**Albatross Research**

# Antipodean wandering albatross census and population study 2017

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# ABSTRACT

Antipodean wandering albatrosses breed almost exclusively on Antipodes Island and following a dramatic population crash in 2006, males have been declining at about 6% per annum and females at about 12% per annum. The number of males and females in the breeding population before 2004 was approximately even but there are now more than two adult males for every adult female, with the population of breeding females only 25% of its 2004 level.

The decline appears to be driven in large part by very high female mortality, in some years up to 20%, though reduced breeding success and increased recruitment age have exacerbated the problem. Since 2005 most females when not breeding have been regularly visiting the coast off Chile, waters which they rarely visited in the past. Considering the absence of land-based threats, the main cause of high female mortality appears to be fisheries bycatch north of New Zealand and in the central and eastern Pacific between 20-30 degrees south. If this steep and rapid decline continues at the current rate there will be fewer than 500 breeding pairs in 20 years.

Antipodean wandering albatrosses are now assessed by the New Zealand Threat Classification System as "Nationally Critical" (Robertson et al 2017), and understanding the causes of and solutions to the high female mortality is urgently required.

# INTRODUCTION

Antipodean wandering albatross (*Diomedea antipodensis*) are endemic to the Antipodes Islands, with approximately 99% of the population breeding there and a few pairs nesting on both Campbell Island and at the Chatham Islands. They forage mainly in the Pacific Ocean east of New Zealand, and to a lesser extent in the Tasman Sea (Walker & Elliott 2006).

They are a regular by-catch in New Zealand long-line fisheries, with small numbers annually caught on observed domestic and chartered vessels (Abraham et al 2015). Numbers actually caught are likely to be considerably higher than those reported, as many long-line hooks set in New Zealand waters are from small unobserved domestic vessels, and there are substantial unobserved long-line fleets in international waters in the south Pacific Ocean where the birds mostly forage (Walker & Elliott 2006).

Due to the vulnerability of this long-lived and slow breeding species to fisheries bycatch, their survival, productivity, recruitment and population trends have been monitored during almost annual visits to Antipodes Island since 1994. This monitoring was started by the ornithologist and sailor Gerry Clark using his yacht *Totorore* to take volunteers to Antipodes Island in 1994 and 1995 to count the population (Clark et al 1995). In 1996–2005 Albatross Research undertook population study and at-sea satellite tracking with funds provided 50:50 from the New Zealand Government and the long line fishing industry. No monitoring occurred during the 2006 season, but skeletal monitoring was restored in 2007–2011 by researchers on the island to study white-chinned and grey petrels. Due to the sharp decline in albatross numbers found during 2007–11, in 2012–2017 full monitoring was resumed by Albatross Research volunteers with some logistic help from the Southland Department of Conservation.

In the 1990's the population increased following a major, presumably fisheries-induced, decline during the 1980's (Walker & Elliott 2005, Elliott & Walker 2005 and Walker & Elliott 2006). However, about 2006 there was a sudden drop in the size of the breeding population, and it has continued to decline since then.

This report summarises the most recent findings on the survival, productivity, population trends and at-sea distribution of Antipodean wandering albatrosses, collected during a 5 week trip to the island during the 2016/17 summer.

# METHODS

Details of the methods used, study area locations and earlier results are given in Walker & Elliott 2005, Elliott & Walker 2005 and Walker & Elliott 2006.

In brief, summer visits are made to Antipodes Island and all birds found within or near a 29 ha "Study Area" (Figure 1) are checked for bands. An attempt is made to identify both birds at every nest in the Study Area, and any breeding birds that have no bands are banded. All nests are labelled and mapped, the outcome of the previous year's nesting attempts are assessed, and the chicks banded. This data enables calculation of survivorship, productivity, recruitment, and attendance on the breeding grounds.

In addition, the number of active nests in 3 different parts of Antipodes Island (Figure 1) are counted each year (only 2 of these areas were counted in the period 2007-11). These 3 areas comprised 14.9% of all the nests on Antipodes Island between 1994 and 1996 (Walker & Elliott 2002), and the annual census of these blocks provides a reliable estimate of population trends.

Survival is estimated from the banded birds with mark-recapture statistical methods using the statistical software M-Surge (Choquet *et al.* 2005), and populations size is estimated from the actual counts of birds and the sighting probabilities produced when estimating survival.


**Figure 1.** Location of the Antipodean wandering albatross study area on Antipodes Island, the two census blocks and the area (shaded green) in which albatrosses do not nest.

### *Changes in the at-sea distribution*

Since 2011 there have been 50 geolocator dataloggers deployed on and retrieved from Antipodean wandering albatrosses in order to compare the foraging locations used when the population was declining with those used a decade earlier when it was growing.

Locations of the birds were calculated from light data using BASTRak software supplied by British Antarctic Survey (Fox 2007) and Intiproc provided by Migrate Technology (http://www.migratetech.co.uk/). More “reasonable” flight paths were obtained from the 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. The monthly sea-surface temperature data used to make this calculation was obtained from http://dss.ucar.edu.

Tracking data collected using geolocator loggers in 2011–2017 and tracking data collected using satellite transmitters in 1996-2001 was compared with 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). Bivariate normal kernels were used, with a normal reference band-width (Venables & Ripley, 2002). Longitudes were transformed by the cosine of latitude to make units of latitude and longitude approximately equal.

# RESULTS

### *Population size estimate from mark-recapture*

The size of the breeding population as estimated by mark-recapture was increasing up until 2005 at a rate of about 6.3% per annum for both sexes. Since 2005 the population of breeding pairs has been declining at about 12% per annum. Females have been declining at a faster rate (12.2% per annum) than males (5.7%), resulting in a sex imbalance since then, with more than 2 adult males for every one adult female (Figure 2).

