Albatross Research

Gibson's wandering albatross population study and census 2016/17

Report on CSP Project 2016-02 1A & B, prepared for
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1. EXECUTIVE SUMMARY

This report presents data on the size of the Gibson's wandering albatross nesting population in 2017, 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 but survival, productivity and recruitment are all still 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 2017 was a little lower than in 2016, probably because of relatively high numbers of pairs breeding, and high breeding success in 2016 likely due to a strong El Niño.

The total estimated number of breeding pairs of Gibson's wandering albatrosses in February 2017 was 4,423, about half the number of pairs breeding in 2004 (ie 8,728) before the population crashed in 2005.

Proportion breeding and nesting success in Gibson's wandering albatrosses appears related to the large-scale patterns of climate variability, the southern oscillation and the Pacific decadal oscillation.

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' (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 2016/17 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 part 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 undertake ground counts in 3 census blocks and estimate the population size of Gibson's wandering albatross.
3. To identify any change in the foraging range of Gibson's wandering albatross which might explain current population trends (note this was not part of the CSP contract).

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 22 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 six 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.

Counts are carried out between 23–31 January 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.

Counts are corrected to take account of any eggs not laid or any failed nests at the time of counting. These corrections are based on the repeated monitoring of nests in the study area.

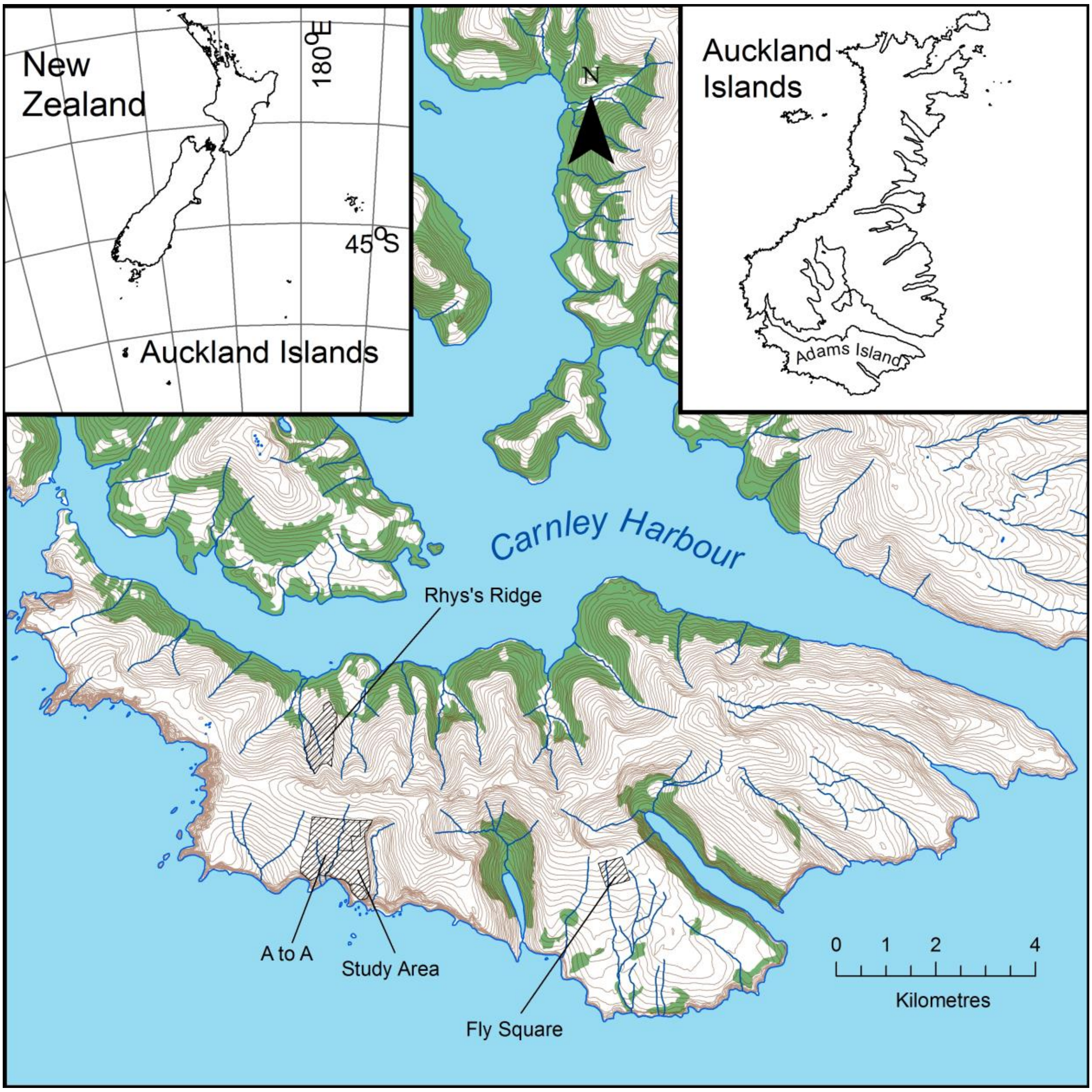

Figure 1: Adams Island, showing the Study Area (61 ha, black) and three other areas in which counts of breeders were made (shaded): A to A (101 ha) Rhys's Ridge (67 ha), and Fly Square (25 ha).

