AUSTRALIAN NATIONAL ANTARCTIC RESEARCH EXPEDITIONS

A N A R E

R E S E A R C H

N O T E S

41

The abundance of Royal penguins (<u>Eudyptes</u> <u>schlegeli</u>, Finsch) breeding at Macquarie Island

G.R. Copson and D.E. Rounsevell

This series allows rapid publication in a wide range of disciplines. Copies of this and other ANARE Research Notes are available from the Antarctic Division. Any person who has participated in Australian National Antarctic Research Expeditions is invited to publish through this series. Before submitting manuscripts authors should obtain a style guide from:

The Publications Office
Antarctic Division
Channel Highway
Kingston
Tasmania 7150
Australia.

CONTENTS

FIGURES

TABLES

THE ABUNDANCE OF ROYAL PENGUINS (EUDYPTES SCHLEGELI, FINSCH)
BREEDING AT MACQUARIE ISLAND

by

G.R. Copson and D.E. Rounsevell

Tasmanian National Parks and Wildlife Service
Sandy Bay, Tasmania, Australia

ABSTRACT

The total number of Royal penguins (Eudyptes schlegeli) breeding on
subantarctic Macquarie Island is estimated at 848 719 pairs (+10.5%) based
on two methods of estimation. The sizes and locations of all 57 colonies
are given as a baseline for future changes in the species' abundance.
Current estimates of the sizes of two colonies are compared with historical
estimates made by the Australasian Antarctic Expedition in 1912-13.

1. INTRODUCTION

Royal penguins (<u>Eudyptes schlegeli</u> , Finsch) breed only at Macquarie Island
(54°30'S, 158°57'E) approximately 200 km north of the Antarctic
Convergence. The Island is 120 km² in area, 34 km long and up to 5.5 km
wide. Breeding colonies are located irregularly around the coastline and in
a few inland sites at altitudes over 200 m. A small colony also exists on
Bishop and Clerk Islets 37 km to the south of the main island (Lugg et al.
1978). Birds in the two largest colonies at Hurd Point and The Nuggets were
commercially exploited for their oil (Cumpston 1968) intermittently from
1892 until 1900. Harvesting continued at The Nuggets until 1919.

<u>E. schlegeli</u> has been regarded as a pale-faced race of the ecologically
similar Macaroni penguin (<u>Eudyptes chrysolophus</u>, Brandt) which breeds on
other subantarctic islands. Differences between these two taxa have been
re-examined by Woehler (1981).

Breeding of <u>E. schlegeli</u>, studied by Carrick (1972), commences in
mid-September when the first birds re-occupy colonies. Eggs are laid in
October and the chicks fledge by mid-February. After a short period at sea
to feed the breeding adults come ashore again in March and April to moult.
The last birds leave the Island by early May and all age groups spend the
winter at sea.

<u>E. schlegeli</u> is the most numerous penguin species at Macquarie Island. Past
estimates of its abundance reported by Horne (1983), Carrick (1972) and
Falla (1937) are incomplete or too inaccurate for use in the International
Survey of Antarctic Seabirds (ISAS). This survey is a component of the
Biological Investigations of Marine Antarctic Systems and Stocks (BIOMASS)
program adopted in 1976 by the Scientific Committee for Antarctic Research
(SCAR) and is designed to measure factors which influence the distribution
and abundance of krill. Penguins were selected for study as they comprise
about 80% of the avian biomass in the Southern Ocean. The Macaroni/Royal
penguins are numerically dominant in the subantarctic and are being used to
derive estimates of the total populations of the species and the biomass of
the food they consume. The diet of <u>E. schlegeli</u> includes euphausiids,
amphipods, fish and squid (Horne 1985) which are all pelagic species
obtained by the birds feeding, possibly at a considerable distance from the
Island.

