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2013 Aerial survey of Salvin's albatross at the Bounty Islands

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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).

The population status of this species is poorly known (DEWHA 2009). Counts completed on The Snares in October each year over the period 2008-2010 ranged from 1,100 to 1,200 breeding pairs (Sagar et al 2011). In 1978, Robertson and van Tets (1982) estimated there were 76,000 pairs in the Bounty Group (Taylor 2000) based on nest densities and the area occupied on each island. 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 showed that the numbers of breeding Salvin's Albatrosses 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).

In 2010 Baker et al (2012) completed an aerial survey of the Bounty Islands and photographed all albatross colonies. They estimated the total count of nesting Salvin's albatrosses to be 41,101 (95% CI 40,696 — 41,506), but were unable to determine if most of the birds visible in photographs were clearly associated with a nest because of the terrain in which birds were nesting. This study represented the first complete population survey of Salvin's albatross on the Bounty Islands.

We have now been contracted by the Department of Conservation to conduct another aerial survey of the Bounty Islands. The objectives of our study are to:

1. estimate the population size of Salvin's albatross at the Bounty Islands.
2. estimate population trend in relation to previous aerial surveys and ground counts of Salvin's albatross at the Bounty Islands.

2. Methods

The Site

The Bounty Islands (47^0 44'S, 179^0 02'E) are a group of bare rocky islands situated 659 km south-east of New Zealand's South Island. They are the smallest island group in the New Zealand sub-Antarctic, and cover only 135 ha in total area. The entire group spans about 4.5 km from east to west, and three km from north to south. The archipelago consists of 22 small islets in three groups (West, Centre and East Groups: Figure 1). All the islands are of coarse biotite granite, with some finer-grained variations, and are the eroded remnants of a ridge of buckled and uplifted basement rock (Taylor 2006). Within the archipelago, Salvin's albatross reportedly breed on ten Islands – Proclamation, Tunnel, Depot, Ruatara, Penguin, Ranfurly, Lion and Spider Islands in the West Group; Funnel Island in the Centre Group; and Molly Cap in the East Group (Tickell 2000). However, Baker et al (2012) did not find birds nesting on Ranfurly and Lion Islands. Most of the albatross colonies are

mixed colonies and contain extensive numbers of erect-crested penguins *Eudyptes sclateri* (Robertson and van Tets 1982).

Field Work

On 23 October 2013 we chartered a fixed-wing aircraft from the New Zealand Flying Doctor Service to conduct a return flight to the Bounty Islands group. The aircraft, a twin turboprop Cesna Conquest II, was piloted by Andrew Currie and Dion Currie, and carried photographer Barry Baker.

The flight was conducted in early October to coincide with the mid-incubation period of the albatross breeding cycle and the presence of a team of scientists on the Bounty Islands. At this time it was anticipated that birds would have completed egg laying and that most of birds that attempted to breed in 2013/14 would still be attending active nests.

We selected a weather window for the operation that predicted clear flying conditions with minimal low-level cloud. Photography was timed to occur between 11.00 to 14.00 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* indicates 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 Christchurch at 10.45 hours and arrived at the Bounty Islands at 12.13 hours. On arrival the weather around the Bounty Islands was fine and clear, with south-westerly winds blowing 20-25 knots on the water and at 30-40 knots at our flight height of 1,000 feet. Conditions for photography were excellent and we were able to obtain clear photographs of most colonies at least once during a number of photographic circuits of the various islands, although the speed of the aircraft combined with the wind speed at flight height and photographic access restricted to a small open window posed some technical difficulties (refer below).

We approached Molly Cap first, and then proceeded to photograph each island systematically until all known albatross sites were photographed. While we had hoped to photograph all islands and stacks in the Bounty Group, irrespective of whether or not albatrosses were known to nest on them, our time in the air over the Bounty Islands was limited to a maximum of 75 minutes because of fuel constraints, and it was not possible to achieve this. All photographs were taken through a small window located on the starboard side near the co-pilots seat and which could be opened. This was not ideal as the position of the window restricted photographic access, but was adequate. When coupled with a minimum aircraft speed of 150-160 knots (aircraft speed 120 knots plus wind speed 40 knots) and the close proximity of some of the islands to each other, it was difficult to be sure at the time that all colonies had complete photographic coverage before we ran out of air time over the islands. However, subsequent analysis of the photographs showed that coverage was complete.

