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Salvin's albatross population size and survival at the Snares Western Chain

Salvin's albatross, The Snares 2014

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Prepared by:
Paul Sagar
Matt Charteris
Paul Scofield

For any information regarding this report please contact:

Paul Sagar
Group Manager, Marine Ecology & Aquaculture
Marine Ecology & Aquaculture
+64-3-343 7855
paul.sagar@niwa.co.nz

National Institute of Water & Atmospheric Research Ltd
10 Kyle Street
Riccarton
Christchurch 8011

Phone +64 3 348 8987

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Contents

Tables

Reviewed by

David Thompson……………………………………

Approved for release by

Graham Fenwick…………………………

Executive summary

This report presents a summary of the results of whole-island counts of Salvin’s albatrosses *Thalassarche salvini* breeding at the Snares Western Chain on 17 September 2014 and compares these results with those obtained using similar methods during 2008 and 2009. In addition, the results of ground-truthing of an aerial survey and a survival analysis based on the recapture of banded birds are presented.

The whole-island surveys used the same methods as those in 2008 and 2009. The survey of Toru and Rima Islets and a rock stack just east of Toru resulted in an estimate of 1213 breeding pairs, which was very similar to the 1195 and 1116 breeding pairs estimated in 2008 and 2009, respectively, indicating that the population has remained stable over the intervening period.

Counts along transects immediately after the aerial survey showed that of 171 birds ashore, 100 (58.5%) were incubating, 14 (8.2 %) were on empty nests, and 57 (33.3 %) were loafing. The relatively high proportion of loafing birds may be a result of breeding failure as a consequence of habitat and disturbance by other birds prior to the survey.

On Toru Islet, a total of 67 birds that had been banded previously as chicks on the nest (in 1986) or breeding adults of unknown age (in 1995, and annually 2008-2010) were recaptured. Analysis of these data in a mark-recapture model resulted in an estimated survival probability of 0.951. This remains among the highest estimated survival of any population of annual breeding albatrosses.

1 Introduction

In recent decades it has become increasingly clear that numbers of albatrosses are declining and their populations are at risk. Of the 24 species of albatrosses worldwide, 21 species are showing declines in greater than 50% of their populations and most species are now classified as globally threatened. Threats to seabird populations include fisheries-related mortality, changes in prey abundance or availability, human predation/disturbance, predation by other mammals, habitat degradation, oil/chemical pollution, disease, and plastic ingestion. New Zealand's Exclusive Economic Zone (EEZ) supports the most diverse and abundant seabird populations in the world and the threats to their populations here are the same as those identified globally. Of these threats, one of the best documented is mortality in longline fisheries. Within the New Zealand EEZ, trawl fisheries also have been responsible for a large proportion of accidental mortalities associated with fishing operations.

Salvin's albatross (*Thalassarche salvini*) is endemic to New Zealand with estimated annual breeding populations of about 40,000 pairs in 2013 at the Bounty Islands (Baker et al. 2014) and 1100-1200 pairs during 2008-2010 at the Snares Western Chain (Sagar et al. 2011). Such population estimates make this the second-most abundant albatross species breeding in New Zealand, after the estimated 100,000 pairs of white-capped albatrosses (*T. steadi*) breeding at the Auckland Islands (Gales 1998). Despite their abundance Salvin's albatrosses are one of the least known albatross species, primarily because breeding is restricted to two isolated archipelagos which are difficult to access due to their exposure to severe sea conditions. However, in recent years they have been recorded in sufficiently high numbers in the bycatch of New Zealand trawl fisheries that they have been identified as at potential risk from the impacts of commercial fisheries (Richard et al. 2011), and so there has been a greater concerted effort to obtain information about the species.

Counts of the numbers of breeding pairs of Salvin's albatrosses on Proclamation Island, Bounty Islands, 1997-2011 indicated a decline of 13% between 2004 and 2011, and an overall decline of 30% between 1997 and 2011 (Amey & Sagar 2013). Additional counts on part of Depot Island, also in the Bounty Islands, indicated a decline of 10% in the numbers of breeding pairs between 2004 and 2011 (Amey & Sagar 2013). The scale of the decline estimated in this population has resulted in the conservation status of Salvin's albatross being upgraded from nationally vulnerable to nationally critical (Robertson et al. 2013).