In 1979 the Tasmanian National Parks and Wildlife Service first experimented
with methods to estimate the abundance of <u>E. schlegeli</u>. In 1981 aerial
photography attempted by the Antarctic Division proved ineffective. A
combination of two methods of ground survey was eventually judged to provide
the best estimates of total abundance. The results of this ground survey
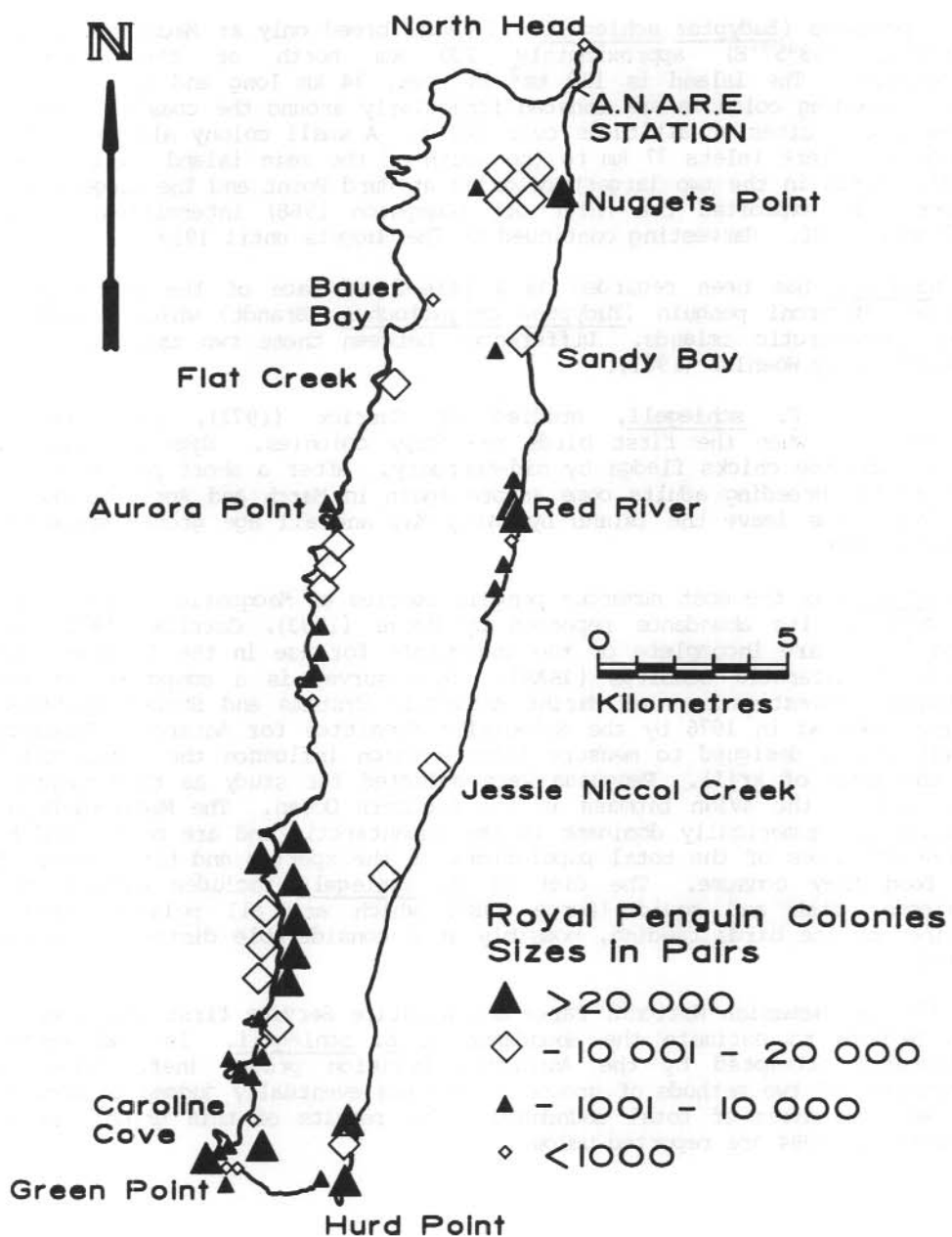conducted in 1984 are reported below.