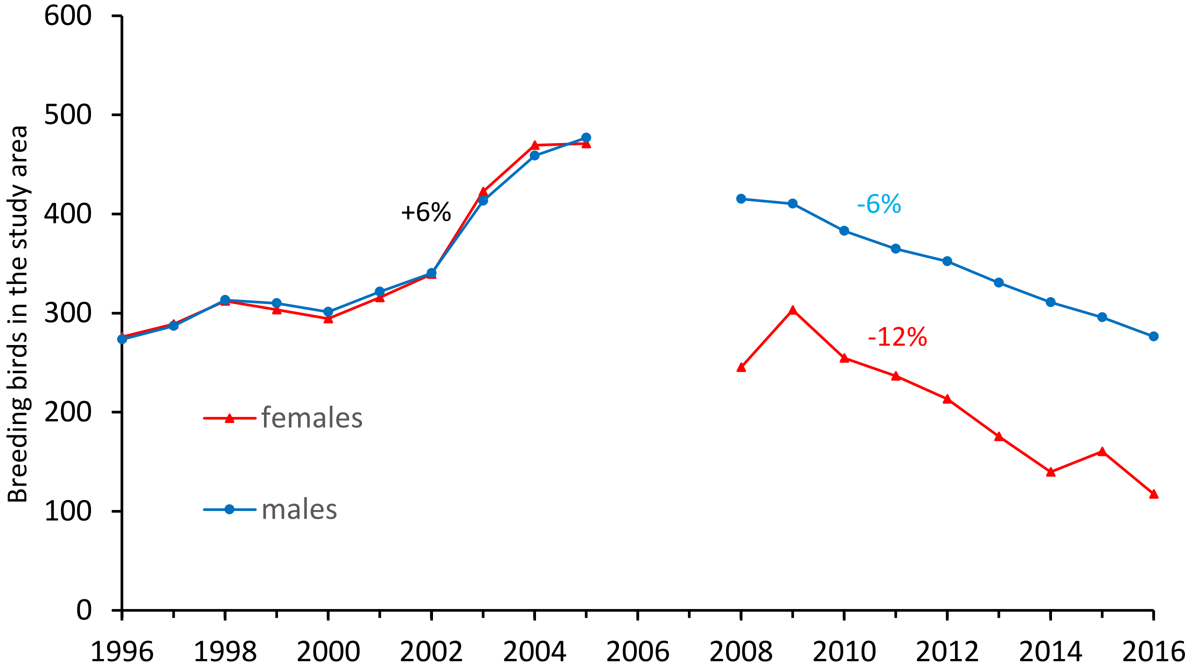


**Figure 2.** The number of breeding birds in the study area on Antipodes Island estimated by mark-recapture.

### *Survivorship*

Adult survival varied around a mean value of about 0.96 up until 2004 and during this period male and female survival was not significantly different. Since 2004 both male and female survival has declined, with female survival significantly lower than that of males (Figure 3).

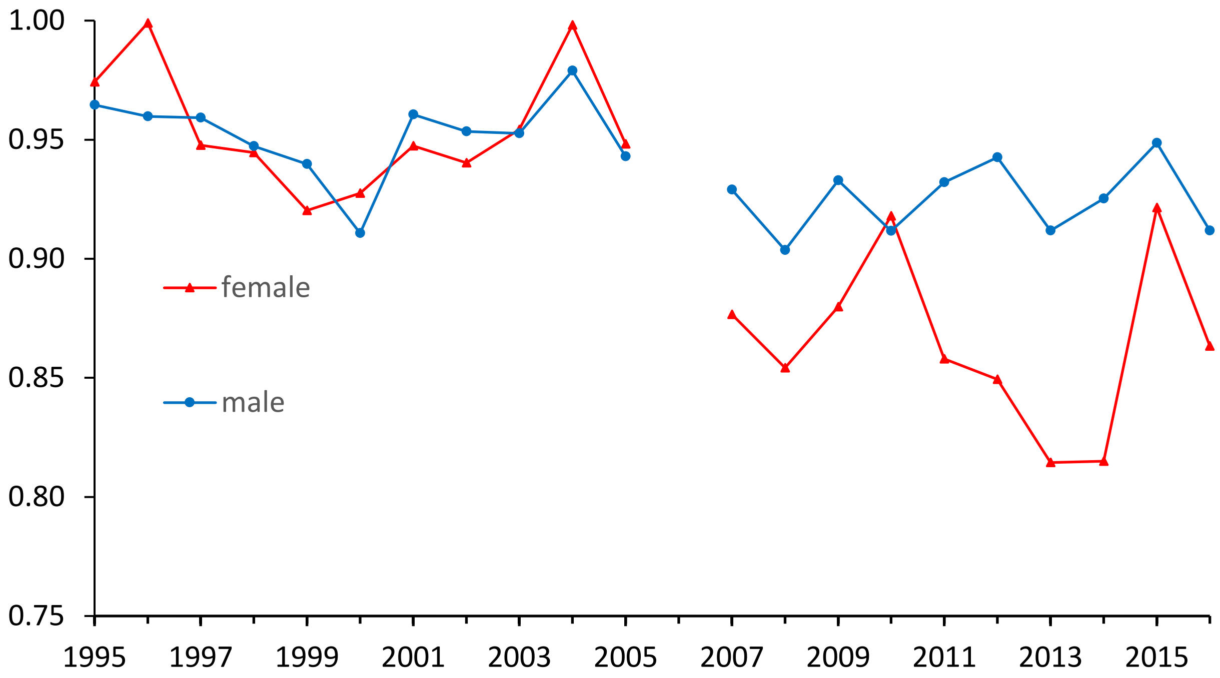


Figure 3. Estimated annual survival of Antipodean wandering albatross on Antipodes Island since 1994. Note that as the island wasn't visited in 2006, survival estimates for 2006 and 2007 were estimated from the survival over a 2-year period and then equally apportioned amongst the 2 years.

To identify groups of birds that might be suffering higher than usual mortality, the survivorships of birds that were breeding and birds that were not breeding were estimated separately (Figure 4). The survival of non-breeding males has remained relatively constant, while the survival of breeding males and females declined dramatically in 2005 with male survival increasing after 2010.

