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Breeding distribution and abundance of surface-nesting petrels in the Rauer Islands, East Antarctica

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BREEDING DISTRIBUTION AND ABUNDANCE OF SURFACE-NESTING PETRELS IN THE RAUER ISLANDS, EAST ANTARCTICA

by

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ABSTRACT

Previous exploration and ornithology in the Rauer Islands are reviewed. Estimates of the nesting populations of southern fulmars and Antarctic petrels are compared with censuses conducted in 1983/84 and 1984/85. Population estimates varied considerably between years, and within the same year between different observers. To remedy this situation the three islands with sympatric breeding populations of the two species were divided into counting units, which are detailed with photographs. The total populations of surface-nesting petrels are in the order of 14000 pairs of fulmars, 2500 pairs of Antarctic petrels and 400 pairs of cape petrels. Chick survival was estimated at the time of banding and varied considerably between species, islands and years.

1. INTRODUCTION

The southern fulmar Fulmarus glacialoides breeds on a number of islands of the Scotia Arc, the Antarctic Peninsula, mainland east Antarctica and probably on the Balleny Islands (Figure 1). The Antarctic petrel Thalassoica antarctica breeds only on continental Antarctica, some close inshore islands and probably on the Balleny Islands (Figure 1).

Breeding ranges of the two species overlap only in East Antarctica, with sympatric breeding at Proclamation Island (55°51'S 53°41'E) (Falla 1937), Scullin Monolith (67°47'S 66°42'E) (Falla 1937), Rauer Islands (68°51'S 77°50'E) (Johnstone et al. 1973), Haswell Island (66°31'S 93°00'E) (Falla 1937, Korotkevich 1964) and Windmill Islands (66°20'S 110°25'E) (Orton 1963) (Figure 1).

The Rauer Islands are located 25 km south of the Australian station Davis (68°35'S 77°58'E) and are therefore more accessible for study than many other localities containing both fulmars and Antarctic petrels. The two species breed sympatrically on three islands in the Rauers (Filla, Hop and Buchan*[1] Islands) where their total breeding populations probably exceed 8000 pairs of fulmars and 2500 pairs of Antarctic petrels.

Other species breeding at the Rauer Islands are Adélie penguin Pygoscelis adeliae, cape petrel Daption capense, snow petrel Pagodroma nivea, Wilson's storm-petrel Oceanites oceanicus and south polar skua Stercorarius maccormicki. These are widespread and abundant throughout the Antarctic region. They occur also on the islands of the Vestfold Hills 12 km to the north, where southern fulmars and Antarctic petrels are absent. The small Svenner Islands 30 km to the south also support significant bird populations including some 2000-3000 pairs of fulmars, but no Antarctic petrels (Johnstone and Williams unpublished).

The existence and locations of most colonies were first reported by Kerry in January 1973 (Johnstone et al. 1973). Johnstone made rough estimates of breeding numbers in December 1981. In December 1983 the Oceanic Research Foundation (ORF) Frozen Sea Expedition censused colonies on Hop and Filla Islands (Lewis and George 1984).

The aim of the authors' study in 1983/84 and 1984/85 was to map the distribution of colonies on the three islands where sympatry occurred and to delineate counting units for periodic censuses.

1. Place names not approved by the Antarctic Names and Medal Committee are identified by an asterisk when first mentioned.