For the purposes of the 2014-15 Conservation Services Programme Annual Plan, key components of the updated seabird risk assessment review, funded by the Ministry for Primary Industries, were included. This review highlighted the need for further population information about Salvin's albatrosses at the Snares Western Chain. Therefore the purpose of this project is to count the number of breeding pairs of Salvin's albatrosses at the Snares Western Chain, and the specific objectives are:

1.1 To estimate the population size of Salvin's albatross at the Snares Western Chain by ground survey.

1.2 To ground truth an aerial survey of Salvin's albatross at the Snares Western Chain by ground survey.

1.3 To collect data on banded Salvin's albatrosses at the Snares Western Chain in order to estimate adult survival.

2 Study area

The Snares Western Chain (48° 02' S, 166° 29'E) is a small group of rocky islets, largely devoid of vegetation, situated about 7 km south-west of The Snares. The group consists of five named islets which rise steeply out of deep water to heights of about 80 m above sea level, and a number of un-named rock stacks (Fleming & Baker 1973). Eleven species of birds have been reported breeding on the islets (Miskelly 1997), the most numerous being Salvin's albatross, Snares penguin (*Eudyptes atratus*), Cape petrel (*Daption capense*), and fulmar prion (*Pachyptila crassirostris*) (Miskelly et al. 2001). Salvin's albatrosses breed on Toru and Rima Islets and an un-named stack just east of Toru.

Figure 2.1: Snares Western Chain, looking east from Rima Islet, towards Wha and Toru Islets, with Rua Islet visible to the right of Toru. The Snares are on the horizon.

3 Methods

3.1 Estimate of population size by ground survey

Landings were made on Toru and Rima Islets of the Snares Western Chain on 17 September 2014. Onshore, we completed a systematic search for breeding Salvin's albatrosses, recording separate totals for birds on nests with an egg, birds on empty nests, and broken/abandoned clean eggs whether in a nest or not. The latter were assumed to represent failed breeding attempts of the current season because eggs from previous seasons were most likely to have been soiled fragments due to their being broken and eaten by subantarctic skuas (*Catharacta antarctica*) and/or trampled by Salvin's albatrosses and Snares penguins. Each nest located was sprayed with orange stock marker to show that it had been counted (Figure 3.1).

On completion of the survey of each islet, a check of at least 100 nests with an egg was made to record the numbers of nests missed or double counted, identified respectively by the absence of spray or presence of two sets of spray. The estimated proportion of missed and/or double counted nests was then applied to total number of occupied nests recorded to derive an adjusted count for each block.

Using 10 x 42 binoculars, a vantage-point count was made of birds on an un-named rock stack just east of Toru Islet.

Figure 3.1: Salvin's albatrosses on nests with an egg, Toru Islet, Snares Western Chain, 17 September 2014. Note orange spray on each nest to show that it had been counted during the survey.

3.2 Ground-truthing for aerial survey

We completed the ground count on Toru Islet just as the helicopter flew overhead to begin the aerial survey. Whilst the aerial survey was underway we waited in an area away from breeding birds in order to avoid disturbing birds. Immediately the aerial survey of Toru Islet was completed we undertook a ground-truthing exercise. This involved walking 2m wide transects to record separately birds on nests with an egg, birds on empty nests, and loafing birds (those standing or sitting but not associated with any apparent nest).

3.3 Recapture of banded birds

A search for banded birds was made on both Toru and Rima Islets during the course of the ground count on 17 September 2014. Any banded bird recaptured was sprayed with blue stock marker so that it would not be disturbed again. Subsequently, another landing was made on Toru Islet on 19 September 2014 specifically to search the study area established in 2008, where 234 breeding birds were banded 2008-2010.

As we had a small sample of recoveries we used the joint recapture/ recovery model of Burnham (1993) to estimate survival probabilities. This model is parameterised with four different probabilities; $S_{i:}$ the probability that a banded individual survives from year i to year i + 1 (here referred to as survival probability), F_i: the probability that a banded individual does not emigrate permanently from the study area from year i to year i + 1 (here defined as fidelity probability), p_i: the probability that a banded individual that is alive and in the study area at i is seen at $i+1$ (the resighting probability), r_i : the probability that a banded individual that has died between year i and i + 1 is found and its band reported to the Banding Office (the recovery probability). The most general model included separate survival (S), fidelity (F) and recovery (r) parameters for each year (t).