3

Figure 1. The distribution of the Royal penguin colonies on Macquarie Island.

2. METHODS

2.1 GENERAL

The survey was carried out between May 1984 and January 1985. The colonies were identified in the field by using a six figure grid reference based on a 1 km^2 grid (Figure 1). A few of the colonies are referred to by convenient locality names. Where two or more large colonies were in the same general area each was recorded separately. Small groups of birds in close proximity to larger colonies were treated as satellite groups and included with their nearest large colony. Small groups over 250 m from a larger colony were recorded separately.

2.2 SURVEY METHODS

Depending on the terrain on which a colony was established one of two methods was used to estimate the number of breeding pairs. In topographically regular colonies which includes most colonies along the east coast of the Island, a conventional ground survey method was used. On the west coast where large boulders and irregular topography are the rule in colonies, simple visual estimates were the only practical means possible.

2.2.1 Ground survey method

Where the ground was relatively even and allowed a reasonably uniform distribution of nest sites the area of the colony was surveyed during the winter when the birds were absent. The outer limits of nest sites in a colony were marked with stakes and the area divided into triangles. Irregularities at the edges of the colony and major changes of slope were allowed for when placing the stakes. The dimensions of the triangles were measured using a Wild theodolite and a 100 m tape, only enough side measurements being taken to provide a baseline and several control lines. Areas were calculated using a Texas Instruments 58 calculator program. Vegetation 'islands' and rock stacks within a colony were measured separately and their areas deducted. The colonies were viewed again the following spring, when penguins were on their nests, in order to check for any major discrepancies between the area surveyed and that occupied by nests.

The nest densities were obtained from two 10 m x 10 m plots staked out in the lower Sandy Bay colony. The plots were photographed in early November when only females were present at the nests and few failures would have occurred. On enlarged photographs each plot was divided into four 5 m x 5 m sections and nest counts were made in each of them to obtain the mean number of nests per square metre and the standard deviation. In a few cases where pairs were evident they were counted as one nest.

The substrate is fairly level and covered with small to medium rocks and very few boulders over 30 cm diameter. On such ground the nesting territories are evenly distributed with minimal space between each. Although this type of substrate (and therefore nest densities) was typical of the greater part of the colonies ground surveyed a few had sections with larger boulders or badly drained ground where nest densities were slightly lower. When calculating the number of breeding pairs in a colony any such sections were estimated separately with a slightly lower nest density per square metre.

5

The number of nests was estimated by multiplying the mean nest density by the area of each colony. The range in the number of nests is given by 95% confidence limits of +2SE of the mean density.

2.2.2 Estimates

Most of the west coast colonies are on very irregular sites containing many large boulders and/or associated with Rockhopper penguins (Eudyptes chrysocome, Forster). As the winter survey method (2.2.1) was impractical at these sites, they were visited in the spring or early summer when birds were present and upper and lower estimates of the number of breeding pairs were made. These estimates were helped by having carried out the ground surveys in the previous winter.

2.3 ACCURACY OF SURVEYS

Using the format given in Croxall and Kirkwood (1979) the ground survey method (2.2.1) would be classified as an estimation of the number of breeding pairs with an accuracy of +5%. The estimations (2.2.2) would be classified as an estimation of adults with an accuracy of 20-50%.

In both cases the data are presented as the number of breeding pairs.

3. RESULTS

All Royal penguins breeding at Macquarie Island were allocated to one of 57 colonies identified by locations (Figure 1) and varying in size from 75 breeding pairs to over 160 000 breeding pairs (Tables 1 and 2).

The mean number of nests in the Lower Sandy Bay plots was $2.43/m^2$ (range at 95% confidence limits 2.32-2.54).