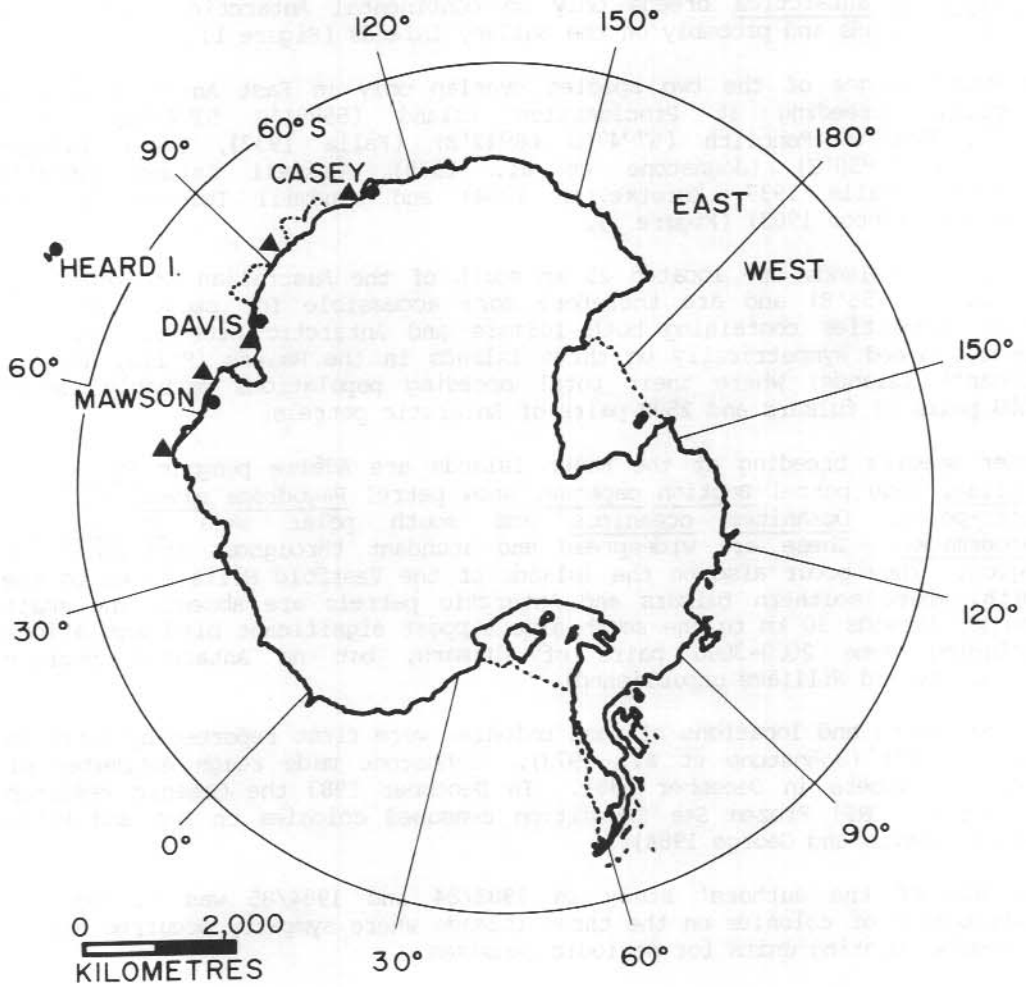


Figure 1. Sympatric distribution of Antarctic petrels and southern fulmars.

2. THE STUDY AREA

The Rauer Islands comprise a group of coastal islands located between 68°45'S and 68°55'S and 77°30'E and 78°00'E in south-eastern Prydz Bay (Figure 2). They consist of Precambrian metamorphic rock with Holocene glacial and marine deposits.

They were discovered in 1935 by the Norwegian Captain Klarius Mikkelsen commanding the Thorshavn who named them after Rauer Island in Oslofjorden, Norway (Alberts 1981). The Thorshavn returned in 1936/37 under Lars Christensen and oblique aerial photographs of most of the coast between 50°E and 80°E were taken, resulting in the slightly inaccurate maps of Hansen (1946). During this expedition both Filla Island and Hop Island were named (McKinnon 1965).

P.G. Law in the Kista Dan visited the Rauer Islands in 1953/54 for aerial scintillometer investigation of radioactivity in rocks (Law 1983). In 1956 the Rauer group was visited by a Soviet expedition which conducted aerial photography over the area; the resulting map appeared in Atlas Antarktiki (1966).

The next recorded visit was after Davis station was established in 1957. A crossing of the Sørsdal Glacier to the Rauer Islands was made between 19 and 27 September 1961 by A. Brown, B. Mercer and M. Hay. They were, however, forced to return to Davis before being able to explore the island group. A manhaul traverse of the Sørsdal Glacier was conducted between 12 and 18 November 1974 by W. Cowell, G. March and B. Brookes but lack of time prevented a descent to the Rauer Islands. In 1983 a further inland route was travelled when a cane line was laid from Long Fjord, near Davis, to a point on the plateau overlooking Filla Island.

The first biological investigation of the Rauer Islands was in January 1973 when K.R. Kerry, D.R. Grace and D.E. Rounsevell visited Hop, Filla and a number of surrounding smaller islands, all containing southern fulmars. Kerry commented that 'the Rauer group is a very important area for this species'. He also found Antarctic petrels nesting on Hop and Filla Islands and estimated that the number of this species would probably not exceed 1000 pairs. On both islands the Antarctic petrels were nesting among southern fulmars.

In 1974 R. Williams visited Ranvik Island, South Tangholmane Island*, Strelka Island and the island to its immediate north (Figure 2), finding only Adélie penguins, cape petrels and snow petrels.

In 1981 Johnstone conducted an aerial reconnaissance of the island group. He landed on some islands and sketch-mapped the location of most colonies, estimating their populations.

In 1983 R. Puddicombe experimented with water offloading to collect stomach contents of cape petrels, Antarctic petrels and southern fulmars but did not conduct any census work. However, in the same year the Oceanic Research Foundation's sloop Dick Smith Explorer (Master, D. Lewis) overwintered at

