Albatross Research

Gibson's wandering albatross: analysis of census techniques

Draft report prepared for

Department of Conservation

Kath Walker and Graeme Elliott

30 April 2015

1. INTRODUCTION

The reliability of recent assessments of the risk commercial fisheries pose to New Zealand seabird species depend to some extent on the accuracy of estimates of the total size of their breeding populations (Richard & Abraham 2014).

The present focus on risk assessments has brought a renewed interest in estimation of the total size of the Gibson's wandering albatross population. Risk assessments also require population trend data, but reliable recent trend data has already been gathered for this species

Current knowledge of the size of the breeding population of Gibson's wandering albatross is based on a series of ground counts made over all or nearly all of the breeding grounds on Adams Island and Disappointment Island between 1991 and 1997 (Walker & Elliott 1999). These counts were done by dividing the whole of Adams Island into convenient "blocks", walking in marked strips backwards and forwards across the blocks and counting all nests with eggs and all non-breeding birds.

Once counting of all the blocks on the island ceased in 1998, annual counts were made of 3 of the blocks, which in 1997 held 12% of the total population counted and which were representative of high, medium and low density nesting areas on Adams Island.

During the series of whole island ground counts in the 1990's, although the total number of breeding pairs present fluctuated, the **proportion** of the total population which each block contained varied little between years. As a result, it has been possible to extrapolate a total population size annually from the detailed ground counts of a subset of the blocks, on the reasonable assumption that the proportion each block holds of the whole population remains relatively constant over time.

In 2014/15 Albatross Research was contracted by the Conservation Services Programme of the Department of Conservation to analyse the suitability of various census methods, including aerial photography, to re-estimate the total number of breeding Gibson's wandering albatross pairs. We were responsible for all the previous whole-island and later the representative census block counts of Gibson's wandering albatrosses in 1991-2015, including counting some blocks directly from a helicopter in 1995, 1997 and 2002.

This report summarizes our investigations into the problems and potential solutions to the difficulties of obtaining an accurate count of this particular species, and provides some suggestions on the most suitable technique to use in a new estimation of total breeding population size.

2. THE AREA TO BE COUNTED

Most Gibson's wandering albatrosses breed on Adams Island, a very large (~20 km x 6 km) mountainous island lying west-east across the bottom of Auckland Island. It rises to 700 m asl, the highest point in the New Zealand subantarctic, and is frequently cloud-covered and raked by strong winds.

About 95% of the population of Gibson's wandering albatrosses breed on 102 square km Adams Island, with most of the remainder on relatively small (<5 square km) Disappointment Island and a handful on the southern end of the main Auckland Island. Nests are relatively sparsely scattered over all the tussock slopes above the rata - *Dracophyllum* forest which covers a large proportion of the island. They are absent from the rata forest itself and the rocky fell-field above the tussock zone.

The largest and densest colonies are in 2 extensive basins on the gentle tussock-covered southern slopes of Adams Island, which terminate abruptly at the top of near-vertical 300-500 m high cliffs. In 1997 these 2 colonies together supported about 5,000 breeding pairs, while all the nesting habitat over the remainder of the island together supported about 1,500 pairs.

3. GROUND COUNTS

Advantages

The major advantage of ground counts over every other method is that birds sitting on nests are checked for the presence of an egg; totals cannot be inflated by the variable presence of non-breeding birds on the breeding grounds.

A secondary advantage is that, particularly now that accurate GPS are available, census can be carried out in the frequent strong winds and low cloud cover which would prevent aerial counts.

Disadvantages

The major disadvantage of ground counts are that some birds on the edges of colonies on the upper margins of forest are hard to see and take a lot of time and effort to reach due to the depth and tangled nature of the vegetation. These low-density colonies occupying a fairly large part of Adams Island take a lot of effort to count well, despite contributing little to the overall population size estimate.

Costs

Undertaking a complete ground count on Adams Island is a big task and takes a determined, positive and fit group of 4 people with strong backcountry skills and experience about 6 weeks.

A boat is required to get the team nearer to the western and eastern-most colonies before counting can begin there. This has previously been achieved by bringing a dinghy with outboard motor down with the team, but this is probably unacceptable in today's health & safety environment.

