

# CORELLA

Journal of the Australian Bird Study Association

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VOLUME 11

JUNE, 1987

NUMBER 2

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Corella, 1987, 11(2): 37-43

## RECOVERIES OF PETRELS BANDED NEAR CASEY STATION, WILKES LAND, ANTARCTICA, 1984 to 1985

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Received 19 May, 1986

Banded birds were recovered during a study of fulmarine petrels near the Australian Antarctic station Casey, in the summer of 1984-1985. Fourteen Southern Fulmars, banded from 1961 to 1963, were retrapped at Ardery Island. Twenty-three Snow Petrels, banded in 1979 and 1980, were retrapped at Reeves Hill close to Casey. Two Antarctic Petrels and one Snow Petrel, banded elsewhere, were recovered at Ardery Island. A Cape Petrel was recovered dead. Recaptures permit some minimum estimates for age and survival, age of first breeding, fidelity to mate and nest-site and provide evidence of chicks becoming established in both natal and other colonies.

### INTRODUCTION

In the Antarctic summer of 1984-1985, a comparative study of the ecology of Antarctic fulmarine petrels was initiated at Ardery Island, Windmill Islands, near the Australian station Casey (66° 17' S., 110° 32' E.; Figure 1). The project will be continued in 1986-1987 and is a sequel to earlier work on the Northern Fulmar *Fulmarus glacialis* (van Franeker and Wattel 1982). Data gained during this southern programme will be used to analyse relationships between the Northern Fulmar and its southern hemisphere relatives. Ardery Island was chosen for the project because it is inhabited by four species (and genera) of Antarctic fulmarine petrels: the Southern Fulmar *F. glacialisoides*,

Antarctic Petrel *Thalassoica antarctica*, Cape Petrel *Daption capense* and Snow Petrel *Pagodroma nivea*. The fifth and last genus of the fulmarine petrels is represented in the Casey area by the Southern Giant-Petrel *Macronectes giganteus*, which breeds on the Frazier Islands (Orton 1963; Cowan 1979).

Investigations were largely restricted to species at Ardery Island, although Snow Petrels were also studied at Reeves Hill, close to station Casey. During the 1984-1985 programme birds were colour banded, their nests marked and morphological measurements recorded. The capturing of a considerable number of birds resulted in recovery of 41 previously banded petrels (40 live; 1 dead). This paper discusses the details and significance of these recoveries.

## RESULTS AND DISCUSSION

### Southern Fulmar *Fulmarus glacialisoides*

From 1961 to 1963, 161 adult Southern Fulmars and 65 chicks had been banded at Ardery Island (Murray, Orton and Penney 1972); subsequent recoveries have been reported by Murray *et al.* (1972) and Cowan (1979). Original banding schedules are not entirely clear but show that between 80 and 100 of the adults had been banded at Mast Head; the remaining adults and all the chicks had been banded in the central northern part of the island (Soucek Ravine, West Gully, Penney Ravine; Figure 1). Many adult

birds had been banded with two metal bands, one on each leg and sometimes a plastic colour band was added. Most of the birds at Mast Head, at least 74, had been double banded.

During the 1984-1985 programme, nearly all work on Southern Fulmars was restricted to the Mast Head area since it formed a clearly defined subcolony, with most nests easily accessible. No searches for banded birds were made in the central northern ravines since exact locations of banding were less clear and because loose stones in the steep ravines were a risk to both birds and observers. At Mast Head we recaptured 14 banded Southern Fulmars. Their band numbers and details of banding and recovery are given in Table 1 and discussed below.

### Band loss

All Southern Fulmars recovered had originally been banded with two metal bands (overlapping strip type) and five of them with an additional plastic colour band. The good survival of plastic bands over a 10 year period, as mentioned by Murray *et al.* (1972), clearly does not extend to over 20 years as all had been lost. Since 5 out of 14 double banded birds had lost one of the metal bands, the minimum chance of an individual band being lost over a 21 to 23 year period is 5 out of 28 or 18 per cent. Accordingly, the minimum risk that a double banded bird had lost both its bands over this period is 3.2 per cent. Murray *et al.* (1972) reported a very low band loss (1 band in 40 recoveries) after 10 years but losses evidently have increased considerably since then. Nevertheless, most bands recovered in 1984-1985 were still in fairly good condition. To prevent further loss of data as a consequence of band loss, the recovered Southern Fulmars were given a new stainless steel or metal CSIRO band (size 9), as well as a code of three coloured plastic bands.

