Antipodean wandering albatross census and population study on Antipodes Island 2019

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ABSTRACT

The Antipodean wandering albatross *Diomedea antipodensis antipodensis* has been in sharp decline for over a decade with males declining at ~ 6% per annum and females at ~ 8% 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 42% of its 2004 level.

The decline appears to be driven in large part by high female mortality, though reduced breeding success and increased recruitment age have exacerbated the problem. Although there has recently been a levelling off in the number of nesting birds, this apparent improvement has been driven by an increase in the proportion of birds breeding and high recent recruitment, neither of which is sustainable. Female survivorship in 2018 improved, but survivorship in 2017 was very low and there is no evidence of a sustained improvement in female survival.

The deployment of 65 satellite tracking devices in January and February 2019 provided the opportunity to better describe the foraging range of various life-history stages, and to identify overlap with fishing fleets that may be increasing Antipodean wandering albatross mortality through bycatch. A range of tracking devices and technologies were used. The overlap between birds and high sea longline fisheries occurs mostly in winter and spring, by which time many devices had failed. Real-time tracking allowed detection of the capture of at least 2 females likely bycaught in fisheries, one bycatch event being confirmed by an international observer on the vessel involved. Tracking should be undertaken for several years preferably using lighter (<30g) and more reliable satellite transmitters to encompass different seasonal oceanic conditions, to help identify fishing fleets with high levels of spatial and temporal overlap with Antipodean wandering albatrosses.

Antipodean wandering albatrosses are ranked by the New Zealand Threat Classification System as "Nationally Critical" (Robertson *et al.* 2017) and identifying the causes of and solutions to the high female mortality remains a high priority.

INTRODUCTION

Antipodean wandering albatross (*Diomedea antipodensis antipodensis*) is one of two subspecies of *D. antipodensis* and is endemic to the Antipodes Islands, with approximately 99% of the population breeding there. A few pairs also nest 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 known bycatch in New Zealand long-line fisheries, with small numbers annually caught on observed domestic and chartered vessels (Abraham & Thompson 2015). Numbers actually caught are likely to be higher than those reported, as many long-line hooks set in New Zealand waters are from small unobserved domestic vessels. In addition, there are substantial long-line fleets with poor observer coverage in international waters in the southern Pacific Ocean (Peatman *et al.*2019) where the birds mostly forage (Walker & Elliott 2006).

Due to the vulnerability of this long-lived and slow breeding species to any additional mortality, their survival, productivity, recruitment and population trends have been monitored during almost annual visits to Antipodes Island since 1994. 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, in 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 seven-week trip to the island during the 2018/19 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 is 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 2002a), 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.

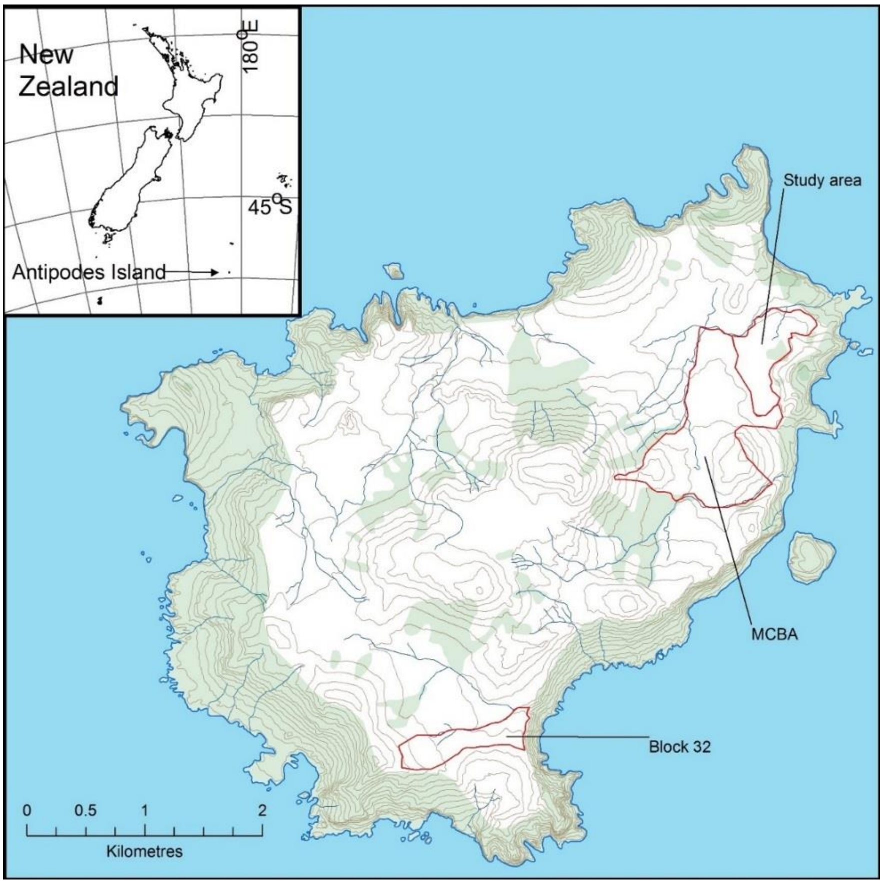

Figure 1. Location of the Antipodean wandering albatross study area on Antipodes Island, the two census blocks and the area (shaded green) in which albatrosses do not nest.

At-sea distribution

Ten Migrate Technology dataloggers attached in February 2018 to 7 female and 3 male adult Antipodean wandering albatrosses were recovered in January 2019. Three of the females had attempted to breed in 2018 but failed early while the remaining 7 birds had lost their partners, so all tracks logged in 2018 were from non-breeding birds. The locations of the birds carrying these loggers were calculated from the light data using IntiProc software supplied by Migrate Technology. More accurate flight paths were obtained by estimating longitude from the logger's light data and estimating latitude by matching the sea temperature data recorded by the logger with the nearest sea-surface temperature at the estimated longitude (Shaffer *et al.* 2005). Monthly sea-surface temperature data was obtained from the United States National Oceanic and Atmospheric Administration (ftp://ftp.emc.ncep.noaa.gov/cmb/sst/oimonth_v2/ASCII_UPDATE). The logger data obtained from 10 birds in 2018 was added to that obtained since 2012, bringing the total number of birds tracked for 12 to 24 months using dataloggers between 2011–2019 to 70; 38 females and 32 males.

To better describe in real time the foraging range across life history stages, and identify ocean areas where albatrosses might be interacting with fishing vessels, 65 satellite transmitter tracking devices of 4 types (Table 1 & Figure 2) were attached to albatrosses between 4 January and 11 February 2019 (Table 2). In addition, 17 loggers of 2 types (Table 1) were deployed: 7 tiny Migrate technology loggers, attached by cable-ties to the engraved metal leg bands of birds to which various satellite transmitters were also fitted to compare device accuracy, and 10 large Sputnik loggers for technology testing. In total 82 devices were deployed in January–February 2019. Twenty fully-grown chicks were tagged, just before they fledged (Table 2). Nesting adults were tagged at their nests whilst incubating, and other adults were tagged either when their 2019 nesting attempt failed early, or when they visited the study area to court (Table 2). All transmitters and the Sputnik GPS loggers were attached to feathers on the birds' backs using Tesa® tape.

Table 1: Four types of transmitters and 2 types of loggers attached to Antipodean wandering albatross. Duty cycle refers to the potential number of locations obtained or estimated.

Model	Location system	Power	Data retrieval	Duty cycle	Radar detection
Wildlife Computers, **Rainier S20**	GPS + Argos	Battery + solar	Satellite	1/hr	
Telonics, **TAV2360**	Argos	Battery	Satellite	3hrs/day	
Lotek, **Pinpoint**	GPS + Argos	Battery	Satellite	4/day	
Sextant Technology, **Sextant**	GPS + Argos	Battery + solar	Satellite	1/hr	✓
Sextant Technology, **Sputnik GLS**	GPS	Battery	At recapture	variable	✓
Migrate Technology, c330 **GLS**		Battery	At recapture	2/day	

Table 2: The number, age, sex and status of Antipodean wandering albatross which had one of 4 types of satellite transmitter or 1 sputnik logger attached. * indicates some birds in this group also had Migrate GLS attached (numbers in brackets)

	Females			Males			Total
	adult breeders	adult non-breeders	chicks	adult breeders	adult non-breeders	chicks	
Rainier S20	4*	6					10
TAV2360			10			10	20
Pinpoint	2	2			9*		13
Sextant	8	8*		3	3		22
Sputnik GLS	9			1			10
Migrate GLS	(1)	(3)			(3)		7
Total	23	20	10	4	15	10	82

Two of the tag types detect and record radar. This provides a record of when birds carrying these devices are close to radar sources. Antipodean wandering albatrosses feed off the shelf edge and boats this far offshore almost invariably carry and use radar. The sputnik dataloggers record large amounts of data and have a short battery life (~1 month) so needed to be removed after a single flight before we left Antipodes Island, whereas all other tracking equipment deployed was expected to run for up to a year. This potentially allows for their recovery in the summer of 2019/20 if they return to Antipodes Island, provided the tags have not fallen off in the meantime as the feathers they are attached to may have moulted off or been damaged by tag wear. The tags attached to fledglings will never be recovered as juveniles do not return to the island for around 5 years and they will have moulted all their feathers before then, and hence lost the device.

Interactions of tracked birds and fishing fleets was analysed by comparing the birds' tracks with the locations of fishing boats available from the Global Fishing Watch website https://globalfishingwatch.org/map/.