Transport to the island for such a big team would probably need to be separate from any shared transport with other Auckland Island teams, so would be an additional cost.

Excluding transport, the cost is likely to be about 65 k.

4. AERIAL PHOTOGRAPHY

Photographs are taken from a helicopter or plane, and the images are subsequently stitched together to form a single photo-mosaic. Birds presumed to be nesting are marked off with a computer drawing package on the photo-mosaic as they are counted.

For our purposes there are two possible methods of making photo-mosaics for albatross counting: low and high resolution.

Low resolution photo-mosaics

A low resolution photo-mosaic can be produced from photographs taken from a hand-held camera taking oblique and near vertical images out the door of a helicopter. The images are then stitched together by eye. The distortion created by the oblique photos makes photo stitching of large areas with very large numbers of images, difficult. The usual way to reduce this difficulty is to take the photographs from higher up so fewer are needed to cover the ground. However, this results in lower resolution images, which brings problems of its own.

This technique is consequently most successfully used on high density colonial nesting species on steep slopes on small islands with many reference points, as it is comparatively easy to later stitch the images of such environments together by eye. This has been a useful technique to count white capped albatrosses on Disappointment Island.

The low resolution means that nesting and non-nesting birds cannot be distinguished – you just count the white dots.

High resolution photo-mosaics

High resolution photo-mosaics can be produced using automatic photographic equipment which takes large numbers of overlapping photographs from a pod suspended beneath a helicopter. The photos are geo-referenced with GPS equipment attached to the camera, and they are ortho-corrected and stitched together semi-automatically by computer.

Because this system can handle stitching together very large number of images, the resulting photo-mosaic can be of high resolution, and birds on nests can be distinguished from those standing or sitting on the ground.

Precision of counts based on low and high resolution photo-mosaics

The number of birds counted is very variable because there are a rapidly shifting number of non-breeders on the ground as well as breeding birds. Counts based on both low and high resolution photo-mosaics require a “correction factor” if they are to be used to estimate albatross breeding population size. The correction factor is the ratio between the number of birds on eggs (breeders) divided by the number of birds counted.

To assess the precision of counts based on high resolution photo-mosaics we undertook ground counts that simulated high resolution mosaics. Every time the study areas on Adams and Antipodes Island were visited, the number of birds on eggs and the number of birds on nests without eggs was counted. Each day such counts were undertaken, the data was collected separately for the morning, middle and late afternoon, and the weather in each time period noted. From this data we calculated a “correction factor” for high resolution mosaics which is the number of birds on eggs divided by the number of birds that were sitting on nests (Figure 1).

