Demography and distribution of Buller's Albatrosses *Thalassarchebulleribulleri*: Final research report of the 2012 field season

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Summary

This report presents the results of demographic and tracking studies of Buller's albatross *Thalassarchebulleri* at three study colonies at The Snares during 21-27 April 2012. Demographic studies at these colonies have been undertaken annually since 1992, 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, showed near-record totals over the period 1992-2012 in all three study colonies. A total of 296 birds that had been banded previously as breeding adults of unknown age wererecaptured within the study colonies. A further 48 breeding birds were banded in the study colonies. These are assumed to be first-time breeders and this total represented 16.1% of the total number of birds captured, a proportion almost twice that recorded in any previous year. Consequently, the increase in the numbers of breeding pairs in all three study colonies is assumed to be a consequence of recruitment of young, inexperienced birds rather than increased survival of older, experienced birds. The oldest birds in the study colonies were banded as breeding birds of unknown age in 1977. Assuming a minimum age of first breeding of ten years, these birds were at least 45 years old in April 2012.

During the period 1992-2004 all chicks that survived to near-fledging were banded and their survival to return to the study colonies in subsequent years has been monitored. This year 121 of these birds were captured, with birds from cohorts banded from 1994 to 2004 being recaptured for the first time, showing the long term monitoring required to obtain reliable estimates of survival of such known-age birds. There is a strong male bias in the known-age birds recaptured, but some of this is explained by females being less likely than males to be recaptured. The average age of first breeding is 10-12 years and recruitment to the breeding population varies widely, so further years of recapture are required before the recruitment rates of all cohorts 1992-2004 can be estimated reliably.

Data from 35 retrieved geolocators have been processed and show that over a 12-month periodBuller's albatrosses are primarily distributed off the coasts of Chile and Peru, around the subantarctic islands, South Island and southern half of the North Island of New Zealand, and the eastern coast of Tasmania. In the Tasman Sea and Pacific Ocean between these land masses, Buller's albatrosses generally occur from 40^{o}S to 50^{o}S. For the first time the kernel density distributions of Buller's albatrosses obtained by geolocator tracking will allow an assessment of the timing and degree of overlap with various fisheries throughout the range of the birds.

1 Background

This project was completed under contract to the Aquatic and Reporting Unit, Department of Conservation, with additional support from NIWA. The main aims of the project were:

1. To build upon the comprehensive demographic database for Buller's albatrosses at The Snares, and

2. To determine the at-sea distribution of Buller's albatrosses over periods for which data are currently lacking.

This report describes the field work completed under permits (Entry 1112/76 and Research and Collection SO-32541-FAU) granted by Southland Conservancy, Department of Conservation, during the 2012 field season at The Snares and outlines the results in comparison with those of previous years. The main aims of the field work were to update population size and adult mortality estimates and foraging distributions of Buller's albatrosses at The Snares. Specifically, the additional information will be used to:

1. Examine long-term trends in the numbers of breeding pairs of Buller's albatrosses in three long-term study colonies (Mollymawk Bay, Lower Punui Bay, and Upper Punui Bay);

2. Estimate adult survival;

3. Determine breeding frequency of banded birds;

4. Record the colony attendance of banded pre- and non-breeding birds; and

5. Examine the at-sea distribution of breeding birds during the period April 2008 - April 2011 with respect to potential overlap with fishing activities.

Field work centred on obtaining further information regarding the population dynamics of Buller's albatross, particularly population size, adult survival, breeding frequency, and recruitment. Demographic data will be analysed using NIWA's dedicated seabird demographic model as part of complementary DOC and MFish supported research. This was the 21stconsecutive year of recording demographic data of Buller's albatrosses at The Snares.

In previous visits to The Snares during April 2008-2011 the at-sea range of Buller's albatrosses over 12-month periods was assessed by the deployment and retrieval of geolocation loggers manufactured by British Antarctic Survey, Cambridge, England. Each loggers weighed 3.5 g and was attached to each bird's leg using a plastic darvic® leg band and a UV-resistant cable tie. During April 2008, geolocation loggers were deployed on 38 banded birds at Mollymawk Bay. Of these birds, 24 were recaptured during April 2009 and 19 loggers were retrieved; 5 loggers had become detached from the darvic® band, and so were lost during the intervening period. During April 2009, a further 22 loggers were deployed on banded breeding and non-breeding birds at the Mollymawk Bay study colony. Of the loggers deployed during April 2008 a further 3 were retrieved and 2 more recorded as lost; leaving 9 loggers still to be accounted from this deployment. Likewise, of the loggers deployed during April 2009, 11 were retrieved and 2 recorded as lost; leaving 9 loggers still

to be accounted from this deployment. During April 2011 a further 2 loggers from the 2009 deployment were retrieved and 3 recorded as lost. Thus, 9 and 6 loggers respectively from the 2008 and 2009 deployments had still to be accounted for and during the current trip a search was made for the birds carrying these devices.