Total number of nests on the island

The number of pairs of Gibson's wandering albatross nesting on the whole of the Auckland Islands was estimated from a whole island population count done in 1997, followed by repeated counts of parts of Adams Island, including the count in 2017. 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 true when the pattern of distribution of nests remains the same from year to year, as it has been found to do on Adams Island (Elliott et al. 2016).

Foraging range

Since 2009 we have been deploying and retrieving geolocator dataloggers on Gibson's wandering albatrosses to compare the foraging locations when the population was declining, with those used a decade earlier when it was growing.

Locations of the birds were calculated from the light data using BASTRak, TransEdit and BirdTracker software supplied by British Antarctic Survey (Fox 2007). More "reasonable" flight paths were obtained when we used estimated longitude from the logger's light data, and estimated latitude by matching the sea temperature data recorded by the logger with the nearest sea-surface temperature at the estimated longitude. We used monthly sea-surface temperature data available from http://dss.ucar.edu.

We compared tracking data collected using geolocator loggers since 2009 with data obtained from satellite transmitters between 1996 and 2004 using kernel density plots. Kernels were estimated using the function kde2d in the MASS package (Venables & Ripley, 2002) in the statistical language R (R Development Core Team, 2011). We used bivariate normal kernels, with a normal reference bandwidth (Venables & Ripley, 2002). Longitudes were transformed by the cosine of latitude to make units of latitude and longitude approximately equal.

5. RESULTS

Survivorship

Data gathered over the 2016/17 summer allowed survival during 2016 to be estimated but since the survival estimates for the last two years for biennially breeding birds invariably have very large confidence intervals, the 2016 results should be treated cautiously and we have not presented those for 2017 (Figure 2).

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.

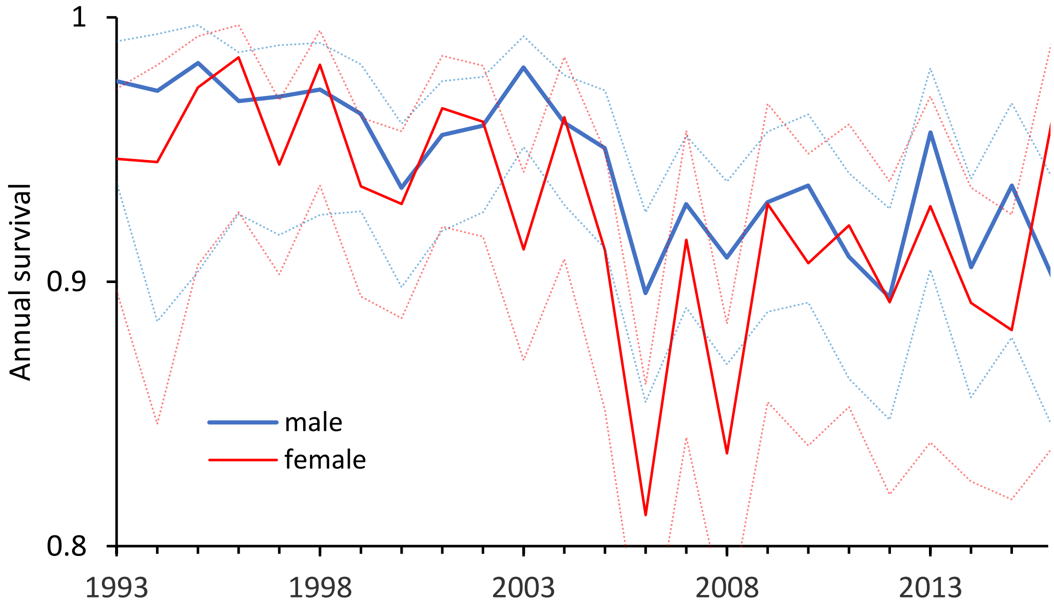

Figure 2: Annual survival of birds in the study area on Adams Island estimated by mark-recapture. The dotted lines are 95% confidence intervals.

Nesting success and productivity

Breeding success was 68.24% in 2016—the highest nesting success recorded for 20 years. Although nesting success has increased to above 2005 (pre-crash) levels, the number of chicks produced is still lower than prior to 2005 because of the reduced number of birds breeding (Figure 3).