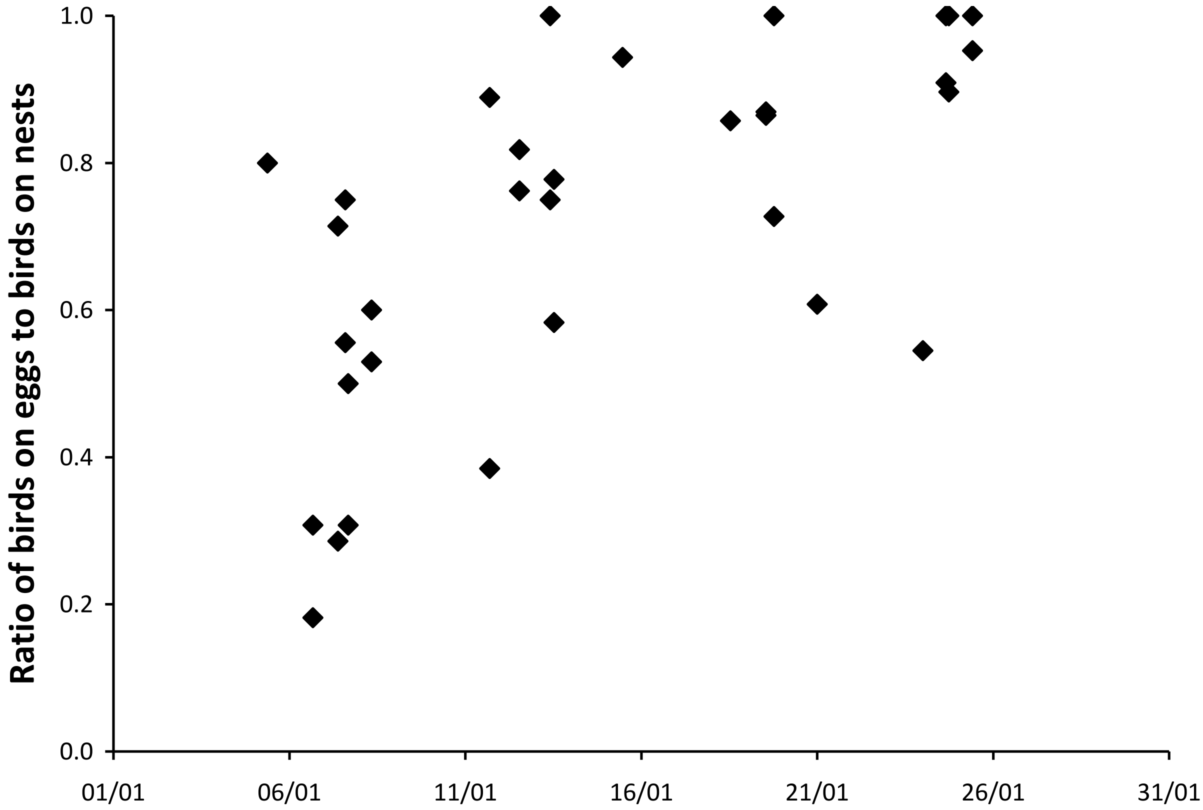

Figure 1: Correction factor for high resolution counts: the number of birds on eggs divided by the number of birds apparently sitting on nests in study areas on Adams and Antipodes Islands in January 2015. The Antipodes Island dates have been adjusted to account for differences in laying dates between the two islands.

We used a much larger historical dataset to assess the likely precision of counts based on low resolution photo-mosaics. We already have data on the number of nesting birds and non-nesting birds on the ground recorded on every visit to the study area in Adams Island since the mid-1990s. The “correction factor” for low resolution photo-mosaics is the number of birds on eggs divided by the total number of birds counted (Figure 2).

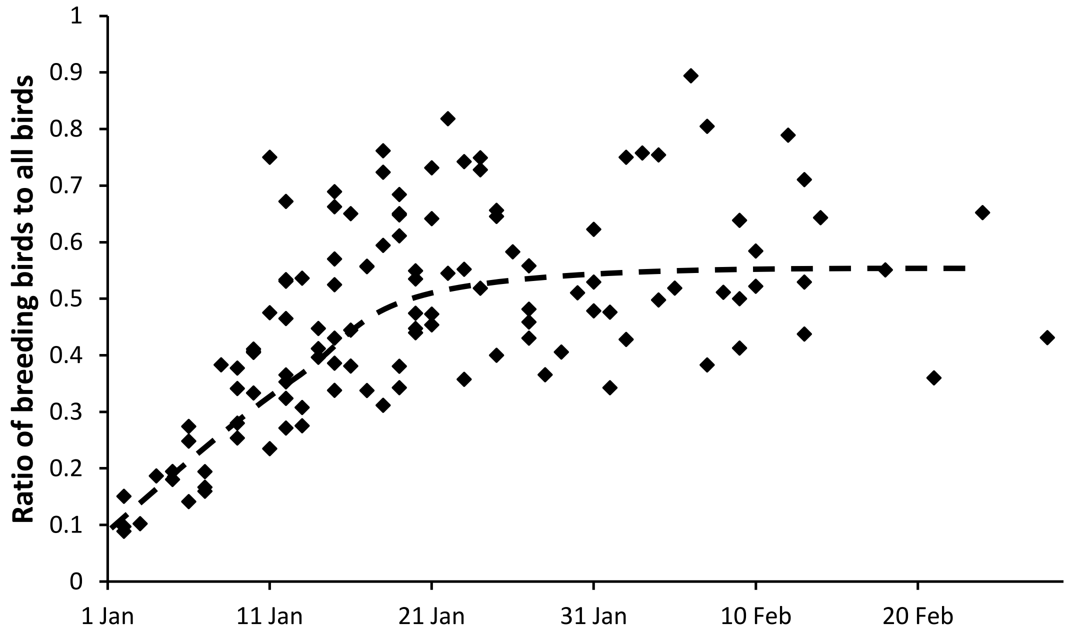

Figure 2: Correction factor for low resolution counts: the number of birds on eggs divided by the number of birds counted in the study area on Adams Island since 2005.

