	0.926	0.02
2016	0.901	0.03
2017	0.895	0.03
2018		
2019	0.929	0.02
2020	0.852	0.03
2021		
2022	0.931	0.01
2023	0.846	36.37

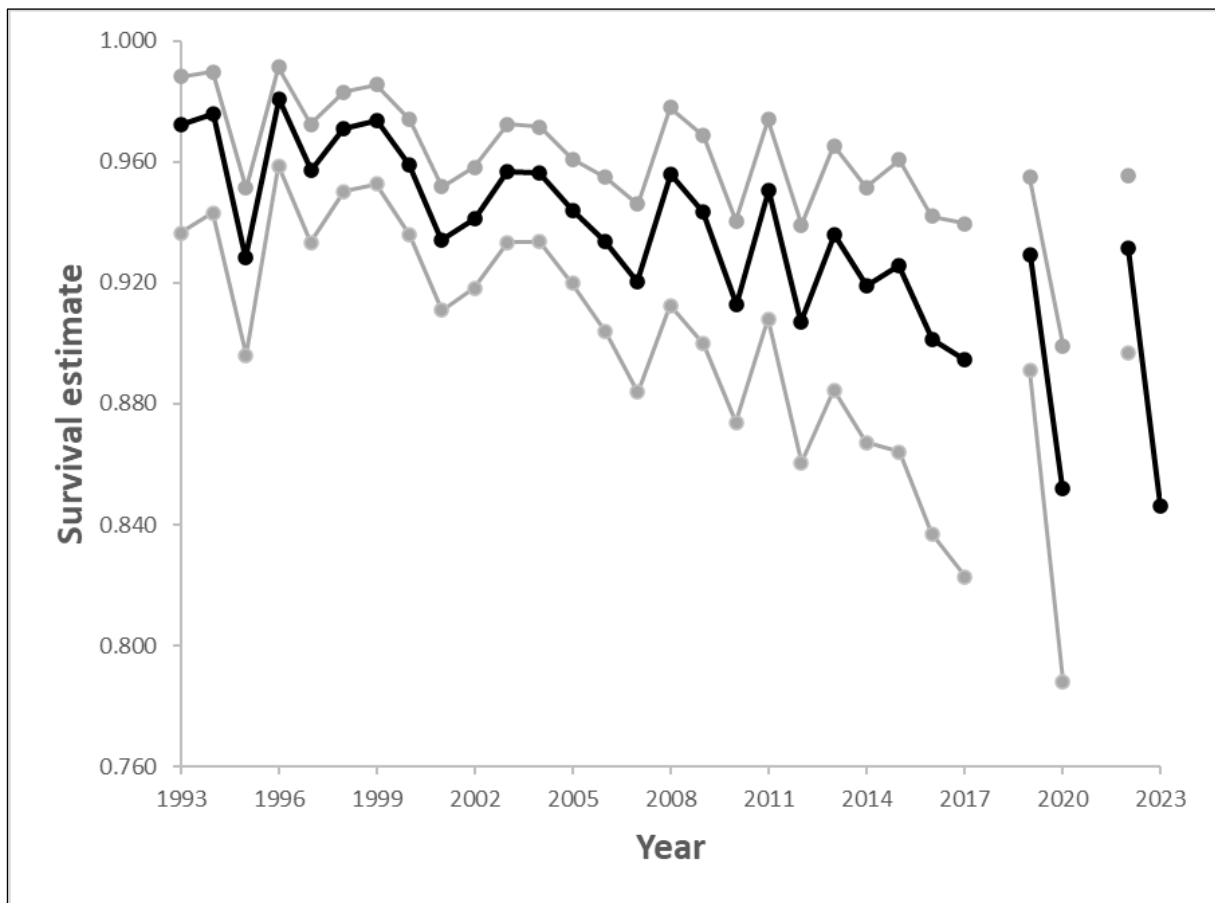


Figure 3-2: Plots of estimated annual survival and upper and lower 95% confidence intervals for southern Buller's albatross at the Snares. Estimates of survival are shown by black dots and black lines and estimates of upper and lower 95% confidence intervals are shown by grey dots and grey lines. Confidence intervals have been omitted for 2023, and no estimates are shown for 2018 and 2021.