RESULTS

Population size estimate from mark-recapture

The size of the breeding population as estimated by mark-recapture was increasing up until 2005 at an average rate of about 8% per annum for both sexes— slowly initially, then rapidly in 2002–2005 (Figure 2). Since 2007 the population of breeding pairs has been declining, initially at about 9% per annum and latterly at about 5% per annum (mean 8% per annum). Detection of some erroneous data, more re-sighting data, and a declining mortality rate are responsible for changes in these estimates over time (see Elliott & Walker 2017). Females have been declining at a faster rate than males resulting in a sex imbalance since 2005 (Figure 2).

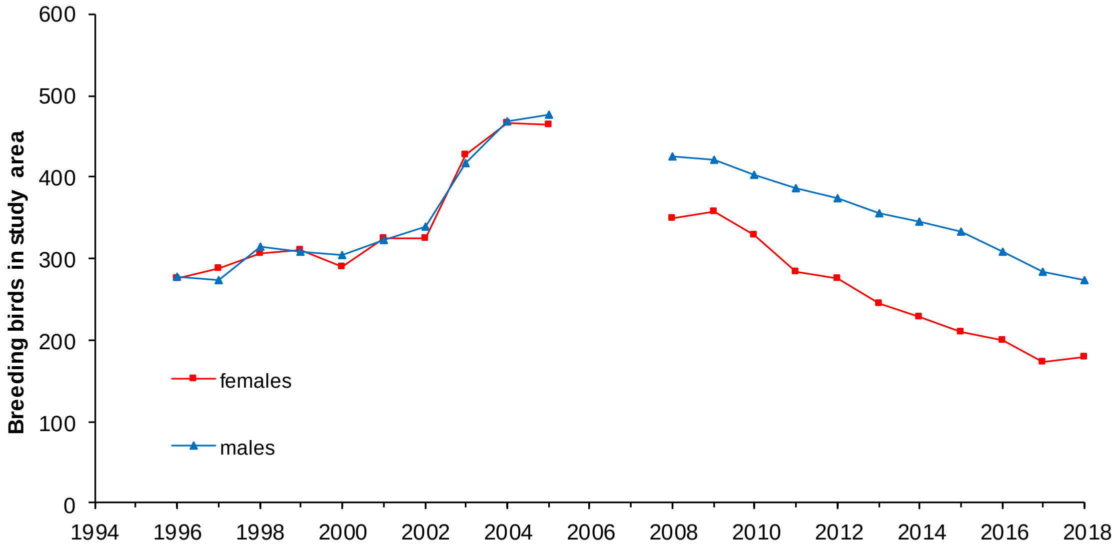

Figure 2. The number of breeding birds in the study area on Antipodes Island estimated by mark-recapture.

Survivorship

Adult survival varied around a mean value of about 0.96 up until 2004 and during this period male and female breeder and non-breeder survival was not significantly different. Since 2004 both male and female survival has declined, with female survival significantly lower than that of males (Figures 3 & 4) with the survivorship of breeding birds of both sexes usually lower than that of non-breeding birds.

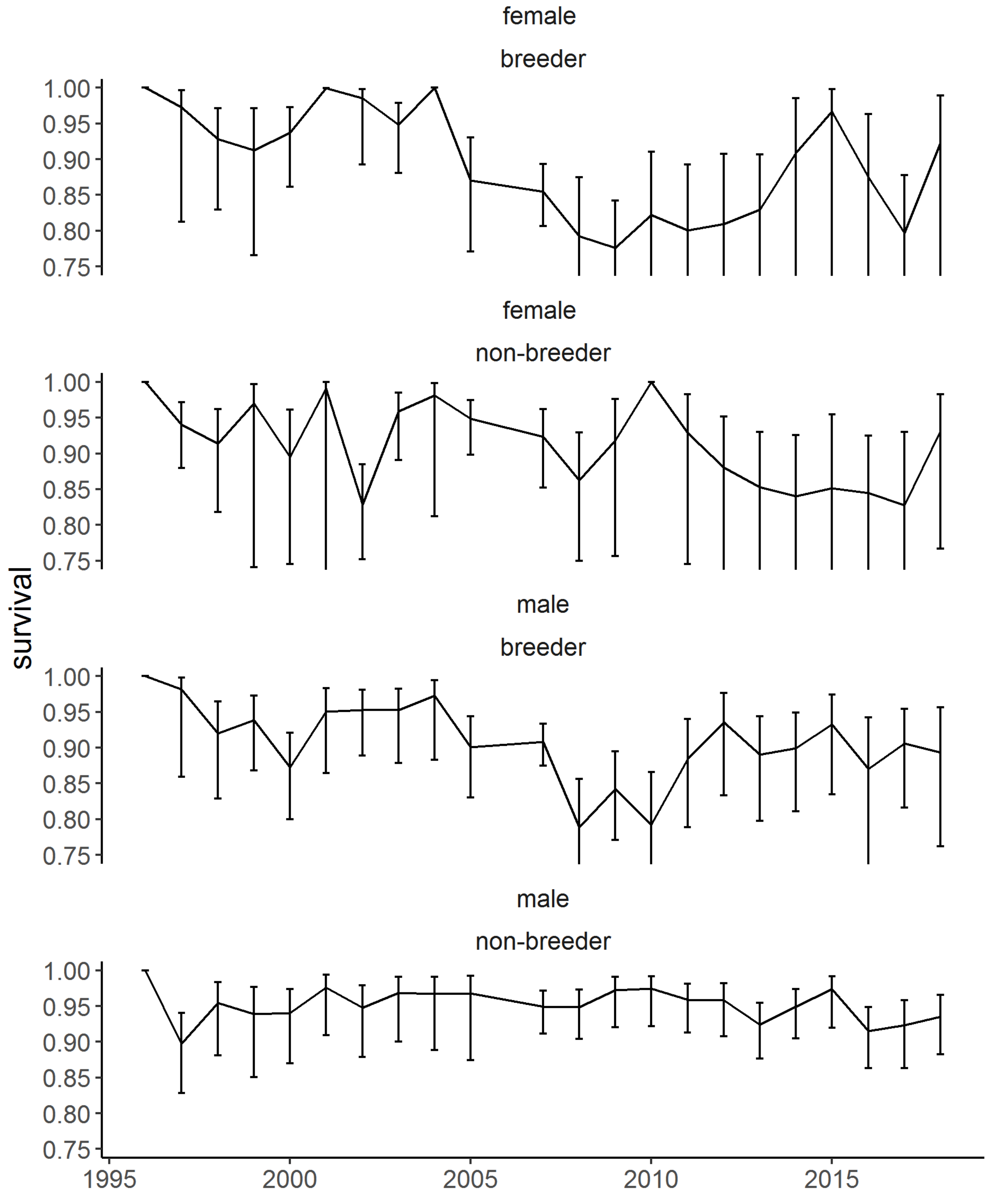

Figure 3. Estimated annual survival of Antipodean wandering albatross on Antipodes Island since 1995 with 95% confidence intervals.

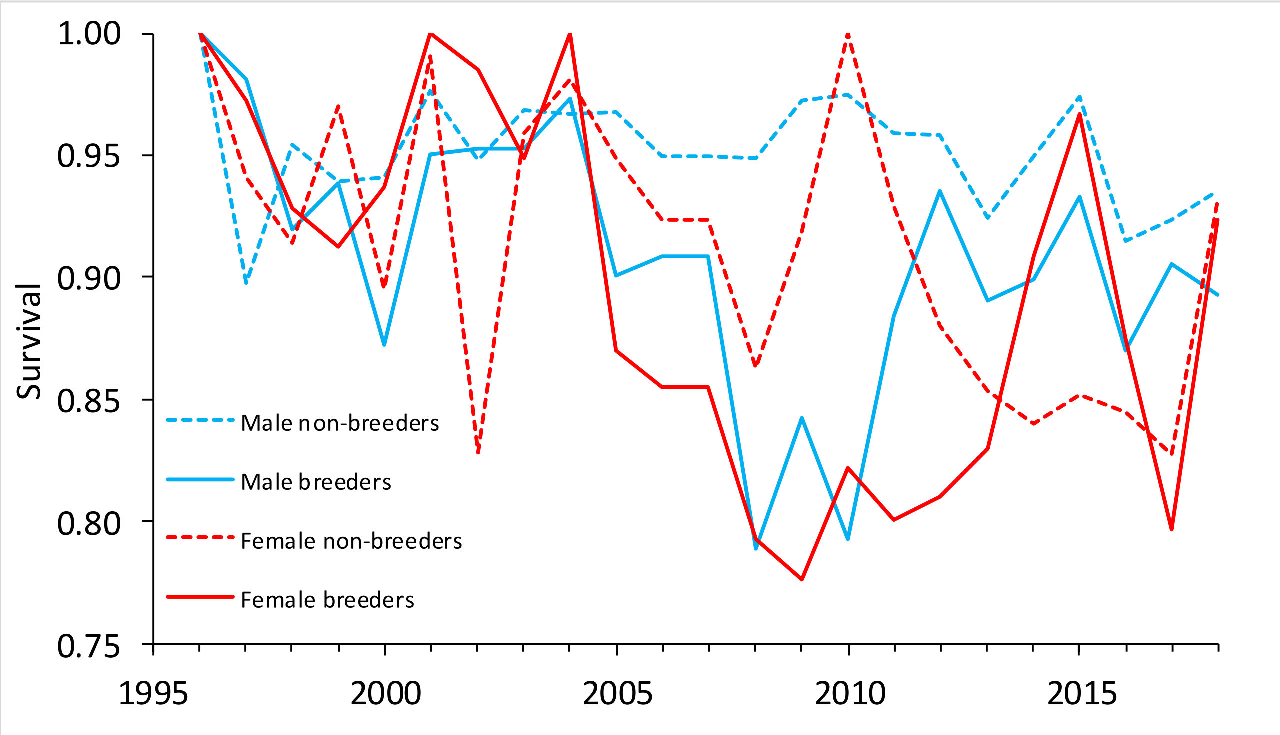

Figure 4. Estimated annual survival of Antipodean wandering albatross on Antipodes Island since 1995.