### Survival

Between 80 and 100 adult Fulmars were banded at Mast Head in 1961 to 1963. In 1984-1985, at least 14 of them were shown to have survived for a mean of 22 years (21-23 years). Assuming 100 birds were originally banded, we can estimate that the minimum mean annual adult survival is 91.5 per cent\*. If only 80 birds were banded the survival increases to 92.4 per cent. The corresponding figures of 8.5 per cent or 7.6 per cent indicate a maximum for annual adult mortality; actual mortality is likely to be lower since band

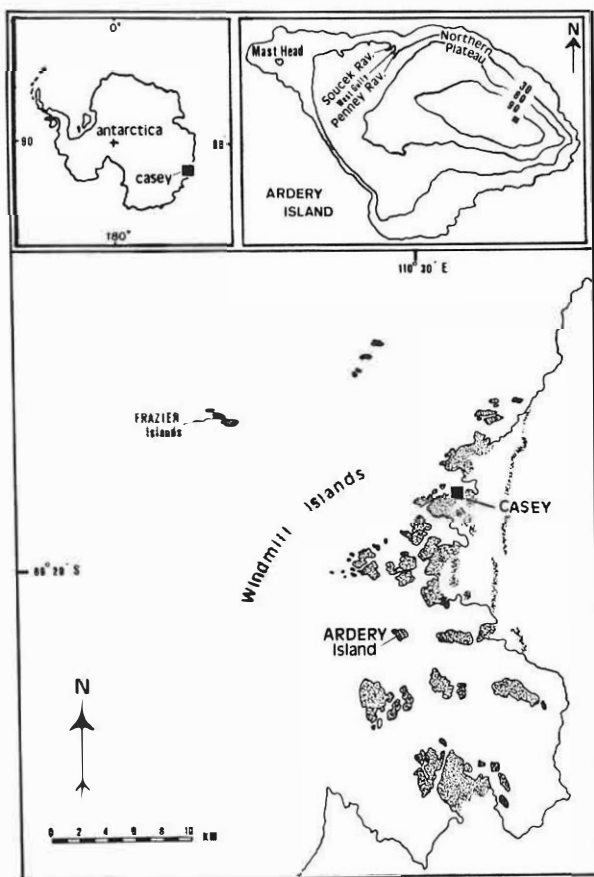


Figure 1. The Windmill Islands and the Casey area, Wilkes Land, Antarctica. Hatched areas are largely free of snow and ice in late summer. Ardery Island is shown with names of locations mentioned in the text.

TABLE 1  
Recoveries of Southern Fulmars at Mast Head, Ardery Island, summer 1984-1985.

Bands present at recovery	Bands lost	Age when banded	Yearssince banded	Partner when banded	Partner when recovered
160- 160-	160-				
20513 26388	—, —	Ad	23	160-26333	m
26333 —	26332, —	Ad	21	160-20513	m
20493 26313	—, P	Ad	23	160-20491	m
20491 20533	—, P	Ad	23	160-20493	m
20490 —	26362, P	Ad	23	M	160-26301
26301 26365	—, P	Ad	21	?	160-20490
26357 —	26358, —	Ad	21	M	m
20497 26314	—, P	Ad	23	M	m
26391 26392	—, —	Ad	21	?	m
20504 26309	—, —	Ad	23	M	—
26364 —	26363, —	Ad	21	M	m
20303 20304	—, —	Ad	23	M	m
20522 20544	—, —	Ad	23	m	m
26311 —	26310, —	Ad	21	M	m

All birds recovered in the Mast Head colony were among the 80 to 100 adults banded at Mast Head from 1961 to 1963. All fulmars recovered originally had two metal bands and sometimes a plastic band (P). Pair-bonds are shown by M = mated to known banded partner (band number given only when recaptured in 1984-1985); m = mated to unbanded partner; ? = mate unknown; and — = unmated.

loss, emigration and undiscovered individuals are not included in calculations.