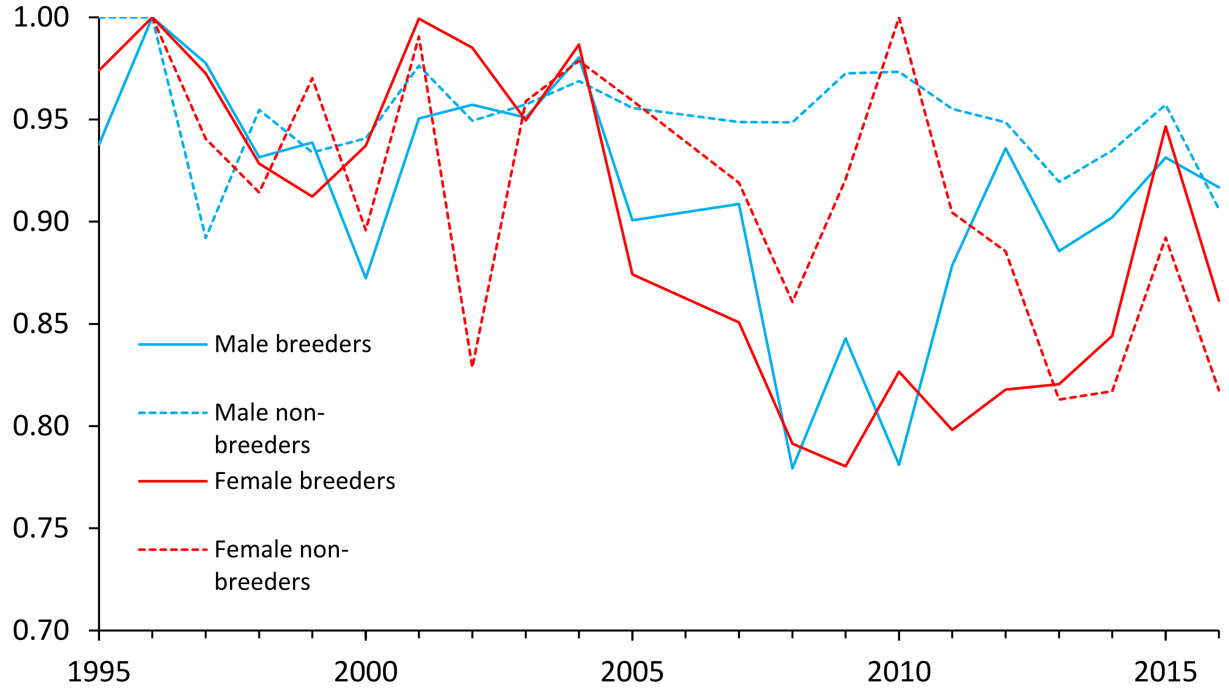


**Figure 4**. Estimated annual survival of breeding and non-breeding male and female Antipodean wandering albatross on Antipodes Island since 1994. Note that as the island wasn't visited in 2006, survival estimates for 2006 and 2007 were estimated from the survival over a 2-year period then equally apportioned amongst the two years.

### *Recruitment*

The number of birds breeding for the first time in the Study Area in 2017 was the lowest ever recorded (Figure 5).

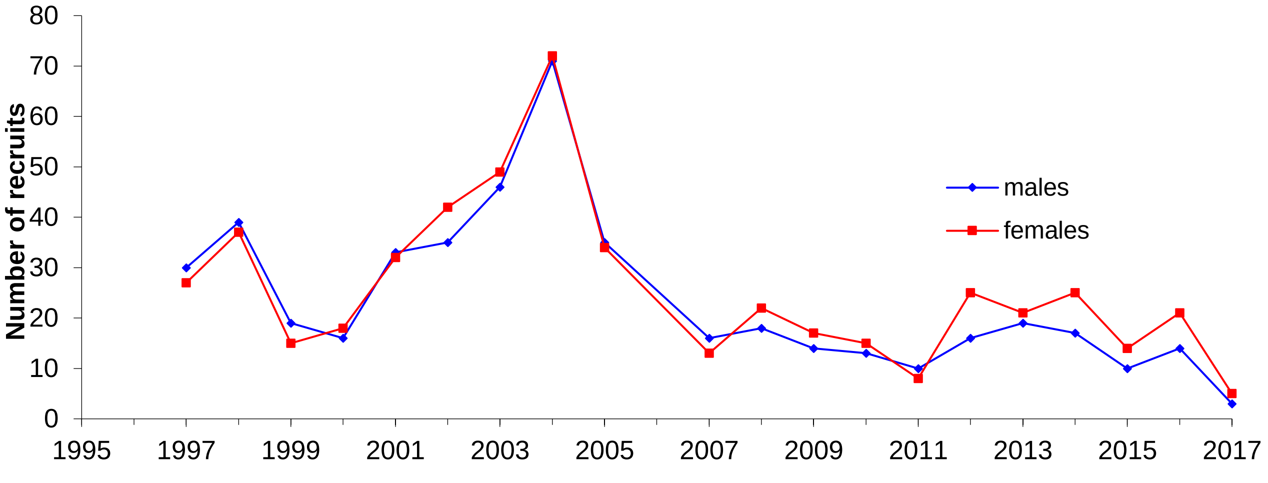


**Figure 5.** Number of birds recruiting to the breeding population in the study area on Antipodes Island since 1997

***Productivity***

Nesting success averaged 74% before 2005 but dropped to an average of 60% after 2005. The number of chicks produced in the study area has declined more markedly than the reduction in breeding success due to the combined effect of fewer birds nesting and reduced nesting success (Figure 6).

