Albatross Research

Gibson’s wandering albatross census and population study 2015/16

Report on CSP Project 4655, prepared for

Department of Conservation

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1. EXECUTIVE SUMMARY

This report presents data on the size of the Gibson's wandering albatross nesting population in 2016, and the key demographic parameters of survival, productivity and recruitment which help identify causes of current population size and trends.

Demographic data was collected from birds nesting and visiting a 61 ha study area on the southern slopes of Adams Island. There has been an improvement in female survival and nesting success. However, survival, productivity and recruitment are all still well below the levels recorded before the 2005 population crash.

The number of nesting birds in three areas representative of high, medium and low density breeding sites which comprise about 10% of the population and which have been counted annually since 1998 were re-counted. The numbers of birds nesting in 2016 was the highest it has been since the 2005 population crash, probably partly because breeding success in 2015 was low.

A census of nesting pairs was also made in the Astrolabe Basin, a large area which together with the study area and one of the regular census blocks supports nearly a quarter of the species population and which was last counted in 2000. The actual number of birds nesting in the wider Astrolabe area was about 8% higher than that estimated using the proportionate change in the annually counted blocks since the last whole-island census. This total probably does not reflect a real increase in numbers but rather more accurate count techniques, and the application of correction factors to daily census totals for late egg laying and early nest failure. There were estimated to be 5,817 pairs of Gibson's albatross breeding in 2016 compared to 5,527 pairs in the very low 2000 breeding season and 7,857 pairs in 1997.

Demographic population data is essential for accurate interpretation of census data, and modelling of the whole population is required for estimation of total population size.

2. INTRODUCTION

Gibson's wandering albatrosses (*Diomedea gibsoni*) are endemic to the Auckland Island archipelago, with approximately 95% of the population breeding on Adams Island, the southern-most island in the group. They forage largely in the Tasman Sea, but also along the continental shelf off southern and south eastern Australia, and off eastern New Zealand (Walker & Elliott 2006). The population has been in decline, and is listed as 'Nationally Critical' in the Department of Conservation's threat ranking (Robertson et al. 2012).

Due to the vulnerability of this long-lived, slow-breeding albatross to accidental capture in commercial surface long-line fisheries, their survival, productivity, recruitment and population trends have been monitored during almost annual visits to Adams Island since 1991. In the 1990's the population slowly increased following a major, presumably fisheries-induced, decline during the 1980's (Walker & Elliott 1999). However, between 2005 and 2008 there was a sudden drop of more than 40% in the size of the breeding population, from which recovery has been very slow. The Gibson's wandering albatross population is still only about two-thirds of its estimated size in 2004, having lost the gains slowly made through the 1990's.

In 2015/16 Albatross Research was contracted by the Conservation Services Programme (CSP) of the Department of Conservation to collect information on the size and trend of the Gibson's wandering albatross population by ground counting nests in a substantial proportion of Adams Island, and to collect those population parameters (survival, productivity and recruitment) key to modelling and understanding the species conservation status.

3. OBJECTIVES

The specific objectives of this project were:

1. To estimate the adult survival, productivity and recruitment of Gibson's wandering albatross.

2. To conduct an extended ground count of the wider Astrolabe Basin;

3. To establish a robust census methodology using GPS marking to allow future comparative ground counts;

4. To estimate the population size of Gibson's wandering albatross.

4. METHODS

Mark-recapture study

Each year since 1991 a 61 ha study area on Adams Island (Figure 1) has been visited repeatedly to band nesting birds and record the band numbers of already banded birds. In addition, areas within a kilometre of the study area are visited less frequently and any bands seen on nesting or non-nesting birds are recorded. All birds found nesting within the study area have been double-banded with individually numbered metal and large coloured plastic bands, and since 1995, most chicks of every cohort have also been banded. The proportion of chicks that are banded each year depends on the timing of the research field trips which in turn is dependant on the availability of transport. In 16 of the last 21 years researchers have arrived at, or soon after, the time at which the first chicks fledge and more than 90% of the chicks were still present and were banded. In the other five years researchers arrived late and as many as 45% of the chicks had already fledged and were not banded.

Survival of birds in the study area is estimated with maximum likelihood mark-recapture statistical methods using the statistical software M-Surge (Choquet *et al.* 2005). For the models used in M-Surge, adult birds are categorised by sex and by breeding status: non-breeders, successful breeders, failed breeders and sabbatical birds taking a year off after a successful breeding attempt. Birds in each of these classes have very different probabilities of being seen on the island but similar survival rates, so the models estimate re-sighting probabilities separately for each class, but survival is estimated separately for only males and females.

Population size is estimated by multiplying the actual counts of birds in each class by its estimated re-sighting probability. The survival estimates assume no emigration which is appropriate because wandering albatrosses have strong nest site fidelity, a pair's separate nesting attempts are rarely more than a few hundred metres apart, and birds nesting at new sites within a few hundred metres of the study area are detected during the census of surrounding country (Walker & Elliott 2005).

Counting nests in 3 representative blocks

Since 1998, all the nests in three areas (Figure 1) have been counted each year. The three areas support about 10% of the Adams Island albatross breeding population and represent high (Fly Square), medium (Astrolabe to Amherst including the mark-recapture study area) and low (Rhys's Ridge) density nesting habitat.

Figure 1: Adams Island, showing the Study Area (61 ha, black) and four other areas in which counts of breeders were made (shaded): Astrolabe (351 ha), A to A (101 ha) Rhys's Ridge (67 ha), and Fly Square (25 ha).

Counts are carried out between 24 January - 5 February just after the completion of laying, and as close as possible to the same time at each place in each year. A strip search method is used where two observers walk back and forth across the area to be counted, each within a strip about 25 m wide and displayed on a GPS map, and count all the nests with eggs in their strip. Every bird on a nest is checked for the presence of an egg, and each nest found with an egg is marked with spray paint and counted. All non-breeding birds on the ground are also counted, and they and most breeding birds on eggs are checked for bands, the number and location of which are recorded. Once the whole block has been counted, the accuracy of the census is checked by walking straight transects at right angles to the strips, checking all nests within 10-15 m of the transect for paint marks indicating the nest has been counted.

Counting nests in the wider Astrolabe Basin

Nests in the Astrolabe Basin, west of the Study Area to Astrolabe census block (Figure 1), were counted between 1-9 February 2016 using the modern census technique described above.