Using the same method for calculating survival (\*) Mougin (1975, Table 81) reported a somewhat lower figure of 90 per cent annual adult survival for Southern Fulmars in Terre Adelie. Mougin's figure is an average for a period of 5 years whereas our figure is an average over 22 years. This suggests that survival does not decrease with increasing age, unless Mougin's data greatly underestimated survival in the earlier years of adult life. This possibility seems unlikely because by a more elaborate statistical approach Mougin (1975, Table 82) could increase his figure for survival to 93.1 per cent or even 96.1 per cent, which comes close to the estimate (by the same method) of about 97 per cent survival in the thoroughly studied Northern Fulmar (Dunnet and Ollason 1978). Unfortunately, this method of estimating survival cannot be applied to the Ardery data because it demands yearly

observations. If age of first breeding in the Southern Fulmar is similar to that in the Northern Fulmar (mean 9.2 years, minimum 6 years; Ollason and Dunnet 1978), the 14 recaptured Southern Fulmars were about 30 years or older in 1984-1985. The above data suggest no evidence for a substantial decrease of survival in birds approaching such an age. The possibility does exist, however, that survival shows minor changes with increasing age.

Cloacal inspection and morphometric data suggested the presence of 6 males and 7 females (1 unknown) in the 14 recaptures at Ardery Island. Assuming similar banding rates for both sexes, this indicates similar survival rates for male and female Southern Fulmars.

#### *Fidelity to nest-site/colony*

The banding programme at Ardery in 1961 to 1963 involved nest-site marking with spray-paint. From 1961 to 1963 Murray *et al.* (1972) observed a strong fidelity to nest-site, though minor changes occurred between years. The old markings at nests had disappeared by 1984-1985, so fidelity to the actual nest cannot be discussed. However, the recoveries of 14 adults very close

$$* \text{ Mean Annual Survival (\%)} = 100 \cdot \frac{\sum_{x=1}^n \sqrt{R_n + x}}{B_n}$$

(In which  $B_n$  is the number of birds banded in year  $n$ , and  $R_n + x$  the number of these birds recovered in the year  $n + x$ ).

to the site of banding after 21 to 23 years indicates strong fidelity to a breeding area. Apparently few birds emigrate from the small Mast Head colony in spite of the presence of large Fulmar colonies a few hundred metres away. Annual emigration from Mast Head must be less than 5 per cent (the difference between the observed minimum survival of about 92% and an expected maximum survival of 97% as in the Northern Fulmar).

This study yielded no information on the fidelity of Southern Fulmar chicks returning to breed in their colony of birth. This is not surprising because only 65 chicks were banded at Ardery in 1961 to 1963, all of them in the central northern ravines. Murray *et al.* (1972) reported a Southern Fulmar banded as a chick in 1960 and recovered breeding in the same ravine in 1972. In the Northern Fulmar in Scotland, Dunnet and Ollason (1978) reported a low return of chicks to their natal colony (only 10% of surviving chicks) but their birds belong to the expanding boreal/low-arctic Fulmar population in the North Atlantic, which may behave differently from other fulmarine petrels.

#### *Fidelity to partner*

In 1963, at least 11 of the 14 recaptured Southern Fulmars were mated to known banded partners (banding schedules by R. K. Hicks). None of these had the same partner in 1984-1985. Mortality could largely explain the breaking of pair-bonds over a 21 year period but Table 1 shows that divorce occurs as well; four of the recovered birds were considered to represent two pairs in 1963 but each was mated to an unbanded partner in 1984-1985. Macdonald (1977) stated that divorce in the Northern Fulmar is not uncommon in spite of a generally strong fidelity to partner and site. The annual rate of dissolution of established pairs by mortality and divorce in the Northern Fulmar is 5 per cent to 6 per cent (Macdonald 1977, Ollason and Dunnet 1978). A similar figure in Southern Fulmars would mean that two or three of the birds recovered should have had the same partner as in 1963. We did not find this, possibly because the sample size was too small. Murray *et al.* (1972) observed six out of seven pairs of Southern Fulmars at Ardery to be intact after one year.