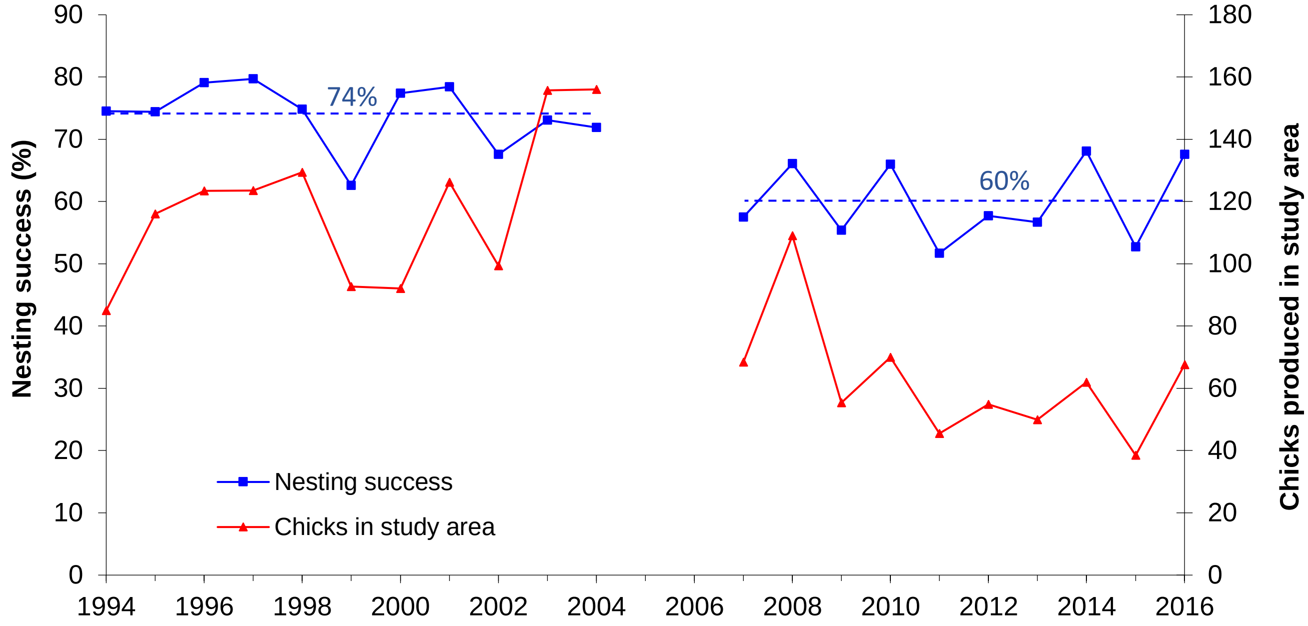


**Figure 6.** Nesting success and the number of chicks fledged from the study area on Antipodes Island since 1994. The dashed lines indicate average nesting success in two periods, 1994-2004 and 2007-2016.

***Nest counts in 3 representative blocks***

After increasing for five years between 2000 and 2005, the number of nests in the study area and Block 32 declined between 2005 and 2007 by about 38% and has continued to decline since then, albeit more slowly (Table1, Figure 7) The pattern of population change in the larger MCBA block, which has been counted less frequently, is approximately the same as the other two blocks.

**Table 1:** Antipodean wandering albatross nests with eggs in February in three areas on Antipodes Id in 1994– 2017.

| Year | Study area | Block 32 | Subtotal | MCBA | **Total** |
|---|---|---|---|---|---|
| 1994 | 114 | 125 | 239 | 544* | **783** |
| 1995 | 156 | 185 | 341 | 482* | **823** |
| 1996 | 154 | 133 | 287 | 418* | **705** |
| 1997 | 150 | | | 464* | |
| 1998 | 160 | | | 534 | |
| 1999 | 142 | | | 479 | |
| 2000 | 119 | 130 | 249 | 462 | **711** |
| 2001 | 160 | 141 | 301 | 443 | **744** |
| 2002 | 148 | 178 | 326 | 605 | **931** |
| 2003 | 214 | 187 | 401 | 608 | **1009** |
| 2004 | 216 | 249 | 465 | 755 | **1220** |
| 2005 | 211 | 186 | 397 | 613 | **1010** |
| 2006 | | | | | |
| 2007 | 119 | 127 | 246 | | |
| 2008 | 165 | 135 | 300 | | |
| 2009 | 98 | 120 | 218 | | |
| 2010 | 106 | 101 | 207 | | |
| 2011 | 88 | 108 | 196 | | |
| 2012 | 95 | 104 | 199 | 345 | **543** |
| 2013 | 88 | 93 | 181 | 297 | **478** |
| 2014 | 91 | 103 | 194 | 341 | **535** |
| 2015 | 73 | 86 | 159 | 291 | **450** |
| 2016 | 100 | 92 | 192 | 291 | **483** |
| 2017 | 57 | 82 | 139 | 230 | **369** |

- estimated (see Walker and Elliott 1998).