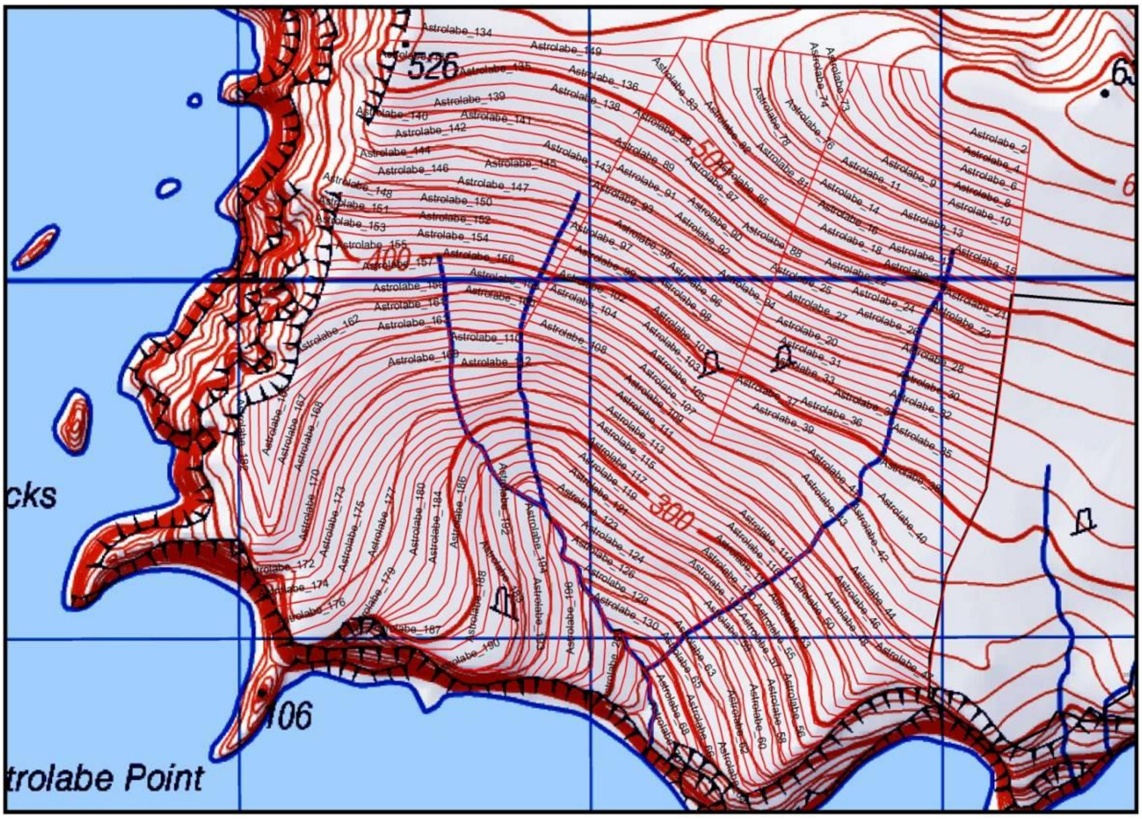

Figure 2: The Astrolabe Basin on the south western slopes of Adams Island. Red vertical lines show the count block boundaries and numbered lines around the contours show the area between each set of lines which each individual counter must check for nests.

Improvements in GPS technology now make it possible to stop then re-start counts at exactly the same site days later in featureless country. As a result, due to its very large size, Astrolabe Basin was divided into 9 blocks, each taking about a day for 2 people to count, each containing some easier as well as some harder vegetation to traverse, and each small enough that there was limited change in aspect and slope as such changes make it harder to ensure all the ground is covered efficiently. In each block numbered lines ~25 m apart were drawn as close as possible to the contour of the land,

and these were imposed onto the topographical map on each observer's GPS. The Astrolabe Basin count area, sub-block locations and individual sweep lines are shown in Figure 2.

Calibration of ground and aerial counts

The number of nests in the study area which contained either an egg and incubating bird, or a broken egg, were counted regularly from the start of laying until the completion of census work elsewhere on Adams Island. These counts allowed calculation of a correction factor to be applied to nest census results elsewhere on the island, to overcome the dual problems of nest counts being carried out before all eggs were laid and after nests had failed and the parent bird had left.

To ground-truth aerial nest counts, the number of birds incubating an egg, and the number of birds sitting on a nest without an egg, sitting on the ground without a nest or egg, or standing in the Study Area were counted on 18 January at the same time that aerial photos of the entire Amherst and Astrolabe Basins were taken by Barry Baker from a helicopter.

5. RESULTS

Population size estimate from mark-recapture

The number of breeding birds in the study area estimated by mark-recapture was increasing up until 2005, but since then the population has declined with females declining more steeply than males (Figure 3).

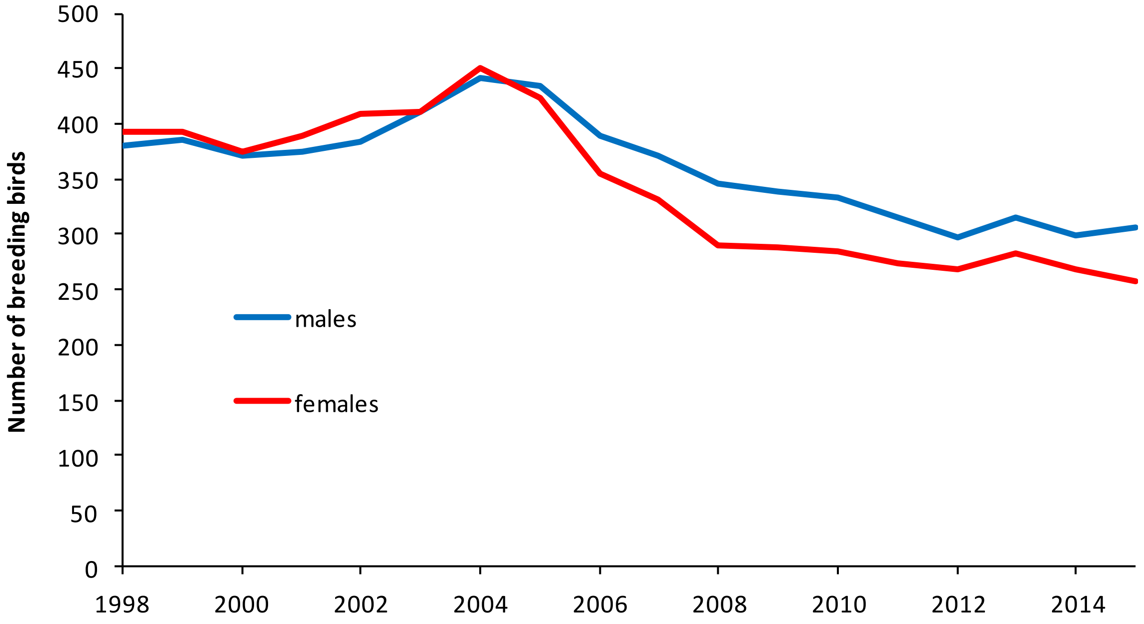

Figure 3: The number of breeding birds in the study area on Adams Island estimated by mark-recapture.