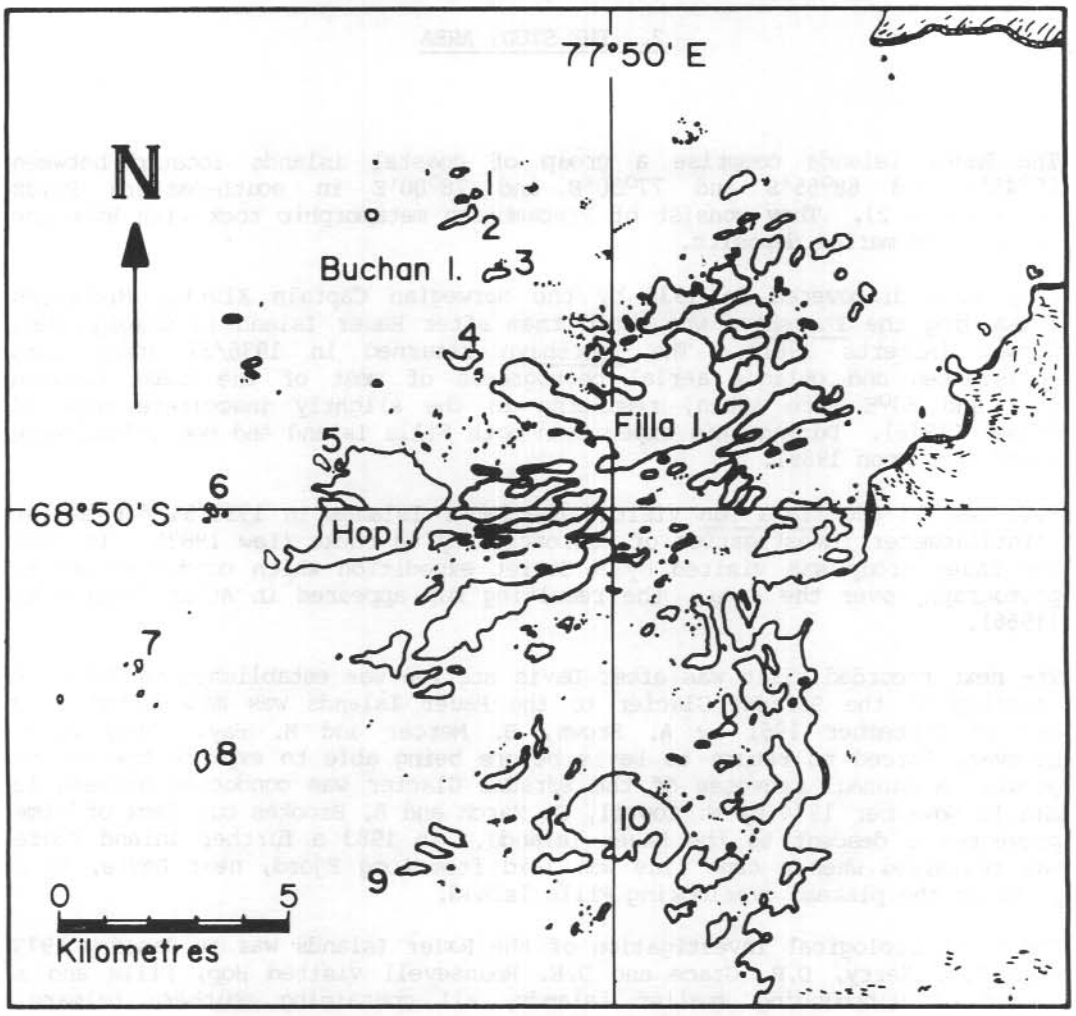


Figure 2. The Rauer Islands:

1. Islands north of Strelka Island
2. Strelka Island
3. Small island north of Buchan Island
4. Kryuchok Island
5. McNab Island
6. Islands A B C & D. A is the biggest and the others are named clockwise from it
7. Northern of two islands north-west of Forpost Island
8. Forpost Island
9. South Tangholmane Island
10. Ranvik Island

Filla Island from 24 February 1983 to 26 January 1984 (Lewis and George 1984). Crew of the sloop conducted censuses of Antarctic petrels and fulmars on Hop and Filla Islands in December 1983.

Green conducted field work during 1983/84 and 1984/85, accompanied by Johnstone in February 1985. A visit to band fulmar chicks and assess their survival was made by D. Reid and R. Besso on 19 February 1985.

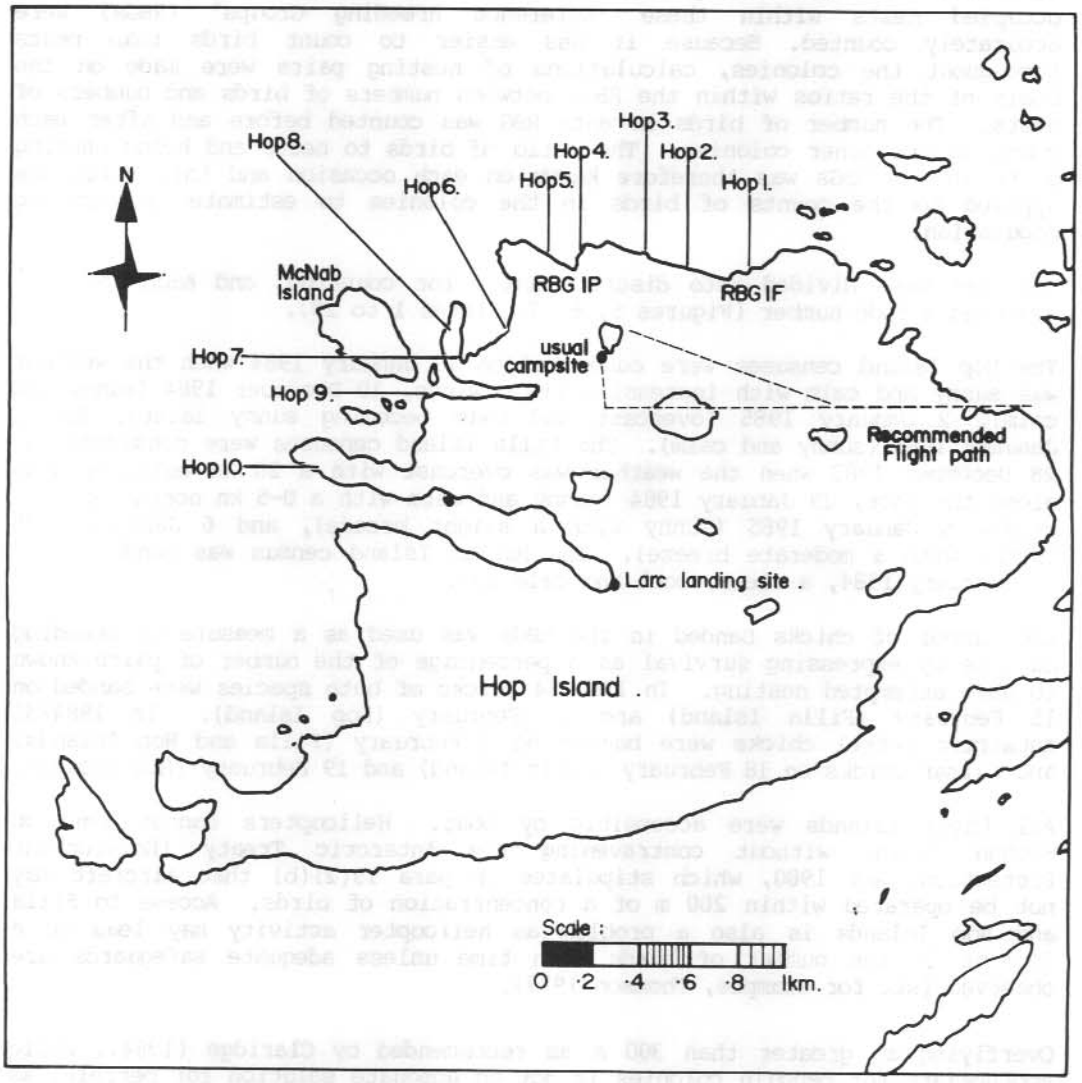


Figure 3. Hop Island showing counting units and access routes.