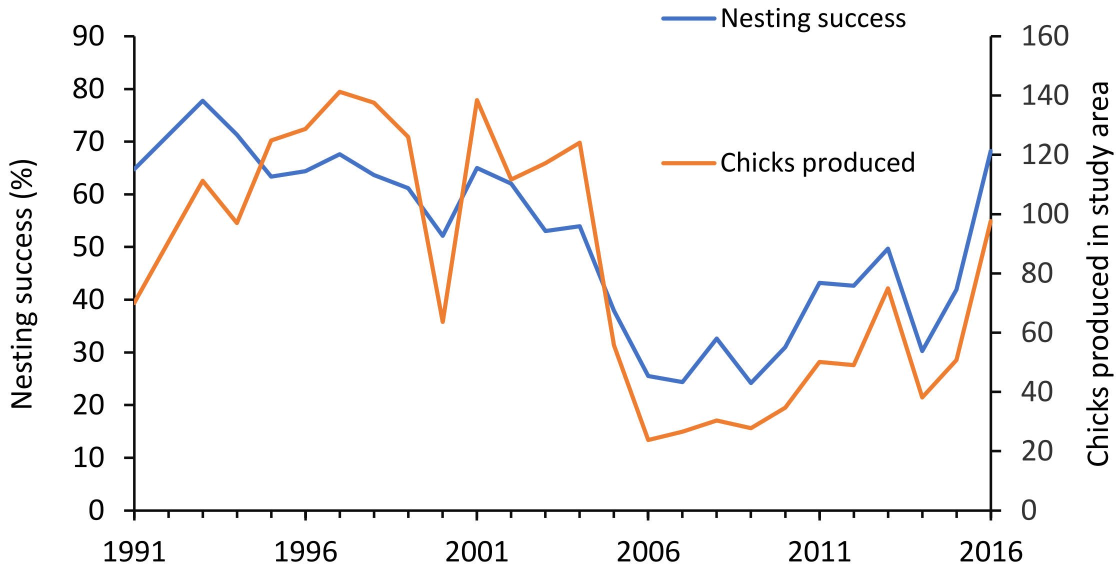

Figure 3: Nesting success and the number of chicks fledged from the study area on Adams Island

Recruitment

The number of birds breeding for the first time in the study area has been slowly and erratically rising, following the big decline in 2006 (Figure 4).

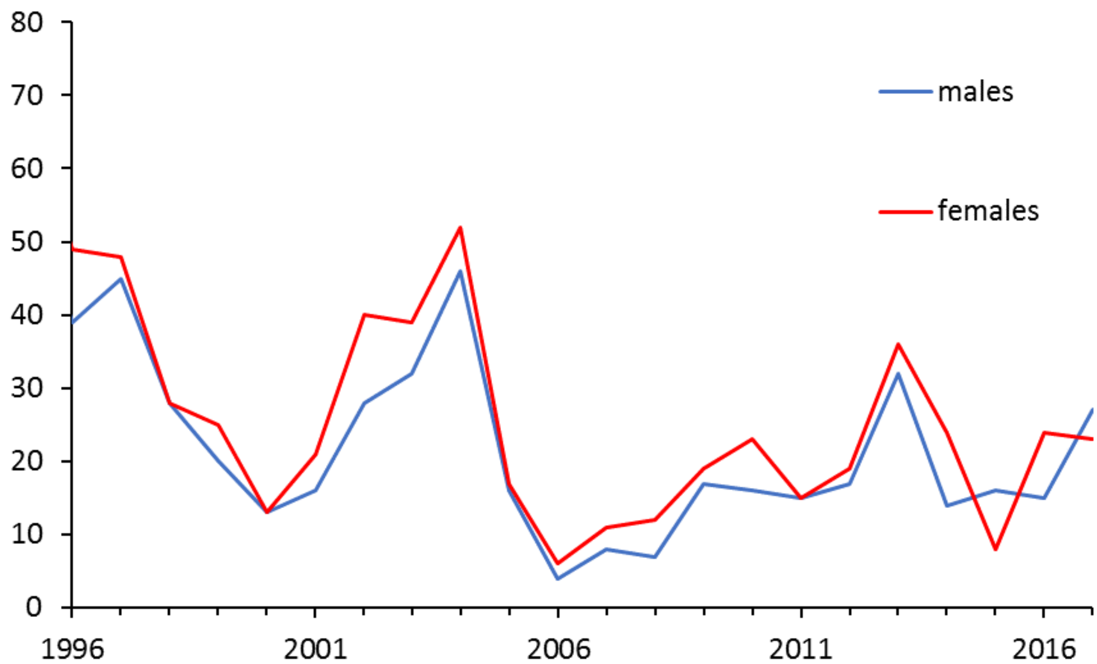

Figure 4: Number of birds breeding in the study area on Adams I for the first time for each year since 1996

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 between 2005 and 2012 the population declined rapidly. Since then the rate of decline appears to eased off (Figure 5).