Using the modelling techniques of Francis *et al.* (2015) it is possible to estimate the size of the total population including pre-breeding birds (as opposed to the total number of breeders) but this is beyond the scope of this report.

Survivorship

Data gathered over the 2015/16 summer allowed survival during 2015 to be estimated but since the survival estimates for the last two years for biennially breeding birds invariably have very large confidence intervals, the 2015 results should be treated cautiously and we have not presented those for 2016 (Figure 4).

Female survival has improved markedly since the catastrophic lows (82%) recorded in 2006-08 and the marked imbalance between male and female survival has decreased. However, at 89% in 2015, survival in both sexes remains much lower than the average prior to the 2005 crash (95%).

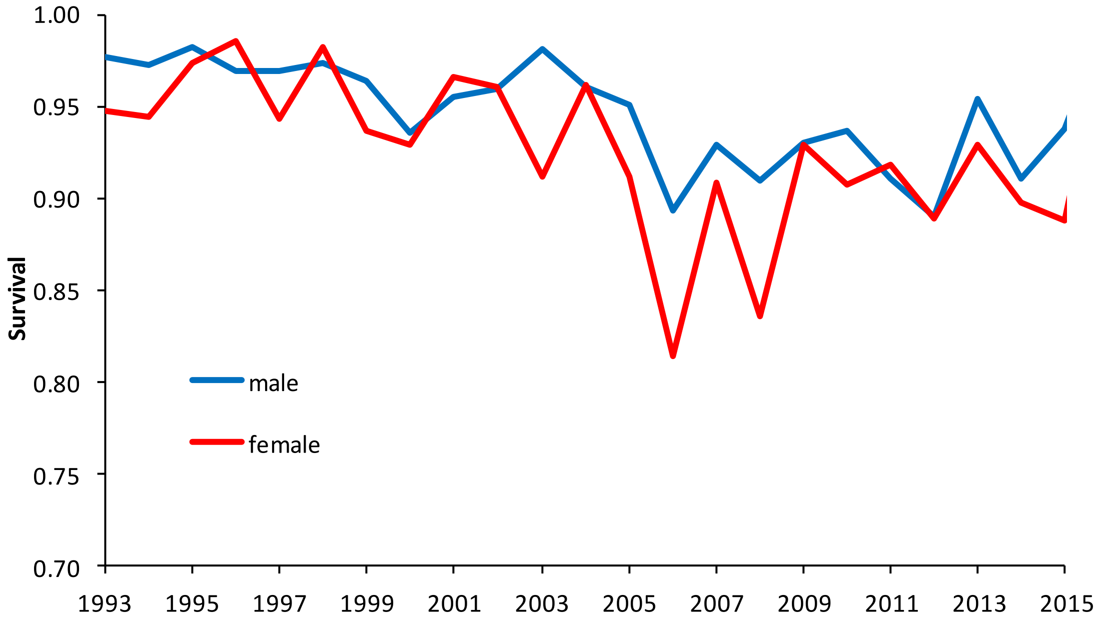

Figure 4: Annual survival of birds in the study area on Adams Island estimated by mark-recapture.

Nesting success and productivity

Breeding success was 42.74% in 2015. Nesting success and chick production seem to be increasing following the 2005 crash (Figure 5), though they have not recovered to their pre-2005 levels when breeding success averaged 63%.

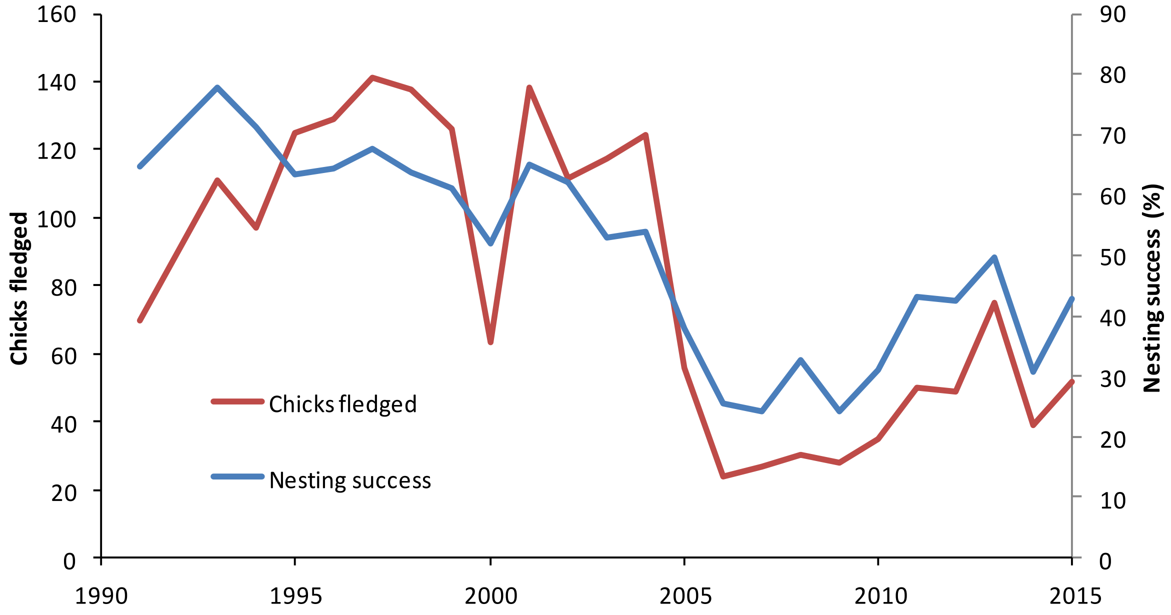

Figure 5: Nesting success and the number of chicks fledged from the study area on Adams Island

Recruitment

The number of birds breeding for the first time in the study area has been slowly rising, following a big decline in 2006 (Figure 6).