3. METHODS

During the main period of the study between December 1983 and February 1985, Antarctic petrels and southern fulmars were censused on Filla, Hop and Buchan Islands, and also on the southern face of McNab Island* (Figures 3 and 4).

Prior to counting, roughly rectangular areas of nesting birds were marked out using natural features as boundaries where possible. One area for each of fulmars and Antarctic petrels was marked out on each island. Birds and occupied nests within these 'Reference Breeding Groups' (RBGs) were accurately counted. Because it was easier to count birds than nests throughout the colonies, calculations of nesting pairs were made on the basis of the ratios within the RBGs between numbers of birds and numbers of nests. The number of birds in each RBG was counted before and after each count in the other colonies. The ratio of birds to nests and hence nesting pairs in the RBGs was therefore known on each occasion and this ratio was applied to the counts of birds in the colonies to estimate the nesting population.

Colonies were divided into discrete units for counting, and each unit was assigned a code number (Figures 5, 6, 7, Plates 1 to 28).

The Hop Island censuses were conducted on 13 January 1984 when the weather was sunny and calm with increasing light winds, 10 December 1984 (sunny and calm), 2 January 1985 (overcast and calm becoming sunny later), and 3 January 1985 (sunny and calm). The Filla Island censuses were conducted on: 28 December 1983 when the weather was overcast with a 20 kn easterly wind along the face, 29 January 1984 (sunny and warm with a 0-5 kn north-westerly wind), 5 January 1985 (sunny with a slight breeze), and 6 January 1985 (sunny with a moderate breeze). The Buchan Island census was conducted on 10 February 1984, a clear, cool and calm day.

The number of chicks banded in the RBGs was used as a measure of breeding success by expressing survival as a percentage of the number of pairs known to have attempted nesting. In 1983/84 chicks of both species were banded on 15 February (Filla Island) and 23 February (Hop Island). In 1984/85 Antarctic petrel chicks were banded on 2 February (Filla and Hop Islands) and fulmar chicks on 18 February (Filla Island) and 19 February (Hop Island).

All three islands were accessible by boat. Helicopters cannot land on Buchan Island without contravening the Antarctic Treaty (Environment Protection) Act 1980, which stipulates in para 19(2)(b) that aircraft may not be operated within 200 m of a concentration of birds. Access to Filla and Hop Islands is also a problem as helicopter activity may lead to a decline in the number of birds with time unless adequate safeguards are observed (see for example, Thomson 1977).

Overflying at greater than 300 m as recommended by Claridge (1984), while appropriate for penguin colonies is not an adequate solution for petrels, as even at this height disturbance is noticeable. Recommended flight paths are marked on Figures 3 and 4 but the effect of these flight paths on the bird colonies should be monitored to ensure that they give adequate protection

against disturbance. It is also recommended that no helicopters land on Buchan Island and that no overflights of colonies take place at all, other than for aerial photography.

LARC or boat landing sites are marked on Figures 3 and 4. Buchan Island is the most difficult island to land at and a large 'Dayglo' orange cross is painted on a white background at the landing site used in 1984. This landing site gives immediate access to a bench, 3-4 m above sea level, that was carved into the gully in 1984. The bench is large enough for one beche tent. A boat should not be left at the landing site unattended.