To make inferences from the data we *a priori* formulated different models, each representing a hypothesis about survival and other mathematically necessary but biologically unimportant parameters (nuisance parameters). These models were fitted using Program MARK 7.1 (White & Burnham 1999). To evaluate the fit of our set of models to the data we used a parametric bootstrap Goodness-of-Fit (GOF) test on the most general model (i.e., the model with the most parameters). If the structure of the general model adequately fit the data, then subsequent models that are constraints of the general model can be derived (White et al. 2001). These bootstrap simulations also provide an estimate of the dispersion parameter ($\hat{c}$), calculated as the observed deviance divided by the average of the simulated deviances ($\hat{c}$ =1) if the model fits perfectly. The models were ranked according to the small sample-size adjusted Akaike's information criterion (AICc ; Burnham & Anderson 1998). To reduce the list of reasonable models, we conducted modelling in two steps (Lebreton et al. 1992). First, we looked for a model that minimised the influence of the nuisance parameters (F, p, r) in the most parsimonious way. The survival part of the model was kept as the most complex structure in this step. Second, we assessed different models for survival while always retaining the most parsimonious structure of the nuisance parameters.

4 Results

4.1 Estimate of population size by ground survey

A total of 1118 adults on a nest with an egg and 88 broken eggs were counted (Table 4-1). Following an assessment of the accuracy of the ground count the total number of adults on a nest with an egg was adjusted upwards to 1125. Assuming that the broken eggs were laid in the current season, there were an estimated 1213 breeding pairs of Salvin's albatrosses on Toru and Rima Islets combined.

Table 4-1: Numbers of Salvin's albatross pairs breeding on Toru and Rima Islets, Snares Western Chain, 17 September 2014. The count for Toru includes 13 birds on nests with an egg estimated on an adjacent rock stack.

Islet	Ground count			Accuracy survey		Adjusted total	Estimated no. breeding pairs
	Birds on nest + egg	Birds on empty nest	Broken eggs	Not sprayed	Sprayed	Birds on nest + egg	Birds on nest + egg + broken eggs
Toru	817	52	74	1	115	824	898
Rima	301	37	14	0	100	301	315
Total	1118	89	88	1	215	1125	1213

4.2 Ground-truthing for aerial survey

A survey showed that of 171 birds ashore, 100 (58.5%) were incubating, 14 (8.2 %) were on empty nests, and 57 (33.3 %) were loafing (Table 4-2).

Table 4-2: Counts of birds on nests with an egg, birds on empty nests and loafers, immediately after aerial survey of Toru Islet, Snares Western Chain, 17 September 2014.

Transect	Birds on nest + egg	Birds on empty nest	Loafers
1	50	5	27
2	25	5	20
3	25	4	10
Total	100	14	57

4.3 Recapture of banded birds

A total of 67 birds banded on previous visits to Toru were recaptured (Table 4-3). These included eight known-age birds that had been banded as chicks in January 1986, and so were 28 years old. The other 59 birds recaptured had been banded as breeding adults of unknown age in 1995, and annually 2008-2010. One thousand bootstrap simulations indicated no obvious lack of fit of the general Burnham model ($P = 0.088$) with only minor over-dispersion ($\hat{c} = 1.139$). Of the 256 possible models run, only two recapture/recovery models had an AICc < 10. One thousand bootstrap simulations of the simple C-J-S model indicated no obvious lack of fit of the general Burnham model (P = 0.06) with some over-dispersion ($\hat{c}$ = 1.980).

Results indicate that the survival (*S*) of birds banded as chicks and breeding adults was not significantly different, and so the two were combined. Apparent survival of the combined group was 0.951 (SE = 0.044, confidence intervals 0.754-0.992). Probabilities of recapture, recovery and fidelity in 2014 were 0.562 (SE = 0.057), 0.029 (SE = 0.021) and 0.972 (SE = 0.451), respectively.

Table 4-3: Numbers of Salvin's albatrosses banded on Toru Islet, Snares Western Chain, 1986-2010 and recaptured September 2014.