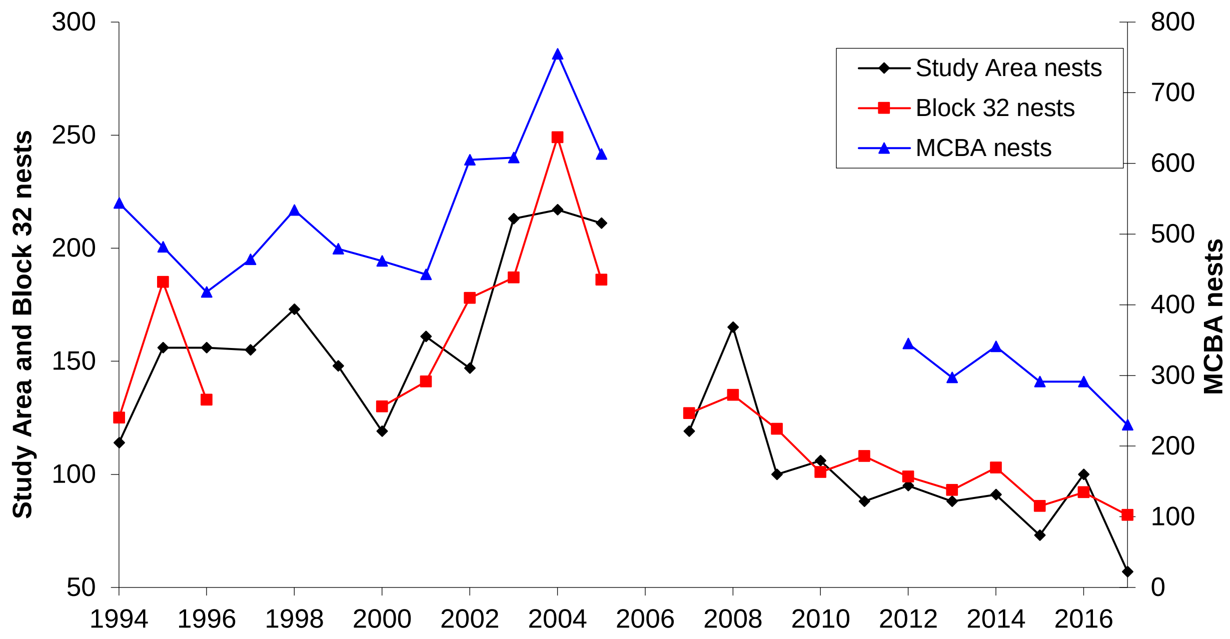


**Figure 7.** The number of Antipodean wandering albatross nests in three blocks on Antipodes Island since 1994.

### *Total number of nests on the island and estimated population size*

The number of pairs of Antipodean wandering albatross nesting on the whole Antipodes Island was estimated in 2017 from counts of the 3 census blocks in 2017 and the proportion of the whole population nesting in these blocks (14.9%) during whole island counts undertaken between 1994 and 1996 (Walker & Elliott 2002).

A total of 369 nesting pairs were counted in the 3 census blocks in 2017, from which it was estimated there were 2477 pairs were nesting on Antipodes Island that year. The mark-recapture analysis indicated that on average only 62% of the breeding females in the study population laid in each of the last 4 years, which suggests that the total number of breeding females and breeding pairs is approximately 3945. This compares with an annual average of 5180 pairs breeding in 1994-96 and a total number of breeding pairs of about 8,600 in 1994-96 (Walker & Elliott 2005). At the rate of decline observed over the last few years (-12%) there will be less than 500 breeding pairs of Antipodean wandering albatross in 20 years.

### *Changes in the at-sea distribution of Antipodean wandering albatrosses*

Dataloggers were deployed and retrieved on 50 birds in 2012–2017, with a roughly even number of males and females tracked during both non-breeding and breeding period foraging trips. In a preliminary analysis, datalogger at-sea tracking results were compared with those gathered by satellite tracking of 65 birds tracked between 1996 and 2004 (Walker & Elliott 2006).

The foraging range of breeding birds has changed less than that of non-breeding birds, with breeding females foraging further north after 2004 than they did before, while the range of breeding males seems only to have increased a little in all directions (Figure 8).

In contrast the range of non-breeding birds, particularly females, has increased dramatically (Figure 9). Breeding females before 2004 were recorded foraging in a relatively limited area centred east of the Chatham Islands. They were never recorded travelling to South America, but post-2004 almost all do.

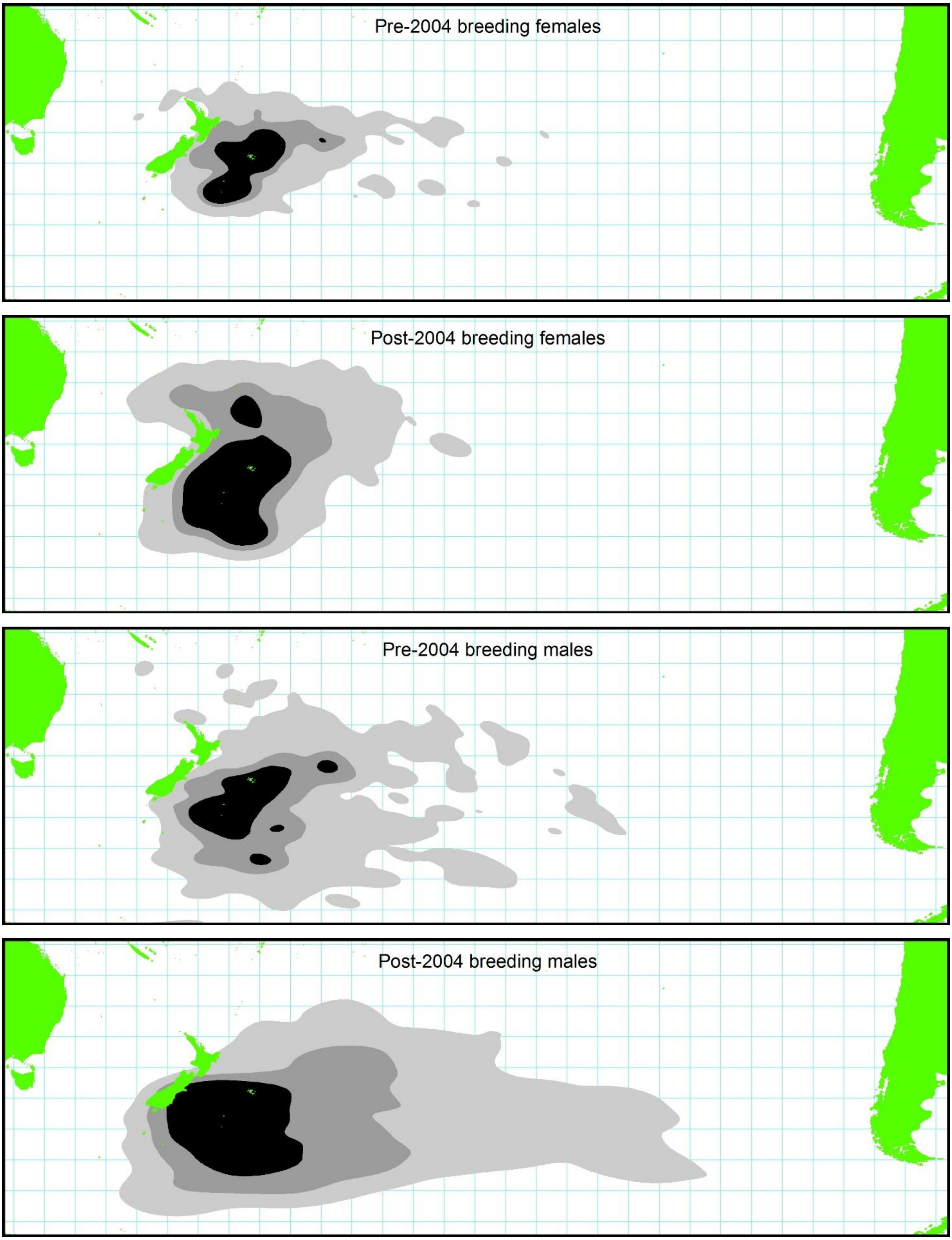


**Figure 8**: Kernel density plots of breeding Antipodean wandering albatrosses tracked in 1996-2004 and in 2011-17. Black indicates the 50% contour, dark grey the 75% contour, and light grey the 95% contour.