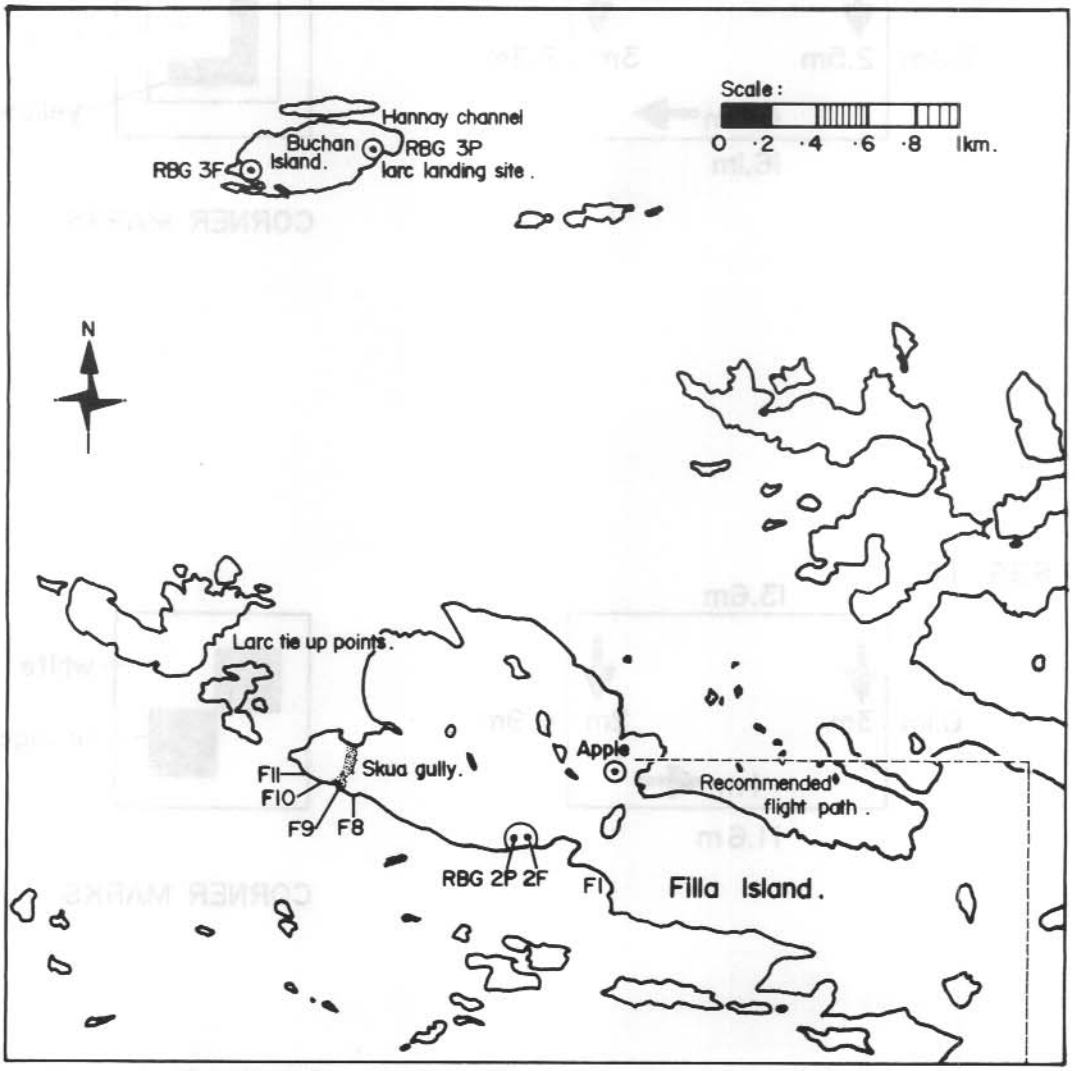


Figure 4. Filla and Buchan Islands showing counting units and access routes.

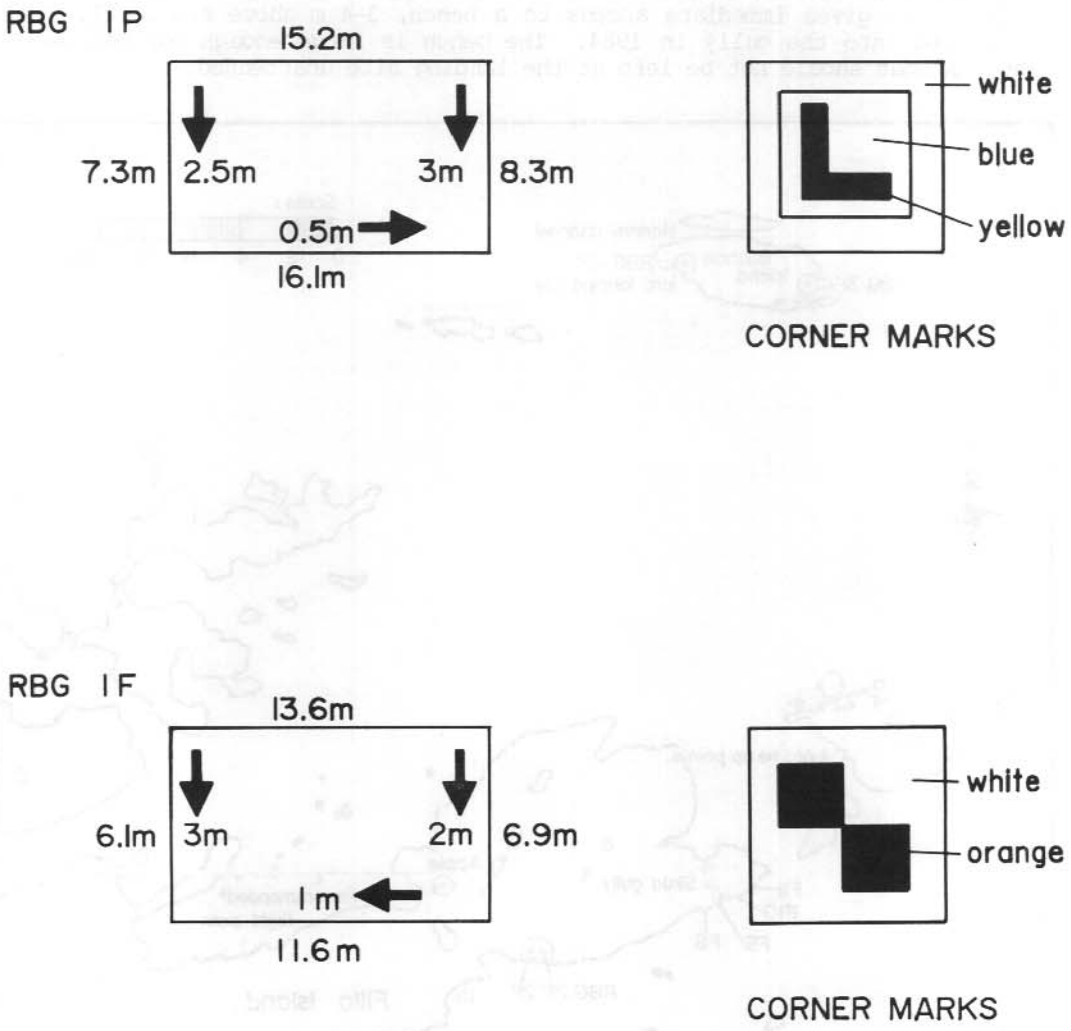


Figure 5. Dimensions and corner marks for Reference Breeding Groups on Hop Island. Arrows show direction of slope downwards between corner marks. All distances and heights are in metres. Where birds were nesting along lines between corners, lines were painted to include or exclude their nest sites.

Plate 1. Hop Island. Hl is the easternmost colony on Hop Island. It includes RBG lF in a central area with Gully l (Gl) to the left and Gully 2 (G2) below and to the right.