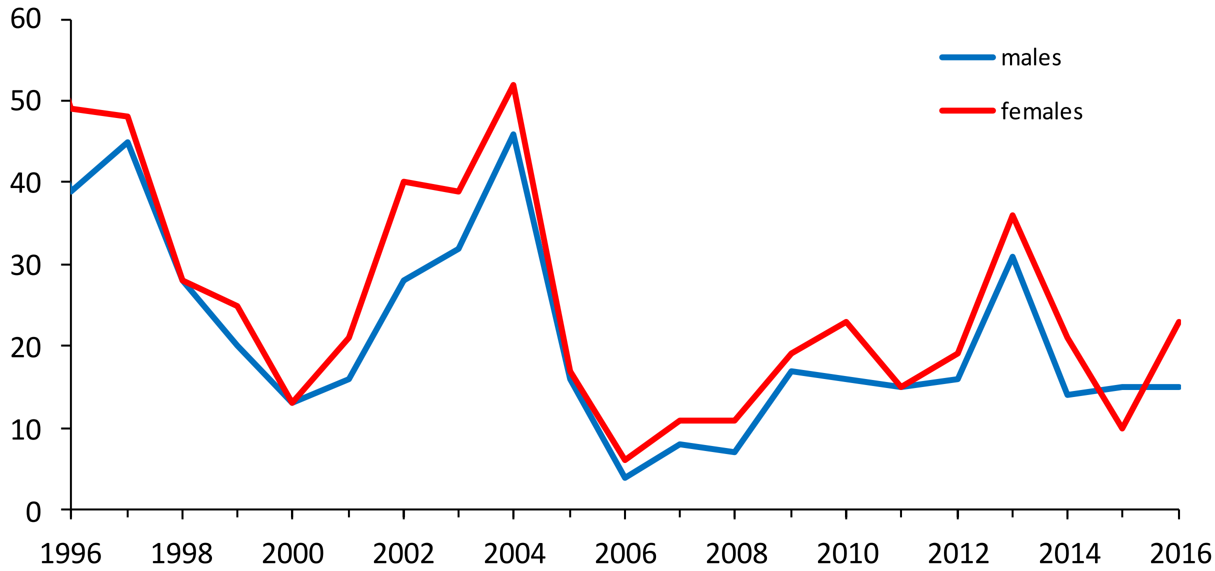

Figure 6: Number of birds breeding in the study area on Adams Island for the first time for each year since 1996

Nest counts in 3 representative blocks

The three blocks in which nests have been counted since 1998 were counted again in late January 2016. There has been a slow improvement in the numbers nesting, with the numbers in 2016 the highest they have been since the 2005 crash (Table 1, Figure 7). The improvement is greatest in the medium and high density blocks with no increase in the low density block (Rhys's Ridge).

Table 1: The number of Gibson's wandering albatross nests in late January in three census blocks on Adams Island in the Auckland Islands group in 1998-2016.

Year	Rhys's Ridge (low density)	Amherst-Astrolabe (medium density)	Fly Square (high density)	Total number of nests
1998	60	483	248	781
1999	60	446	237	743
2000	45	284	159	488
2001	64	410	201	675
2002	60	408	246	675
2003	71	496	217	784
2004	77	501	284	862
2005	34	323	72	412
2006	15	185	79	279
2007	38	230	132	400
2008	26	201	91	318
2009	28	238	120	386
2010	32	237	114	383
2011	33	255	137	425
2012	35	224	120	379
2013	39	315	138	492
2014	29	267	134	430
2015	39	237	105	381
2016	34	332	153	519

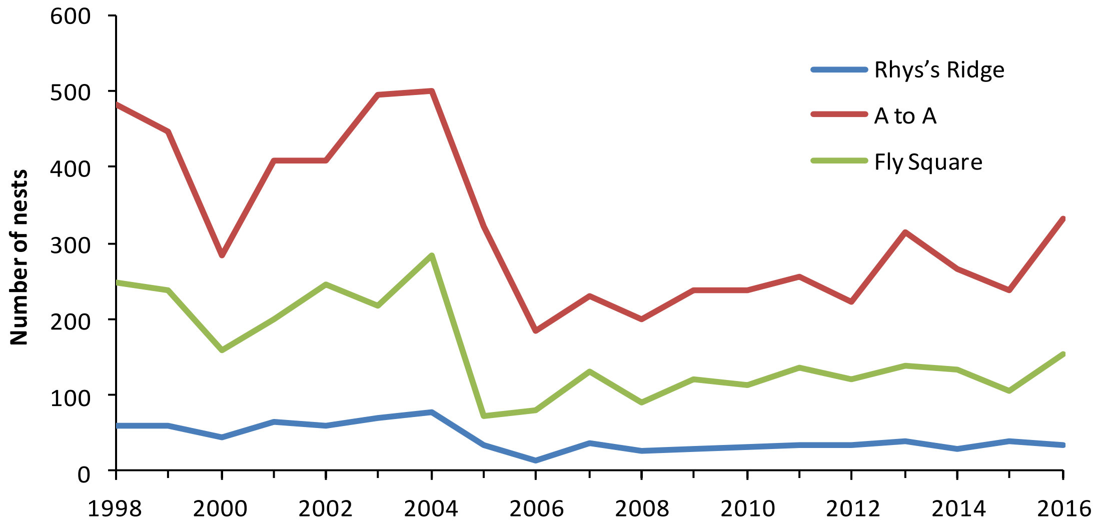

Figure 7: The number of Gibson's wandering albatross nests in late January in three census blocks on Adams Island 1998-2016.

Nest counts in the wider Astrolabe Basin

Counting the entire Astrolabe Basin with only 2 observers took 42 hours and was done in five and a half days, but poor weather meant the count was done over a period of 9 days. Although physically and mentally tiring the count was achieved without incident. Each nest was recorded by GPS, allowing production of a nest distribution map (Figure 8). As anticipated, there were no nests in the highest parts of the basin in fell-field, nor were there any in the lowest part of the basin in very deep tussock, and these areas could be excluded in any subsequent census which would reduce the time needed to about 32 hours . The lowest area has not been counted on foot previously, instead being inspected through binoculars, and the ground count this year provided useful confirmation that the area was unsuitable for albatrosses.

A total of 777 nests (excluding those which had already failed) were counted in Astrolabe Basin. This is 8% higher than estimates made using the proportionate change in the annually counted blocks since the last whole island census.