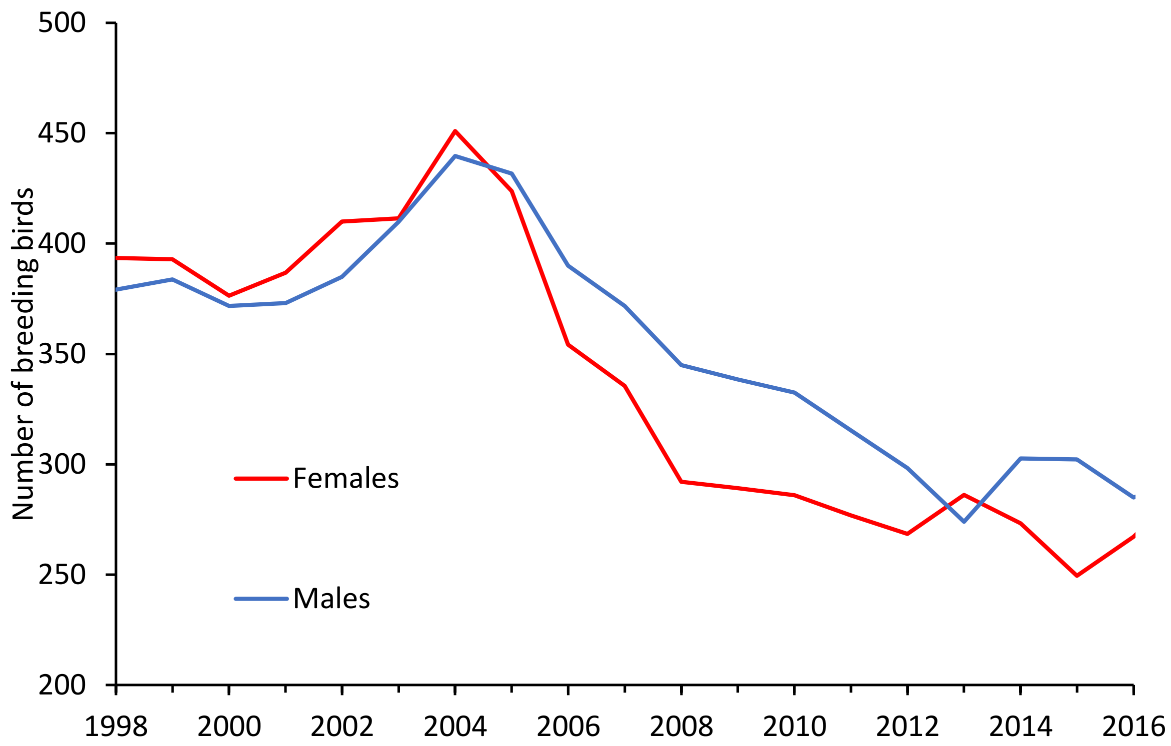

Figure 5: The number of breeding birds in the study area on Adams Island estimated by mark-recapture.

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.

Nest counts in 3 representative blocks and estimate of the total number of nests on the island

The three blocks in which nests have been counted since 1998 were counted again in late January 2017 and the counts "corrected" to take account of as-yet un-laid eggs and nest failures at the time of census (Elliott *et al.* 2016). There has been a slow improvement in the numbers nesting since the 2005 crash (Table 1, Figure 6).

Table 1: The number of Gibson's wandering albatross nests in late January in three census blocks on Adams Island in 1998–2017. Corrected total is the estimated number of nests in the three blocks taking account of the number of failed and un-laid nests at the time of counting. Estimated total population is the estimated number of nests on the island, based on the number of nests in the three counted blocks in 1997 when the last whole island count was undertaken.

Year	Rhys's Ridge (low density)	Amherst-Astrolabe (medium density)	Fly Square (high density)	Total no. of nests	Corrected total	Estimated total pop
1998	60	483	248	781	798	7875
1999	60	446	237	743	746	7367
2000	45	284	159	488	497	4904
2001	64	410	201	675	706	6969
2002	60	408	246	675	740	7303
2003	71	496	217	784	791	7809
2004	77	501	284	862	884	8728
2005	34	323	72	412	452	4467
2006	15	185	79	279	341	3363
2007	38	230	132	400	430	4245
2008	26	201	91	318	341	3371
2009	28	238	120	386	426	4211
2010	32	237	114	383	392	3872
2011	33	255	137	425	438	4323
2012	35	224	120	379	418	4131
2013	39	315	138	492	519	5120
2014	29	267	134	430	473	4669
2015	39	237	105	381	406	4010
2016	34	332	153	519	545	5385
2017	32	252	140	424	448	4423

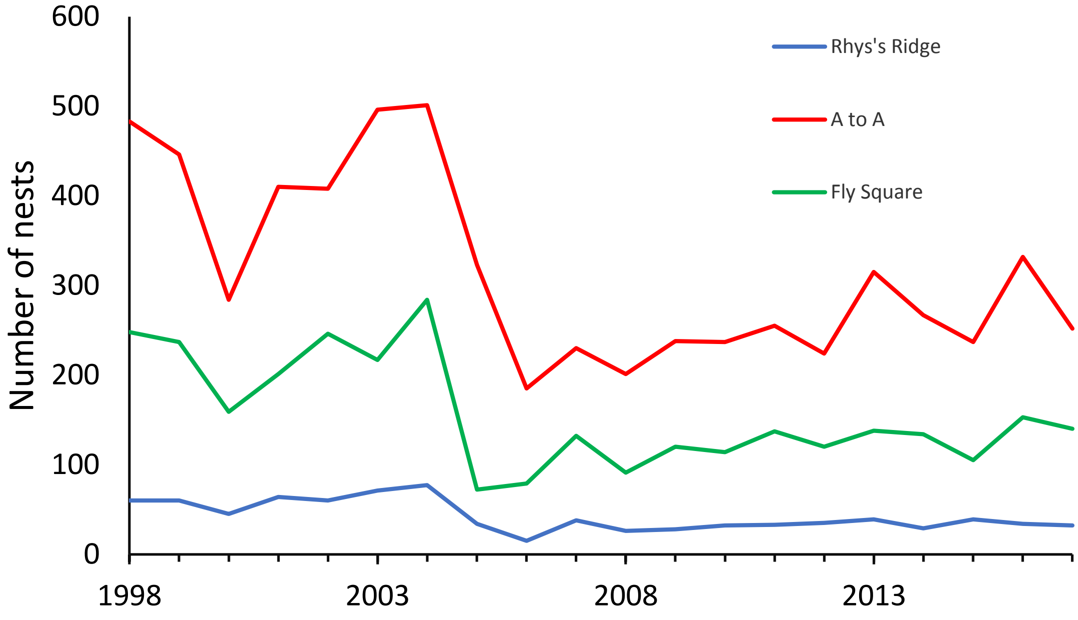

Figure 6: The number of Gibson's wandering albatross nests in late January in three census blocks on Adams I in 1998–2017.