Proportion of birds breeding

By comparing the number of nesting females in the study area with the mark-recapture estimate of the number of females in the breeding population, it is possible to estimate the proportion of females that breed each year. Before 2005 about half of the breeding females nested each year but between 2005–2010, the proportion of females that attempted to breed dropped to as low as 24%, before recovering (Figure 5). In 2016 and 2018 the proportion breeding was back to about 50%. The low proportion breeding in 2017 is almost certainly the result of very high breeding success in 2016 (80%) which meant that many birds took a year off breeding in 2017.

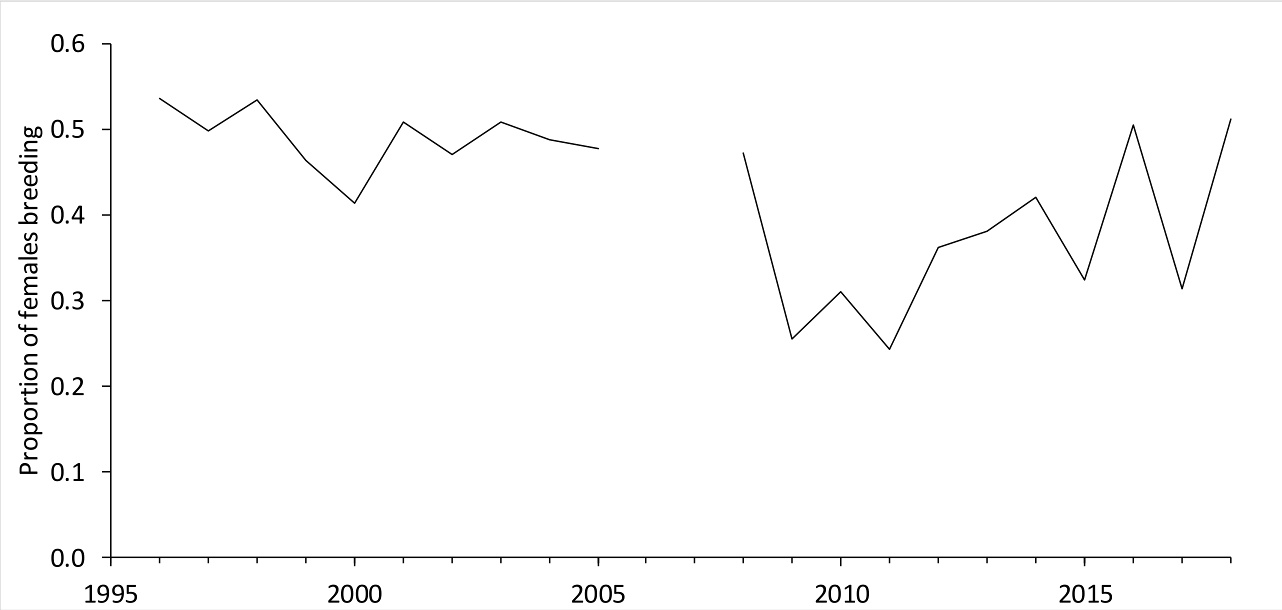

Figure 5. Proportion of female Antipodean wandering albatrosses breeding in the study area on Antipodes Island.

Recruitment

The number of birds breeding for the first time in the study area in 2019 was higher than in any year since the population crash in 2005 (Figure 6). Nearly one third of the pairs breeding in 2019 were first time breeders, suggesting the size of the pre-breeding population is a major determinant now of any population recovery.

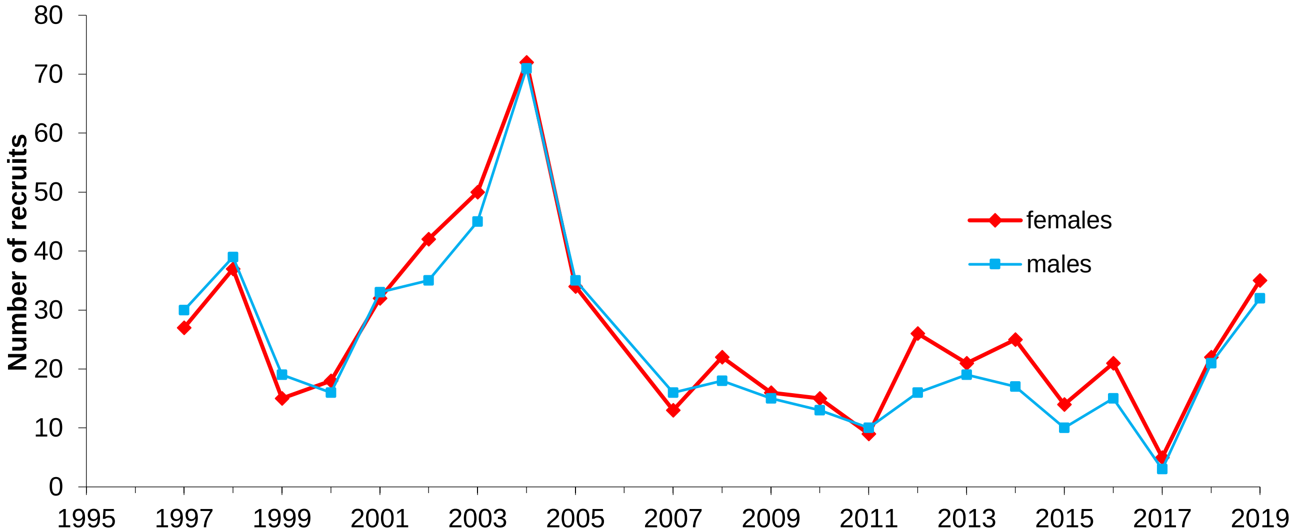

Figure 6. Number of birds recruiting to the breeding population in the study area on Antipodes Island since 1997.

In 2019 the average age of recruiting birds banded as chicks was 18 years old, about the same as it was in 2016–2018. Our data cannot tell us whether the average age of recruitment has changed over time, because many recruits are un-banded and of unknown age. However, the average age of known-age recruits does suggest that most of the birds recruiting into the breeding population now, hatched during a time of high productivity before 2005.

Many of the un-banded birds now recruiting to the study area population were probably reared in the study area. The presence of so many un-banded recruits likely reflects suboptimal timing of Antipodes Island expeditions over the years, rather than immigration of birds from outside the study area. In four of the past 25 years no chicks in the study area were banded (2004, 2006, 2009, 2014), in another four seasons about half of the study area chicks were banded (1996, 1998, 1999, 2005) and all or almost all chicks were banded in the remaining 15 breeding seasons between 1995 and 2019.

Productivity

Nesting success in 2018 was 66%, identical to that in 2016, but much lower than the post-crash high point of 80.4% success in 2017. While the nesting success in 2018 has slipped back to more average post-crash levels, the last 3 years have all been on the positive side of that level, presumably indicating improved breeding conditions as a long period of La Nina gives way to El Nino dominated weather. However, despite 66% breeding success in 2018, only 64 chicks were produced (Figure 7) due to the reduced size of the breeding population.

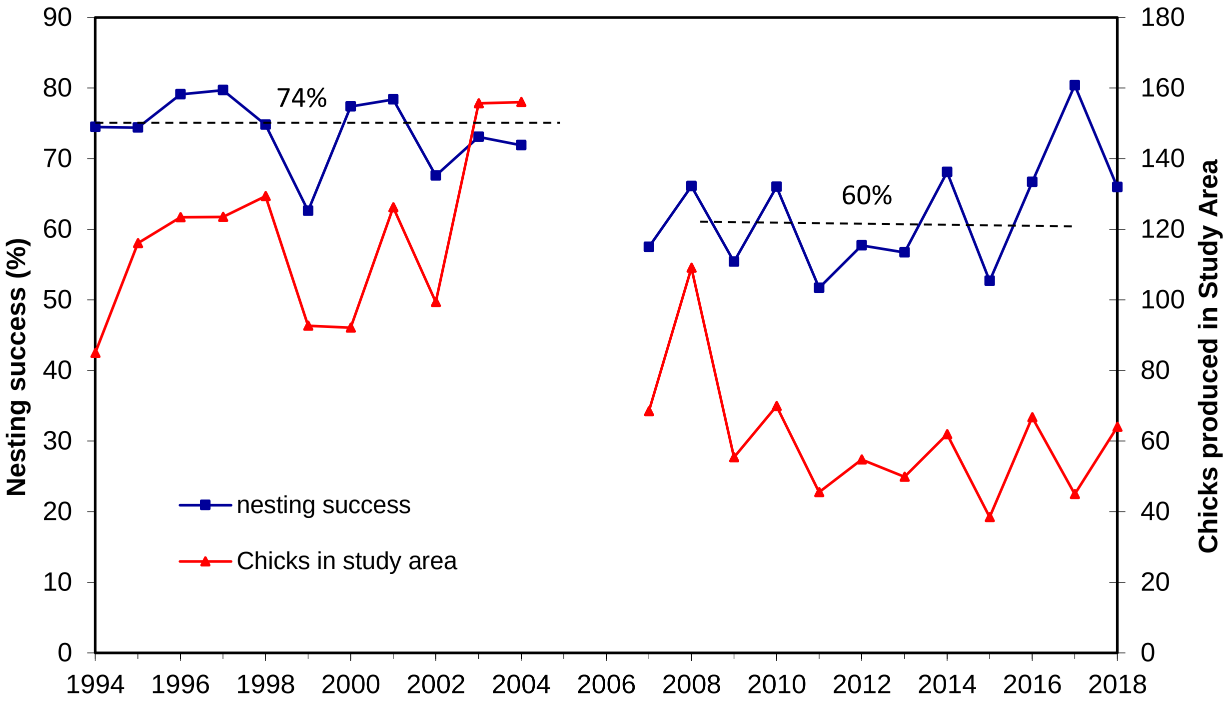

Figure 7. Nesting success and the number of chicks fledged from the study area on Antipodes Island since 1994. The dashed lines indicate average nesting success in two periods, 1994-2004 and 2007-2016.