When combined with the other nest counts undertaken west of Amherst Stream, the nest counts undertaken in the wider Astrolabe Basin provide a count of about 24% of the total population. This very large Amherst-Astrolabe block has now been counted 3 times (Table 2); once in a high breeding season (1997), once in a very poor breeding season(2000), and now in the best breeding year since the 2005 crash (2016).

Table 2: Active wandering albatross nests counted on the southern side of Adams Island between Amherst Stream and Astrolabe Point in 1997, 2000 and 2016. Totals corrected for counts made before laying was complete and the rate of nest failure as measured each year in the study area.

Year	Nests counted
1997	1421
2000	1078
2016	1109

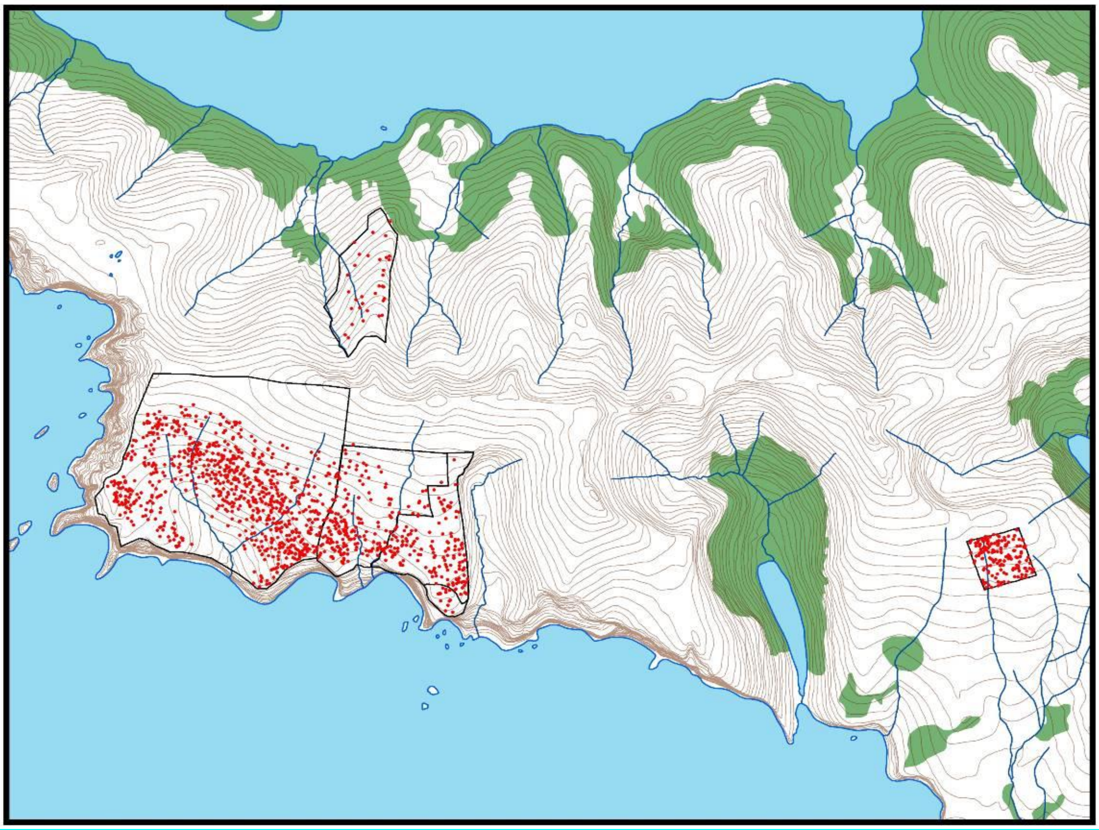

Figure 8: Distribution of nests in the Astrolabe Basin and the 3 representative census blocks in February 2016

Total number of nests on the island

In previous annual reports we have estimated the number of pairs of Gibson's wandering albatross nesting on the whole of the Auckland Islands based on a whole population count done in 1997, and then repeated counts of parts of Adams Island. The proportion of the total population in 1997 that was nesting in those parts of the island that were subsequently repeatedly counted was used to estimate the total population using the following formula.

$$\hat{t}_i = \frac{t_{1997}}{p_{1997}} \times p_i$$

Where

$\hat{t}_i$ is the estimated total number of pairs nesting in year *i*

t_{1997} is the total number of pairs counted nesting in 1997

p_{1997} is the number of pairs counted nesting in 1997 in those parts of the island that were subsequently repeatedly counted.

p_i is the number of pairs counted nesting in year *i* in those parts of the island that are repeatedly counted

This estimate assumes that the proportion $\frac{t_i}{p_i}$ is constant from year to year which is only true if the pattern of distribution of nests remains the same from year to year.

Counts of nesting pairs in parts of Adams Island have not been carried out at exactly the same time of year because of the exigencies of weather and transport. Since eggs are laid over a period of 5 or 6 weeks and since some nests fail and are abandoned throughout the laying period, there is no perfect time to undertake a count that will guarantee all the nesting pairs are detected. Counts always underestimate the number of pairs, and the degree of underestimation varies with the time of the count.

There are 3 ways in which we can improve confidence in our estimates of the total number of pairs:

1. We can make corrections to account for changes in the timing of counts.
2. We can count a larger proportion of the total population.
3. We can examine the assumption that the pattern of distribution of nests remains the same from year to year.

These approaches are discussed in more detail below.

1) Corrections for timing of counts

Because the study area is checked at regular intervals during the period over which counts are undertaken, we can use the laying and failure rates observed in the study area to correct counts undertaken elsewhere. On every occasion that we visit the study area we can estimate the proportion of the eggs that have been laid (*plaid*) and the proportion of nests that have failed (*pfail*), and thus a correction factor for that day.

$$plaid_i = \frac{number\ of\ eggs\ laid\ on\ or\ before\ day_i}{number\ of\ eggs\ laid\ at\ end\ of\ laying}$$

$$pfail_i = \frac{number\ of\ nests\ failed\ on\ or\ before\ day_i}{number\ of\ eggs\ laid\ at\ end\ of\ laying}$$

$$correction_i = \frac{number\ of\ nests\ on\ day_i}{plaid_i \times pfail_i}$$

We can calculate a correction factor for days between visits to the study area by linear interpolation.

Application of a correction factor assumes that the laying and failure rates in the study area are representative of laying and failure rates throughout the population. This year we retrospectively applied these corrections to all the counts since 1997 and in Figure 9 and Table 3 we compare counts and population estimates for parts and all of Adams Island with and without these corrections.