Foraging range

The data from dataloggers attached to 77 birds since 2009 was collated and a preliminary analysis undertaken. It was compared to satellite tracking data obtained from 57 birds tracked between 1996 and 2004 (Walker & Elliott 2006).

The foraging range of breeding birds has changed relatively little although the ranges of both sexes have increased and moved north (Figure 7). In contrast the range of non-breeding birds, particularly females has greatly increased (Figure 8). Both sexes now forage in the Great Australian Bight more than they used to and this change is most pronounced in females (Figure 8).

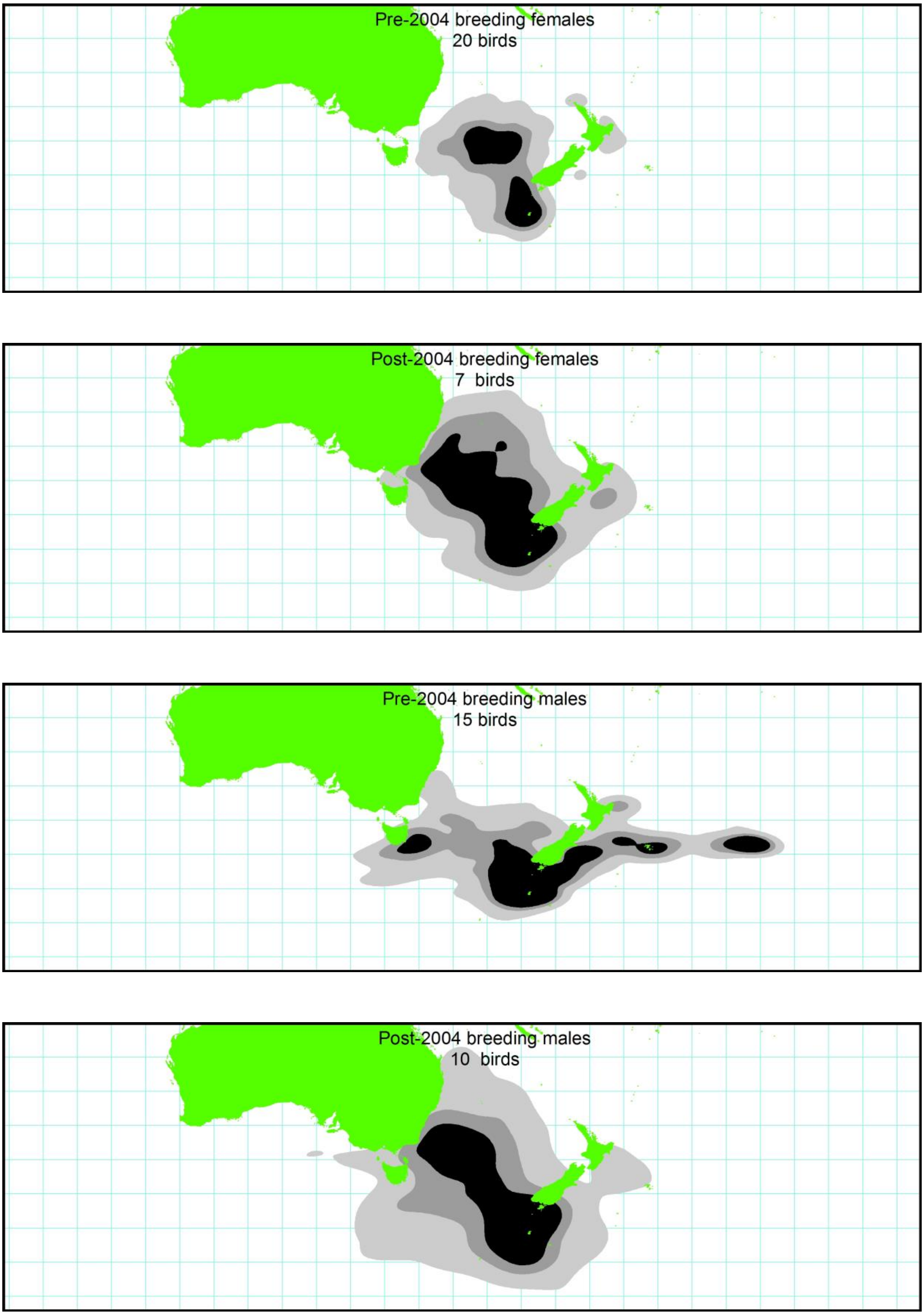

Figure 7. Kernel density plots of breeding Gibson's wandering albatrosses tracked in 1996–2004 and in 2009–17. Black indicates the 50% contour, dark grey the 75% contour, and light grey the 95% contour.