Plate 2. Hop Island. H2 contained a small group of nests beneath an overhang about one third of the way between H1 and H4. It can easily be missed if not searched for, but bird activity in the area indicated its presence.

Plate 3. Hop Island. H3 is in a gully located two thirds of the way between H1 and H4.

Plate 4. Hop Island. H4 and H5 occupy both sides of the gully nearest to the usual campsite (Figure 3). The dividing line down the middle of the gully is quite distinct for most of its length. H4 occupies the eastern side of the gully. It is impossible to count from any one spot.

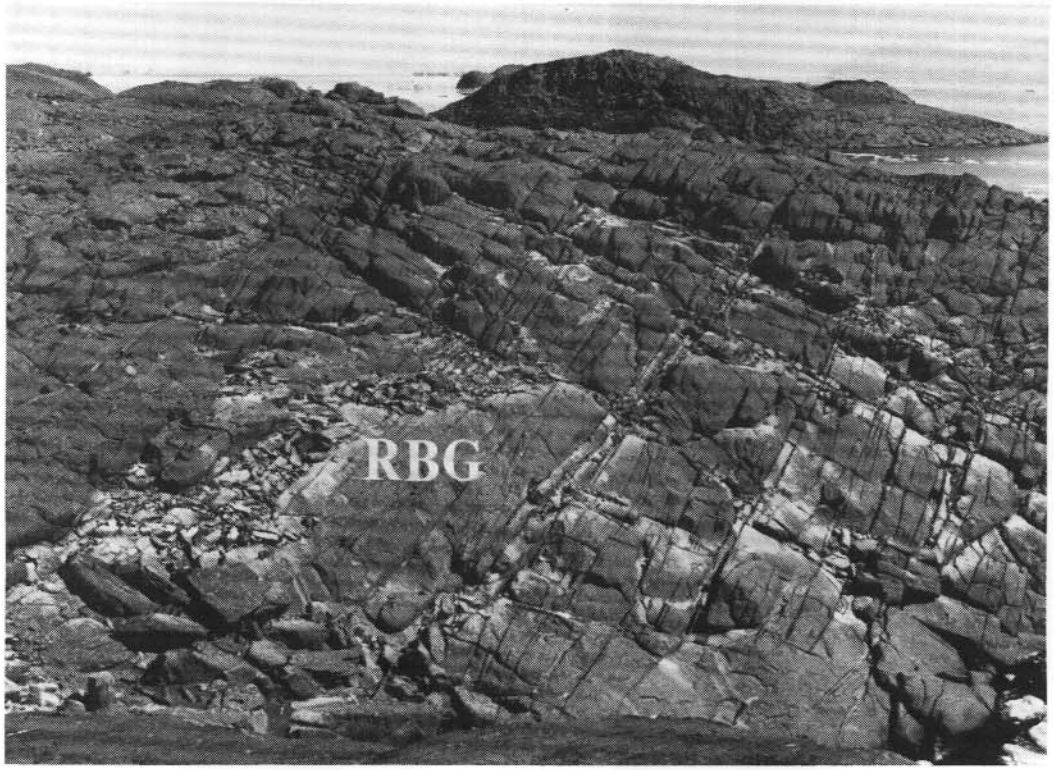


Plate 5. Hop Island. H5 is on the western side of the gully from H4. It contained a core of Antarctic petrels (including RBG 1P) with peripheral fulmars. It was the only colony containing Antarctic petrels on Hop Island.

Plate 6. Hop Island. H6 is in a small gully along the wide bay between H5 and H8.

Plate 7. Hop Island. H7 is at the base of the peninsula containing H8. It begins in a gully leading up onto a narrow face which also contained fulmar nests.

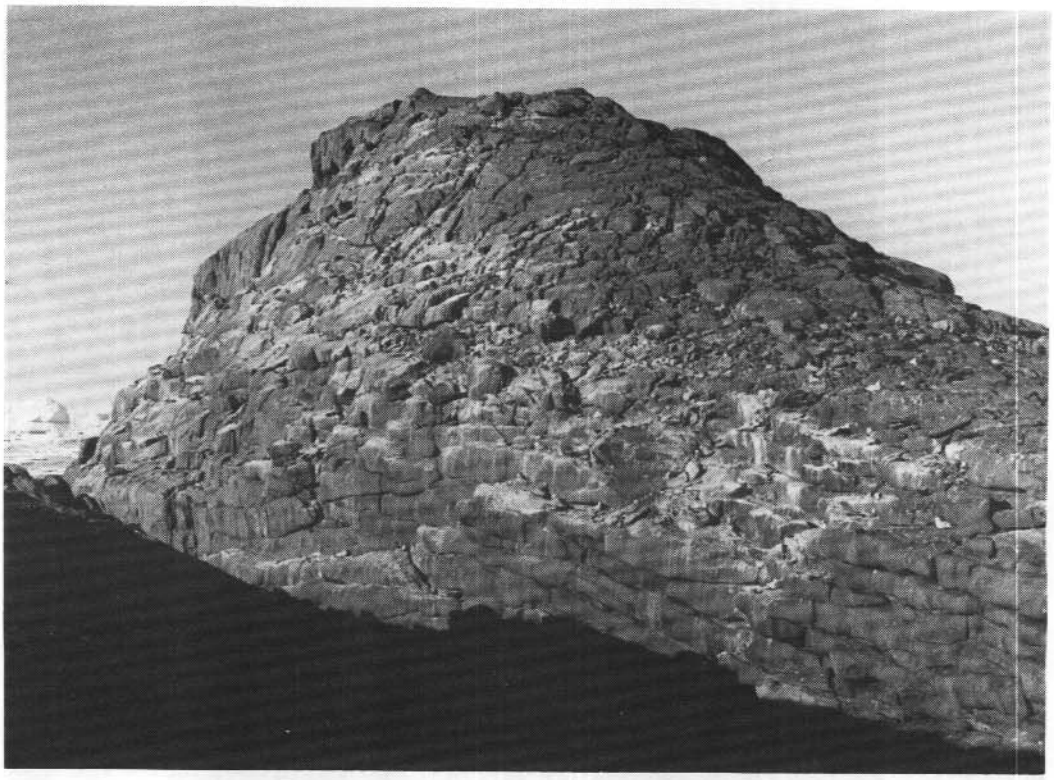


Plate 8. Hop Island. H8 is on a peninsula which appears to be an incipient island as a gash cuts it almost to sea level. The peninsula encloses the wide bay containing H6 and H7.