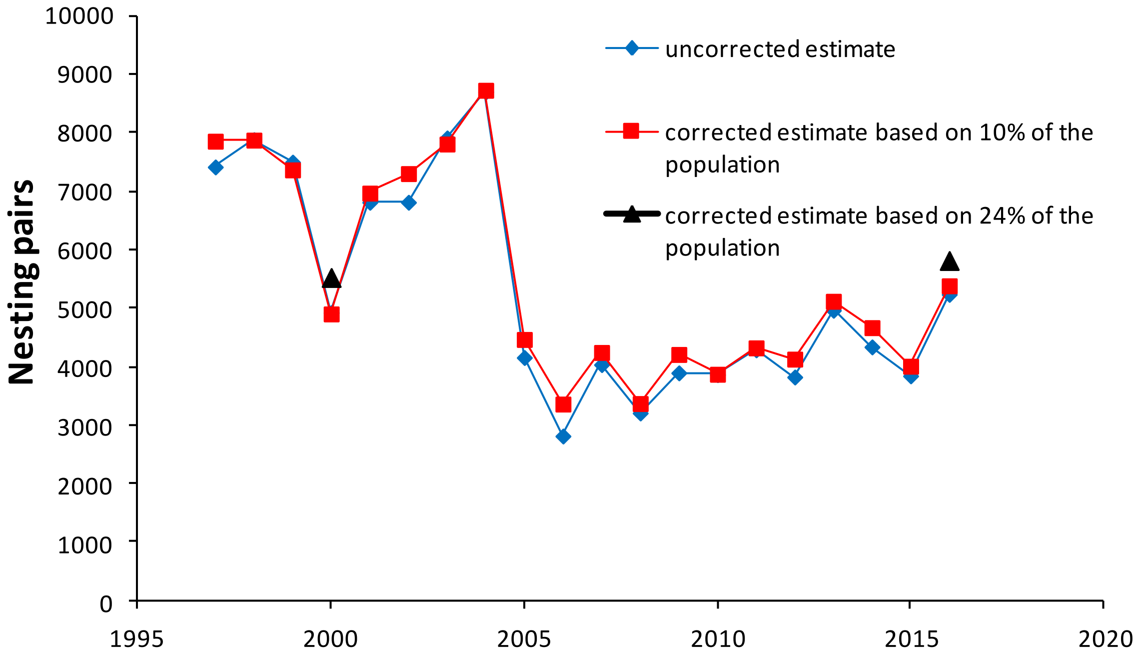

Figure 9: Estimates of the number of pairs of Gibson's wandering albatross breeding each year since 1997, based on counts of 10% of the Adams Island population, 24% of the Adams Island and with and without corrections applied to account for the variable timing of counts.

Corrected estimates are on average 4.2% higher than uncorrected estimates with correction factors greatest in years with a high nest failure rate. For example the correction factor in 2006, at the height of the population crash when 74.5% of nests failed, many of them early, was 19%. While the application of correction factors improves estimates of the number of nesting pairs, it doesn't substantially change the between-year trends.

2) Counting a larger proportion of the population

Total population estimates that we have previously reported have been based on counts of areas of Adams Island that contained 10% of the albatross population. In theory counting a larger proportion of the island should lead to a more accurate estimate of the whole population. Counts of parts of the island undertaken in 2000 and 2016 included an area that contained 24% of the population in 1997 and produced estimates that were 12 and 8 % higher respectively than the estimates based on a count of a smaller part of the island (Figure 9 and Table 3).

Table 3: Corrected and uncorrected estimates of the number of nesting pairs of Gibson's wandering albatross based on counts of 10, 24% and 100% of the population. Corrected estimates incorporate a correction factor for the time at which counts were made (see (1) Corrections for timing of counts above).

Year	Uncorrected estimate	Corrected estimate based on 10% of the population	Corrected estimate based on 24% of the population	Corrected estimate based on 100% of the population
1997	7417			7857
1998	7883	7875		
1999	7499	7367		
2000	4926	4904	5527	
2001	6813	6969		
2002	6813	7303		
2003	7913	7809		
2004	8701	8728		
2005	4158	4467		
2006	2816	3363		
2007	4037	4245		
2008	3210	3371		
2009	3896	4211		
2010	3866	3872		
2011	4290	4323		
2012	3825	4131		
2013	4966	5120		
2014	4340	4669		
2015	3845	4010		
2016	5238	5385	5817	

While the counts of a larger proportion of the island might produce a more accurate estimate of the total population, it is difficult to estimate the magnitude of any improvement in accuracy.

We can however, usefully visualise likely changes in precision in the following way. Let us assume that the distribution of nests on the island is approximated by a probability density surface and that the number of nests in an area in any year is the sum of the probability densities in that area multiplied by the total number of nesters in that year. Let us also assume that variation about the expected number of nesters in an area is approximately Poisson in nature. A count of any part of the island will thus have a theoretical standard deviation derived from the Poisson distribution and a total population estimate based on this count will have a proportionate standard error with a finite population correction. Using this thinking the 95% confidence interval for a population of about the size estimated in 2016 is shown in Figure 10.