Nest counts

A total of 471 nests were counted in the 3 representative census blocks in 2019 (Table 3, Figure 8). The estimated total number of pairs breeding on Antipodes Island in 2019, based on the proportion of the total population nesting in those 3 blocks in 1994–1997, was 3,148 pairs (Table 3).

After an increase between 2000 and 2005, the number of nests in the study area and Block 32 dropped between 2005 and 2007 by about 38% and has continued to decline since then, though at a slowing rate since 2018 (Figure 8). In the largest count area, the MCBA, which has been counted less frequently than the two smaller blocks, the population change follows approximately the same pattern as the two smaller blocks. Counts of the three areas have changed in parallel since counts were started, suggesting the changes represent an island-wide trend. There has been a visible thinning out of nests everywhere (illustrated in the study area in Figure 9) rather than the abandonment of some former nesting areas.

Table 3: Antipodean wandering albatross nests with eggs in February in three areas on Antipodes Island in 1994– 2019.

Year	Study area	Block 32	Subtotal	MCBA	Total counted	Estimated nests on island
1994	114	125	239	544*	783	5233
1995	156	185	341	482*	823	5500
1996	154	133	287	418*	705	4712
1997	150			464*		5463
1998	160			534		5827
1999	142			479		5172
2000	119	130	249	462	711	4752
2001	160	141	301	443	744	4972
2002	148	178	326	605	931	6222
2003	214	187	401	608	1009	6743
2004	216	249	465	755	1220	8153
2005	211	186	397	613	1010	6750
2006						
2007	119	127	246			4368
2008	165	135	300			5327
2009	98	120	218			3871
2010	106	101	207			3676
2011	88	108	196			3480
2012	95	104	199	345	543	3629
2013	88	93	181	297	478	3195
2014	91	103	194	341	535	3576
2015	73	86	159	291	450	3007
2016	100	92	192	291	483	3228
2017	57	82	139	230	369	2466
2018	97	97	194	315	509	3402
2019	99	96	195	276	471	3148

* estimated (see Walker and Elliott 2002b).

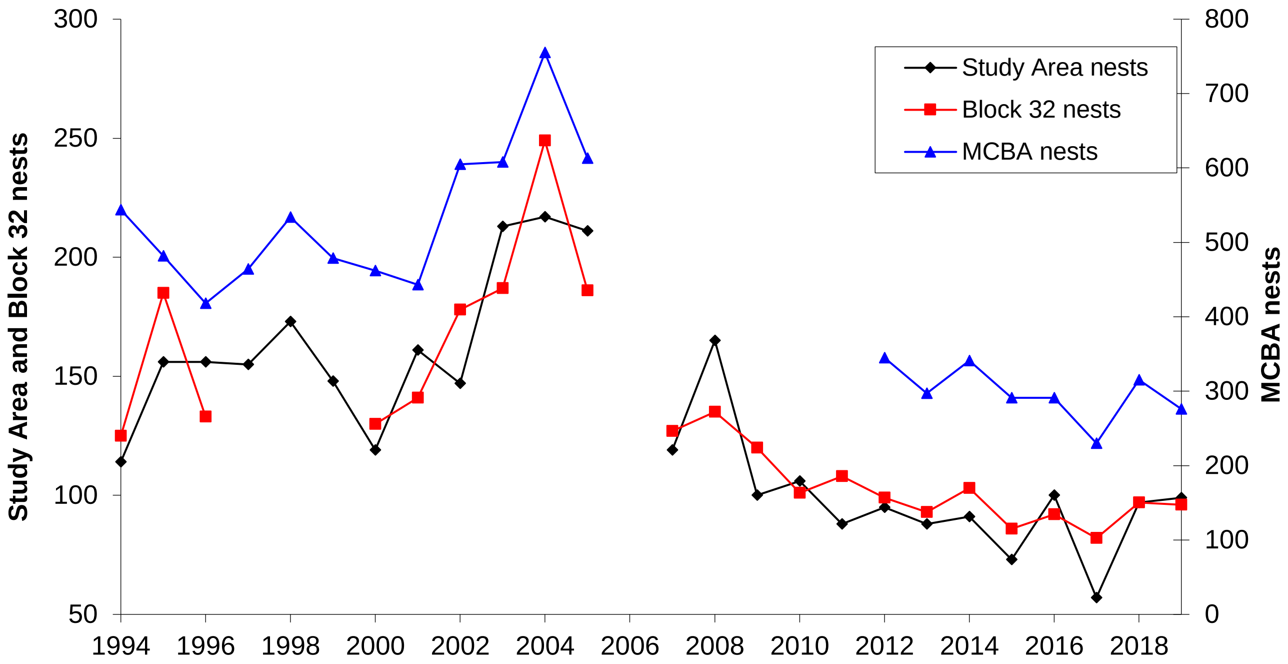

Figure 8. The number of Antipodean wandering albatross nests in three blocks on Antipodes Island since 1994

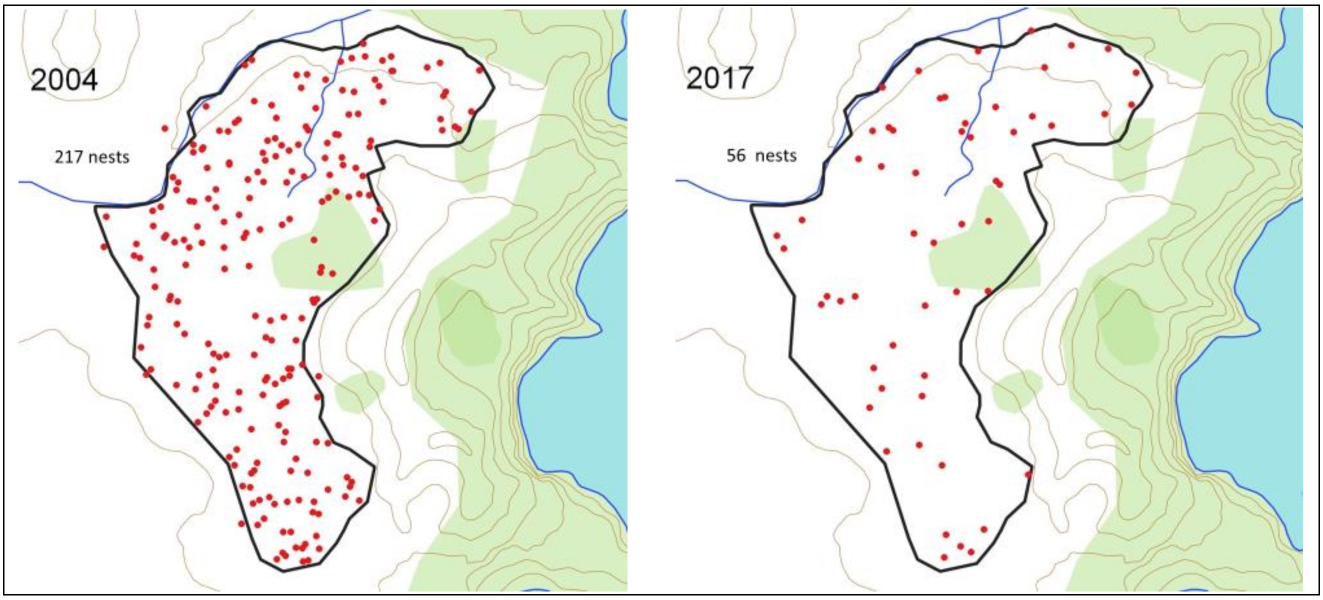

Figure 9. Location of wandering albatross nests (red dots) in the study area on Antipodes Island in February 2004, just before the population crashed, and in February 2017 when the lowest number of nests so far was recorded.

At-sea distribution

In 2018 very few of the 10 non-breeding birds tracked with loggers visited the coast off Chile (3 of 10, including 2 of 7 females) (Figure 10). This was in marked contrast to 2017 when almost all the 10 non-breeding birds tracked with loggers visited the coast of Chile (9 of 10, including 5 of 6 females) (Elliott & Walker 2018), as indeed had the majority of non-breeders in 2011-2017 (Elliott & Walker 2017).

