SHORT COMMUNICATIONS

REPRODUCTION AND MORTALITY OF WANDERING ALBATROSSES ON MACQUARIE ISLAND

In this paper I calculate the breeding success of Wandering Albatrosses *Diomedea exulans chionoptera* on Macquarie Island from 1974 to 1978, and document and discuss the apparently high mortality rate of adults. Since 1954 Wandering Albatrosses have been banded by members of the Australian National Antarctic Research Expeditions (ANARE), under the guidance of the Biology Section of the Antarctic Division, Department of Science and Technology, Hobart. Birds were banded with numbered metal bands supplied by the Australian Bird Banding Scheme, CSIRO, Canberra and, more recently, with unique combinations of coloured plastic bands. Each year ANARE personnel occasionally visited numbered nest sites and noted colour combinations on all birds seen and the contents of nests, and banded adults and large chicks.

I calculated the size of the breeding population of Wandering Albatrosses at Macquarie Island by using the method developed by Tickell (1968). This method consists of adding the number of eggs laid in any year (year x) and the number of eggs laid in the preceding year (year x – 1) and substracting the number of eggs of pairs that bred in both years. The result is considered to be the total population of pairs alive in year x (Table I). It is necessary to include breeding pairs in year x and year (x – 1) since successful pairs breed only in alternate years.

TABLE I

Breeding success and breeding population of Wandering Albatrosses on Macquarie Island (1974 to 1978). Figures in parenthesis are percentages.

Year	Total eggs laid	Eggs hatched No. %	Chicks fledged No. %	No. Pairs that laid in preceding year	No. of breeding pairs
1974	14+	7 (50)	7 (50)	—	—
1975	16	12 (75)	9 (56)	3	27
1976	9	8 (89)	7 (78)	2	23
1977	7	1 (14)	0 (00)	1	15
1978	11+	7 (64)	7 (64)	4	14
All years	57	35 (62)	30 (53)		

Note: + Stage of failure of one egg in 1974 and 1978 not known.

Unless remains were found, it is assumed chicks banded in the period July to September fledged. I estimated the mean annual survival of banded breeding birds, assuming that successful breeders always miss the next year and return the year after to breed if they are still alive, and that birds whose breeding attempts fail before July return the next year to breed if still alive (Tickell 1968). Several analyses of annual mortality were considered: the capture/recapture methods of Jolly (in Southwood 1971), Method B of Leslie & Chitty (in Orians & Leslie 1958), and Maximum Likelihood Estimate (MLE, Seber 1973). The MLE, was considered the most satisfactory as only it allowed for the short time span under consideration, low frequency and varying intensity of recapture efforts, biennial breeding, possible emigration, and high probability of recapture. The MLE method computes the value with the minimum possible variance unbiased estimator, i.e. the value which is most likely to represent the population from which the sample was taken. The MLE was estimated by Dr G. Waterson (Department of Mathematics, Monash University).

RESULTS

Breeding success

The breeding population of Wandering Albatrosses on Macquarie Island declined from 27 pairs in 1975 to 14 pairs in 1978 (Table I). Fledging success (percentage of eggs laid that produced fledglings) on Macquarie Island from 1974 to 1978 ranged from 0 to 78% (Table I). During these five years two eggs (3%) failed due to human interference, twenty (35%) failed during incubation or soon after hatching. Only 14% of eggs that hatched failed before fledging and thus fledging success of chicks was greater than hatching success of eggs ($\chi^2 = 5.20$, df = 1, $p < 0.01$).

Adult mortality

In this study at least one partner of 15 of the 16 pairs that lost their egg or chick before 30 June returned to the colony the following season, and partners of 18 of the 19 pairs that lost their chick after 30 June or whose chick fledged returned to the colony the second season after their egg failure or chick fledging.

The difference of the estimated MLE between the

0158-4197/85/0140+03 $2.00

sexes was not significant and the data for the two were pooled to give a mean survival rate for the population of 0.79 (SE = 0.034). Thus the annual mortality or disappearance rate for banded breeding birds was 21% (Table II).