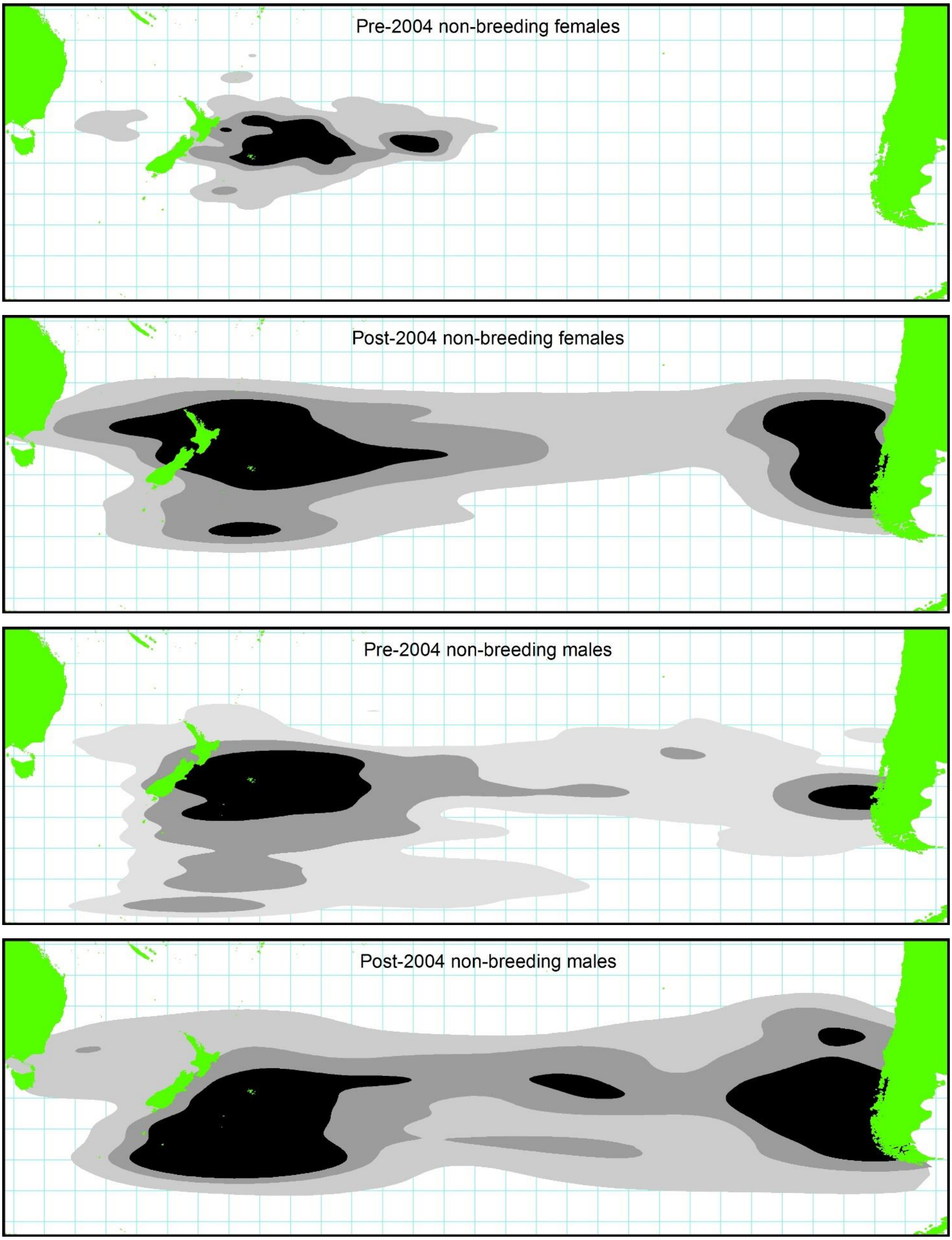


**Figure 9.** Kernel density plots of non-breeding Antipodean wandering albatrosses tracked in 1996-2004 and in 2011-17. Black indicates the 50% contour, dark grey the 75% contour, and light grey the 95% contour.

Birds are not using all ocean areas at all times of year (Figure 10). Females are confined to the oceans around the Antipodes and Chatham Islands while breeding, but many non-breeding females travel to southern Chile in the autumn and then move up to seas west of Juan Fernandez Islands in early winter, return to northern New Zealand waters and the Tasman Sea in mid-winter to early spring, then return to the southern Chilean coast again in late spring.