2 Methods

The Snares were visited from 21 to 27 April 2012 and the team comprised Paul Sagar (field leader, NIWA, Christchurch) and Tom Williams (University of Canterbury). Logistical support was provided on charter by *RVTiama* (skipper HenkHaazen, crew Steve Parsons).

2.1 Demographic data

2.1.1 Study colonies

Each of the three study colonies (Mollymawk Bay, Lower Punui Bay, and Upper Punui Bay) was visited daily during 21-27 April. During 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 were captured and fitted with a uniquely numbered stainless steel leg band. All adult birds recorded on this first visit were marked with raddle (a temporary stock marker) so that they were not recaptured on our subsequent visits. Subsequently, all nests in each colony were checked and any birds not marked 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 banded non-breeding birds as possible.

All results reported refer to data collected within the three study colonies unless otherwise stated.

2.1.2 Mollymawk Bay-Penguin Slope

For comparison with counts completed in previous years and to assess whether trends in the study colonies were representative of the wider Buller's albatross population the contents of all nests in colonies between Mollymawk Bay and Penguin Slope, along the east coast of North East Island, were recorded. This involved walking to all nests and spraying stock marker on the nest to indicate that it had been checked. In addition, all adult birds associated with these nests were checked for bands.

2.2 Tracking data

2.2.1 Geolocator loggers

All banded adults in the study colonies were checked for darvic® colour bands and associated geolocator loggers.

Light data from retrieved loggers were processed using software Transedit (British Antarctic Survey), with sunrise and sunset transition times identified from light-curve thresholds. Latitude was calculated from length of day and night and longitude from the time of local midday or midnight relative to Greenwich Mean Time. Locations (2/day) were assumed to have an accuracy of 186±114 km (s.d.) (Phillips *et al.* 2004). Given that global day-length is uniform around the equinoxes locations occurring within three weeks of these were excluded.

Seasonal changes in foraging distribution were examined using kernel analysis, following Shaffer *et al.* 2009 and Rayner *et al.* 2011)..

3 Results and discussion

3.1 Demographic data

3.1.1 Breeding population size

Study colonies

Counts of nests where breeding had occurred that season (based on the presence of an egg or chick, or the remains thereof) were made in each colony. During 2012 totals of 145, 65 and 75 nests with an egg or chick were counted in Mollymawk Bay, Lower Punui Bay and Upper Punui Bay, respectively. These totals represent increases, relative to the numbers counted during April 2011, of 9.0%, 13.0%, and 8.7% in Mollymawk Bay, Lower Punui Bay and Upper Punui Bay, respectively. This trend is consistent with the increase evident in these colonies since 2010, and numbers of breeding pairs are near-record totals in all three study colonies since 1992 (Figure 3-1).