Generally, we conducted at least three circuits of each island: the first circuit to familiarise ourselves with the island topography 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 island. All photographs were taken using Nikon D800 digital cameras and an image-stabilised Nikkor 70— 200mm F2.8 zoom lens. Shutter speeds were set at 1/1000s or faster to minimise camera shake. From the circuits of each island we produced a complete series of overlapping images that covered the entire area of the island where albatrosses were nesting. Additional photographs using maximum photo-extension (200mm) were also taken at some islands to assist in determining the proportion of albatrosses to penguins in mixed-species colonies, and to provide information on the number 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. 2011). 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 Bounty Islands 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.

A total of approximately 498 digital photographs were taken during the survey flight. All photographs of colonies taken as raw images and subsequently saved as fine JPG format files. The survey photographs were taken at an altitude of about 350 metres, 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 zoom lens set at 200mm. 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 DVDs or 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 13.45 hours and we then departed the Bounty Islands, arriving back at Christchurch airport at 15.26 hours.

Ground counts

Ground counts of nesting Salvin's albatrosses were undertaken on Proclamation Island on 23 October 2013, the day that aerial photography was undertaken, to determine the proportions of nests containing eggs and non-breeding birds present in the colony. Two transects were marked out using stock marker and then walked, counting nests with eggs 1 m either side of the lines; a walking pole was used to measure off the 1 m. As each transect was walked all nests located with eggs were spot marked, together with any empty (non-egg) nests. Subsequently, repeated counts of each of the transects were conducted at two-hourly intervals, and the number of nests with eggs, empty nests with bird on, and loafing birds (birds not associated with a nest plus birds sitting beside another at a nest) were recorded. The length of each transect was determined by the density of nesting birds, with both transects terminated when 100 active nests with eggs had been located. Counts along each transect were undertaken by one observer at 1000, 1200, 1400 and 1600 hours.

3. Results

We estimated the total count of Salvin's albatrosses in the Bounty Islands in October 2013 to be 53,893 (95% CI 53,429 — 54,357) (Table 1).

We were unable to determine from an analysis of close-up photographs 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, it was not possible in many cases to determine if birds were sitting on nests or simply resting on rocks from aerial photographs.

The ground counts of Salvin's albatross at Proclamation Island indicated that the mean proportion of breeding birds in the colony between 1000 to 1600 hours was 0.74 (range 0.71 — 0.77; Table 2). The mean proportion of occupied nests that contained eggs over the same period was 0.90 (range 0.88 — 0.91). Subjective observations indicated that very few albatrosses were arriving and departing from the colony during the period 09.00 to 15.00, with the numbers of birds in the air over the islands increasing from 15.05 with a constant stream of birds landing until dark.

Estimated annual counts for all breeding sites in the Bounty Islands were adjusted to account for the presence of non-breeding birds (Table 2), giving an estimate of the annual breeding pairs in 2013 of 39,995 (95% CI 39,595 — 40,395) (Table 1). For purposes of comparison, we applied the same correction factor to 2010 counts as well, as we have no other basis for determining the proportion of non-breeding birds present in the colony at the time of the 2010 counts. These adjusted figures for 2010 (31,786 annual breeding pairs, 95% CI 31,430 — 32,143) indicate that substantially more birds (26%) were breeding in 2013 (Table 1).

Table 1. Raw counts and estimated annual breeding pairs of Salvin's albatrosses in the Bounty Islands in October 2010 and October 2013, following adjustment to account for the proportion of breeding birds seen in ground counts in October 2013. We have assumed that the proportion of breeding birds in 2010 was similar to that observed in 2010.

Island	Raw Count 2010	Annual breeding pairs 2010	Raw Count 2013	Annual breeding pairs 2013
Molly Cap	3,361	2,494	4,390	3,258
Funnel Island	5,159	3,829	6,983	5,182
Castle Island	0	0	0	0
Spider Island	3,750	2,783	4,644	3,446
Ranfurly Island	0	0	0	0
Lion Island	0	0	0	0
Depot Island	17,862	13,256	18,510	13,737
Penguin Island	2,203	1,635	1,407	1,044
Ruatara Island	5,313	3,943	6,754	5,012
Tunnel Island	2,333	1,731	4,629	3,435
Proclamation Is	2,851	2,116	6,576	4,880
Total Bounty Islands	42,832	31,786	53,893	39,995
SE	207.0	232.2	178.3	200.0

Table 2: Ground counts of Salvin's albatross at Proclamation Island showing nesting status of birds encountered along 2m width transects.