#### *Snow Petrel *Pagodroma nivea**

In the antarctic summers of 1978-1979 and 1979-1980 L. Cole marked 77 Snow Petrel nests

close to Casey and banded 55 adults and 40 chicks. Most of this work was done on Reeves Hill, with 58 marked nests and 79 banded birds. At Ardery Island no Snow Petrels had been banded before 1984-1985.

In 1984-1985 we retraced 51 of the marked nests at Reeves Hill and during weekly inspections 23 banded Snow Petrels were recovered. At Ardery Island a Snow Petrel banded in Terre Adelie was recovered. Band numbers and details of banding and recovery are given in Table 2 and discussed below.

#### *Band loss*

Estimates of band loss in Snow Petrels are not possible since birds had been only single banded. However, band loss may be expected to be very low since birds had been banded no more than 5 to 6 years previously and all recovered bands (stainless steel) were in very good condition.

#### *Survival*

Only birds originally banded at Reeves Hill are used in calculating minimum rates of survival because activities in 1984-1985 were restricted to this area. At Reeves Hill 18 adult Snow Petrels were banded in 1978-1979 and 29 in 1979-1980 (total 47). Of these birds 8 and 13 respectively (total 21) were recovered in 1984-1985. Derived figures for minimum mean adult annual survival are 87.4 per cent and 85.2 per cent, or combined 86.3 per cent. The literature indicates a higher survival of 93 per cent to 96 per cent (Guillotin and Jouventin 1980, Croxall 1981). The lower figure in this study is probably largely due to the fact that many birds, including at least two banded ones, could not be captured during the limited time available for work at Reeves Hill.

#### *Age of first breeding*

Two chicks banded in 1979-1980 were recovered at Reeves Hill in 1984-1985. The youngest bird (082-42138), 5 years of age, was seen only once and no partner or egg was observed. In our opinion, the bird did not actually attempt breeding although the presence of a broodpatch showed that it was close to sexual maturity. The older bird (081-78108) had mated to a bird banded as an adult in 1978-1979 and proved to be a female, producing an egg at 6 years of age. The extremely small egg (width 35.3 mm cf. normal egg-widths between 38 and 41 mm) failed due to improper timing of first change-over between partners, indicating that this was probably the female's first egg. This agrees with an average age of first

TABLE 2  
Recoveries of Snow Petrels in Casey area, Summer 1984-1985.

Band number	Age when banded	Years since banded	Site where banded (Reeves Hill)	Site where recovered	Partner when banded	Partner when recovered
081-78131	Ad	6	S45	S45	081-78130	081-78130
081-78130	Ad	6	S45	S45	081-78131	081-78131
081-78147	Ad	5	S83	S83	081-78148	081-78148
081-78148	Ad	5	S83	S83	081-78147	081-78147
081-78146	Ad	5	S17	S17	081-78132	081-78132
081-78132	Ad	6	S17	S17	081-78146	081-78146
081-78119	Ad	6	S18	S18	082-42112	082-42112
082-42112	Ad	5	S18	S18	081-78119	081-78119
082-42117	Ad	5	S58	S58	M	M(number unknown)
081-78134	Ad	5	S54	S21	081-78135	—
081-78135	Ad	5	S54	S54	081-78134	m
081-78120	Ad	6	S46	S46	M	081-78108
081-78108	Pu	6	S27	S46	—	081-78120
082-42107	Ad	5	S40	S40	M	m
081-78124	Ad	6	S19	S19	?	?
081-78126	Ad	6	S43	S43	?	?
081-78136	Ad	5	S64	S64	?	?
082-42110	Ad	5	S22	S22	?	?
081-78140	Ad	5	S29	S38	M	m
081-78125	Ad	6	—	S57	?	m
081-78144	Ad	5	S22	S93	M	m
082-42101	Ad	5	S26	S72	M	?
082-42138	Pu	5	S88	S44	—	—
FL 10995 (Paris)	Pu(?)	16	Terre Adelie	Ardery Isl.	—	?

All birds recovered at Reeves Hill were among 47 adults and 32 chicks banded at Reeves Hill from 1978 to 1980. Sites were marked in the field with red paint. Pair bonds are shown by: M = mated to known banded partner (band number given only when recaptured in 1984-1985); m = mated to unbanded partner; ? = mate unknown; and — = unmated.

breeding in Snow Petrels of 6 to 7 years (Croxall 1981).