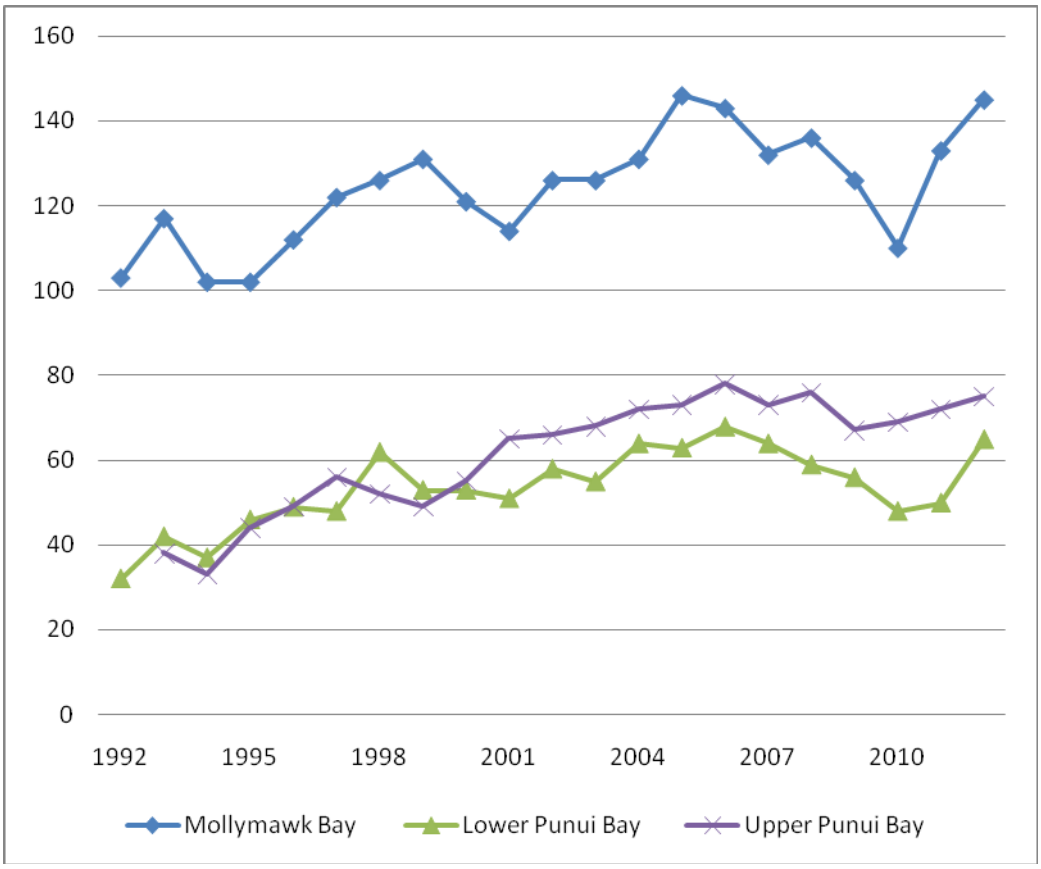

Figure 3-1: Numbers of breeding pairs of Buller's albatrosses counted annually at three study colonies, The Snares 1992-2012.

Mollymawk Bay-Penguin Slope

Excluding the nests recorded in the three study colonies, a total of 615 nests containing an egg, chick or their remains were counted in the area between Mollymawk Bay and Penguin

Slope. This total compares with counts of 174, 415, 528 and 626 occupied nests in the same area in 1969, 1992, 1997 and 2002, respectively. These totals suggest that the numbers of Buller's albatrosses breeding at The Snares were similar in 2002 and 2012, following a period of increase between 1969 and 2002, and so support the assumption that trends indicated by the numbers of pairs breeding in the three study colonies are representative of the Buller's albatross breeding population at The Snares.

3.1.2 Productivity

Of 285 nests counted in the three study colonies on 21 April 2012, 28 (9.8%) contained an egg, 24 (8.4%) contained a broken egg, 225 (78.9%) contained a chick, and 8 (2.8%) contained a dead chick. Of the extant chicks, 156 (69.3%) were being guarded by an adult (i.e. at the guard stage) and 69 (30.7%) were alone at the nest (post-guard stage). Since 2005 annual visits to the study colonies had been made during the first two weeks of April, when all chicks were at the guard stage, and so our 2012 visit indicates the rapid switch to the post-guard stage by the end of the month.

The number of broken eggs this year (24) was twice the previous highest number recorded (12 in 2010). In addition to the broken eggs we also noted that chicks were left alone at the nest at a much younger age than in any previous year, except 2010, of this study. The loss of eggs and abandonment of chicks recorded during 2010 was likely due to the El Nino conditions prevailing that year, which may have resulted in less natural food being available to the adults; and so resulted in lower breeding success. In contrast, La Nina conditions prevailed during early 2012 and at this stage we have no indication of the level of natural food available to Buller's albatrosses.

3.1.3 Adult survival

A total of 296 birds that had been banded previously as breeding adults of unknown age were recaptured. This total comprised breeding birds, non-breeders and failed breeders. In addition, a further 48 breeding birds were banded within the study colonies. This total of recaptured birds is about 100 fewerthan any other year since April visits were initiated in 2006. Two factors contributed to this lower number of recaptures:

(1) On the first check of the study colonies about 31% of chicks were in the post-guard stage, and so the parents were not available for recapture, and

(2) The almost complete absence of non-breeding birds.

During the post-guard stage adults return every few days, usually remaining at the nest for only the few minutes that it takes to feed the chick. Consequently, there is less likelihood of recapturing these adults. The almost complete absence of non-breeding birds is more problematic. In previous years large numbers of non-breeding birds had been present in the study colonies during the first two weeks of April and during the period May-August. This was the first occasion when we have visited the study colonies during late April, and so their almost complete absence may well have been usual for this stage of the breeding cycle. Alternatively, birds may have been prevented from coming ashore by the gale-force north-westerly wind that occurred throughout most of the period 21-27 April.

Despite the relatively low number of adults recaptured the number of new birds banded (48, representing 16.1% of birds captured in 2012) was the highest since April visits were initiated

in 2006, with numbers banded from 2006 to 2011 ranging from 27 to 38, representing 6.2-9.2% of the total number of birds captured.

Because birds breeding in the study colonies have been 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). Consequently, the increase in the numbers of breeding pairs during 2012 appears to be a result of the recruitment of a greater proportion of young birds into the population, rather than increased survival of more experienced, older birds.

The oldest birds were banded as breeding birds of unknown age in 1977. Assuming a minimum age of first breeding of ten years, these birds were at least 45 years old in April 2012.

Banding schedules for all newly banded birds have been completed and sent to the Banding Office, Department of Conservation, Wellington.

