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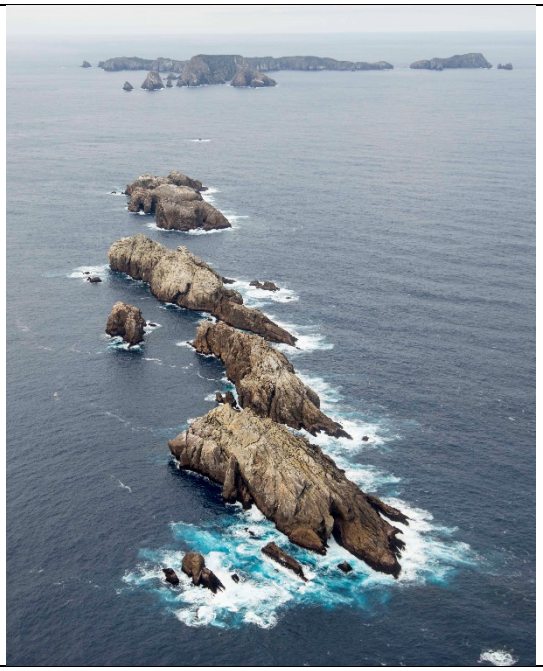
2014 Aerial survey of Salvin's albatross at The Snares, Western Chain



Final Report prepared for

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2014 Aerial survey of Salvin's albatross at The Snares, Western Chain

Final Report

Executive Summary

Salvin's albatrosses *Thalassarche salvini* is an abundant albatross species in New Zealand, breeding mainly on the Bounty Islands and the Western Chain of The Snares. The species roams widely in winter, moving eastwards across the South Pacific to the waters off the west coast of South America.

In September 2014 we completed an aerial survey of the Western Chain, The Snares, and photographed all albatross colonies we observed. Salvin's albatross was breeding on two (Rima and Toru) of the five islets in the Western Chain archipelago. The photographs were used to compile photo-montages of each colony, and these images were used to count birds on each islet. Ground counts of nesting Salvin's albatrosses were also undertaken on Toru Islet on the day that aerial photography was undertaken.

We estimated the total number of Salvin's albatrosses ashore in the Western Chain in 17 September 2014 to be 2,307 (95% CI 2,211 — 2,403. Of these, 675 (CI 623 — 727) were on Rima Islet, and 1,632 (CI 1,551 — 1,713) were on Toru Islet. Ground counts at Toru Islet showed that of 171 birds ashore, 100 (58.5%) were incubating, 14 (8.2 %) were on empty nests, and 57 (33.3 %) were loafing. 'Close up' photographs taken using a large telephoto lens to assess the proportion of breeding and loafing birds were not useful for this purpose because we were unable to determine if most of the birds visible were clearly associated with a nest. Raw counts of birds ashore were adjusted to account for the presence of loafers. This provided an estimate of 1,486 (95% CI 1,409 — 1,563) annual breeding pairs in 2014/15, which was 32% higher than the ground counts undertaken on the same day of the aerial survey.

Aerial survey proved to be an effective method of rapidly assessing the population size of Salvin's albatross in the Western Chain, The Snares. Despite the difference between the aerial and ground counts, it should not be assumed at this stage that one survey methodology is more accurate than the other, as there is potential for error using both methods.

The use of close up aerial photographs has proven useful in correcting raw counts to estimate the number of annual nesting pairs at other albatross colonies, but their utility for this purpose at the Western Chain, would appear to be limited. Ground counts indicated the proportion of loafing birds in colonies (33.3%) was high, but consistent with that observed at the Bounty Islands (25.8%) in 2013. These values exceed those previously recorded for other *Thalassarche* albatrosses during the early to mid-incubation period, but may be normal for Salvin's albatross because of the nature of their nesting sites where egg loss appears to be very high. 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

If population size (annual breeding pairs) is to be regularly estimated using aerial photography, it would appear more appropriate to use the correction factor derived by the 2014 ground count to adjust raw counts each year, noting that this correction factor will likely be dependent on the time of the breeding season that the count is undertaken. Further ground-truthing undertaken concurrently with aerial photography would be of use to refine the correction factor. Alternatively, aerial photography could be used to simply assess the number of birds ashore and use this as an index of abundance to assess population trend over time.