#### *Fidelity to nest-site/colony*

All 23 Snow Petrels recaptured at Reeves Hill had been banded in the same area. More importantly, 16 out of 21 adult recoveries were re-trapped in the nest where they had been banded 5 to 6 years before. This indicates that annually at least 5 per cent of adult birds move from one nest-site to another. A maximum figure for nest-site change can be calculated at about 18 per cent annually (16 retraps in the same burrows, out of a total of 47 birds banded 5 to 6 years before) but this is likely to be an overestimate. Guillotin and Jouventin (1980) calculated an annual change of site of 13.5 per cent for Snow Petrels in Terre Adelie.

The fidelity of Snow Petrel chicks returning to their natal colony cannot be calculated because chicks hatched in 1979 or 1980 had hardly reached breeding age in 1984-1985 (see the two recaptures discussed above). According to Mougins (1975) about 25 per cent of chicks may be expected to survive to breeding age. For 32 chicks banded at Reeves Hill this would mean that eight could be expected to breed. The recovery of two of these chicks at their hatching ground indicates a minimum return of surviving chicks of 25 per cent. However, since breeding age had only just been reached and considering the incompleteness of the work at Reeves Hill, a higher return of chicks to their hatching grounds is likely. These figures differ considerably from the 10 per cent return of surviving chicks in Scottish Northern Fulmars (Dunnet and Ollason 1978). On the other hand, it seems

unlikely that fidelity of Snow Petrel chicks to their natal colony is close to 100 per cent as stated by Weimerskirch, Jouventin, Mougín, Stahl and van Beveren (1985). One Snow Petrel, probably banded as a chick in Terre Adélie (some 1 300 km east) in 1969, was recovered at Ardery with a broodpatch indicating (attempted) breeding. This is the first record of establishment in a 'foreign' colony.

#### *Fidelity to partner*

Sixteen of the 21 recovered adults were mated to known banded partners in 1979-1980. Nine of these 16 birds were mated to the same partner in 1984-1985 (assuming loyalty for 082-42117) indicating that at least 11 per cent of birds change partner (or 89 per cent are loyal) annually. A maximum figure for annual change of partner of 27 per cent (73 per cent loyalty) can be derived from the total of 47 banded adults of which at least 10 apparently remained loyal over the intervening 5 years between banding and recapture (including assumed loyalty for 082-42117 and its banded partner). Guillotin and Jouventin (1980) calculated annual change of partner at 17.3 per cent for Snow Petrels in Terre Adélie.

As in the Southern Fulmar, the recaptures of Snow Petrels show that separation is caused not only by mortality but also by divorce. In 1979-1980, Snow Petrels 081-78134 and 081-78135 were partners in nest-site S54; 78135, judged to be the female by cloacal inspection, still occupied nest S54 in 1984-1985 but was mated to an unbanded bird. Her former mate was recovered single and non-breeding in another site.

#### **Antarctic Petrel** *Thalassoica antarctica*

The 1984-1985 programme was the first to band Antarctic Petrels in the Casey area. However, two Antarctic Petrels were recovered on the Northern Plateau (Figure 1) at Ardery Island bearing Polish bands (Gdansk EA-00-264 and EA-00-228). Both had been banded as chicks in early 1979 at Haswell Island near Mirny Station (66°33'S., 93°00'E.), some 780 km west. Actual breeding of these six year old birds was not observed but since they were first recovered at Ardery on 21 and 28 December respectively, when successful breeders were incubating, they may have attempted breeding but failed in an early egg-stage. Both birds possessed a broodpatch indicating either attempted breeding or at least a

closeness to sexual maturity. Petrel EA-00-264 was seen frequently at its nest-site, always with the same partner; EA-00-228 also returned regularly to its nest-site (a few metres away from EA-00-264) but its pair-bond remained uncertain.

The recovery of these two Antarctic Petrels provides the first evidence that chicks may establish themselves in colonies that are not their natal ones. At 6 years of age, they were apparently close to breeding for the first time. The recovery virtually side by side of two birds banded nearly 800 km away 6 years previously, is remarkable! The chance of such a recovery is negligible if one assumes a solitary life of chicks after fledging and reasonably high fidelity to natal colony. In our opinion, this recovery suggests that fledglings may group together in flocks that persist over a long period of time. Weimerskirch *et al.* (1985) noted a similar example: two Cape Petrel chicks banded at the same time in Terre Adélie were recovered alive almost simultaneously 17 months later in the same feeding area near New Zealand.