3.1.4 Survival and recruitment of known-age birds

Return rate of known-age birds

The return rate of known-age 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, 121 were recaptured during April 2012. These birds were from cohorts banded from 1992 to 2004. The oldest known-age bird recaptured for the first time was from the 1994 cohort. This indicates that many more years of recapture effort is required to obtain reliable estimates of the survival of known-age birds in these albatrosses.

Of the 1991 birds banded as chicks near fledging in the study colonies during the period 1992-2004 (which would now be at least eight years old), 441 (22.2%) have been recaptured. The lowest rate of return (2.8%, 3/107) is for the 2003 cohort in Punui Bay (Lower and Upper study colonies combined) and highest rate of return (44.3%, 27/61) from the 1995 cohort in these same study colonies (Table 3-1). However, as indicated by the first-time recapture of a bird banded in 1994 and a plot of the return rate of birds banded as chicks 1992-2004 (Figure 3- 2), these return rates are likely to increase with further recaptures in subsequent years, especially for cohorts banded from 1999.

Table 3-1: Number (% of total banded) ofBuller's albatrosses, banded as well-grown chicks in 1992-2004, returning to The Snares, by cohort and colony of provenance.

Colony/cohort	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
MollymawkBay	19 (27.1)	27 (30.7)	26 (37.1)	6 (26.1)	19 (22.4)	20 (21.0)	30 (37.0)	29 (32.9)	15 (16.9)	14 (17.3)	15 (15.8)	11 (11.6)	5 (5.0)
PunuiBay	20 (43.5)	12 (20.7)	18 (41.9)	27 (44.3)	21 (32.3)	26 (34.7)	16 (20.8)	8 (15.7)	14 (16.7)	9 (11.0)	7 (7.5)	3 (2.8)	4 (4.5)

As in previous years there was considerable bias in the sex ratio of the known-age birds recaptured, with 75.0% (66/88) estimated as males on the basis of leg and bill

measurements. Of the 435 known-age birds recaptured since the start of this study where the gender was estimated from measurements, 71.5% (312/435) were male. This male bias in the known-age birds recaptured probably, in part, reflects differences in the behaviour of sexes. Our observations have shown that pre-breeding females spend considerably less time ashore and visit colonies farther from their natal colony than do males. Consequently, females are less likely to be recaptured. However, more recently, we have shown that there was a male bias in the sex of chicks fledged in the study colonies during 2002-2004, and so this too would have contributed to the observed male bias in the known-age birds recaptured.

Despite searches for banded birds being made in areas adjacent to the three study colonies, some birds, particularly females, will have settled elsewhere on The Snares (Sagar et al. 1998), and so the percentage returns from each cohort should be considered as a minimum.

Recruitment rate of known-age birds

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

In April 2012, 36 known-age birds, banded as chicks in the study colonies, were found breeding for the first time i.e. they had recruited to the breeding population. Of these, two were aged eight years (banded as chicks in 2004), one was aged ten years (banded as a chick in 2002), two were aged 11 years (banded as chicks in 2001), five were aged 12 years (banded as chicks in 2000), eight were aged 13 years (banded as chicks in 1999), five were aged 14 years (banded chicks in 1998), eight were aged 15 years (banded as chicks in 1997), one was aged 16 years (banded as a chick in 1996), two were aged 17 years (banded as chicks in 1995, and two were aged 18 years (banded as chicks in 1994).

Mean age of first breeding is 10-12 years (Francis & Sagar 2012). Although a plot of recruitment rates of birds banded as chicks 1992-2004 (Figure 3-2) shows an apparent decline from 1999 the extreme age of first breeding suggests that more birds are likely to be recorded breeding in future. Therefore, it is probably prudent to estimate recruitment (i.e. rate at which birds banded as chicks enter the breeding population) only for the 1992-1999 cohorts i.e. birds aged 13-20 years. Even so, recruitment rates for cohorts banded from 1997 are likely to increase with recaptures in future years. Currently, recruitment rates from the 1992-1999 cohorts range from 4.4% (for the 1995 cohort in Mollymawk Bay) to 28.3% (for the 1992 cohort in Punui Bay) (Table 3-2).

Given the bias in the sex ratio of birds returning to their natal colonies (see above), the figures for the recruitment rate should be considered minimal because it is likely that a proportion of females, in particular, will be breeding at other colonies and so are less likely to be recaptured.

3.2 Tracking data

3.2.1 Retrieval of geolocation loggers

None of the outstanding geolocator loggers was found on birds recaptured in the study colonies, and so no new information on the distribution of birds during 2011-12 is available.

Only two geolocation loggers were retrieved during the April 2011 visit to the study colonies, and so it is assumed that the lack any further retrievals in April 2012 indicates that the birds carrying these devices have died.