Time	Transect #	Nest with eggs	Empty nests with bird on	Loafers	Total birds	Proportion birds breeding
10.00	1	100	10	28	138	0.72
	2	100	11	19	130	0.77
12.00	1	100	10	27	137	0.73
	2	100	14	19	133	0.75
14.00	1	100	11	29	140	0.71
	2	100	12	20	132	0.76
16.00	1	100	11	27	138	0.72
	2	100	11	19	130	0.77

4. Discussion

Comparison of Annual Photographic Counts

Aerial survey of the Bounty Islands proved to be an effective method of rapidly assessing the population size of Salvin's albatross in the Bounty Islands, and our population estimates of 31,786 (95% CI 31,430 - 32,143) and 39,995 (95% CI 39,595 - 40,395) annual breeding pairs in October 2010 and 2013, respectively, represent the first complete population surveys of the species on the archipelago. Our photo coverage of all colonies was generally high and we are confident we missed very few birds. Areas where our coverage was incomplete in 2010 were on Molly Cap, Tunnel, Proclamation and Penguin Islands, and details of this are provided in our earlier report (Baker et al 2011). These difficulties would have biased the counts overall, but we conservatively estimate the accuracy of our counts would be within 1,000 pairs of the true figure, and would certainly have not been responsible for the substantially larger estimate for 2013.

Not all the birds counted were nesting, and we were fortunate in having a field team on Proclamation Island at the time of the 2013 flight to provide ground counts of the proportions of nesting and loafing birds. This provided a correction factor that accounts for birds 'loafing' in colonies and birds sitting on nests without an egg. The proportion of loafing birds in the colonies (25.8%) is high, but this may be normal at this stage (mid-incubation period) of the albatross breeding cycle. Robertson et al (2007b) estimated that nearly 12% of black-browed (*Thalassarche melanophyris*) and grey-headed (*Thalassarche chrysostoma*) albatrosses attending a colony were loafers during the early incubation period. Baker et al (2013) found that few non-breeding birds are generally present in white-capped albatross (*Thalassarche steadi)* colonies during ground counts in the early incubation period. From 84 observations, ≤ 2% of birds present were non-breeders on 86% of observations, and ≤ 5% on 97% of the total observations. The maximum number of non-breeders present at any one time was 10%. Analysis of close-up photography taken over seven years in the same study showed that the proportion of non-breeders in the early incubation period ranged from 3-4%, but was higher during mid-incubation (three-year mean 17%, range 10-24%). Laying dates of salvin's albatrosses at the Bounty islands are not known, but in 1997 the mean hatching date of 48 eggs was 14 November (Clark et al 1998). Therefore, assuming a similar incubation period to the closely related shy albatross (*Thalassarche cauta*) of 73 days (Hedd and Gales 2005), the mean laying period of Salvin's albatrosses at the Bounty Islands would be early-mid September. Consequently, the timing of our aerial survey would be mid-incubation, when the proportion of loafers ashore was higher than that expected earlier in the incubation period.

If population size is to be regularly estimated using aerial photography, it will be necessary to adjust raw counts each year, noting that an appropriate correction factor may be dependent on the time of the breeding season that the count is undertaken.

Trend analysis

Previous attempts to estimate the size of the Salvin's albatross population in the Bounty Islands have relied on using density estimates from one island and extrapolating to all known occupied islands in the Bounty Group (Robertson and van Tets 1982; Booth and Amey, in Taylor 2000). 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 showed that the numbers of breeding Salvin's Albatrosses 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).

Because the methods used by these authors differed greatly from those used in this study, and counts were undertaken at different times of the year, we do not consider it appropriate to draw conclusions about population changes by combining all data sets. Instead, we recommend that analysis of population trend be based on future aerial surveys of all breeding sites in the Bounty Islands, using this study as a baseline. Seabird count data for long-lived species typically exhibits strong inter-annual fluctuations (e.g. Baker and Holdsworth 2013), and which encompasses counting error, the presence of non-breeding birds during counts, environmental stochasticity and other unknown variables that are not easily quantified. To reduce the effect of these variables on population estimates we recommend standardising survey techniques and timing of surveys, which should allow inferences about long-term trends to be made in time (a further three to five years). This information should then provide a statistical basis for making decisions pertaining to management of these populations.