1. Introduction

Salvin's albatrosses *Thalassarche salvini* is an abundant albatross species present throughout the year on all continental shelf areas around New Zealand (J.A. Bartle pers. comm. in Gales 1993). The species roams widely in winter, moving eastwards across the South Pacific to the waters off the west coast of South America (Chile and Peru), where it has been observed throughout the Humboldt Current System between 7-42°S, most frequently over the continental slope (Spear et al 2003; ACAP 2009). Small numbers of non-breeding adults regularly fly across the Tasman Sea to south-east Australian waters, but it is scarce in the southern Indian Ocean (Jouventin 1990; ACAP 2009). It is only a rare vagrant to the South Atlantic, though small numbers are present in the shelf waters of South Africa (Marchant and Higgins 1990).

This species is essentially endemic to New Zealand, breeding mainly on the Bounty Islands and the Western Chain of The Snares. Other breeding sites include The Pyramid in the Chatham Islands, where two occupied nests were reported in 1995 (Croxall and Gales 1998), and Ile des Pingouins in the Crozet archipelago where four breeding pairs were recorded in 1986 (Jouventin 1990). The total breeding population was estimated to be approximately 32,000 pairs in 1998 (ACAP 2009), with 98.5% of the population concentrated on the Bounty Islands (Amey and Sagar 2013).

While there have been recent population estimates for both the major breeding locations, the population status of this species is unclear (DSEWPAC 2011), and there is conflicting evidence as to whether the population is declining or increasing. Counts completed on the Western Chain of The Snares in October each year over the period 2008-2010 ranged from 1,100 to 1,200 breeding pairs (Sagar et al 2011) but provide no indication of trend. In 2010 and 2013 Baker et al (2012, 2014) completed aerial surveys of the Bounty Islands and photographed all albatross colonies, providing the first complete population surveys of the species on the archipelago. Using correction factors to account for the presence of non-breeding birds, they estimated there were 31,786 and 39,995 annual breeding pairs in 2010 and 2013, indicating that substantially more birds (26%) were breeding in 2013. This contrasted with earlier analysis of ground counts of Salvin's albatross nests on Proclamation Island (Bounty Islands) in November 1997 (Clark et al. 1998), November 2004 (de Roy & Amey 2004) and November 2011, which showed that the numbers of breeding Salvin's albatrosses on that island declined by an estimated 30% between 1997 and 2011 (Amey and Sagar 2013). Similarly, on Depot Island there was an estimated decrease of 10% in the numbers of breeding pairs between 2004 and 2011 (Amey and Sagar 2013).

Following the recent population estimates for the Bounty Islands, in September 2014 we undertook an aerial survey of the Western Chain, The Snares, to obtain an updated population estimate for the Western Chain, The Snares, last surveyed in 2008-10. The objectives of our study were to:

1. estimate the population size of Salvin's albatross at the Western Chain, The Snares, by aerial photographic survey; and
2. analyse the findings with regard to ground truthing data collected.

2. Methods

The Site

The Western Chain (48^{o} 02'S, 166^{o} 29'E) is a small group of rocky islets about 7 km south-west of The Snares. The group consists of 5 islets which rise steeply out of deep water to heights of about 80 m a.s.l, and a number of rock stacks (Fleming & Baker 1973), all of which are largely devoid of vegetation (Miskelly et al. 2001). Sagar et al (2011) summarise the limited ornithological history of the group, much of which has been confined to day visits and a few longer stays that did not exceed 10 day in duration. Salvin's albatrosses breed on two of the five islets, Toru and Rima, of the Western Chain.

Field Work

On 17 September 2014 we chartered a helicopter from Southern Lakes Helicopters to conduct a return flight to the Bounty Islands group. The aircraft, a single-engined Squirrel AS350B3 helicopter, was piloted by Sir Richard Hayes, and carried photographer Barry Baker and DOC representatives Sharon Trainor and Kris Ramm.

Sagar et al (2014) reviewed the limited data available on the breeding phenology of Salvin's albatross at the Western Chain (Sagar 1977; Clark 1996; Sagar et al 2011) and estimated that laying at this site extends from about 18 Aug to 8 September. This flight therefore occurred during the early-mid incubation period of the albatross breeding cycle, when it was anticipated that most of the breeding pairs attempting to breed in

2014/15 would be still be attending active nests (as defined by the presence of an incubating bird). The flight was timed to coincide with the presence of a team of scientists on the Western Chain to conduct a ground count and verify the proportion of birds in the colony that were breeding, but predicted weather conditions and the need for safety dictated the selected flight date.