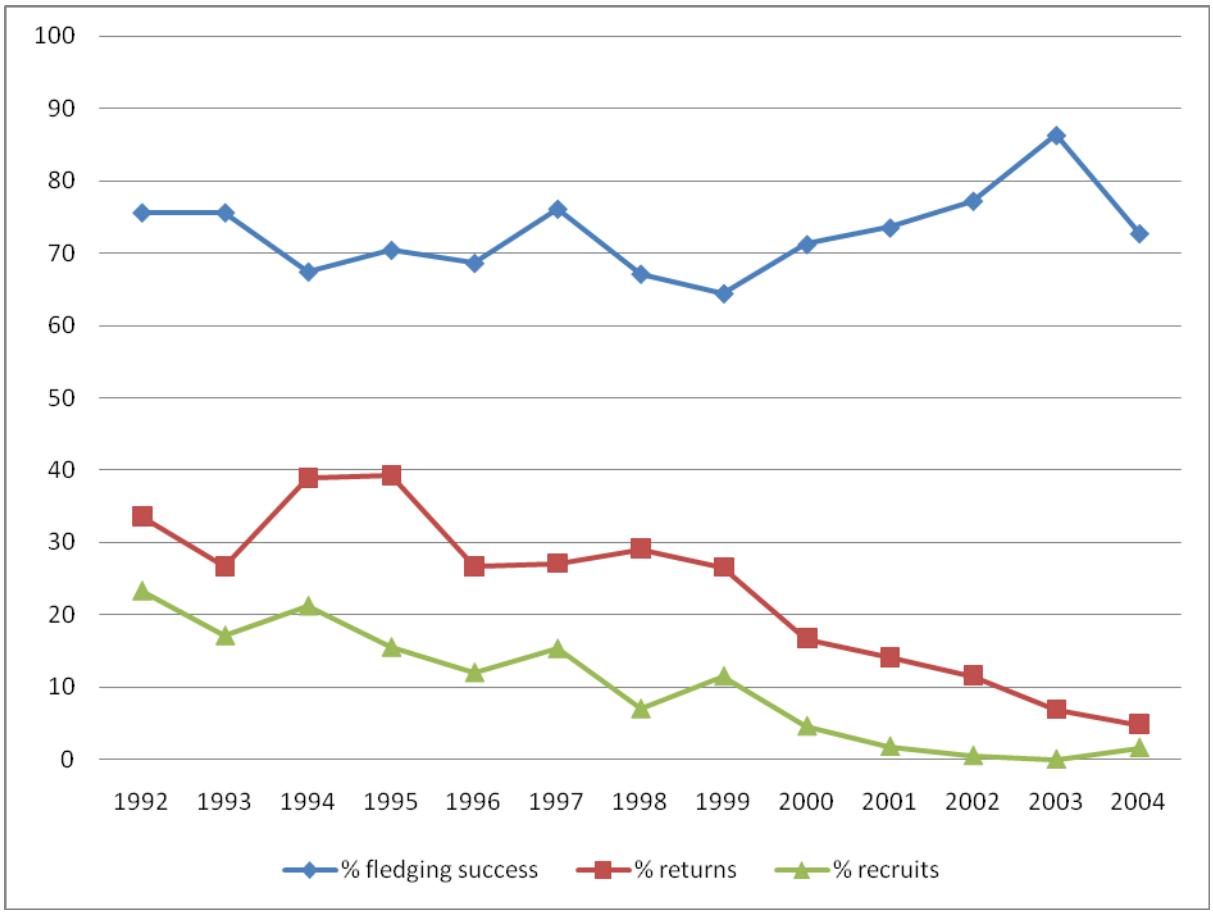

Figure 3-2: Fledging success and return rate and recruitment of Buller's albatrosses banded as chicks in three study colonies at The Snares, 1992-2004.

Table 3-2: Numbers (% of total banded as well-grown chicks) of known-age Buller's albatrosses recruiting (i.e. returning to breed) to The Snares, by cohort and colony of provenance.

Colony/cohort	1992	1993	1994	1995	1996	1997	1998	1999
MollymawkBay	14 (20.0)	17 (19.3)	14 (20.0)	1 (4.4)	8 (9.4)	8 (8.4)	5 (6.2)	12 (13.6)
PunuiBay	13 (28.3)	8 (13.4)	10 (23.4)	12 (19.7)	10 (15.4)	18 (24.4)	6 (7.8)	4 (7.8)

3.2.2 At-sea distribution 2008-2011

The processed geolocation logger data provides information about the movements and locations of Buller's albatrosses for the period April 2008 to April 2011; this is the first time that this species has been tracked throughout its complete annual cycle.

Initial analysis of the resulting processed data shows (Figures 3-3 - 3-6) that over all months and years Buller's albatrosses are primarily distributed off the coasts of Chile and Peru, around the subantarctic islands, South Island and southern half of the North Island of New Zealand, and the eastern coast of Tasmania. In the Tasman Sea and Pacific Ocean between these land masses, Buller's albatrosses generally occur from 40°S to 50°S (Figure 3-3).