The estimations of annual survival by sex were similar to those for the population as a whole, with no discernible difference between the survival of males and females (Table 3-2).

Table 3-2: Estimates of annual survival, with one standard error, for southern Buller's albatross at The Snares, 1993 to 2023, for males and females.

Year	Males		Females	
	Survival Estimate	Standard Error	Survival Estimate	Standard Error
1993	0.990	0.01	1.000	<0.01
1994	1.000	<0.01	1.000	<0.01
1995	1.000	<0.01	1.000	<0.01
1996	0.985	0.01	0.994	0.01
1997	0.969	0.01	0.959	0.01
1998	0.969	0.01	0.974	0.01
1999	0.987	0.01	0.979	0.01
2000	0.951	0.01	0.969	0.01
2001	0.935	0.01	0.949	0.01
2002	0.936	0.01	0.941	0.02
2003	0.967	0.01	0.950	0.02
2004	0.973	0.01	0.944	0.02
2005	0.952	0.01	0.948	0.02
2006	0.950	0.02	0.916	0.02
2007	0.912	0.02	0.934	0.02
2008	0.977	0.02	0.937	0.03
2009	0.936	0.02	0.957	0.03
2010	0.940	0.02	0.886	0.03
2011	0.947	0.02	0.963	0.02
2012	0.898	0.03	0.904	0.03
2013	0.938	0.03	0.934	0.03
2014	0.880	0.03	0.963	0.03
2015	0.943	0.03	0.911	0.04
2016	0.945	0.04	0.861	0.04
2017	0.879	0.04	0.883	0.04
2018				
2019	0.923	0.02	0.952	0.02
2020	0.834	0.04	0.867	0.04
2021				
2022	0.941	0.02	0.923	0.02
2023	0.799	38.96	0.762	55.11

3.3 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 colonies between 1992 and 2004, 139 were recaptured during March-April 2023. The oldest known-age bird recaptured in the three study colonies for the first time was

from the 1998 cohort, and so was 25 years old. This indicates that 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 19 years old), 577 (29.0%) have been recaptured. The lowest rate of return (14.9%, 16 recaptured from 107 banded) 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) from the 1995 cohort also in the Punui Bay colonies (Table 3-3).

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

Colony	Cohort												
	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Mollymawk Bay	19 (27.1)	28 (31.8)	26 (37.1)	6 (26.1)	19 (22.4)	19 (20.0)	32 (39.5)	34 (38.6)	26 (29.2)	17 (21.0)	21 (22.1)	30 (31.6)	31 (31.3)
Punui Bay	18 (39.1)	12 (20.7)	17 (39.5)	27 (44.3)	21 (32.3)	29 (38.7)	21 (27.3)	12 (23.5)	20 (23.8)	17 (20.7)	24 (25.5)	16 (14.9)	35 (39.3)

A plot of the overall return rate (all three study colonies combined; Figure 3-3), shows that from these cohorts the percentage of banded known-age birds returning varied from 26.7% (1996 cohort) to 39.3% (1995 cohort) for the cohorts banded from 1992 to 1999. Currently, the return rate of cohorts banded from 2000 to 2004 varies from 22.1% (2001 cohort) to 32.4% (2004 cohort) indicating that more birds from these cohorts have yet to be recaptured.

Of 40 birds banded as chicks near fledging in the study colonies during September 2013 three were recaptured for the first time in 2023, bringing to five the total number of this cohort to be recaptured.