We selected a weather window for the operation that predicted clear flying conditions with minimal low-level cloud. Photography was timed to occur between 12.00 to 15.00 hours. Although there is little information on the behaviour of breeding Salvin's albatrosses, information from the closely-related shy *Thalassarche cauta* and white-capped albatrosses *T. steadi* suggest that at this time the ratio of incubating to loafing birds is high as most loafers are at sea during the middle of the day (B. Baker unpublished).

We left Invercargill at 12.15 hours and arrived at The Snares at 13.25 hours where we set the aircraft down to remove a door for the photography. The nominated set down point, Seal Point, was not suitable at the time because of the presence of numerous skuas *Catharacta lonnbergi*, so we landed on a north-east headland of North East Island (48.01620^{o} S, 166.59710^{o} E). On arrival the weather around The Snares was overcast but fine, with winds less than 10 knots. Conditions for photography were excellent and we were able to obtain clear photographs of all colonies during a number of photographic circuits of the two islets.

Photography of the Western Chain commenced at 1358 hrs, and we were fortunate to find that the ground survey team was present on Toru Islet at the time we arrived on site. We approached Rima first, and then proceeded to photograph Toru. Generally, we conducted at least three circuits of each islet: the first circuit to familiarise ourselves with the topography of the islet and to obtain more distant photographs that would assist in compiling photo-montages; and then two closer circuits to provide the images that were used to count the breeding birds on the islet ('survey photos'). All photographs were taken using Nikon D800 digital cameras and an image-stabilised Nikkor 70— 200mm F2.8 zoom lens or a 300 mm F2.8 telephoto lens. Shutter speeds were set at 1/1000s or faster to minimise camera shake. From the circuits of each islet we produced a complete series of overlapping images that covered the entire area of the islet where albatrosses were nesting. Additional photographs ('close-up photos') using the 300mm telephoto lens were also taken at both islets to assist in determining the proportion of non-breeding birds present in the colony.

Counts of photo montages were undertaken by one observer only. Previously we have undertaken multiple counts of photomontages from Auckland Island censuses to estimate counter variability associated with miscounting and misidentifying white spots on the ground as birds (Baker et al. 2014). These count data were statistically modelled by Poisson regression, a special case of a Generalised Linear Model (McCullagh and Nelder, 1989), with observer and area as fixed effects. After allowing for both mean observer and mean area differences, there was no evidence to suggest that our model and data were incompatible, based upon regression diagnostics and model checking. There was also no evidence of a difference between observers and hence an observer bias. We have no reason to believe that data collected from the Western Chain should have different distributional properties to our Auckland Island data and so we assume the current data are also compatible with a Poisson model. Thus we present raw counts only and assume the deviation is estimated as the square root of the count, a property of the Poisson model. The estimated confidence intervals represent counter variability only, and do not take into account other sources of counting error.

Close up photos were analysed and every bird categorised as follows:

- Bird on nest
- Bird possibly on nest i.e. crouched on rock substrate but no visible nesting material
- Bird clearly not associated with a nest i.e. standing
- Breeding status uncertain i.e. bird partially hidden from view
- Abandoned or broken egg

A total of approximately 754 digital photographs were taken during the survey flight. All photographs of colonies were taken as raw images and subsequently saved as fine JPG format files. The survey photographs were taken at an altitude of about 900 feet initially, and later 700 feet, with most photographs taken with the zoom lens set at a focal length of between 70 to 130mm. The close-ups were taken with the 300mm telephoto lens at an altitude of 700 feet. The full flight path and altitudes were recorded using a GPS receiver and have been downloaded and archived along with the photographs. The entire set of photographs were subsequently replicated to ensure that four complete back-up sets existed both on hard drives and in at least three different locations. A full collection of photographs and details of the flight path will also be submitted to NIWA and the Department of Conservation on the completion of the contract.

The survey of all the albatross colonies was completed by 14.47 hours and we then returned to North East Island to put the door on the helicopter, before departing for Invercargill. Total flight time Te Anau-Snares-return was 4.4 hours.

Ground counts

Ground counts of nesting Salvin's albatrosses were undertaken on Toru Islet on 17 September 2014, the day that aerial photography was undertaken, to determine the proportions of nests containing eggs and non-breeding birds present in the colony. A total count of all birds ashore was also undertaken (Sagar et al 2014). Whilst the aerial survey was underway the ground crew waited in an area away from breeding birds in order to avoid disturbing birds. Immediately after the aerial survey of Toru Islet was completed, the ground-truthing exercise was undertaken. This involved walking 2-m 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). The ground-truthing exercise was terminated when 100 active nests with eggs had been located (Sagar et al 2014).