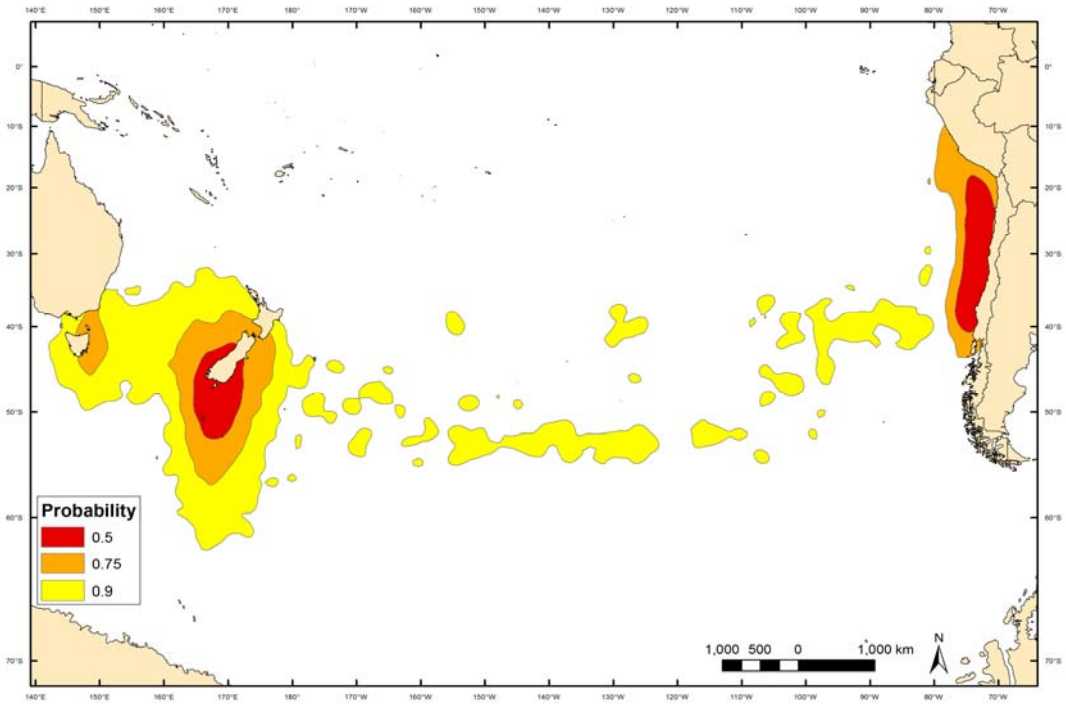

Figure 3-3: Kernel densities of the overall distribution of Buller's albatrosses April 2008-April 2011 inclusive, as indicated by geolocation loggers.

During December, January and February there was movement west across the Pacific as breeding birds returned to Australasian waters for the start of the breeding season; birds relieved of incubation duty foraged primarily over the continental shelf and slope around the southern half of the South Island, Challenger Plateau, eastern Tasman Sea, and off the eastern coast of Tasmania (Figure 3-4).

In April, during the guard-stage of the chick, most breeding birds confined their foraging within the EEZ, primarily over the Snares Shelf and farther south, and off the west coast of the South Island (Figure 3-5).

In May, after the guard-stage, foraging extended primarily off the east coast of the South Island. There was some movement of birds east across the Pacific, presumably following breeding failure (loss of egg or chick).

During July, breeding birds continued to forage off the east coast and there was also an increase in foraging off the west coast of the South Island. Failed breeders foraged primarily off the coast of Chile.