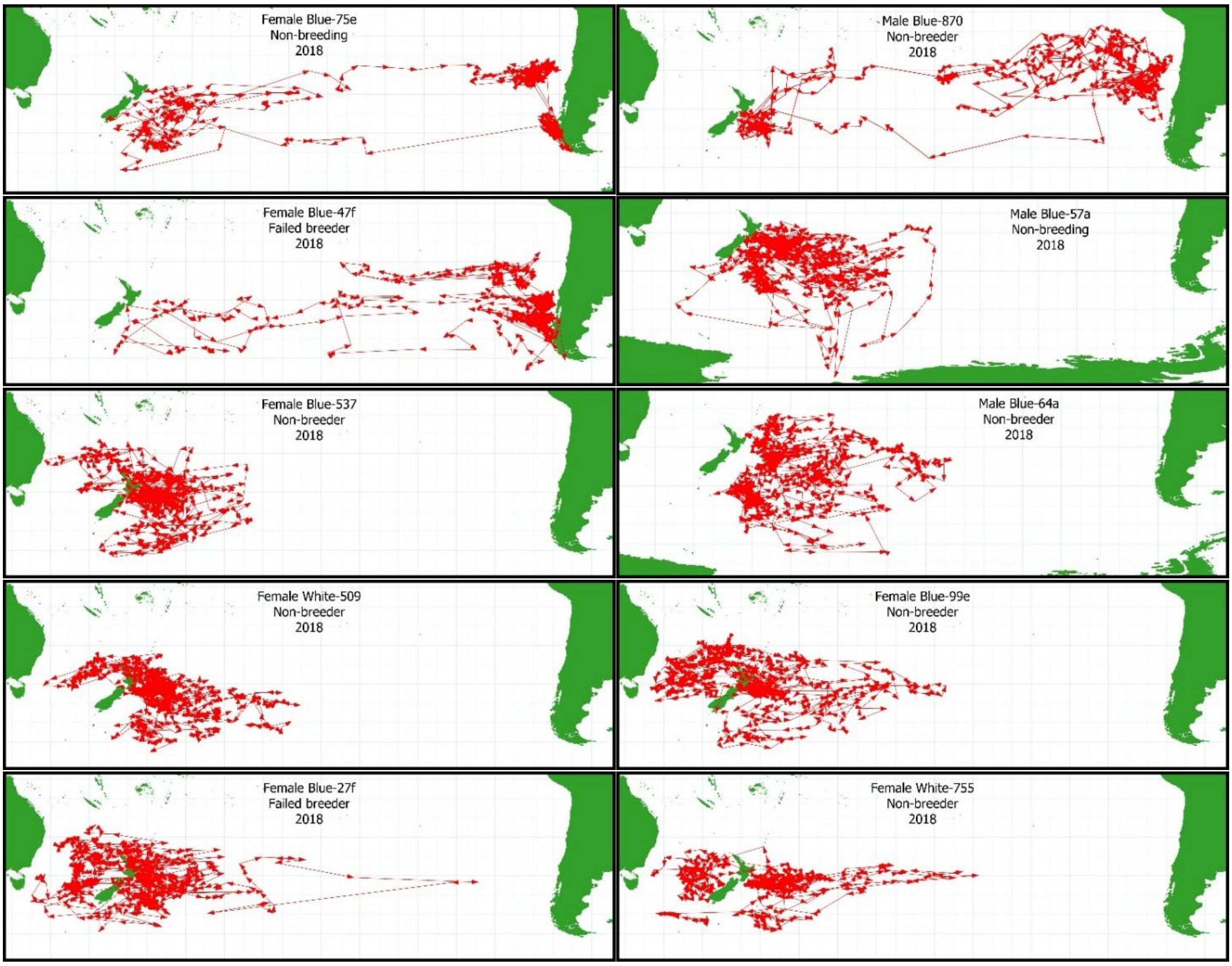

Figure 10. Tracks of 10 non-breeding adult Antipodean wandering albatrosses, 7 females and 3 males, whose locations were recorded by Migrate dataloggers throughout 2018

The most sophisticated and potentially useful tracking device, Sextant's Xargos which can detect vessel radar, is still in its development phase and proved unreliable, with 3 of 25 transmitters not functioning by the time we reached Antipodes Island. Six more stopped functioning only a few days after they had been taped onto birds; 4 of these were able to be retrieved but 2 birds did not return to

Antipodes Island before our departure. This leaves 7 Xargos transmitters in hand which could be repaired and improved for summer 2019/20. Many of the other Xargos transmitters which were still functioning when we left Antipodes Island at the end of February, stopped transmitting over the following months due to either loss from the bird or failure of the device, with 100% no longer transmitting by the end of June 2019. In addition to software problems, the Xargos transmitter has not yet been miniaturized and appeared too large and heavy to last long on the relatively small feathers of female Antipodean wandering albatrosses (Figure 11), which were the highest priority birds to track.

The loss rate for Lotek's bulky, round "Pinpoint" transmitters (Figure 12) was also high at 85% by 30 June 2019. By contrast, Wildlife Computers "Rainier S20" (Figure 12) and Telonics "TAV2360" which were both much lighter and smaller than the Xargos or Pinpoint transmitters had only a 30% and 10% loss rate respectively by 30 June 2019, increasing the likelihood that several of those losses were due to the death of the bird. The loss/failure rate seems to be related to transmitter size, shape and weight, with the heaviest transmitters having the highest loss/failure rate (Table 4). This suggests that transmitters are most likely falling off rather than failing.

Table 4. The weight and attachment status at 30 June 2019 of 4 different satellite tracking devices attached to Antipodean wandering albatrosses in January–February 2019

		Male			Female					
		Breeder	Non-breeder	Chick	Breeder	Non-breeder	Chick	**Total**	Still going	Weight (g)
Wildlife Computers	GPS + Argos + solar				2	8		**10**	60%	30
Telonics	Argos + battery			10			10	**20**	85%	45
Pinpoint	GPS + Argos + battery		9		3	1		**13**	15%	60
Xargos	GPS + Argos + solar + radar	3	2		8	7		**20**	0%	90
Total		**3**	**11**	**10**	**13**	**16**	**10**	**63**	**48%**	

Figure 11. Above left, an adult female Antipodean wandering albatross with an Xargos transmitter taped to her back feathers. This was the first transmitter taped on and all subsequent Xargos transmitters were modified (above right, on male albatross) by shortening and re-sealing the plastic ends of the transmitters and reconfiguring the taping for more feather/tape/transmitter contact whilst still leaving the solar panel exposed to the sun.

Figure 12. Above left, an adult male Antipodean wandering albatross with a Pinpoint transmitter glued and cable-tied to a small strip of plastic, taped to the bird's feathers. The plastic strip was needed as the transmitter unit had no attachment holes itself, and the high rounded shape of the transmitter gave little space for feather/transmitter/tape contact. Above right, a small Rainier S20 transmitter taped to a female Antipodean wandering albatross.

The tracking data will be analysed in detail when it has all been collected, but initial results from the 20 fledglings shows some differences from some tracking of fledglings undertaken before the 2005 population crash: three fledglings that were tracked in 2004. In February–October 2019 all 20 tracked male and female fledglings foraged largely between Louisville Ridge and New Zealand (Figure 13), whereas in 2004 two (probably male) fledglings quickly went further east or west of this region and remained there for the remainder of the year (Figure 14). Given the much larger sample of chicks in 2019, their distribution being so localized near New Zealand was surprising, and counter to the wider and strongly eastward distribution of adults in recent years, but in keeping with that recorded with loggers on non-breeding adults in 2018 (Figure 10).

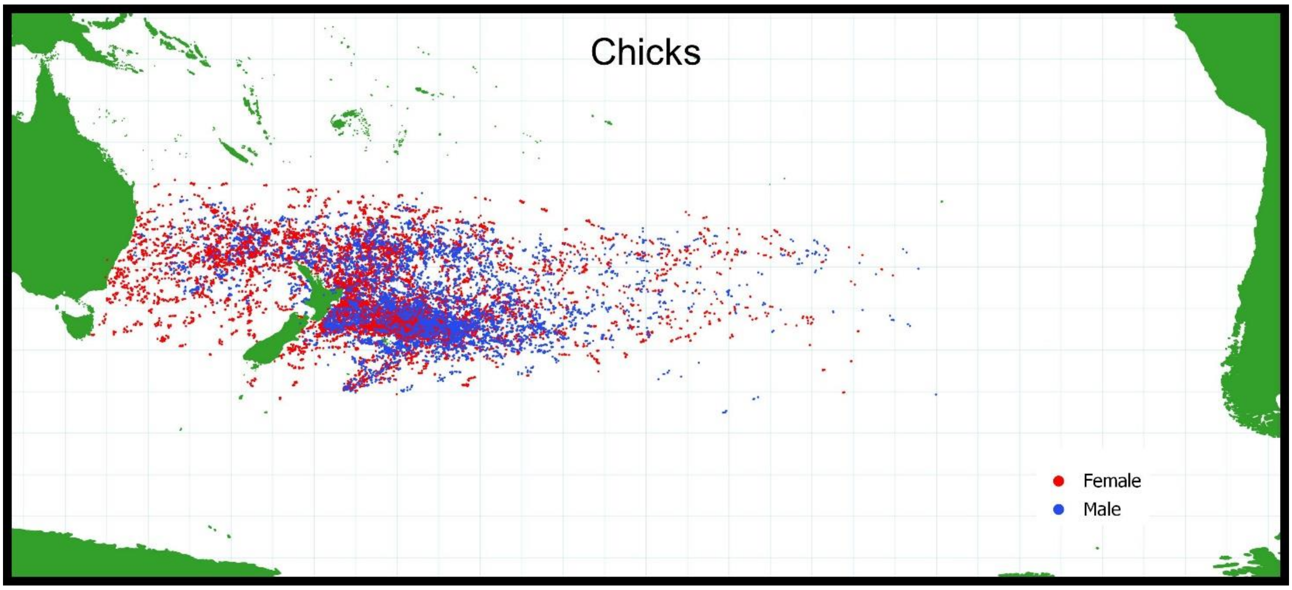

Figure 13. Locations of 20 (10 presumed female and 10 presumed male) recently fledged Antipodean wandering albatrosses tracked between 4 January & 7 October 2019.