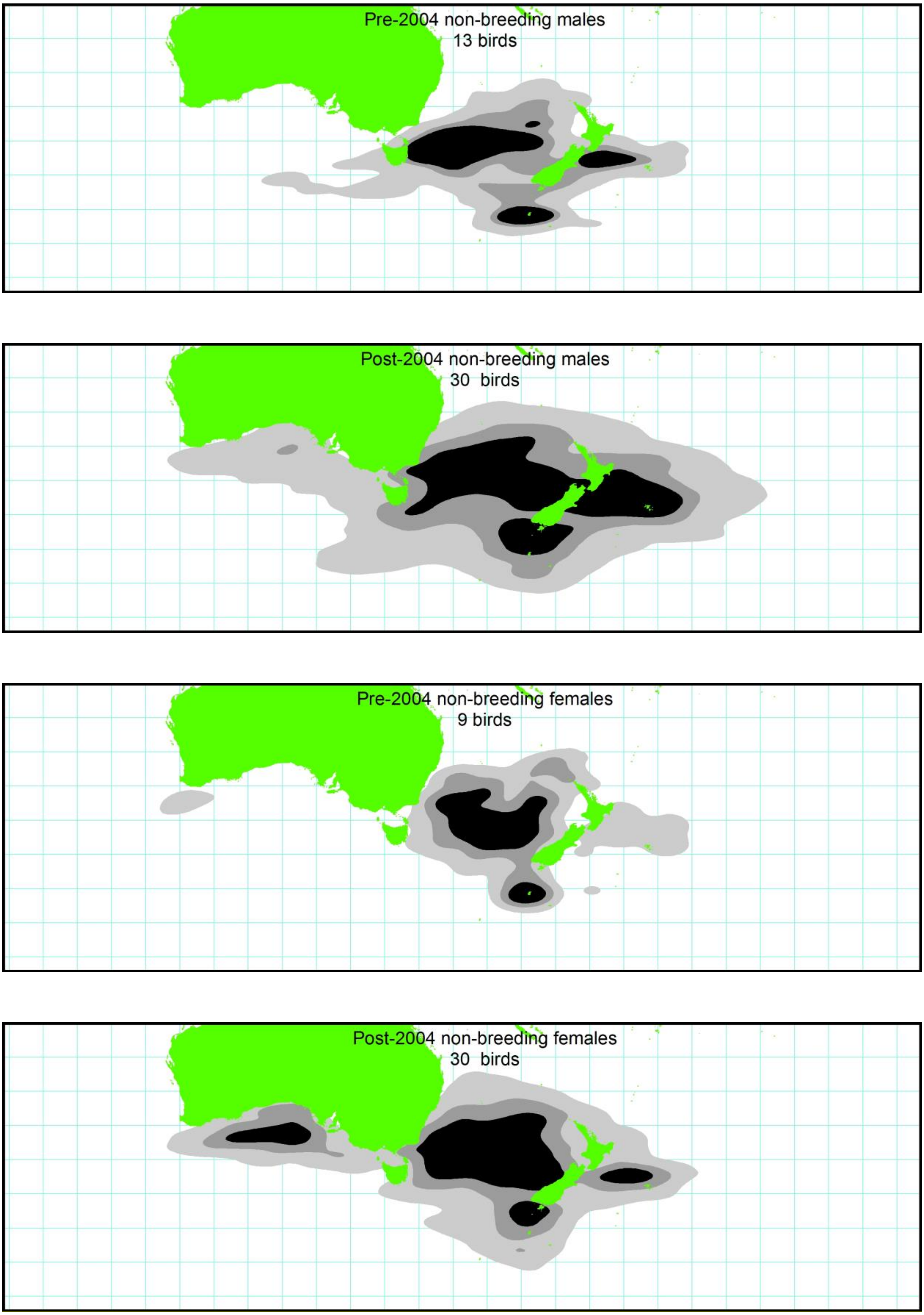

Figure 8. Kernel density plots of non-breeding Gibson's wandering albatrosses tracked in 1996–2004 and in 2009–17. Black indicates the 50% contour, dark grey the 75% contour, and light grey the 95% contour.

DISCUSSION

Population trends

The trend of improving survivorship and productivity of Gibson's wandering albatross described in our last report continued into 2017. However, numbers still have not risen to the levels they were before the 2005 crash. The mark-recapture estimates of the size of the breeding population in the study area indicate the rate of decline of the population has slowed, though it is still decreasing or is at best stable (Figure 5). In contrast, counts of the number of nesting birds continue to gradually increase (Figure 6). 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.