By bootstrap sampling from these data we simulated the likely variability in estimates of the number of breeding birds based on high and low resolution photo-mosaics (Table 1). For these simulations we assumed there were 5000 breeding pairs. The high resolution photo-mosaics provide a more precise estimate.

Table 1: Estimates of population size of a 5000 pairs breeding population taken from simulated low and high resolution photo-mosaics.

	Lower 95% CI	Estimate	Upper 95% CI
Low resolution photo-mosaic	3380	5000	9604
High resolution photo-mosaic	3672	5000	7831

Timing of aerial counts

If aerial counts are undertaken before all the eggs are laid then there has to be an additional correction made to the estimate of the number of breeding pairs. This introduces further uncertainty into the estimates which can be avoided if the counts are done after 25 January, by which time most of the eggs have been laid.

Advantages of aerial counts

The main advantage of aerial census is that nesting habitat which is difficult to reach on foot can be easily and painlessly reached by helicopter, and such habitat is likely to be more comprehensively counted by air.

A secondary advantage is that as long as a helicopter is based at the Auckland Islands for some time following completion of laying (late January), it is easier logistically to organize a single days photography than 6 weeks field work.

Disadvantages of aerial counts

The main disadvantage of all aerial photography is that it is not possible to distinguish breeding birds from non-breeding birds. Correction factors gained from ground counts can help reduce, but not remove this problem, due to huge variability in the attendance of non-breeding birds on the colonies. The number of birds on the ground which are not breeding varies enormously with wind direction and speed, cloud cover, time of day, the previous day's weather and the geographical position of the area being counted. Furthermore, the dramatic change in the population in 2005 on Adams Island led to a shift in the proportion of birds breeding (Figure 3) which would not be detected by aerial counts.

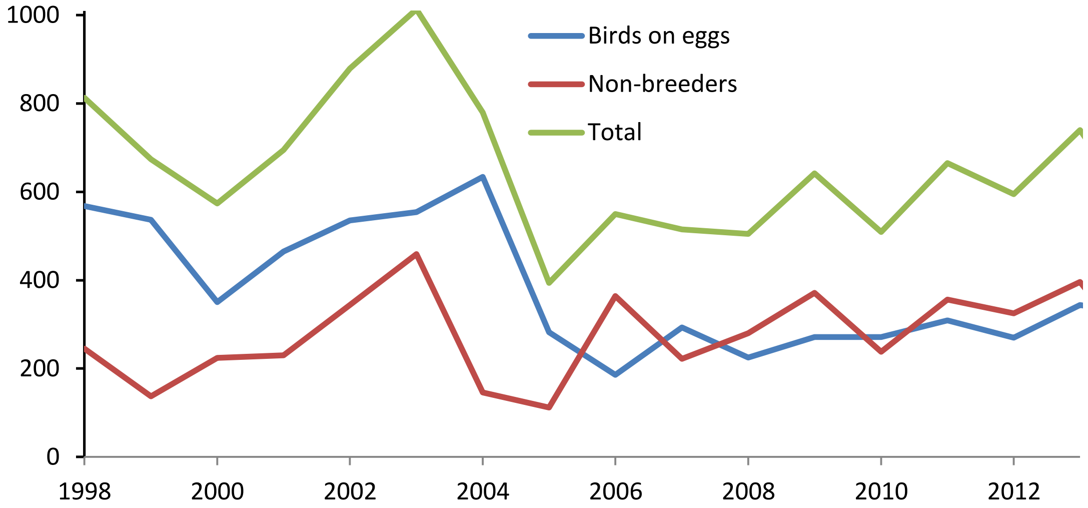

Figure 3: Number of breeding and non-breeding Gibson's wandering albatrosses on the ground in the 3 census blocks on Adams Island counted annually in late January or early February in since 1998.