Operational considerations relevant to aerial survey

Helicopters remain our preferred platform for aerial photography of albatross colonies, but the distance between New Zealand and the Bounty Islands currently precludes their use unless ship-based access is possible. There is no conveniently located fuel available near the Bounty Islands, and fixed wing aircraft are the only viable option at present. Aerial survey of the Bounty Islands was feasible using fixed wing aircraft but the aircraft used in this study is not ideal, because it is difficult to keep air speed below 120 knots. It is also difficult to obtain accurate weather conditions on the Bounty Islands immediately pre-flight unless fishing or other vessels in the vicinity can be contacted. Nonetheless, the Cesna Conquest II aircraft remains the most cost-effective form of aerial platform for photography of the Bounty Islands at this stage, and we believe it is possible to reliably take photographs suitable for the purpose of counting large surface-nesting seabirds such as albatross and penguins.

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References

Agreement on the Conservation of Albatrosses and Petrels. 2009. Species assessments: Salvin's Albatross. Downloaded from http://www.acap.aq on 1 May 2011.

Amey, J. and Sagar, P. 2013. Salvin's albatross population trend at the Bounty Islands,1997-2011. Report to Department of Conservation. National Institute of Water & Atmospheric Research, Christchurch.

Baker, G. B., Jensz, K., Cunningham, R. 2013. White-capped albatross population estimate — 2011/12 and 2012/13. Final research report by Latitude 42 for the Department of Conservation, Wellington. Available for download at http://www.doc.govt.nz/conservation/marine-and-coastal/conservation-services-programme/csp-reports/white-capped-albatross-population-estimate-2013/.

Baker, G.B. and Holdsworth, M. 2013. Seabird monitoring study at Coringa Herald National Nature Reserve 2012. Report prepared for Department of the Sustainability, Environment, Water, Populations and Communities. Latitude 42 Environmental Consultants Pty Ltd, Kettering. (www.latitude42.com.au).

Baker, G.B., Jensz, K., Sagar, P. 2012. Data collection of demographic, distributional and trophic information on Salvin's Albatrosses to allow estimates of the effects of fisheries on population viability. Report prepared for Ministry of Fisheries PRO2006-01E. Ministry of fisheries, Wellington.

Clark, G., Booth, A. and Amey, J. 1998. *The 'Totorore' expedition to the Bounty Islands New Zealand October 1997 to January 1998*. Unpublished report to the Department of Conservation, Invercargill.

Croxall, J.P. and Gales, R.P. 1998. An assessment of the conservation status of albatrosses. Pp. 46–65 in *Albatross: Biology and Conservation*. Robertson, G. and Gales, R. (eds.). Surrey Beatty and Sons, Chipping Norton.

de Roy, T. and Amey, J. 2004. *Mahalia Bounties/Antipodes Expedition November 2004*. Unpublished report.

Gales, R. 1993. *Co-operative Mechanisms for the Conservation of Albatrosses*. ANCA, Hobart.

Hedd, A.; Gales, R. 2005. Breeding and overwintering ecology of shy albatrosses in southern Australia: year-round patterns of colony attendance and foraging-trip duration. Condor 107: 375-387.

Jouventin, P. 1990. Shy albatrosses *Diomedea cauta salvini* breeding on Penguin Island, Crozet Archipelago, Indian Ocean. Ibis 132: 126.

McCullagh, P. and Nelder, J.A. 1989. Generalised Linear Models, Second Edition. Chapman and Hall, London.Marchant, S. and Higgins P.J. 1990. *Handbook of Australian, New Zealand and Antarctic Birds Vol. 1*. Oxford University Press, Australia.

Robertson, C.J.R., van Tets, G.F. 1982. The status of birds at the Bounty Islands. Notornis, 29: 311-336.