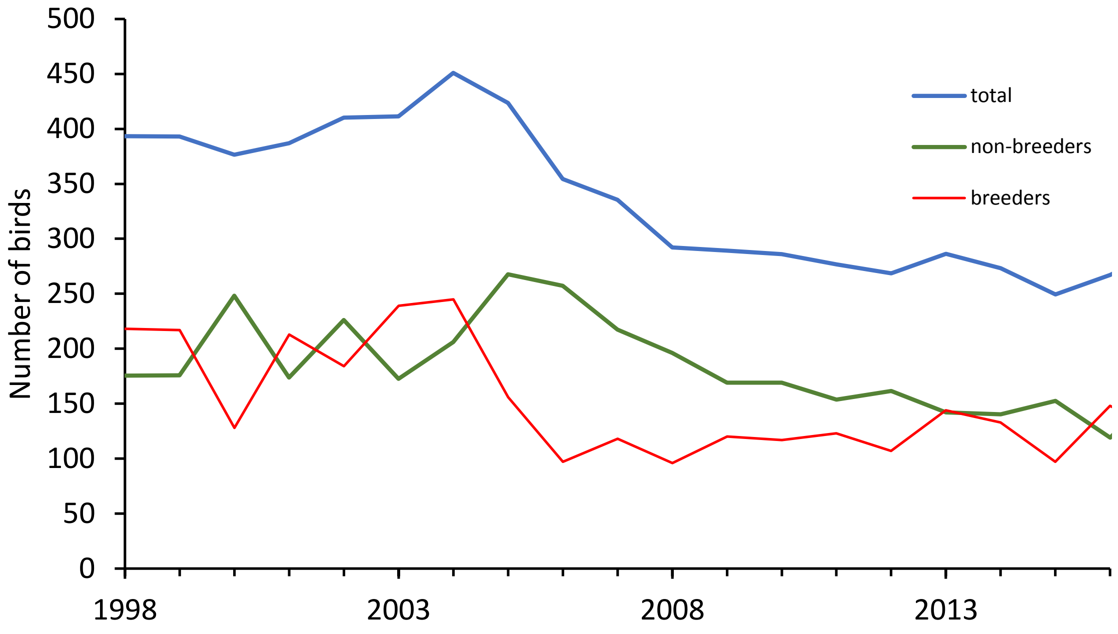

Figure 10: Total number of breeding females using the Adams Island Study Area, and the number that breed and don't breed each year.

Both the number of birds nesting and the nesting success in 2016 were particularly high and this seems likely to have been related to a strong El Niño in the months leading up to and following egg-laying (*i.e.*, October 2015-March 2016). Not only did more chicks fledge in the 2016 breeding year than in the previous decade but the chicks fledged earlier.

Numbers breeding dropped in 2017, at least in part because so many pairs were successful at raising chicks in 2016 that there were few returning failed-breeders. Even if ocean conditions remain favourable, a rapid increase in the size of the breeding population of Gibson's wandering albatross is unlikely as productivity has been low for almost a decade so there are few young birds available to join the breeding population.

Factors affecting population trends

The 2015/16 El Niño was amongst the strongest in recorded history, and the coincident improvement in Gibson's albatross breeding success suggests there may be a relationship. El Niño brings cooler temperatures and presumably also increased productivity to the Tasman Sea where this species predominantly forages. Linear regression indicates that the southern oscillation index (SOI) is a nearly significant predictor of nesting success (p=0.090) (Figure 11) and the proportion of females breeding (p=0.096), but it is not a significant predictor of survival (p=0.423). The proportion of the variance in nesting success and proportion breeding that is explained by regression against SOI is low (R^2 = 0.13 and 0.12) and the sharp decline in nesting success and proportion breeding in 2005 is not coincident with a marked change in the SOI. None-the-less there is a hint that there is a relationship between Gibson's wandering albatross demography and the southern oscillation and it is worth further investigation.

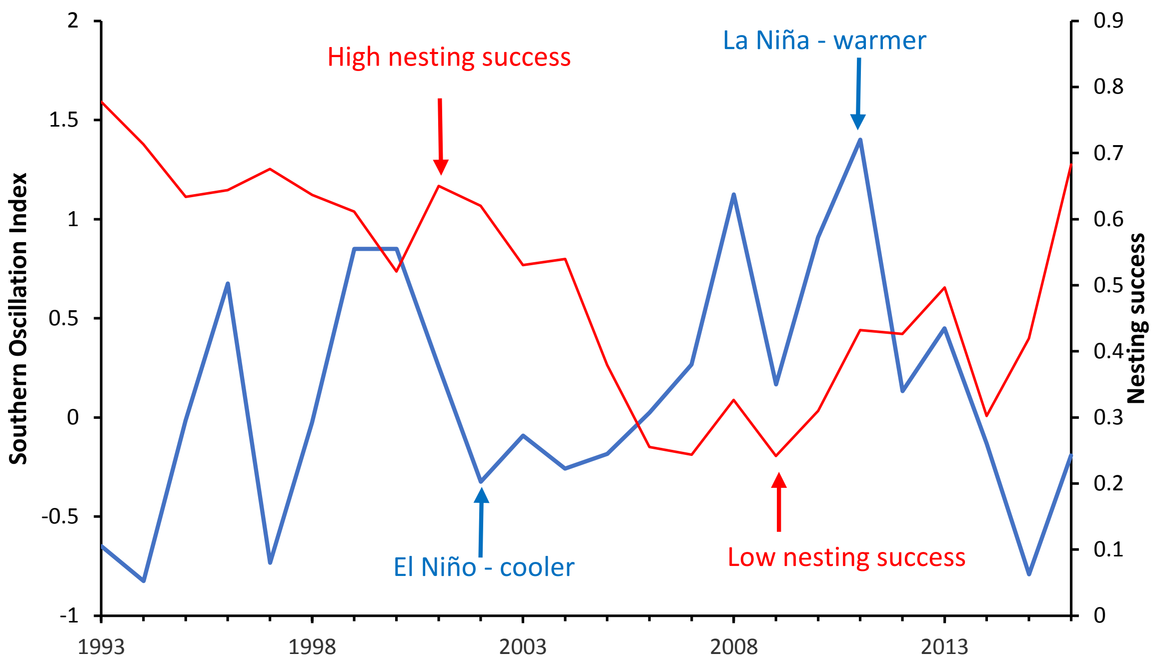

Figure 11: The Southern Oscillation Index and a possible relationship with the nesting success of Gibson's wandering albatross.