3. Results

Salvin's albatross was breeding on two (Rima and Toru) of the five islets in the Western Chain, and birds were not located on the other three islets in the archipelago. We were able to obtain clear photographs of both colonies during a number of photographic circuits of the two islets. The topography of the islet was such that stitching of photographs along ridgelines required great care to ensure no overlap of nesting birds occurred. This was best achieved by allowing the distribution of birds, in the absence of clear landmarks, to indicate appropriate stitch lines and thus avoid double-counting or missing birds.

We estimated the total number of Salvin's albatrosses ashore in the Western Chain in 17 September 2014 to be 2,307 (95% CI 2,211 — 2,403) (Table 1), including 89 birds assessed as being the partners of birds assumed to be nesting. Of these, 675 (CI 623 — 727) were on Rima Islet, and 1,632 (CI 1,551 — 1,713) were on Toru Islet. The Toru Islet count includes a total of 40 birds ashore on an adjacent rock stack.

The ground counts of Salvin's albatross at Toru Islet 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 2; Sagar et al 2014).

Although the close up photographs were clear and provided sharp images of birds ashore, we were unable to determine from an analysis if most of the birds visible in the photographs were clearly associated with a nest. The bare nature of the site means that many birds are unable to construct substantial nest pedestals typical of many albatross colonies elsewhere. As a result, from aerial photographs it was not possible in many cases to determine if birds were sitting on nests or simply resting on rocks (Table 3). For both islets, of 714 birds ashore only 16% of all birds were clearly associated with a nest, while another 23% were obviously loafing. Breeding status of the remaining 61% of birds ashore was unknown – many birds were sitting on rock substrate, but no nest was visible and therefore association with a nest could not be assumed. A total of 12 abandoned eggs were also visible, which is far fewer than the number recorded by the field team. If the categories where only breeding status was clear (i.e. on nest, incubating; and loafers; less partner of incubating bird, or pair) are analysed, 46% of all birds were associated with a nest, and the remaining 66% were assessed as loafers. The proportions of birds assessed as loafing through the use of close up photographs greatly exceeded that derived from ground counts (66% v 33.3%).

Estimated annual counts for all breeding sites in the Western Chain, The Snares, were adjusted to account for the presence of non-breeding birds (Table 1), using the proportion of loafing (non-breeding) birds as a correction factor. This provided an estimate of 1,486 (95% CI 1,409 — 1,563) (Table 1) annual breeding pairs in 2014/15, which was 32% higher than the ground count before adjustment to account for broken eggs (Sagar et al 2014).. If the comparison is made between the aerial estimate and the ground count estimate, adjusted to include the 88 broken eggs, the difference is 23%.

Table 1. Raw counts and estimated annual breeding pairs of Salvin's albatrosses in the Western Chain, The Snares in September 2014, following adjustment to account for the proportion of breeding birds seen in ground counts. The ground count estimate shown does not include an adjustment to account for 88 broken eggs detected in the colony (see Sagar et al 2014).

Islet	Raw Count (including. partners)	Raw Count (excluding partners)	Correction factor	Annual breeding pairs	
				Aerial count	Ground count
Rima	**675**	**638**	**0.33**	**427**	**301**
Toru I	**1,632**	**1,580**	**0.33**	**1,059**	**824**
Total Western Chain	**2,307**	**2,218**	**0.33**	**1,486**	**1,125**
SE	**48.03**	**47.6**		**38.6**	

Table 2: Ground counts of Salvin's albatross at Toru Islet showing nesting status of birds encountered along 2m width transects. Counts were taken immediately after aerial survey of Toru Islet was completed. Data from Table 4-2 in Sagar et al (2014).