A straggling colony of fulmars spread over the face of McNab Island could be counted with binoculars from near H8.

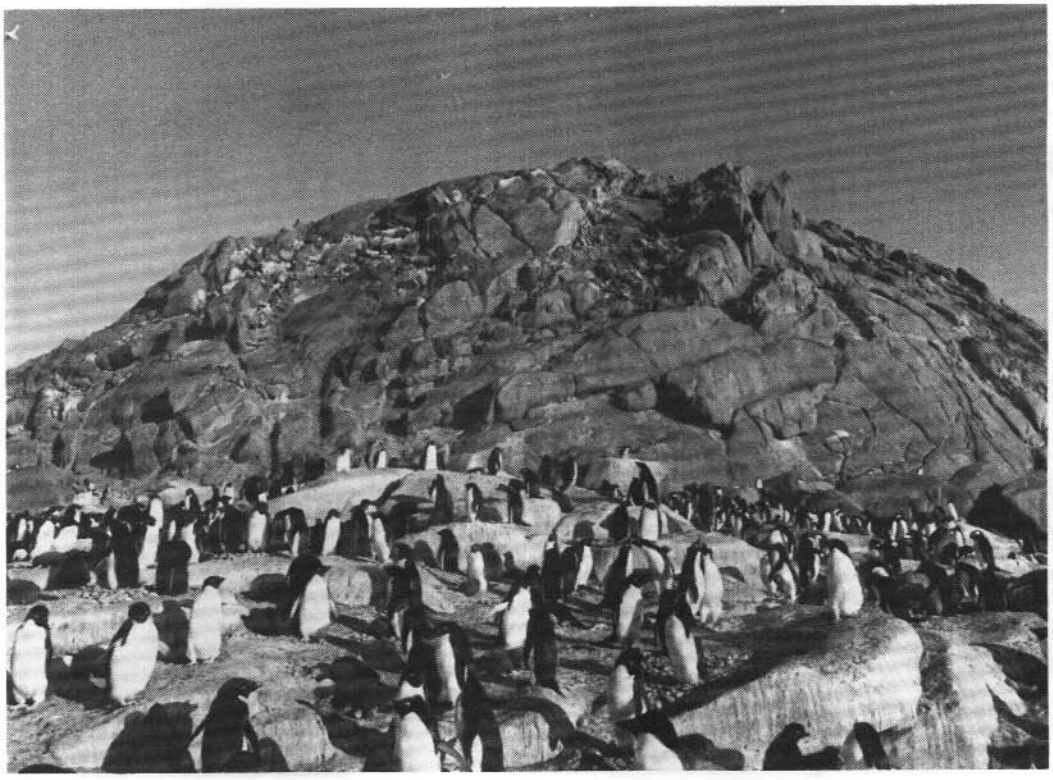


Plate 9. Hop Island. H9 is on a knoll above a penguin colony. Most of it can be counted from the shore.

Plate 10. Hop Island. H10 is at the end of a peninsula and is broken by a deep fissure. The fissure can be reached at sea level on the southern side but crampons are needed to climb inside as it contains permanent ice. The fissure overhangs on the eastern side which makes counting from the top difficult. To reach the western side of the fissure would require some climbing expertise. In short this is a most difficult colony to count.

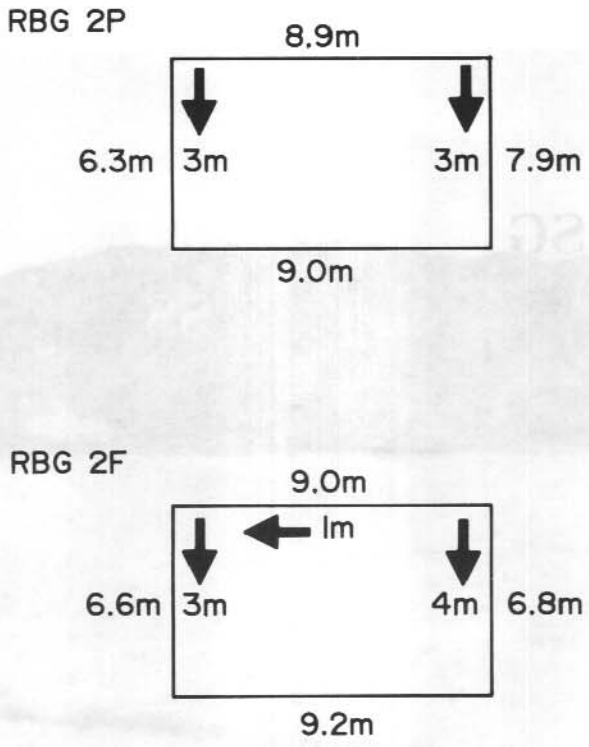


Figure 6. Dimensions and corner marks for Reference Breeding Groups on Filla Island.