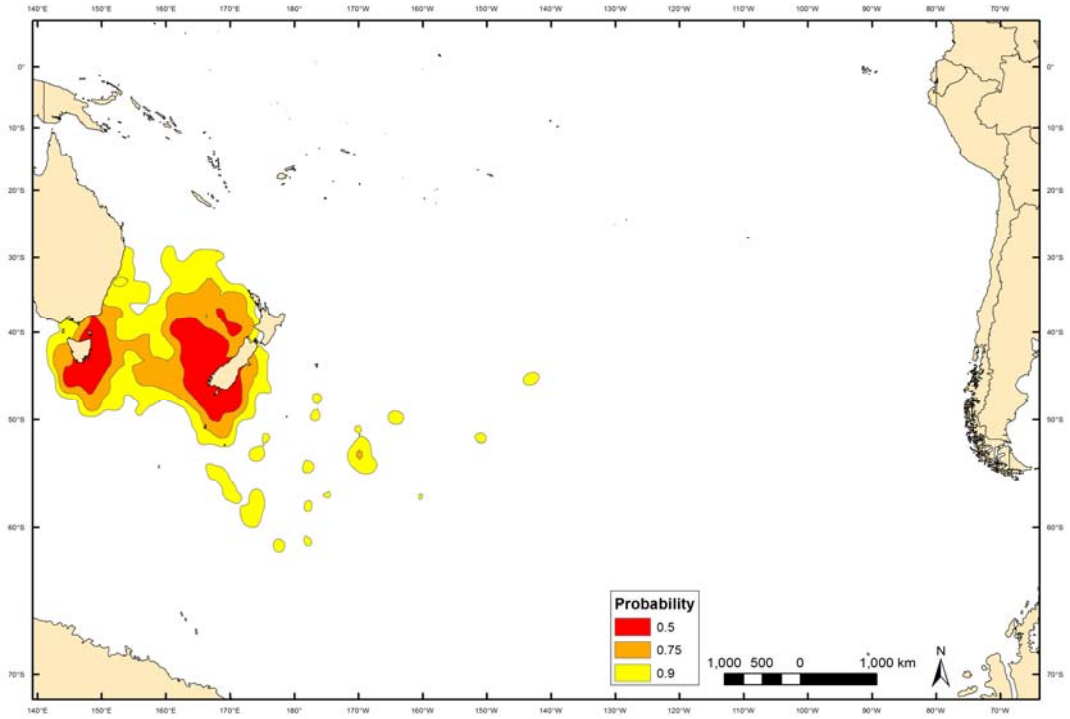

Figure 3-4: Kernel density distribution of Buller's albatrosses during February in each of 2009, 2010 and 2011, as indicated by geolocation loggers.

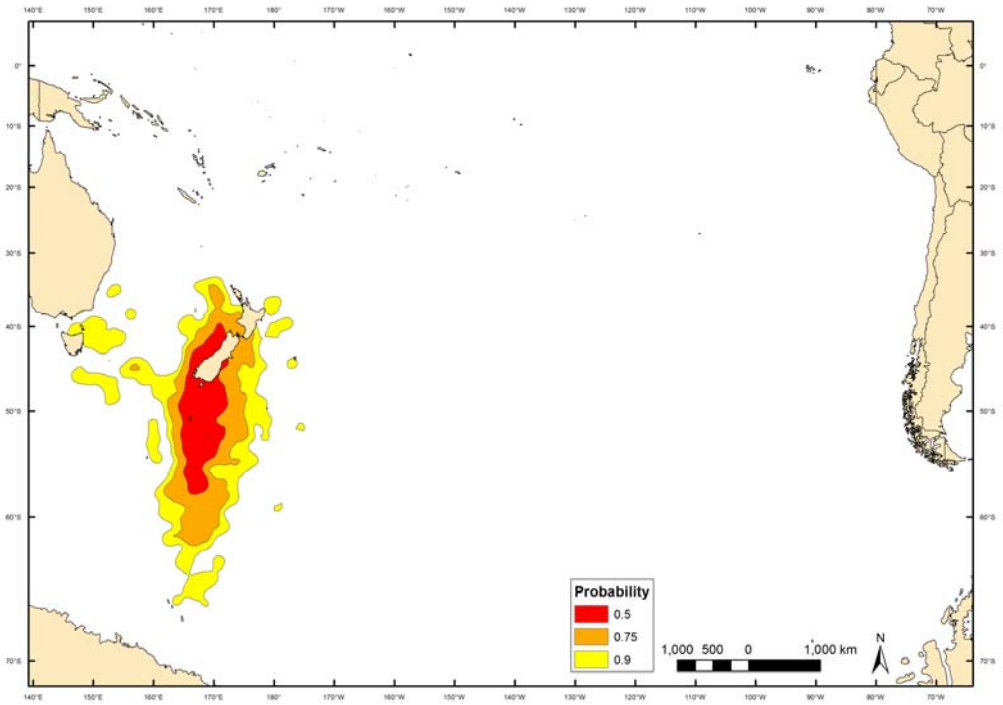

Figure 3-5: Kernel density distribution of Buller's albatrosses during April in each of 2008, 2009 and 2010, as indicated by geolocation loggers.

By August there was a contraction of the foraging range along the east coast of the South Island and the movement of presumed successful breeders east across the Pacific.

At the end of the breeding season birds migrated across the Pacific to South American waters during October and by November all birds were distributed off the coasts of Chile and Peru (Figure 3-6).