Month/year banded	Status at banding	No. banded	No. (% total banded) recaptured 2014
Jan 1986	Chick	71	8 (11.3)
Oct 1995	Breeding adult	123	10 (8.1)
Oct 2008	Breeding adult	71	22 (31.0)
Oct 2009	Breeding adult	40	14 (35.0)
Sep 2010	Breeding adult	20	13 (65.0)
Total		325	67 (20.6)

4.4 Sightings of other albatross species

During the survey of Toru and Rima were also recorded three other albatross taxa, as follows. Chatham albatross *T. eremita* – two birds incubating and a further two birds loafing, all on Toru Islet. White-capped/Shy albatross *T. steadi/cauta* – one bird incubating on Rima Islet. Black-browed albatross *T. melanophris* – one bird displaying at an empty nest on Toru Islet.

5 Discussion

5.1 Estimate of population size by ground survey

Our estimated total of 1213 breeding pairs in September 2014 is very similar to the totals of 1195 and 1116 breeding pairs estimated during October 2008 and September-October 2009, respectively (Sagar et al. 2011). The 2008 and 2009 estimates also included failed nests (nests with fresh egg fragments), but not clean eggs out of nests which were counted in 2008 but not in 2009. If these are added, the 2008 estimate increases to 1229 breeding pairs.

The 2014 count was completed 19-20 days earlier than the 2008 count and 15 days earlier than the 2009 count. Therefore, it is necessary to consider whether laying was complete and the failure rate of incubating birds when comparing these totals. The laying dates of Salvin's albatrosses have not been reported. However, Clark (1996) reported that laying had taken place before a landing on Toru on 30 September 1995 and on Toru hatching occurred from 29 October to 19 November 1995. In comparison, Sagar (1977) reported that on 21 November 1977 there were 122 live chicks (all at the guard stage) and five unhatched eggs still being incubated on Rima. Also, Sagar et al. (2011) reported that on Toru, a chick had broken through the eggshell and could be heard peeping on 13 October 2008. The incubation period of Salvin's albatrosses is not known, but assuming that it similar to the 73 days of the shy albatross (Hedd & Gales 2005) then laying would have extended from about 18 August to 8 September. Consequently, the ground counts in 2008, 2009 and 2014 all occurred after the end of laying.

By 17 Sep 2014 an estimated 88 out of 1213 (7.25%) nests had failed. Observations from a previous study showed that over a 16-day period on Toru in 2010 the failure rate was 0.7% of nests per day (Sagar et al. 2011). Therefore, assuming that laying had occurred over the period 18 August to 8 September the 7.25% recorded in 2014 was not unusual. The cause of many nest failures appeared to be a combination of the lack of substrate with which to construct a nest and interference from birds attending the colony. Some nests were merely a veneer of mud around the perimeter, with the egg resting on bare rock. Consequently, it was all too easy for the egg to be broken or roll out if there was any disturbance from loafing birds.

5.2 Ground-truthing for aerial survey

The results of the transect counts showed that 41.5% of birds ashore were not breeding – either they were on empty nests, and so perhaps failed breeders, or were loafing in the colony. Colony attendance by non-breeding albatrosses has been studied extensively in few species. In a study of the colony attendance of various categories of non-breeding and failed breeding Buller's albatrosses on the nearby Snares Islands, Stahl & Sagar (2006) reported that during incubation about 32% of birds ashore were not breeding. Of the non-breeding birds about half were known former breeders taking a sabbatical and half were known or presumed pre-breeding birds (i.e. birds that were likely to breed in subsequent seasons). In that study only 2% of birds ashore were failed breeders, but given the number of broken eggs and eggs rolled out of nests recorded in our present study failed breeders are likely to have contributed to a larger proportion of the Salvin's albatrosses ashore, hence the greater overall proportion of birds not incubating during the aerial survey.

5.3 Recapture of banded birds

With an estimated combined survival probability in 2014 of 0.951 for birds banded either as chicks in 1986 or as adults 1995-2010, the survival rate of this population of Salvin's albatrosses remains among the highest recorded among any species of annual-breeding albatrosses. Analysis of the survival probability of this population over the period 1986-2010 resulted in estimates of 0.967 and 0.939 for adults and chicks, respectively (Sagar et al. 2011). However, by 2014 there was no significant difference in the estimated survival probability of the two groups, perhaps indicating greater site fidelity with age.

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