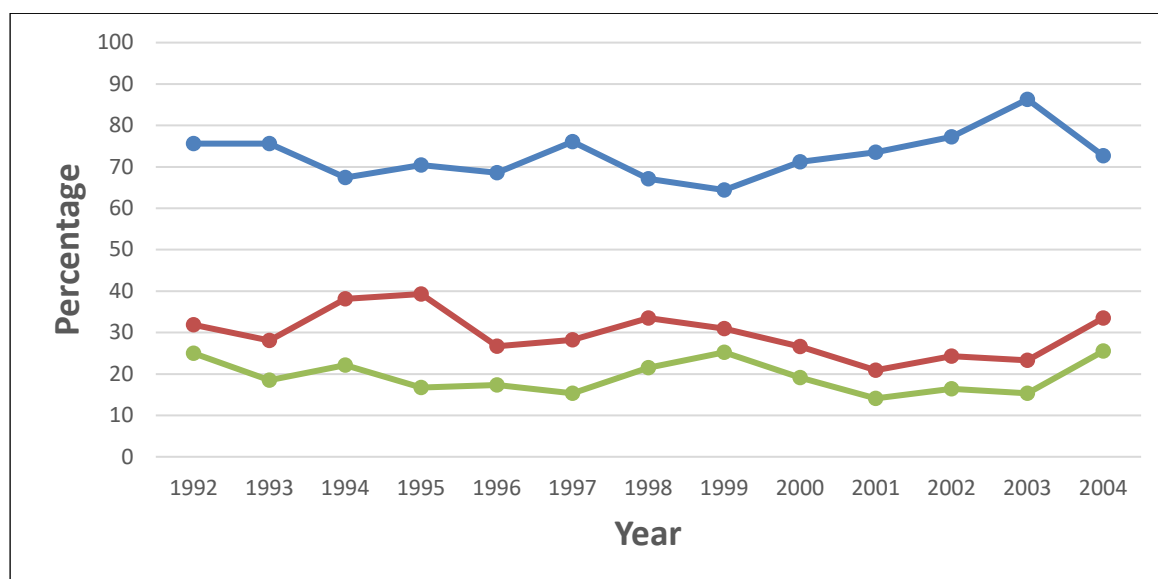


Figure 3-3: Fledging success and return and recruitment rates of southern Buller's albatrosses banded as chicks in three study colonies at The Snares, 1992-2004. Fledging success - blue, return rate - red and recruitment rate - green.

3.4 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-April 2023, 11 known-age birds, banded as chicks in the study colonies in the period 1992-2004, were found breeding for the first time i.e., they had recruited to the breeding population. Of these, one was aged 19 years (banded as a chick in 2004), four were aged 21 years (banded as chicks in 2002), five were aged 23 years (banded as chicks in 2000), and one was aged 25 years (banded as a chick in 1998).

A plot of recruitment rate, by cohort, of birds banded as chicks from 1992 to 2004 (Figure 3-3) shows an apparent decline from 1992 to 1997, followed by increases in 1998 and 1999 before declines again from 2000 to 2003. 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 to 1999 cohorts i.e., birds aged 20-27 years. Currently, these range from 8.7% for the 1995 cohort from Mollymawk Bay to 32.6% for the 1992 cohort from Punui Bay (Table 3-4). In addition, there is considerable variation in the recruitment rate both between years and between colonies in the same year (Table 3-4).

Table 3-4: Numbers (% of total banded) of known-age southern Buller's albatross recruits (i.e. returning to breed) to The Snares. For cohorts banded between 1992 and 1999, by colony of provenance and with Punui Bay colonies combined.

Colony	Cohort							
	1992	1993	1994	1995	1996	1997	1998	1999
Mollymawk Bay	14 (20.0)	20 (21.6)	15 (21.4)	2 (8.7)	11 (12.9)	8 (8.4)	17 (21.0)	24 (27.3)
Punui Bay	15 (32.6)	8 (13.8)	10 (23.3)	12 (19.7)	15 (23.1)	19 (24.0)	16 (20.8)	11 (21.6)

A plot of the overall recruitment rate (all three study colonies combined; Figure 3-3), shows that the percentage of banded known-age birds from the 1992 to 2004 cohorts that returned and survived to breed varied from 15.9% (1997 cohort) to 25.5% (2004 cohort). With chicks from the 1998 to 2004 cohorts being recorded breeding for the first time in 2023, more birds from these cohorts are likely to be recorded in the future.