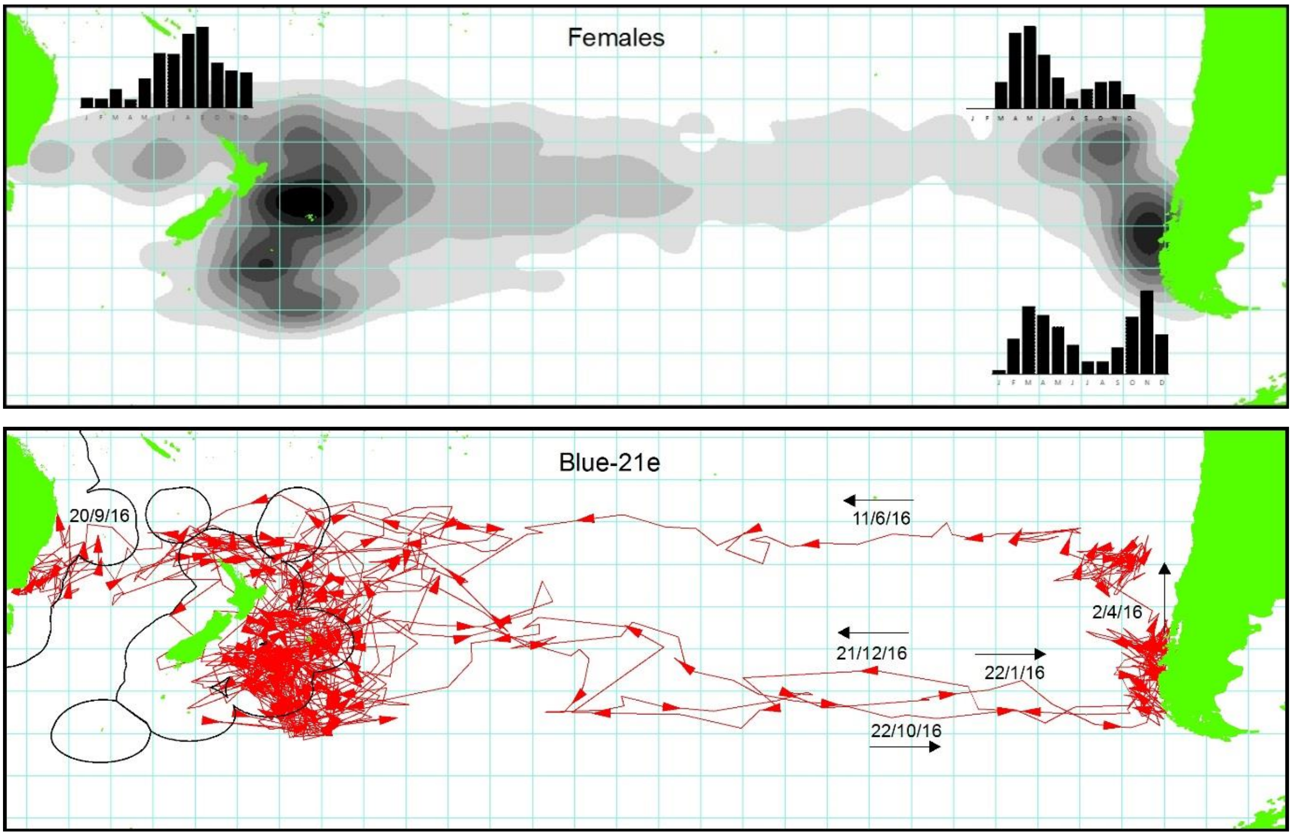


**Figure 10**. The foraging range of female Antipodean wandering albatrosses. The bar charts in the upper map show the timing of female birds visiting 3 ocean areas, and the lower map shows the foraging range of one female bird breeding in 2015 and having a "sabbatical" year in 2016. Black lines mark the extent of New Zealand and Australian territorial waters.

Since female Antipodean wandering albatrosses have suffered higher rates of mortality than male Antipodean and either male or female Gibson's wandering albatrosses (Walker et al. 2017), it follows that the ocean areas where female Antipodean wandering albatrosses go but other New Zealand wandering albatrosses do not, might be the places where they are suffering higher mortality. Those places have been identified by subtracting the rasterized versions of kernel density plots of the range of male Antipodean wandering albatrosses and male and female Gibson's wandering albatrosses from that of female Antipodean wandering albatrosses (Figure 11). Rasters were normalised so that they each added to one before subtraction.

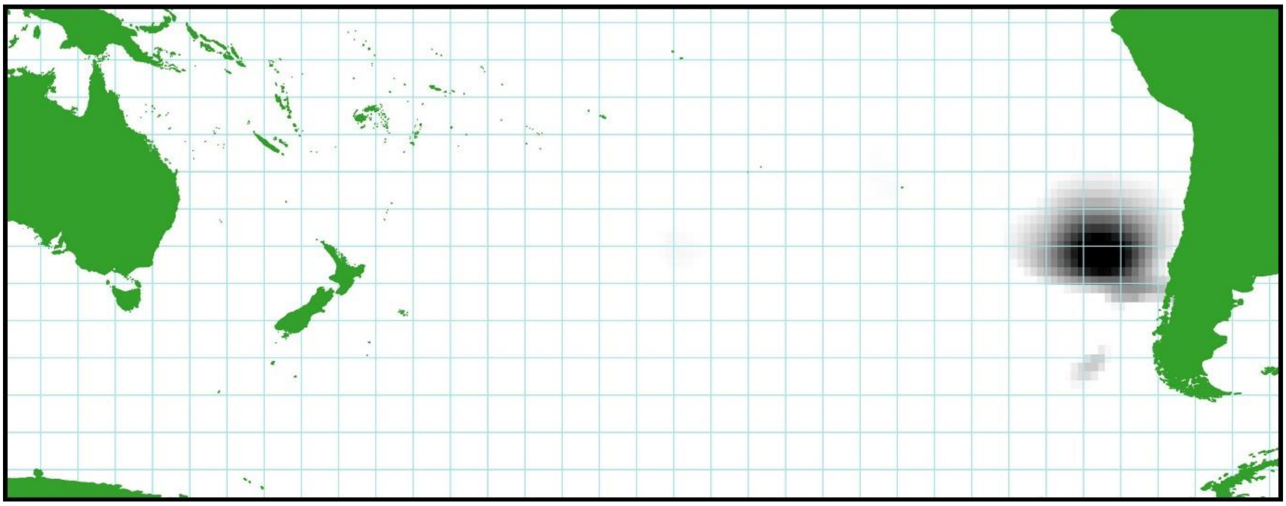

**Figure 11:** Places where female Antipodean wandering albatrosses go, but males and Gibson's wandering albatrosses do not go.