Five males and five females of known age disappeared during the study, the males at 13, 15, 16, 18, and 18, and the females at 13, 14, 18, 20 and 21 years of age respectively. The maximum possible age for any bird was 24 years. Croxall (1981) found on Bird Island, South Georgia that breeders aged 8–11 years had a lower survival rate than those age 11–14 years; the data are too few to determine if this occurred on Macquarie Island.

The number of non-breeders seen at Caroline Cove, where 59% of the Macquarie Island population was caught in 1976/77, was six males and two females in 1975/76, and nine males and five females in 1976/77. The number of females not seen again was not significantly greater than the number of males not seen again ($\chi^2 = 0.81$, df = 1, $p > 0.05$).

Non-return of banded breeding pairs

Failure of a bird to return to Macquarie Island for two or more years (i.e. it disappeared) was taken to imply that it had died (Tickell 1968) or bred on a different island. Thirty-one banded breeding birds in 1974 to 1977 did not reappear (10 females, 5 males and 8 pairs). Inspection of the data suggests that the disappearance rates were similar in all four years. Examining the disappearance rate for pairs it appeared that in more cases than might have been expected both partners disappeared in the same year. However, the small sample sizes and the increasing rate of adult mortality made it impossible to test if the observed number of such pairs (8) was greater than could statistically be predicted.

TABLE II

Annual mortality of banded breeding Wandering Albatrosses on Macquarie Island (1974 to 1978).

	Sighted	Not sighted
Females expected* to return one year after breeding	14	6
Females expected* to return two years after breeding	15	12
	29	18
Males expected to return one year after breeding	25	3
Males expected to return two years after breeding	18	10
	43	13

	Maximum Likelihood Estimates		Annual Mortality
Females	0.732*	(SE = 0.054)	26.8%
Males	0.834*	(SE = 0.042)	16.6%
Combined	0.787	(SE = 0.034)	21.3%

* difference between sexes not significant

DISCUSSION

The few breeding pairs of Wandering Albatross on Macquarie Island seem to be decreasing. The number of chicks fledging has decreased from 11 in 1967 and 15 in 1968 (Carrick & Ingham 1970) to zero in 1977 and seven in 1978 (Table I). The few new breeders do not offset the annual mortality rate of 21.3%. Wandering Albatrosses also decreased on South Georgia from the 1960's to the late 1970's, for no obvious reason (Croxall 1979).

The fledging success on Macquarie Island was no different in this study (53%) and the four years 1965 to 1968 (45%, Carrick & Ingham 1970) from that on Bird Island (59%, Tickell 1968 & Croxall 1979) or l'Ile de la Possession (64%, Fressanges du Bost & Segonzac 1976) ($\chi^2 = 0.85$, df = 2, $p > 0.05$). Thus poor breeding success on Macquarie Island does not explain the apparent decrease in the population.

An adult death rate of 21.3% seems high compared with other colonies, (5–10% at Bird Island, Tickell 1968; Croxall 1981, 3.6% at l'Ile de la Possession, Barrat et al. 1976). However, this figure may be an overestimate. First, some of the birds that disappeared may have been overlooked; either because they bred at remote localities, or because they failed early in the season. Secondly, the recapture effort varied from year to year, and birds which had lost a partner may have only visited infrequently. Thirdly, some "missing" birds from previous years have subsequently reappeared (Antarctic Division records). These prolonged absences indicate that the biennial breeding pattern on Macquarie Island may not be as rigid as that on Bird Island (Croxall 1981; Tickell 1968). Fourthly, birds may have moved to another island to breed, for instance one male banded in 1967 as a non-breeding adult on Macquarie Island was found breeding on Heard Island (Johnstone 1980). Further, Mougin (1977) reported a Wandering Albatross hatched on l'Ile de la Possession breeding on Marion Island; and Richdale (1950) documented Royal Albatrosses *D. epomophora* colonizing Taiaroa from colonies hundreds of kilometres away. If the 8 pairs that disappeared bred on other islands the adjusted

mortality rate is 9.8%, which is similar to that on Bird Island.