Transect #	Bird on nest with egg	Bird on empty nest	Loafers	Total birds
1	50	5	27	83
2	25	5	20	50
3	25	4	10	39
Total	**100**	**14**	**57**	**171**
Proportions	**0.59**	**0.08**	**0.33**	

4. Discussion

Aerial survey of the Western Chain, The Snares, proved to be an effective method of rapidly assessing the population size of Salvin's albatross in the Western Chain, although our population estimate of 1,486 (95% CI 1,409 — 1,563) annual breeding pairs in 2014/15 was 32% higher than the total ground count of breeding birds. At this stage it should not be assumed that one survey methodology is more accurate than the other employed during this study. The difference may be due to double counting birds on aerial photographs, although we remain confident that this did not occur, even though stitching of ridgelines required great care. Alternatively, the ground counts may have missed groups of birds that were more readily observed from the air, as has been found in some other studies where site topography is rough (Robertson et al 2007; G. Robertson unpublished), and for which there was some evidence in this case. For example, we note that ground counts of a rock stack adjacent to Toru Islet estimated 13 pairs were nesting (Sagar et al 2014), whereas the aerial photography estimate was 27 nesting pairs, derived from a total of 40 birds ashore. However, the field team are confident that they got to all breeding sites on Toru and Rima (Paul Sagar, unpublished data). They covered the ground thoroughly, climbing down to some hard-of-access nests on Rima Islet, in particular, and counted some nests (c. 50) that were in caves and probably not visible from the air. It is also possible the transects used in the ground-truthing exercise were not completely representative of both

islets as a whole, and that groups of non-breeding birds were present and counted in the aerial survey, but ignored in the ground count of nesting birds.

Not all the birds counted were nesting, and we were fortunate in having a field team on Toru Islet at the time of the 2014 flight to provide ground counts of the proportions of nesting and loafing birds. Ground counts indicated the proportion of loafing birds in colonies (33.3%) was high, but consistent with that observed at the Bounty Islands (25.8%) in 2013 (Baker et al, 2014). These values exceed those previously recorded for other *Thalassarche* albatrosses, which typically do not exceed 10-12% during the early to mid-incubation period (Robertson et al 2007; Baker et al 2014), but may be normal for Salvin's albatross because of the nature of their nesting sites where egg loss appears to be very high. Sagar et al (2014) estimated that by the time of the 2014 survey an estimated 7.25% of nests on the Western Chain had failed, and that over a 16-day period in 2010 the failure rate was 0.7% of nests per day (Sagar et al. 2011, 2014). 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. Sagar et al (2014) noted that some nests were merely a veneer of mud around the perimeter, with the egg resting on bare rock, thus providing little protection to prevent eggs to be broken or roll out of the nest. Observations on Albatross Island, Australia, indicate the importance of nest site quality to hatching success in the shy albatross (Rachael Alderman, unpublished data). At this site a range of high and low quality nesting sites are available. In rocky sites with minimal substrate, egg loss is high, and birds that have lost an egg have been observed to still occupy their nest site for some time after. It is possible that the high number of loafing birds on both the Bounty Islands and the Western Chain may include a large number of breeding birds that have nested and failed, but still attend nesting sites to retain occupancy rights for future years.

The use of close up aerial photographs has proven useful in correcting raw counts to estimate the number of annual nesting pairs at other albatross colonies (Baker et al 2014). However, their utility for this purpose at the Western Chain, would appear to be limited because of the nature of the site. If population size (annual breeding pairs) is to be regularly estimated using aerial photography, it would appear more appropriate to use the correction factor derived by the 2014 ground count (Sagar et al 2014) to adjust raw counts each year, noting that this correction factor will likely be dependent on the time of the breeding season that the count is undertaken. Further ground-truthing undertaken concurrently with aerial photography would be of use to refine the correction factor. Alternatively, aerial photography could be used to simply assess the number of birds ashore, and use this as an index of abundance to assess population trend over time.

Acknowledgements

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Table 3. **Counts of 16 randomly selected close-up photographs taken at the Rima and Toru Islet colonies, The Snares, Western Chain, October 2014.**

Islet	Photo	On nest - Incubating birds	Possibly on nest	Not sure	Loafers - clearly not on nest	Partner of incubating bird (pair)	Abandoned eggs	Total Birds Ashore	Total birds - breeding status 'known'
Rima Islet		**42**	**166**	**43**	**75**	**6**	**2**	**332**	**111**
Proportion - breeding status known		**0.38**			**0.68**				
Proportion - all birds ashore		**0.13**			**0.23**				
Tori Islet		**73**	**169**	**27**	**90**	**23**	**10**	**382**	**140**
Proportion - breeding status known		**0.52**			**0.64**				
Proportion - all birds ashore		**0.19**			**0.24**				
Total		**115**	**335**	**70**	**165**	**29**	**12**	**714**	**251**
Proportion - breeding status known		**0.46**			**0.66**				
Proportion - all birds ashore		**0.16**			**0.23**				

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