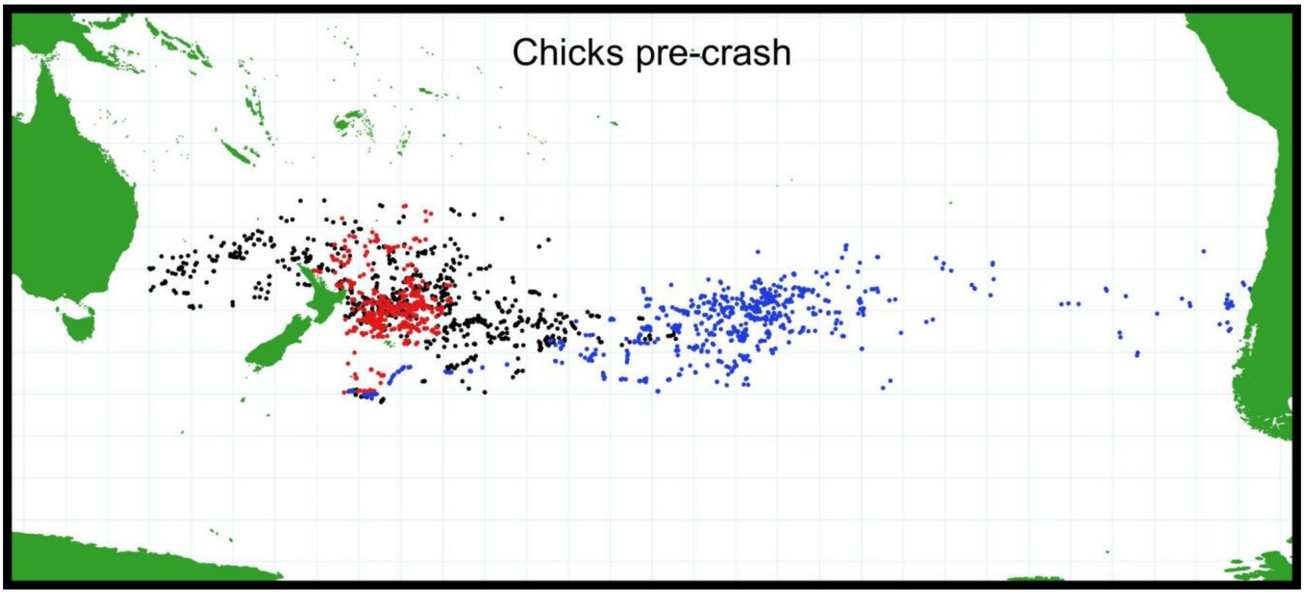

Figure 14. The locations of 2 presumed male (black and blue dots; January–December 2004) and 1 presumed female (red dots; January–September 2004) Antipodean wandering albatross chicks after fledging from Antipodes Island in February 2004.

While the majority of birds carrying transmitters in 2019 are non-breeders or failed breeders, most returned repeatedly to Antipodes Island to court throughout the autumn months (March–May) and largely stayed just east of New Zealand, with only one female travelling across to South America before moving into the Tasman Sea during this period. While more birds eventually travelled to the Chilean coast in winter/spring, greater than anticipated use was made of the seas just east of New Zealand in 2019 (Figure 15). The latitudinal differences noted between the foraging areas used by male and female Antipodean wandering albatrosses in earlier tracking (Walker & Elliott 2006) was again conspicuous in 2019, with males using much more southern waters than females (Figure 15).

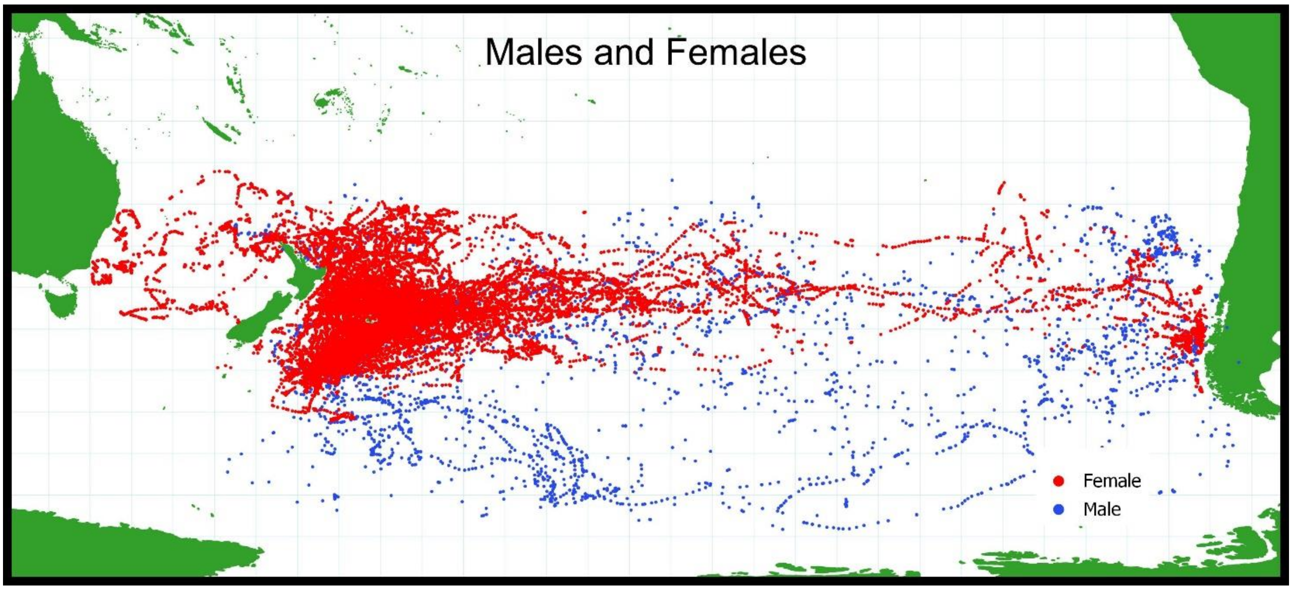

Figure 15. Locations of 6 adult male and 38 adult female Antipodean wandering albatrosses tracked between 9 January–12 May 2019.

Some of the 16 smallest and lightest transmitters worn by females failed in May–June 2019, before the feathers and tape holding the transmitters in place were expected to break. Detailed investigation of the location of each of these birds at the time their transmitters stopped revealed at least 2 birds were likely to have been accidentally caught in fishing activity, with one of these incidents confirmed by an international observer on the vessel involved. The bird in this incident was a female chick banded White-44J before she fledged from Antipodes Island in February 2019, and was wearing a TAV2360 transmitter when she was caught by a longline fishing boat in international waters north-east of New Zealand at 27 degrees south on 2 July 2019. Her band and transmitter were returned to New Zealand.

A second bird, a 16-year old female banded "White -755", was wearing a Rainier transmitter (Figure 16) which was transmitting regular, approximately hourly locations, until it suddenly stopped transmitting on 19 May 2019 while she was foraging near the Louisville Ridge. This failure coincided with overlap with longline fishing activity (Figure 17). The at-sea movements of White-755 the previous year had been recorded by data logger (Figure 10), and though she used similar waters in 2018 to those used in 2019, the site her transmitter stopped in 2019 was further north than she had earlier ventured (Figure 18).

Figure 16. Female Antipodean wandering albatross White-755 who fledged in January 2004 and was back on Antipodes Island courting in 2009, 2010, 2013 (bird at back, photo on left) and 2014. She nested for the first time (unsuccessfully) in 2015 as a 12-year old. She successfully reared a chick with the same 11-year old male in 2016, and with him built poor nests which failed in 2018 and 2019. A Rainier transmitter is visible on W-755 below several feathers which she has preened out while waiting for her mate beside her nest with its broken egg on 20 January 2019 (photo on right).