Carrick & Ingham (1970) estimated that the annual mortality rate for breeding adults on Macquarie Island from 1965 to 1968 was 5.4%, much less than the mortality in this study. Whereas natural causes cannot be discounted it is possible that some human factor may account for the increased mortality. Some albatrosses are accidently caught in fishing tackle (ABBS records, Barton in NSW, and Sinclair in South Africa, pers. comm.), and this number may be increasing. Albatrosses have also been shot off south-eastern Australia (J.D. Gibson pers. comm., Brothers 1982 and pers. comm., Andrews pers. comm.), where Wandering Albatrosses from Macquarie Island visit (ABBS records).

It seems unlikely that Macquarie Island is on the edge of the suitable geographic breeding range for these Wanderers, as the same subspecies breeds in very large numbers on Marion Island, which is also approximately 220 km north of the Antarctic convergence, and enjoys a similar climate (Watson 1975). Further, even considering the different mortality rates and feeding efficiency of various age groups (Croxall 1981), a scarcity of food does not seem to limit the population on Macquarie Island, as breeding success there is similar to that at some large colonies.

ACKNOWLEDGEMENTS

The Director, Antarctic Division, gave me access to Antarctic Division records and permitted me to visit Macquarie Island. Members of ANARE, especially Nigel Brothers and David Parer, assisted in field observations. The Department of Zoology, Monash University provided facilities for data analyses. Drs Johnstone and Cullen criticised draft manuscripts and M. Hindell assisted in the use of a word processor. N. Brothers and P. Andrews provided information on shot albatrosses held by Tasmanian National Park and Wildlife Service and by the State Museum of Tasmania respectively. J.D. Gibson allowed me access to his bird banding records at Bellambi, NSW. A grant from the M.A. Ingram Trust helped defray expenses of preparation of the paper for publication.

R.J. TOMKINS, *64 Tompson Rd, Revesby, NSW 2212.*

8 August 1983

REFERENCES

BARRAT, A. H. BARRE & J.-L. MOUGIN. 1976. Données écologiques sur les Grands albatros *Diomedea exulans* de l'Ile de la Possession (Archipel Crozet). L'Oiseau 46: 143-155.

BROTHERS, N. 1982. Shot an albatross lately? FINTAS 5: 36. Fisheries development Authority, Hobart.

CARRICK, R. & S.E. INGHAM. 1970. Ecology and population dynamics of Antarctic sea birds. In Vol. 1 Antarctic Ecology. Ed. M.W. Holgate. London: Academic Press.

CROXALL, J.P. 1979. Distribution and population changes in the Wandering albatross *Diomedea exulans* at South Georgia. Ardea 67: 15-21.

——. 1981. Aspects of the population demography of Antarctic and Subantarctic seabirds. Colleque sur les ecosystèmes subantarctiques. C.N.F.R.A. No. 51.

FRESSANGES du BOST & M. SEGONZAC. 1976. Note complementaire sur le cycle reproducteur du Grand albatros (*Diomedea exulans*) de l'Ile de la Possession, Achipel Crozet. C.N.F.R.A. No. 40: 53-60.

JOHNSTONE, G.W. 1980. Australian islands in the Southern Ocean. The Bird Observer 586: 85-87.

MOUGIN, J.-L. 1977. Nidification à l'Ile Marion (46°53'S, 37°52'E) d'un Grand Albatros (*Diomedea exulans* L.) né à l'Ile de la Possession, Archipel Crozet (46°25'S, 51°45'E). C.R. Acad. Sc. Paris, Serie D: 2277-2280.

ORIANS, G.H. & P.H. LESLIE. 1958. A capture-recapture analysis of a shearwater population J. Anim. Ecol. 27: 71-86.

RICHDALE, L.E. 1950. The pre-egg stage in the albatross family. Bio. Monogr. 3, Dunedin.

SEBER, G.A.F. 1973. The estimation of animal abundance and related parameters. London: Griffin. pp 309-327.

SOUTHWOOD, T.R.E. 1971. Ecological methods with particular reference to the study of insect populations. London: Chapman and Hall.

TICKELL, W.L.N. 1968. The biology of the Great albatrosses, *Diomedea exulans* and *Diomedea epomophora*. Antarctic Research Series 12: 1-55. Antarctic Bird Studies. Ed. O.L. Austin Jr. American Geophysical Union, Washington, D.C.

WATSON, G.E. 1975. Birds of the Antarctic and Subantarctic. American Geophysical Union, Washington, D.C.