Despite searches for banded birds being made 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 so the percentage returns from each cohort noted here should be considered as minima.

At the Snares, breeding birds were banded during studies in 1948, 1961 and most years from 1967 to 1977. No birds from these years were recorded during March-Apr 2023. 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). None of these birds, which would now be 51 years old, were

recorded during March-April 2023 despite repeated searches made of the breeding sites of the three birds from the 1972 cohort recaptured during 2019 and 2020.

One of the 40 birds banded as a chick in the Mollymawk Bay study colony in 2013 was recorded breeding for the first time, at age 10 years.

3.5 GLS retrieval

During March-April 2023, a further three GLS tags were retrieved, all from birds that were not actively breeding.

3.6 Trail cameras

During March-April 2023, we retrieved the SD cards from all 12 trail cameras deployed to cover 4-6 southern Buller's albatross nests in March-April 2022. Additionally, new SD cards and new batteries were installed in the cameras and the cameras positioned to record mostly still images and some video footage for the forthcoming year. Wherever possible, cameras were left in the same position they were sited in 2022. However, for some cameras doing so would have produced few useful images, and so in these cases cameras were re-positioned. For example, in one case a large branch had fallen directly in front of a camera, completely obscuring the lens.

4 Discussion

4.1 Study colonies

Information from the three study colonies overall suggests that the breeding population peaked during 2005-2006, then trended downward until 2010 and subsequently 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 2023 were lower than those recorded in 2022 (Figure 3-1).

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 during 1992-2004 (Sagar et al. 2000) followed by declines through to 2016 (Francis & Sagar 2012; Sagar et al. 2017; Table 3-1 and Figure 3-2). 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 is likely sustaining the breeding population and without it the population would decline. This suggestion is further supported by the results of the current trip, with a further 82 breeding birds of unknown age banded in the study colonies.

4.2 Estimated annual survival

Despite the relatively high estimates of adult survival in 2019 and in 2022 (Table 3-1), the longer-term and continued decline of the estimated annual survival rates of birds banded as breeding birds of unknown age is concerning. Generally, since 2011 the estimated annual survival has been relatively low, usually below 0.92, which is probably insufficient to maintain a stable population. At 0.85, the estimate for 2020 is the lowest recorded during the 30 years of the current study. The lack of any marked difference in annual survival estimates for males and females (Table 3-2) would tend to suggest that throughout the species' annual cycle both sexes are exposed to similar threats and impacts.

4.3 Return and recruitment rates

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 (Table 3-3 and Table 3-4). Although future field work is likely to increase both return and recruitment rates for the cohorts 2000-2004, few new birds are likely to be recaptured from cohorts banded 1992-1999 inclusive. It would appear possible, perhaps likely, that elevated recruitment rates in recent years have 'offset' the relatively low rates of annual survival in breeding birds and resulted in a relatively stable population overall, albeit with temporal variation.

4.4 GLS data loggers

As for loggers retrieved in 2022, the three additional loggers retrieved in 2023 were returned to the Department of Conservation for further analyses and data interpretation.

4.5 Trail cameras

Despite all the years that Buller's albatross has been studied at the Snares, beginning with Lance Richdale in 1948, the only season when breeding was followed from start to finish was in 1971-72 when Carol Horning diligently visited the Mollymawk Bay study colony daily at key times through the breeding cycle; so 1971-72 is the only season for which we have both laying dates and fledging dates to calculate breeding success. Laying dates are available in the 1968-69, 1969-70, 1970-71, 1974-75 and 1976-77 seasons, but there are no fledging data from those seasons. For our current study, which began in 1992, we have estimated breeding success between 1992 and 2004 from the numbers of eggs estimated to have been laid and the numbers of chicks banded near fledging. Consequently, analyses of the photographs taken by the trail cameras will provide further information about such key events as the timing of return of adults to the breeding colonies, estimated breeding success and the timing of departure from the breeding colonies.

5 Acknowledgements

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