While El Niño southern oscillation (ENSO) events generally bring a cooler Tasman Sea for 6-18 months, the larger-scale Pacific decadal oscillation (PDO) may have played a role in longer-term Gibson's albatross population trends (Figure 12). The PDO was in positive phase, bringing generally cooler temperatures to the western Pacific from 1977 to 2000, but has been in negative phase bringing more La Niña's and warmer waters in the western Pacific since about 2005. Linear regression indicates that the Pacific Decadal Oscillation index (PDO) is a significant predictor of the proportion of females breeding (p=0.030) (Figure 11) and a nearly-significant predictor of nesting success (p=0.068), but it is not a significant predictor of survival (p=0.248). The proportion of the variance in proportion breeding and nesting success that is explained by regression against PDO is 0.20 and 0.14 respectively.

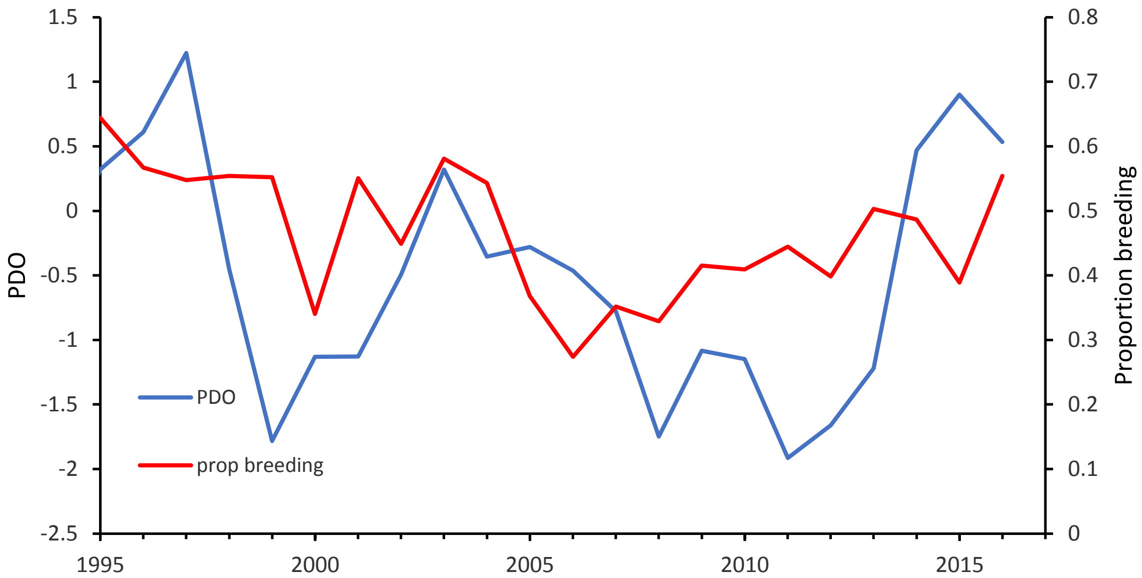

Figure 12: The Pacific Decadal Oscillation index and a possible relationship with the proportion of female Gibson's wandering albatross that breed.

While the relatively long Gibson's wandering albatross dataset and the improving availability of climate and ocean data make it easy to examine possible correlations between them, there are many other factors, such as changes in fishing effort, that might influence albatross demography which we have not examined.

While the conservation status of Gibson's wandering albatross is so poor, monitoring its population structure and trend on Adams Island remains an important conservation priority.

6. ACKNOWLEDGEMENTS

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7. REFERENCES

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

Elliott G, Walker K, Parker G, Rexer-Huber K. 2016. Gibson's wandering albatross census and population study 2015/16. Report on CSP Project 4655, prepared for the Department of Conservation, Wellington. http://www.doc.govt.nz/Documents/conservation/marine-and-coastal/marine-conservation-services/reports/pop2015-03gibsons-albatross-final.pdf

Fox JW. 2007. Geolocator manual version 6 (06/06/07). Unpublished report, British Antarctic Survey, Cambridge, UK.

Francis RICC, Elliott G, Walker K. 2015. Fisheries risks to the viability of Gibson's wandering albatross *Diomedea gibsoni*. *New Zealand Aquatic Environment and Biodiversity Report* **152**. Ministry of Primary Industries, Wellington.

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/.

Robertson HA, Dowding JE, Elliott GP, Hitchmough RA, Miskelly CM, O'Donnell CFJ, Powlesland RG, Sagar PM, Scofield RP, Taylor GA. 2012. Conservation status of New Zealand birds, 2012. *New Zealand threat classification series* **4**, Department of Conservation, Wellington.

Venables WN, Ripley BD. 2002. *Modern applied statistics with S*. Springer, New York.

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.