It may not be possible to stitch together a low resolution photo-mosaic of the sparsely distributed but extensive Gibson's wandering albatross colonies, particularly those on the broad gentle southern slopes of Adams Island. The large numbers of images required to cover the area even at low resolution would be difficult to stitch together by eye, particularly as they would mostly be oblique images.

Costs

Helicopter costs - about 10 hours flying to cover all the colonies on the island, plus the costs of reaching and standing-by at the Auckland Islands in the period 25 January-7 February

Camera costs - $US32,000 to buy an automatic geo-tagged camera and software for the high resolution approach.

Image stitching costs, and the costs of identifying and counting birds on the images

5. WHICH METHOD TO USE?

The four methods we've discussed fall on continuums of cost and precision.

Increasing precision →

Low resolution aerial count	High resolution aerial count	Estimates based on existing counts	Ground count

Increasing cost →

Estimates based on existing counts	Ground count	Low resolution aerial count	High resolution aerial count

Furthermore, the certainty of outcome also falls on a continuum. We are confident we can make whole population estimates based on the existing annual ground counts of a known proportion of the total population as measured in 1997, and we are confident that we can do a ground count. The aerial mapping experts we have consulted are confident that they can stitch together high resolution geo-tagged images – but we've not seen it done for albatrosses. We're not sure whether low resolution non-ortho-corrected, non geo-referenced images can be stitched together well enough to form reliable mosaics of an area.

Baker and Jensz (2014) and Baker *et al*. (2014) suggested that it may be difficult to stitch together low resolution photos of the large nesting great albatross colonies and that it might be more appropriate to count albatrosses along sample transects. Baker noted that it would take some field work to measure transect widths and we believe it would also require considerable effort to accurately map the spatial extent of the albatross colonies so that the estimates from the transects can be scaled-up to a whole island estimate.

Such an approach would have error associated with the non-breeder correction factor we have already discussed; it would also have extra sampling error associated with the transects; and some error in estimating the spatial extent of albatross colonies. Furthermore there is an as-yet un-quantified cost of estimating the total extent of Gibson's wandering albatross nesting colonies which would require an accurate aerial mapping exercise or a ground count. Given the likely low precision of such an estimate, and the fact that there is already an estimate of current population size, it is not obvious that photo transects would be worth the extra cost.

There is another possible approach. Large colonies which are easy to count could be counted from the ground with great precision, and the northern ridges and fringes of the large albatross colonies could be counted from the air with much less precision. Because the northern ridges and fringes support only about 1/3 of the nesting birds, the reduced precision of the aerial counts would not greatly compromise the precision of the whole count. However, its not clear how a line could be physically drawn on the ground at the bottom of the very large Fly Basin area to indicate where counts from the air of the scrubby lower slopes and ground counts of the clearer upper slopes stop and start.

This alternative approach would significantly reduce the cost and effort of a ground count.

6. ACKNOWLEDGEMENTS

Moira Pryde and Peter Moore carried out repeated ground counts of birds in the study area on Adams Island in January 2015. Their careful notes created a valuable dataset for assessing the potential variability in high resolution aerial counts, and we thank them for so cheerfully and diligently carrying out this field work.

Steve Laming of Aerial Surveys provided a great deal of useful information on methods of collecting high resolution ortho-corrected geo-referenced aerial images of Adams Island, and we are most grateful for his time and experience, so kindly given.

Our assessment of possible census techniques was supported by funding from the Department of Conservation's Conservation Services Programme (www.doc.govt.nz/csp) project 4627, partially funded through a levy on the quota holders of relevant commercial fish stocks, and we thank the New Zealand long-line fishing industry for their contribution to this.

7. REFERENCES

Baker, G.B.; Jensz, K. 2014. Gibson's albatross at Disappointment Island - analysis of aerial photographs. Report prepared for the Department of Conservation, Wellington.

Baker, G.B.; Jensz, K.; Hamer, D. 2014. Southern royal albatross at Enderby Island - analysis of aerial photographs 2014. Report prepared for the Department of Conservation, Wellington.

Richard, Y.; Abraham, E. 2014. Assessment of the risk of commercial fisheries to New Zealand seabirds, 2006-2007 to 2012-2013. New Zealand Aquatic Environment and Biodiversity Report.

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