There are no published data on survival or fidelity in Antarctic Petrels but intended observation (1986-1987) of birds banded at Ardery in 1984-1985.

#### **Cape Petrel** *Daption capense*

The only Cape Petrels banded at Ardery had been 10 chicks banded in February 1960 with bands of the Fish and Wildlife Service, Washington, U.S.A. We recovered one of these, band number 534-15205 on a solitary tarsus, so there is no information about when the bird died. Possibly it was even killed as a chick by a South Polar Skua *Stercorarius maccormicki*; the tarsus was found close to an old nesting site of this species, which usually takes chicks not adults.

The literature indicates a strong similarity between the Cape Petrel and other fulmarine petrels. Croxall (1981) mentions an annual adult survival between 93 per cent and 96 per cent and an average age of first breeding of 6 years. Pinder (1966) reported a strong fidelity of adult Cape Petrels to both nest-site and partner and found that chicks returned preferentially to their natal colony.

#### **Southern Giant-Petrel** *Macronectes giganteus*

Apart from banding chicks in late summer, no work was done on the Southern Giant-Petrels breeding at Frazier Islands. Extensive banding

had been done at this location in earlier years. Several banded birds, both adults and immatures, were observed in 1985 but none was captured. It would certainly be rewarding for future workers to study the Giant-Petrels at Frazier Islands.

### CONCLUSION

Recaptures of banded fulmarine petrels in the Casey area confirm the longevity, age of first breeding and fidelity to mate and site common in *Procellariiformes* (Croall 1981).

The recapture of 14 Southern Fulmars shows that this species can live up to 30 years or older, indicating its considerable longevity. More importantly, the data indicate no substantial decrease of annual adult survival for birds reaching such an old age.

Despite the high level of fidelity, divorce occurs in both Southern Fulmar and Snow Petrel.

Fidelity of adults to a once chosen breeding locality seems to be very strong but the fidelity of chicks to their hatching-grounds is still uncertain. The return of Snow Petrel chicks to their colony indicates that the 10 per cent fidelity of surviving chicks found in Scottish Northern Fulmars (Dunnet and Ollason 1978) cannot be considered general in fulmarine petrels. Conversely, the recoveries of "foreign" chicks of the Snow Petrel and Antarctic Petrel at Ardery Island contest the suggested near complete fidelity of chicks to hatching grounds (Weimerskirch *et al.* 1985). The "twin" recovery of two foreign Antarctic Petrels is particularly interesting, since it strengthens the idea of flock-like dispersal of fledglings that was suggested for Cape Petrels by Weimerskirch *et al.* (1985). Assuming a generally strong fidelity of chicks to hatching grounds, a tentative hypothesis from flock-like dispersal could be that population-exchange in fulmarine petrels may involve an occasional sudden exchange rather than a gradual process.

Understanding the extent of population exchange and the processes involved is extremely important in both studies of evolutionary history and of wildlife management in antarctic seabirds. At present such knowledge is fragmentary for fulmarine petrels; only extensive programmes of banding and monitoring can supply the information that is needed. By banding nearly 1000 petrels (647 adults and 351 chicks) in the Casey area, we hope that the 1984-1985 programme has contributed to progress in this field.

### ACKNOWLEDGEMENTS

The Australian Antarctic Division (Department of Science) supplied transport and logistics to the Ardery Island project. We thank the Director and all others involved for their many efforts. Funds for van Franeker's travel from the Netherlands to Australia were raised by the Netherlands Organisation for the Advancement of Pure Research (ZWO) and the Netherlands Ministry of Science and Education. The Institute of Taxonomic Zoology (University of Amsterdam) provides facilities for van Franeker's Fulmar studies. The national bird banding schemes of Australia, France and Poland kindly supplied information on recoveries. We are grateful to Dr G. W. Johnstone and Dr W. J. Wolff for their many valuable comments on an earlier draft of this paper.

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