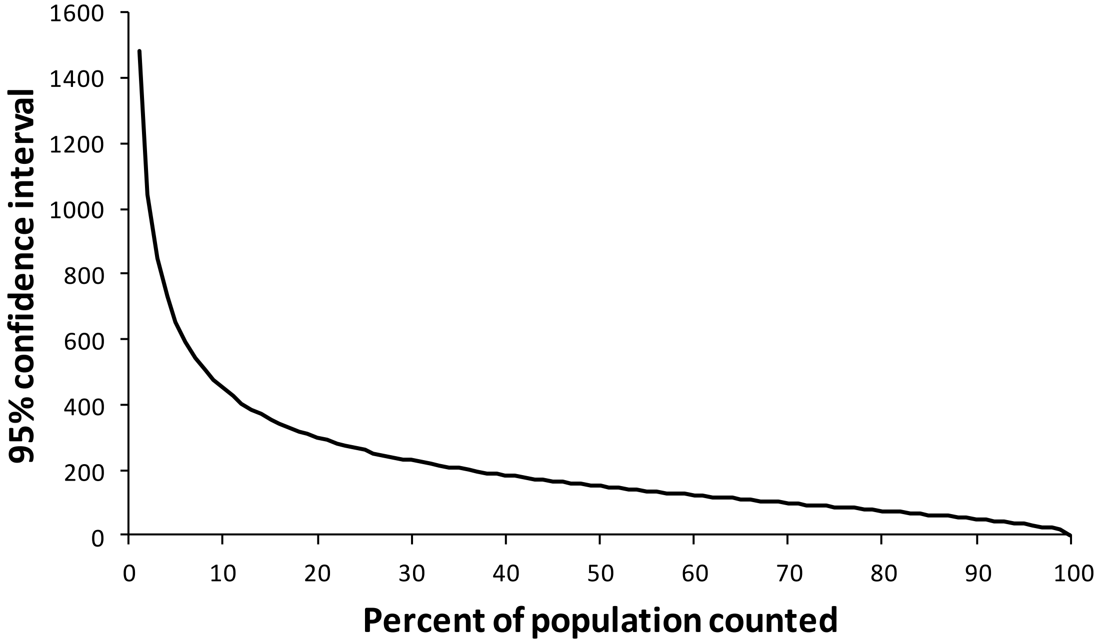

Figure 10: Theoretical error in population estimation as a function of the proportion of the population sampled.

This analysis suggests that there are considerable improvements to precision gained by increasing the proportion of the population counted up until about 10% but thereafter the gains are smaller. The above analysis assumes that sampling is the only source of error, but in reality there are other sources of error: in particular not counting nests obscured by vegetation and counting birds that appear to be nesting but are not. Including these sources of error would simply shift the curve in Figure 10 upwards.

3) The assumption that the pattern of distribution of nests remains the same from year to year.

If the pattern of nest distribution is the same among years, we expect breeding bird numbers in different count blocks (e.g. Figure 7) to change in parallel over time. To test whether the lines are parallel, we used generalised linear models with Poisson errors to assess whether the pattern of distribution of birds on the island varied from year to year or remained approximately constant. To do this we compared two models of the number of birds counted in 4 blocks on the island in all years since 1997:

Model 1 count ~ block + year

Model 2 count ~ block * year

Both block and year were treated as factors. We compared the two models using AIC (Burnham & Anderson 2002).

If model 1 is “best” it implies that the proportion of birds nesting in each block remains constant from year to year, but the total number of birds varies from year to year.

If model 2 is “best” it implies that not only does the number of birds vary from year to year, but the proportion in each block varies.

Table 4: Two models of the relationships between nest counts, blocks and years, and their AIC values. Formulas are shown in the notation of R (R Core Team 2016).

Model	Formula	AIC
Model 1	count ~ block + year	739.14
Model 2	count ~ block * year	776.64

Model 1 is clearly superior to model 2 which leads to the conclusion the abundance of nests in the four blocks that are counted each year vary in parallel. We take this to indicate that the pattern of distribution of birds around the island remains the same from year to year. This further leads to the conclusion that counts of nests in any parts of the island will give a good indication of the trend for the whole population.

6. DISCUSSION

Population trends

The survivorship and productivity of Gibson's wandering albatross has improved since the population crash in 2005, but still have not risen to the levels they were before the crash. The mark-recapture estimates of the size of the breeding population in our study area indicate that the rate of decline of the population has slowed though it is still decreasing (Figure 3). In contrast counts of the number of nesting birds have gradually increased since the 2005 crash (Figure 7). The apparent contradiction between the nest counts and the mark-recapture estimates of population size arise from the changing demography of Gibson's wandering albatross (Figure 10). Immediately after the 2005 crash a high proportion of the population did not breed. Since then the proportion of birds breeding each year has increased, so that even though the total population of breeding birds declined, the number nesting increased because a higher proportion of the birds chose to nest.

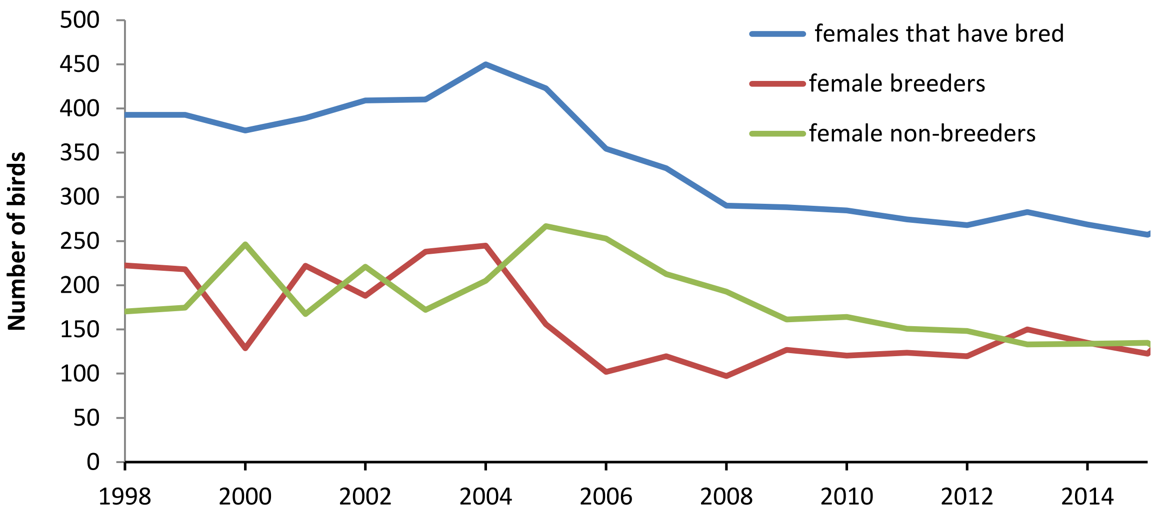

Figure 10: Total number of breeding females using the Adams Island Study Area, and the number that breed and don't breed each year.

Population size

In 2016 GPS-based ground census techniques were used on a large scale on Adams Island for the first time, with the large albatross colony in the wider Astrolabe Basin counted.

Although the GPS-based census techniques are more accurate than those used in the past, comparison of this year's counts with previous counts is complicated by the difficulty of distinguishing real population change from artefacts of the counting techniques. Given the large effort required to ground census such a large area, it was thought more important to obtain the most accurate count possible, than to replicate past techniques. Replicating past techniques would best facilitate estimation of trends, but these are better estimated from our mark-recapture study, so we focused on accuracy.