The occupied area given for Hurd Point colony has been reduced by 5% from that surveyed to allow for two areas included in the survey which were subsequently found not to be used by breeding birds in the 1984-85 season (see Discussion).

The variation in the difference between the lower and upper estimates of individual colonies given in Table 2 ranges from 17% to 50%. This was mainly due to the extreme variability of the terrain and/or the degree of association with Rockhopper penguins.

The number of breeding pairs calculated for the colonies surveyed through the winter (2.2.1) was 487 932 (range 465 838-510 014).

The total estimated for the unsurveyed colonies was 360 787 (range 294 100-427 475) breeding pairs. The total estimated number of breeding pairs of Royal penguins on Macquarie Island is 848 719 $\pm10.5\%$ (range 759 938-937 489).

7

Colony	Area (m^2)	Number of breeding pairs		Range	
Nuggets 1	8 032	19 518	18 634	20 401	
Nuggets 2	5 475	13 304	12 702	13 907	
Nuggets 3	12 515	30 417	29 035	31 788	
Nuggets 4	5 981	14 533	13 876	15 192	
Nuggets 5	4 960	12 053	11 507	12 598	
Nuggets 6	3 112	7 562	7 220	7 904	
Lower Sandy Bay	5 707	13 868	13 240	14 496	
Upper Sandy Bay	3 754	9 122	8 709	9 535	
Red River	3 062	7 441	7 104	7 777	
094495	709	1 723	1 645	1 801	
095493	9 674	23 508	22 444	24 572	
093485	11 764	28 587	27 292	29 881	
091474	1 317	3 200	3 055	3 345	
Jessie Niccol Creek	7 987	19 408	18 530	20 287	
062394	6 453	15 681	14 971	16 391	
050324	23 035	55 975	53 441	58 509	
049319	3 695	8 979	8 572	9 385	
Hurd Point	67 519	164 071	156 644	171 498	
Hurd Point Hut	462	1 123	1 072	1 173	
Caroline Creek	8 545	20 764	19 824	21 704	
Flat Creek	6 638	16 130	15 400	16 862	
Bauer Bay	397	965	921	1 008	
TOTAL		487 932	465 838	510 014	

Table 1. Areas of colonies surveyed during winter with the numbers of breeding pairs of Royal penguins.

Colony	Average	Estimated number of pairs Lower	Upper
North Head	375	250	500
Aurora Point (north)	2 625	1 750	3 500
Aurora Point (south)	8 500	7 000	10 000
094488	62	50	75
042483	11 250	7 500	15 000
041481	17 500	15 000	20 000
040475	17 500	15 000	20 000
040463	1 625	1 500	1 750
039457	8 750	7 500	10 000
037445	750	500	1 000
039452	2 625	1 750	3 500
038451	2 625	1 750	3 500
030403	30 000	25 000	35 000
028398	30 000	25 000	35 000
028391	23 500	20 000	27 000
031385	13 500	10 000	17 000
031381	21 500	18 000	25 000
031376	17 500	15 000	20 000
031374	21 500	18 000	25 000
030372	17 500	15 000	20 000
028366	22 500	18 000	27 000
022356	8 500	7 000	10 000
025354	13 500	10 000	17 000
023348	325	250	400
023345	5 250	3 500	7 000
017342	9 750	7 500	12 000
018339	2 750	2 000	3 500
021338	8 750	7 500	10 000
023330	450	400	500
014322	6 000	5 000	7 000
012320	7 500	5 000	10 000
013314	625	500	750
017314	450	400	500
Green Point	23 500	20 000	27 000
015313	1 750	1 500	2 000
TOTAL	360 787	294 100	427 475

Table 2. Estimated numbers of breeding pairs of Royal penguins in unsurveyed colonies.