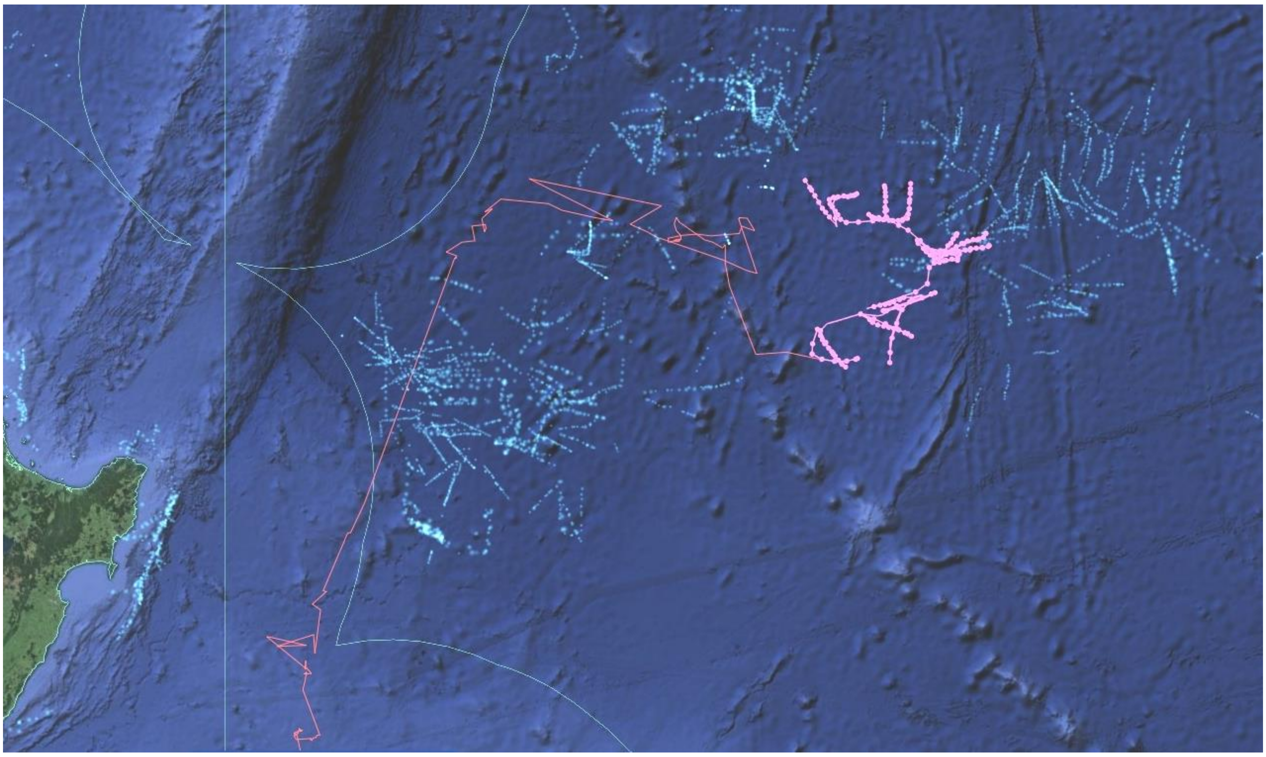

Figure 17. The location of the last few signals (red line) received from the female Antipodean wandering albatross "White-755", and the location of the long-line fishing vessel (pink dots and line) nearest W-755 when her transmitter stopped functioning on 19 May 2019. The faint blue lines and dots are other fishing vessels.

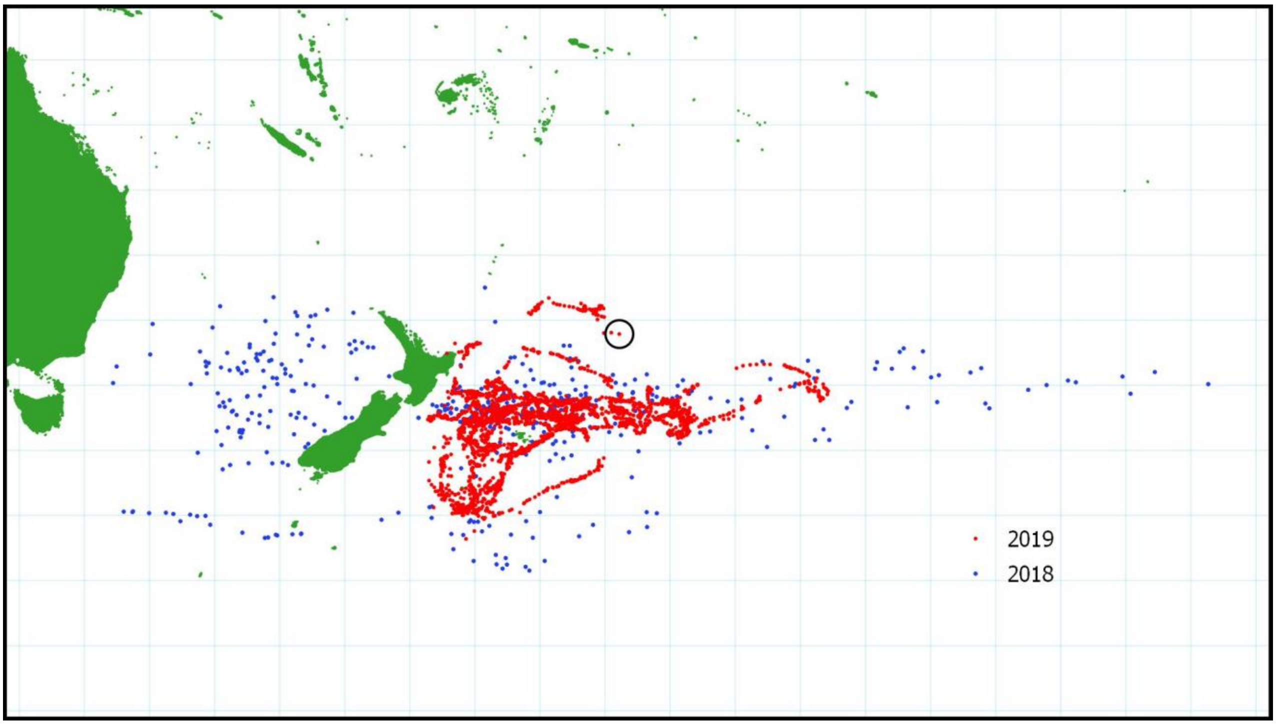

Figure 18. The locations White-755 visited in February–December 2018 (blue dots) recorded by a datalogger, and in January–May 2019 (red dots) recorded by a transmitter, after her nesting attempts failed early, and her last known position (black circle) when her transmitter suddenly stopped on 19 May 2019.

DISCUSSION

The mark-recapture estimates of the number of breeding Antipodean wandering albatrosses indicate a population decrease in recent years of ~8% per annum, whereas counts of nesting birds indicate the population is declining more slowly at a rate of ~4% per annum and that in the last couple of years the decline in nesting birds may even have stopped. The mark-recapture estimates are a much better indicator of population change than are simple counts of nests. In 2005–2010, the proportion of females that attempted to breed dropped as low as 28% but since 2016 it has returned to between 40 and 80%, in a similar pattern to that recorded in closely-related Gibson's wandering albatross (Rexer-Huber *et al*. 2019) (Figure 19). Thus, while the actual population continues to decline at about 8%, the decline in the number of nests is less because a higher proportion of the surviving birds have returned to breeding. The apparent levelling off in the number of nests has also been caused by a higher proportion of recruitment: 40% of the nesting females in 2019 were first-time breeders.

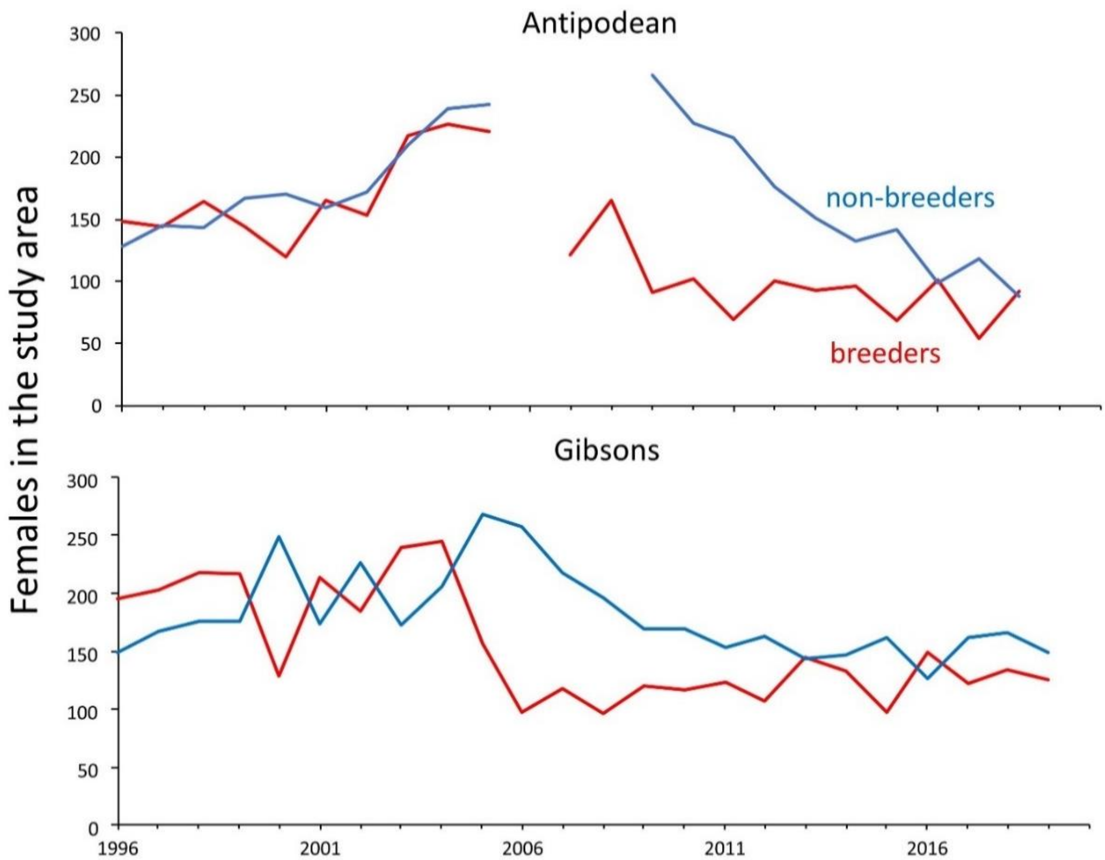

Figure 19. The proportion of female Antipodean wandering albatross (top) and Gibson's wandering albatross (bottom) breeding (red line) or not breeding (blue line) in the study area on Antipodes and Adams Island respectively in 1996–2019.

Just why the proportion of females breeding declined in 2005–2016 and began returning to normal is unclear. That the same change was occurring in Gibson's wandering albatross at much the same time (Figure 19) suggests that oceanic conditions both west and east of New Zealand were suboptimal in 2005–2016 and have since improved. However, despite that similarity, the trajectory of the Antipodean wandering albatross population is now markedly different to that of Gibson's wandering albatross (Figure 20).