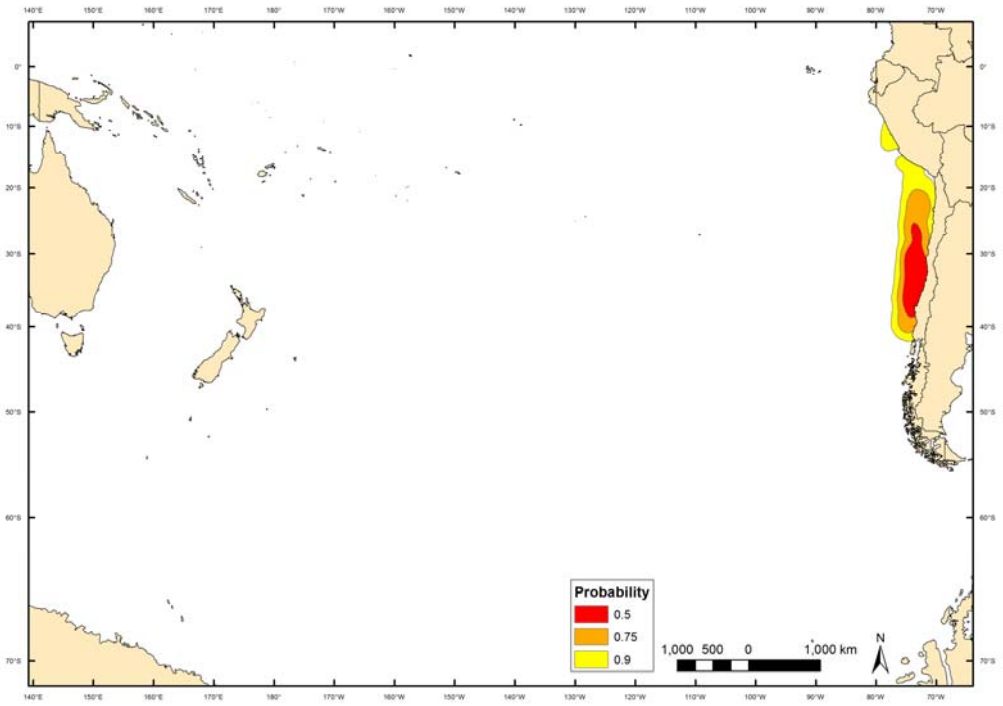

Figure 3-6: Kernel density distribution of Buller's albatrosses during November in each of 2008, 2009 and 2010, as indicated by geolocation loggers.

4 Research recommendations

4.1 Bird distribution and remote sensing data

The GLS information collected during this study may now be analysed with respect to the marine ecosystems in which the birds forage. We recommend that the complete set of processed geolocator data could be analysed to determine foraging distribution by gender, age, and breeding status of individuals. In addition, the foraging distribution of the birds could be overlain with other remote sensing datasets e.g., sea surface temperature, ocean colour and fishing catch effort to ascertain the environmental conditions encountered by foraging birds.

4.2 Interactions with fisheries

Buller's albatross have been amongst the most frequently reported seabird bycatch in the New Zealand EEZ since the late 1980s (e.g., Bartle 1991; Murray et al. 1993; Conservation Services Programme 2008). More recently, they have been reported in the bycatch of small-scale fisheries off Peru and Chile (Mangels 2012). For the first time the kernel density distributions of Buller's albatrosses obtained by geolocator tracking will allow an assessment of the timing and degree of overlap with various fisheries throughout the range of the birds.However, it should be borne in mind that overlap with fishing vessels does not equate to interaction because much of it is coincident, probably because both birds and fishing vessels are after the same prey. Therefore, identification of specific Buller's albatross-fisheries overlap allows targeted fine-scale GPS tracking studies to be undertaken to distinguish between overlap and interaction rates (Torres et al. in press).

We have already completed a fine-scale tracking study during the guard-stage for Buller's albatrosses breeding at The Snares (Torres et al. in press). This is the period when the birds forage relatively close to the island. During the incubation and post-guard stages birds forage over greater distances (e.g., Figures 3-4& 3-5), and so overlap with different fisheries. Therefore, It would be particularly useful to GPS-track Buller's albatrosses during the post-guard stage (late April-early September), the period when they overlap with trawl and longline fisheries which account for most of the recorded bycatch (Conservation Services Programme 2008). Now we recommend the contemporaneous tracking of birds from both the Solander Islands and The Snares, the two major breeding sites of this species, to compare the overlap of each breeding population with fisheries activities.

4.3 Long-term effects of environmental change and fisheries effort

This demographic study of Buller's albatrosses at The Snares now extends from 1992 to 2012, and so provides an opportunity to use the population trend and survival data as indicators of environmental change. Therefore, we recommend the continuation of at least annual visits to The Snares to record the numbers of breeding pairs and survival of banded birds in the three study colonies. These demographic data may then be analysed in relation to remote sensing data such as sea surface temperature and ocean colour, and with respect to the catch per unit effort of various fisheries.

5 Acknowledgements

This research was funded by the Marine Conservation Services of the Department of Conservation and NIWA. We are grateful for their continued support of this long-term research. We particularly thank Tom Williams for his making himself available at short notice and for his efficiency and assistance in achieving the scientific results of this trip. We thank staff at the Southern Islands Store for their continued efficient and unfailingly help during our times in Invercargill. Thanks also to the staff at the Stewart Island Field Centre for their daily radio skeds. Finally, thanks to Henk and Steve for their cheerful, helpful and efficient assistance and for being such good company while we were on *RVTiama*.

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