### *Threats from fisheries*

Wandering albatrosses are a regular bycatch in observed surface longlining fisheries in New Zealand waters (Abraham et al 2015), though not all are identified to species level. As Antipodean wandering albatrosses spend much of their time foraging in international waters, the bycatch estimates from within the New Zealand EEZ are likely to be significantly underestimating total fisheries bycatch. In the decade 1988-98, 90 Antipodean wandering albatrosses were recovered dead from observed fisheries in New Zealand waters (Walker & Elliott 2006). Between 2004 and 2014, 29 Antipodean wandering albatrosses were reported caught on observed fisheries vessels in New Zealand waters (Abraham & Thompson 2015). Over the same period there were 41 fisheries-related band recoveries of Antipodean wandering albatrosses, many of which came from international waters in the central and eastern Pacific (Walker & Elliott 2006), six of them since 2007 (Figure 12).

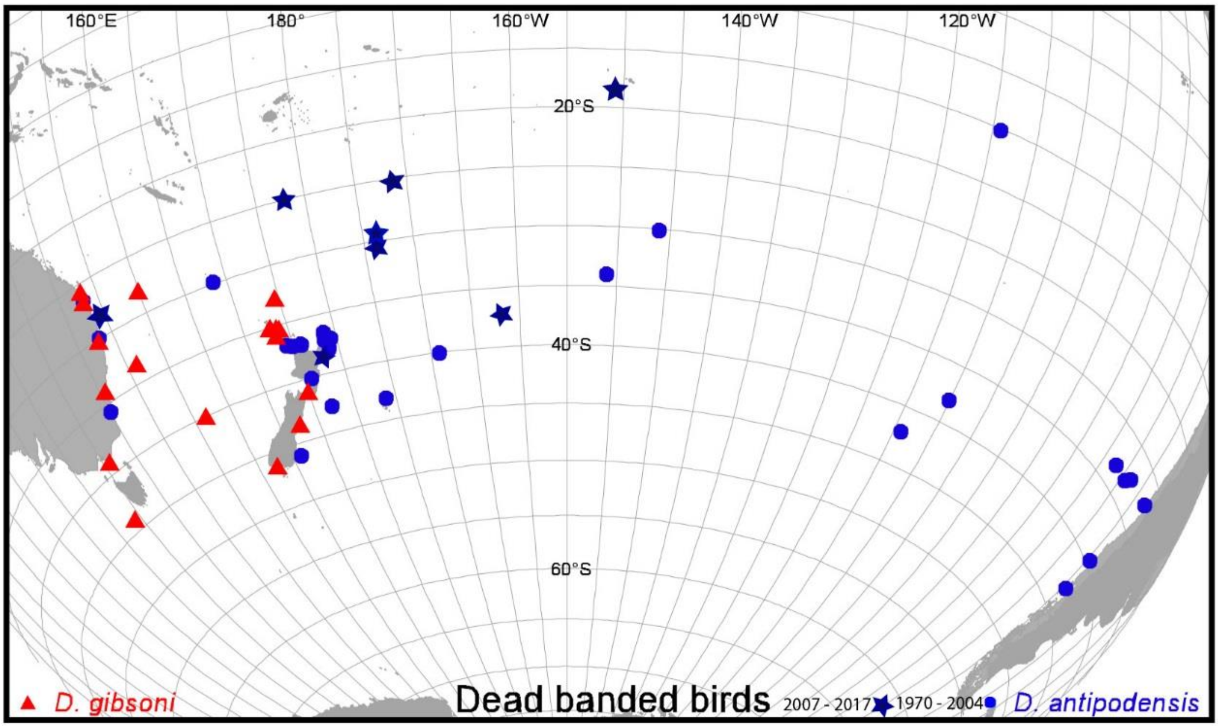


**Figure 12:** Distribution of recoveries between 1970 and 2017 of 41 Antipodean wandering albatrosses banded on Antipodes Island (48$^0$S, 178$^0$E), and between 1970 and 2004 of 18 Gibson's wandering albatrosses banded on Adams Island (50$^0$S, 166$^0$E).

# CONCLUSIONS

The population of Antipodean wandering albatross is now only 60% the size it was in 1994 when the population was first counted, and only 40% the size it was at its highest recorded level in 2004. The main cause of the decline since 2006 is high mortality of females, with their survival rates much lower than that of males. Since 2006, although female survival has varied between years, at its worst 20% of adult females died each year. For a long-lived, slow reproducing species, such high mortality rates are unsustainable. If the current rate of decline (12%) continues, there will be fewer than 500 breeding pairs of Antipodean wandering albatrosses in 20 years, a level sometimes equated with functional extinction.

The recent tracking data suggests that since the dramatic downturn in the Antipodean wandering albatross population after 2006, the birds have been foraging over a greater area of ocean than previously and are now frequently visiting places that they only rarely visited in the past. Females now routinely forage in two places they previously never or rarely visited, and to which males seldom travel: the seas north-west of Juan Fernandez Islands and the seas north-east of New Zealand.

The population of the closely related Gibson's wandering albatross which feeds primarily in the Tasman Sea and in the great Australian Bight has also been in sharp decline since 2005. Since 2005 its annual breeding success was on average 24 percentage points lower than that of Antipodean albatross while in 2005–2009 female mortality was—like that of female Antipodean wandering albatrosses—very high, causing that population's steep decline.

However, since 2010 survival of female Gibson's wandering albatrosses has improved, while that of Antipodean females has not. This difference, in association with their differing foraging ranges, suggest the recent Antipodean wandering albatross high mortality originates in the seas north-east of New Zealand, rather than in the Tasman Sea. Further, the markedly higher breeding success of Antipodean wandering albatross compared to Gibson's wandering albatross suggests the high mortality of Antipodean females is not due to nutritional stress but rather to misadventure, most probably as bycatch in fisheries, in the more northerly and eastern waters they, and probably also juvenile birds (Walker & Elliott 2006, Weimerskirch et al 2012) are foraging in.

The "nationally critical" status of Antipodean wandering albatross (Robertson *et al.* 2012) and its rapid decline mean that population monitoring and exploration of the likely causes of and solutions to its decline are high priorities.

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