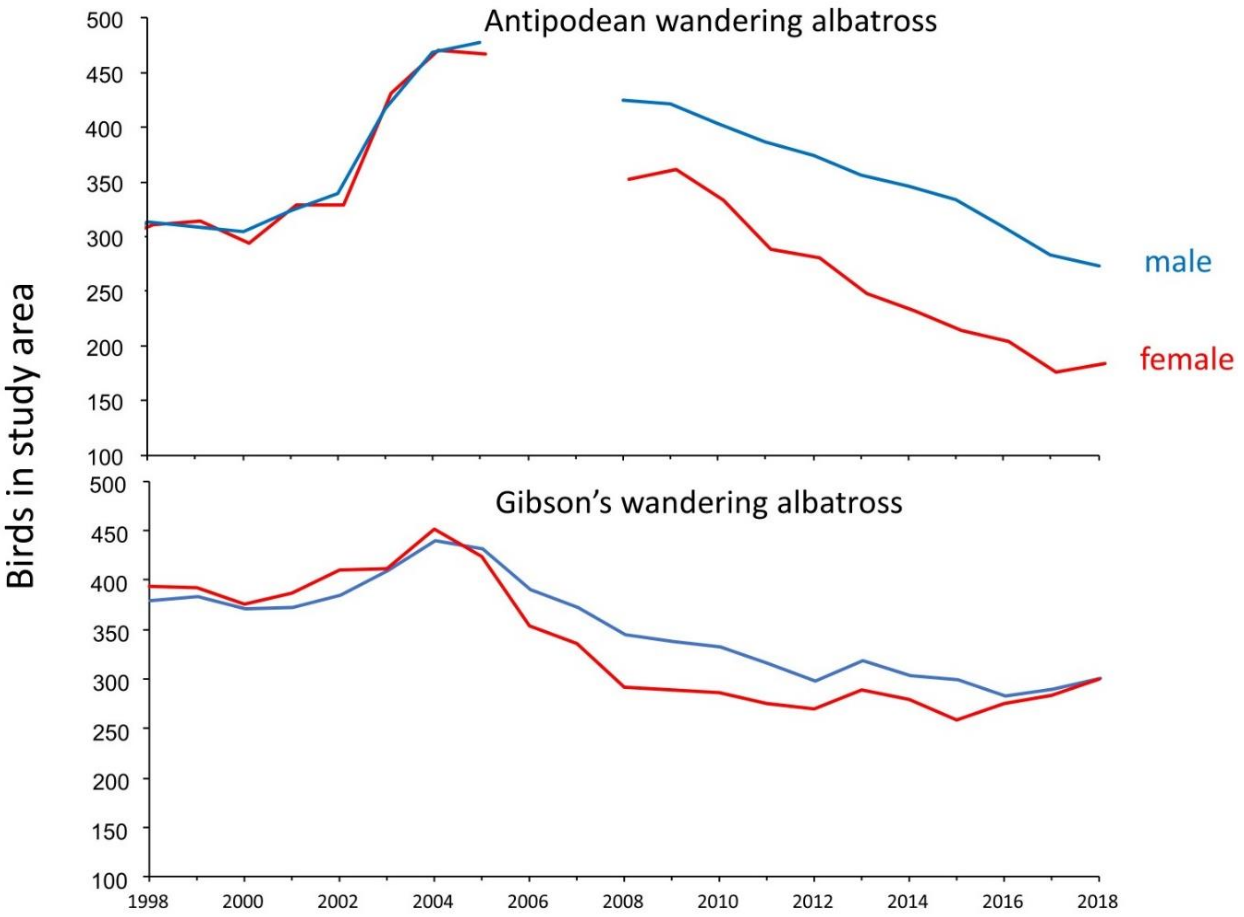

Figure 20. The number of breeding pairs of Antipodean (top graph) and Gibson's wandering albatrosses in the study areas on Antipodes and Adams Island respectively in 1998–2018 estimated by mark-recapture

The number of pairs of Antipodean wandering albatrosses nesting is now only 65% of what it was in 1994 when the population was first counted, and only 42% of its highest recorded level in 2004. The main cause of the decline since 2006 is high mortality of females, with their survival rates still much lower than that of males. Since 2006 female survival has varied between years, but at its worst 20% of adult females died each year. For a long-lived, slow reproducing species, such high mortality rates are unsustainable.

Female survivorship was better during 2018 than the average for the last 10 years, but survivorship was very low in 2017 (Figure 21) so there is not yet evidence of a sustained improvement in female survivorship. Although the number of nesting birds recently appears to have stopped declining, this has been driven by an increase in the proportion of birds breeding and high recent recruitment. Further recovery from increases in the proportion of birds breeding is not possible, as it is already high. Given the low productivity of Antipodean wandering albatrosses in the last 14 years, the recent high level of recruitment is also unsustainable. The population will not stop declining until female survivorship increases.

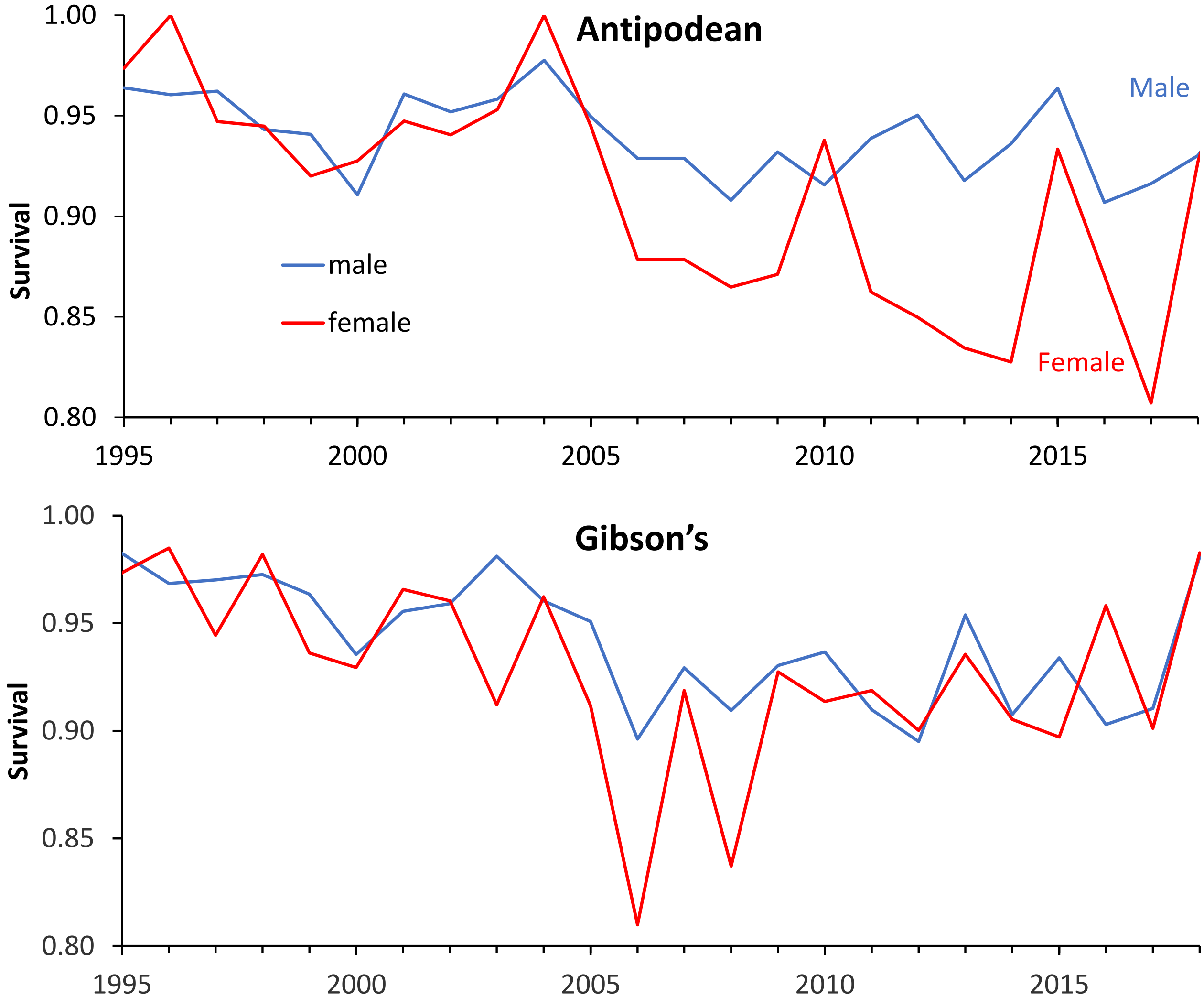

Figure 21. Survival of male (blue) and female (red) Antipodean (top) and Gibson's (bottom) wandering albatrosses in 1993–2018. Gibson's wandering albatross data from Rexer-Huber *et al*. 2019.

The large number of tracking devices deployed in 2019 offered the hope of identifying high-seas fishing fleets which may be causing high albatross mortality, but the largest and heaviest transmitters did not stay going long enough to coincide with the winter period when the distributions of Antipodean wandering albatrosses and high seas fishing fleets overlap most (Elliott & Walker 2018). However, 2 of the 16 females tracked with light and dependable transmitters (ie the Rainier S20 and TAV2360) were caught or appeared to be caught by longline fishing boats in late autumn/winter 2019. These initial satellite tracking results suggest bycatch in fisheries is at a level consistent with bycatch as explanatory of the low female survival observed. However, the high inter-annual variation in both survival and foraging location found in this study indicates it will be necessary to continue tracking birds for at least a few years to get a reliable estimate of the scale of interaction between birds and fishing fleets.

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

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