When the first attempts to count albatross on Adams Island were made in 1991, rows of people walked in parallel lines across the breeding grounds. This technique relied on everyone walking at the same pace and each person communicating with their neighbours to arrange who was going to count nests on the boundary between them. The outermost person marked the edge of the counted area with fluorescent pink tape and on the next sweep recovered the tape. The placing and recovery of tapes took time and energy, and nests could be missed or counted twice when the line of counters walked at varying speeds due to variable topography or vegetation denseness. The counts became more efficient in 1997 when the pink tape was replaced by spray paint and this became the standard technique until accurate GPS units with maps and tracking functions became available in 2011. These crucially allowed a counter to see the boundaries of counted areas, and how much of the land they had covered. In 2012 we drew parallel lines ~25 m apart on the GPS maps of each census block and this meant for the first time each counter (1) had a defined area to count; (2) didn't have to leave a visible line on the ground; (3) had a way of checking whether the whole of their zone had been walked, and (4) had a way to record exactly where each nest was found so double counts could be avoided.

From post-census reliability checks undertaken in the 3 representative census blocks, which are well-defined and comparatively easy to count, there seems to have been little change in the accuracy of counts in count blocks since they began in 1998, despite the move to GPS-based methods after 2011. There has, however, been a substantial reduction in the effort required.

There is however, likely to have been an increase in the accuracy of the counts undertaken of much larger and more difficult parts of the island. The larger count undertaken in 1997 included substantial areas of tall tussock and scrub where the old techniques were most tested: it was difficult to ensure all ground was covered, and it was tempting to widen sweeps because walking was so difficult. The most recent GPS–based techniques ensure all ground is covered and that sweeps are not widened.

Inaccuracies in counting large areas have previously been considered small, as albatross density in the deeper vegetation of the difficult-to-count parts is always very low. The count in the wider Astrolabe Basin in 2016 was the first time we have attempted to test this assumption by applying the most recent GPS-based census techniques to a large area which included some tall and difficult vegetation.

We found that the number of nests in Astrolabe Basin in 2016 was about 8% higher than we predicted from the 1997 whole-island count and subsequent counts of small areas. This might be a real increase (i.e. there had been a change in the pattern of distribution of nests on the island), might reflect an improvement in our counting techniques, be the result of chance, or a combination of all these.

We have already shown that there has been no significant change in the pattern of distribution of nests amongst our four regularly counted small blocks, which suggests that chance (sampling error for example) or improvements in our counting techniques are more likely to account for the apparent change in the Astrolabe Basin count. However, in assessing this question we've intensively re-analysed all the whole-island and the previous Astrolabe Basin counts to check the results and in the process found (1) a transcription error in the 1997 census (which forms the basis of the extrapolated counts) which left out 200 birds, and (2) that for accuracy, census results need to be adjusted by laying and failure rates on the day the census was made. These corrections have now been incorporated into the total population estimates in Table 3.

Is it worth counting a larger area in future? Intuitively, counting a bigger area should give a more accurate count. However, the modelled results (Figure 10) indicate there are relatively small improvements in accuracy of whole population estimates when 24% of the island is counted as it was this year, compared to the normal 10%, but the larger-area counts bring considerable costs (an additional fortnight's work for 2 people).

Should the whole island be ground-counted using modern GPS techniques? It is debatable, but important points to consider are:

1. Because of inter-annual variation in the number of birds nesting, only repeated counts of the whole population will give a reliable estimate of the average number of nesting pairs – it is more than a one year job.

2. The number of nesting pairs is often not a reflection of the size of the breeding-aged population. Between 2006 and 2016 the number of nesting pairs increased in those parts of the Adams Island that are regularly counted, but the mark-recapture study indicated that over the same period time the population actually decreased (see Figure 10). To estimate the total population size, or the size of the breeding population, requires a mark-recapture study to estimate the proportion of the breeding population that chose to breed in the years of the counts, as well as an accurate count.

3. The number of nesting pairs is often not a reflection of the size of the total population. Not only are there birds that have bred in the past but are not breeding in the year of the count, but there are young birds which have yet to join the breeding population. An estimate of the total population size requires not only an accurate count of nests, but also a mark recapture study and some modelling to estimate the size of the non-breeding population.

4. Our analysis of the laying and failure rates of nests indicated that in some years counting nests can underestimate the number of nesting pairs by as much as 20%. To accurately estimate the number of nesting pairs from counts also requires concurrent detailed monitoring of egg laying and nest failure in at least some small representative part of the island.

Monitoring the population structure of Gibson's wandering albatrosses on Adams Island remains an important conservation priority, as simple point counts of numbers of birds alive does not accurately reflect the conservation status of the species.

7. ACKNOWLEDGEMENTS

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8. REFERENCES

Burnham, K.P.; Anderson, D.R. 2002. Model selection and multimodel inference: a practical information-theoretic approach. Springer Verlag, New York.

Choquet, R.; Reboulet, A.M.; Pradel, R.; Giminez, O.; Lebreton, J.D. 2005. M-SURGE 1-8 User's Manual. CEFE, Montpellier, France. http://ftp.cefe.cnrs.fr/biom/Soft-CR/

Elliott G.; Walker, K. 2005. Detecting population trends of Gibson's and Antipodean wandering albatrosses. *Notornis* 52: 215-222.

Francis, R.I.C.C.; Elliott, G.; Walker, K. 2015. Fisheries risks to the viability of Gibson's wandering albatross Diomedea gibsoni. New Zealand Aquatic Environment and Biodiversity Report No. 152. Ministry of Primary Industries, Wellington.

Robertson, H.A.; Dowding, J.E.; Elliott, G.P.; Hitchmough, R.A.; Miskelly, C.M.; O'Donnell, C.F.J.; Powlesland, R.G.; Sagar, P.M.; Scofield, R.P.; Taylor, G.A. 2012. Conservation status of New Zealand birds, 2012. New Zealand threat classification series 4, Department of Conservation, Wellington.

Walker, K.; Elliott, G. 1999. Population changes and biology of the wandering albatross *Diomedea exulans gibsoni* at the Auckland Islands. *Emu* 99: 239-247

Walker, K.; Elliott, G. 2005. Demographic parameters of Gibson's albatross (*Diomedea gibsoni*). Unpublished report to the Conservation Services Programme, Department of Conservation, Wellington.

Walker, K.; Elliott, G. 2006. At-sea distribution of Gibson's and Antipodean wandering albatrosses, and relationships with long-line fisheries. *Notornis* 53 (3): 265-290.

R Core Team (2016). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL https://www.R-project.org/.