Robertson, R., Lawton, K., Moreno, C., Kirkwood, R. and Valencia, J. 2007a. Comparison of census methods for black-browed albatrosses breeding at the Ildefonso Archipelago, Chile. Polar Biology DOI 10.1007/s00300-007-0342-7

Robertson, R., Moreno, C., Lawton, K., Arata, J., Valencia, J., Kirkwood, R. 2007b. An estimate of the population sizes of Black-browed (*Thalassarche melanophrys*) and Grey-headed (*T. chrysostoma*) Albatrosses breeding in the Diego Ramírez Archipelago, Chile. Emu 107, 239-244.

Sagar, P.M., Charteris, M.R. and Carroll, J.W.A. 2011. Population size, breeding frequency and survival of Salvin's albatrosses (*Thalassarche salvini*) at the Western Chain, The Snares, New Zealand. Notornis 58, 57-63.

Taylor, G.A. 2000. Action plan for seabird conservation in New Zealand. Part A: Threatened Seabirds. Threatened Species. Occasional Publication No.16. Department of Conservation, Wellington.

Taylor, R.H. 2006. *Straight through from London. The Antipodes and Bounty Islands, New Zealand.* Heritage Expeditions New Zealand Ltd, Christchurch.

Tickell, W. L. N. 2000. Albatrosses. Pica, Sussex

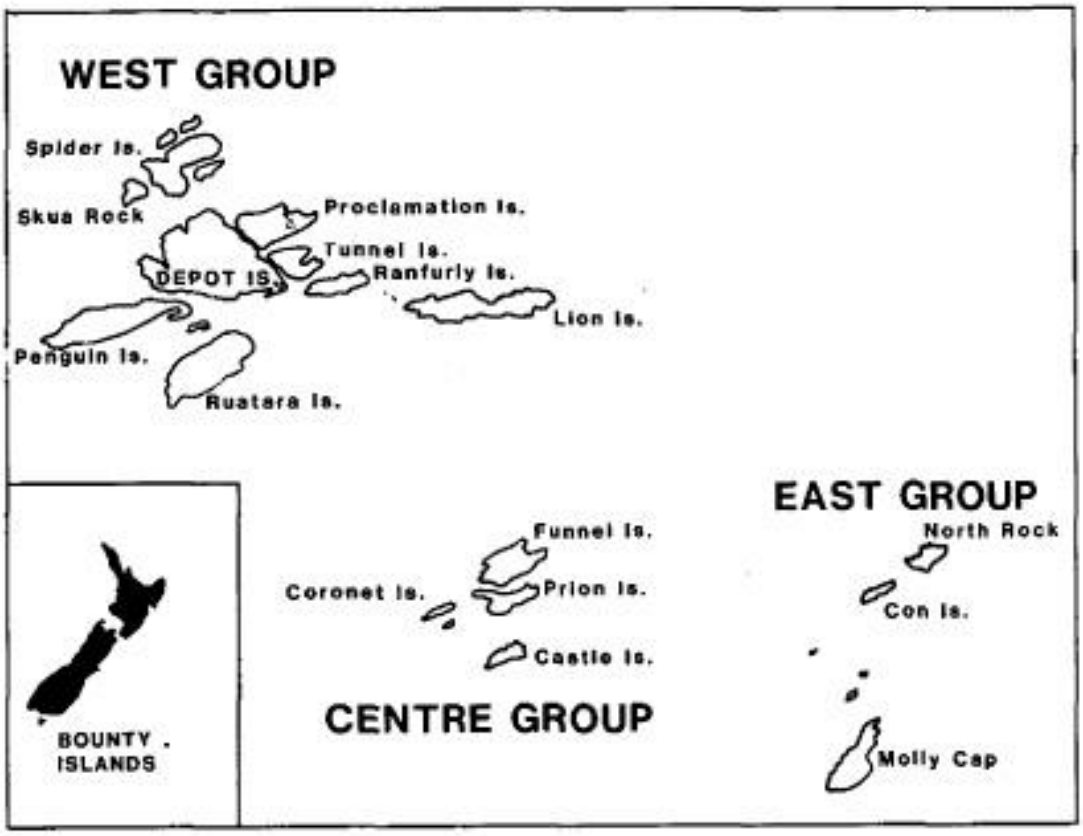

Figure 1. Map showing the Bounty Islands and their location relative to New Zealand (from Robertson and van Tets 1982). Salvin's albatross nest on Molly Cap, Funnel, Spider, Depot, Proclamation, Tunnel, Ruatara and Penguin Islands.