4. DISCUSSION

There are very little accurate early data on the number or sizes of Royal penguin colonies on Macquarie Island. Warham (1971) gives the number of colonies as 'about 46' but points out the difficulty of precise delimitation of colony boundaries. He reports a small new colony 'about 60 nests' being situated in the King penguin (Aptenodytes patagonicus, Miller) colony at Lusitania Bay in 1960-61. This is no longer there, the King penguin colony having expanded considerably in the last few years (Rounsevell and Copson 1982). In this Research Note, 57 colonies are recorded (excluding overflow groups attached to larger colonies) eight of which contain less than 1000 breeding pairs. The occurrence of these small and in some cases ephemeral colonies may well indicate an increasing population with birds having to colonise new areas as the others become overcrowded. It should be possible to monitor any long term changes in the population by repeating parts or all of the winter ground survey program at suitable intervals.

During the Australasian Antarctic Expedition, 1911-14, L.R. Blake carried out ground surveys on the Royal penguin colonies at Hurd Point (December 1912) and The Nuggets (June 1913) (Mawson 1942). The area of the Hurd Point colony, 16.5 acres (66 772 m^2) was only 1.1% less than obtained in 1984.

Early on in four breeding seasons Copson noted a large (several hundred square metres) unoccupied area in the centre of the Hurd Point colony. The area was occupied by non-breeding birds after the eggs were laid each season. Inspection of the area while carrying out the survey in 1984 showed it to be well drained and substantially no different from other parts of the colony occupied by breeding birds. It was however one of the remotest areas from any edge of the colony. It is possible that the difficulty of relocating a nest site in a large area without a fixed reference point and/or having to 'run the gauntlet' past several hundred birds on nests, sets limits to the extent of unbroken ground that can be utilised for nest sites. The area for the colony given in Table 1 has been reduced by 5% from that surveyed to allow for this area unoccupied by nest sites and another area adjacent to a beach that was occupied by an Elephant seal (Mirounga leonina L.) colony in the spring of 1984.

The total area of nesting sites in The Nuggets colonies were calculated as 8.5 acres (34 398 m^2) in 1913 (Mawson 1942) and 40 075 m^2 in 1984. Large numbers of birds from these colonies were killed annually for their oil from before the turn of the century until 1919. This fact alone could account for the 16.5% increase in the population between 1912 and 1984.

10

REFERENCES

Carrick, R. (1972). Population ecology of the Australian black-backed magpie, Royal penguin and Silver gull. In: Population ecology of migratory birds: a symposium. Wildlife Research Report 2:41-99. U.S. Department of the Interior.

Croxall, J.P. and Kirkwood, E.D. (1979). The distribution of penguins on the Antarctic Peninsula and islands of the Scotia Sea. British Antarctic Survey, Cambridge.

Cumpston, J.S. (1968). Macquarie Island. ANARE Scientific Reports Series A(1) Number 93. 380 pp.

Falla, R.A. (1937). Birds. BANZARE Reports Series B 2:1-304.

Horne, R.S.C. (1983). The distribution of penguin breeding colonies on the Australian Antarctic Territory, Heard Island, the McDonald Islands, and Macquarie Island. ANARE Research Notes Number 9. Antarctic Division, Kingston.

Horne, R.S.C. (1985). Diet of Royal and Rockhopper penguins at Macquarie Island. The Emu 85(3):150-156.

Lugg, D.J., Johnstone, G.W. and Griffin, B.J. (1978). The outlying islands of Macquarie Island. The Geographical Journal 144:277-287.

Mawson, D. (1942). AAE Scientific Reports Series A 1(1). Narrative.

Rounsevell, D.E. and Copson, G.R. (1982). Growth rate and recovery of a King penguin Aptenodytes patagonicus, population after exploitation. Australian Wildlife Research 9:519-525.

Warham, J. (1971). Aspects of breeding behaviour in the Royal penguin. Notornis 18(2):91-115.

Woehler, E.J. (1981). A study of the phenotypic variation in the Royal penguin, Eudyptes schlegeli, at Macquarie Island. B.Sc. Thesis, University of Tasmania.