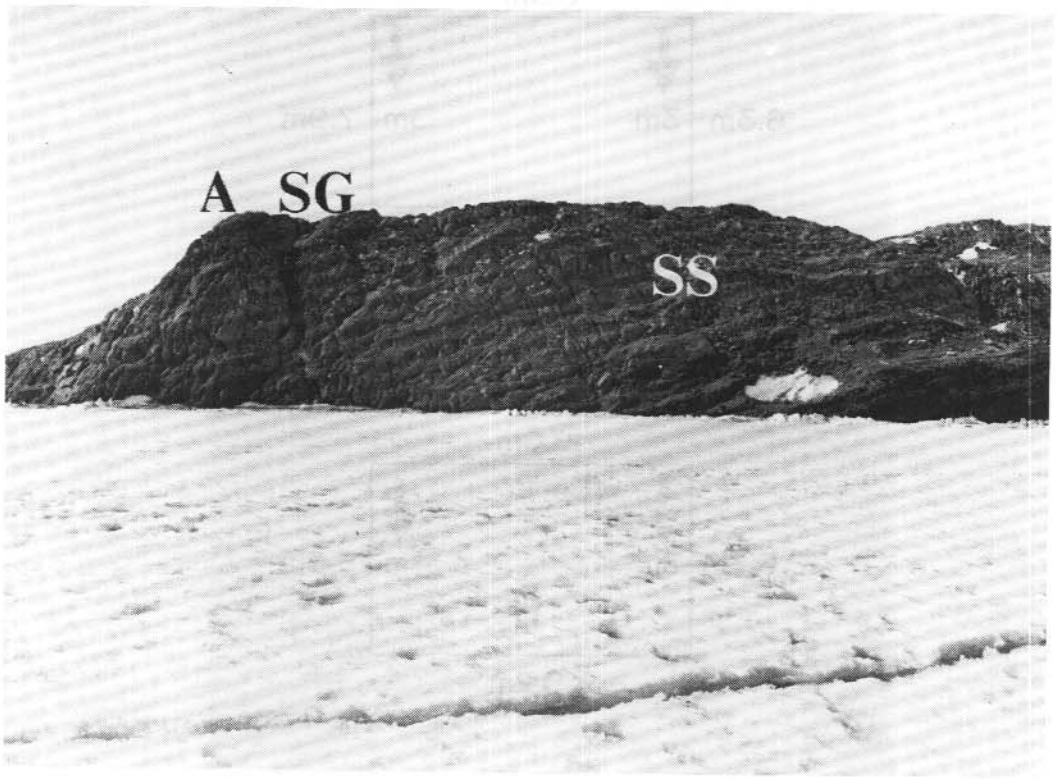


Plate 11. Filla Island. F1 is south-east of the pronounced isthmus. This was the only sizeable colony not situated on the same side of the isthmus as the 'Apple' hut. The count takes in the area from 'steep gully' (SG) to the scree slope (SS) inclusive. A few fulmars were nesting above and to the left of A. Antarctic petrels moved into this colony in the 1984/1985 breeding season. The count is best done from the top with a short scramble down into 'steep gully'.

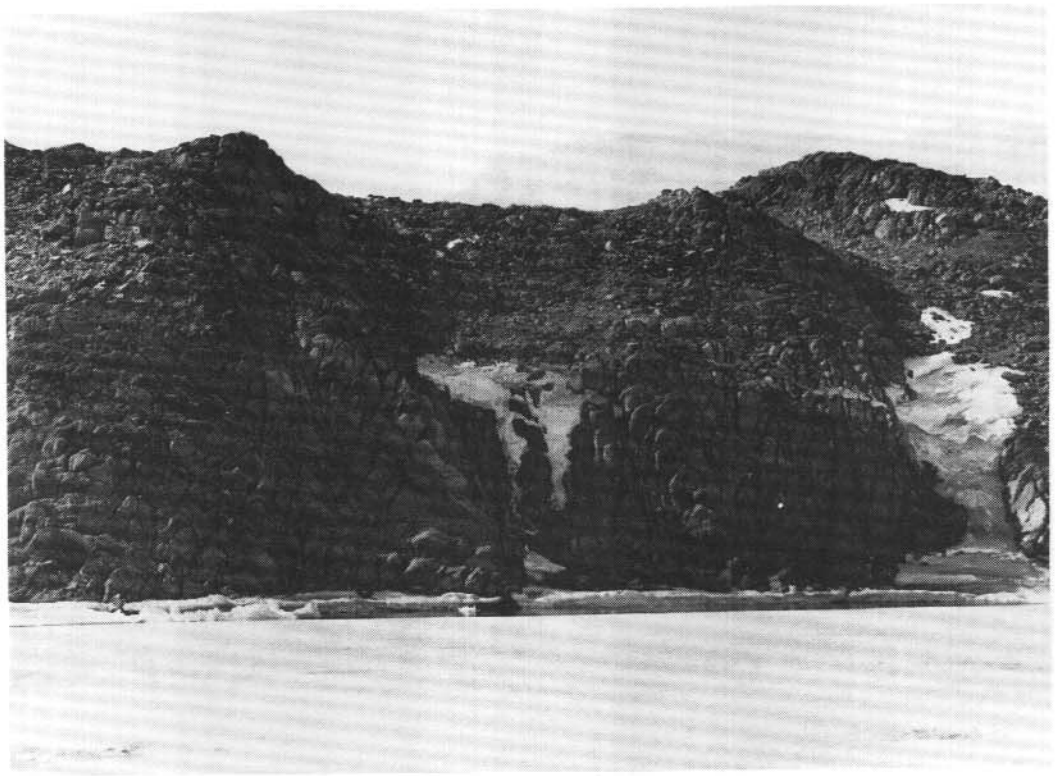


Plate 12. Filla Island. F2 is the first colony west of the isthmus and contained only cape petrels. It includes the area below the saddle and the gully to the right of this extending down to some nests almost at sea level.

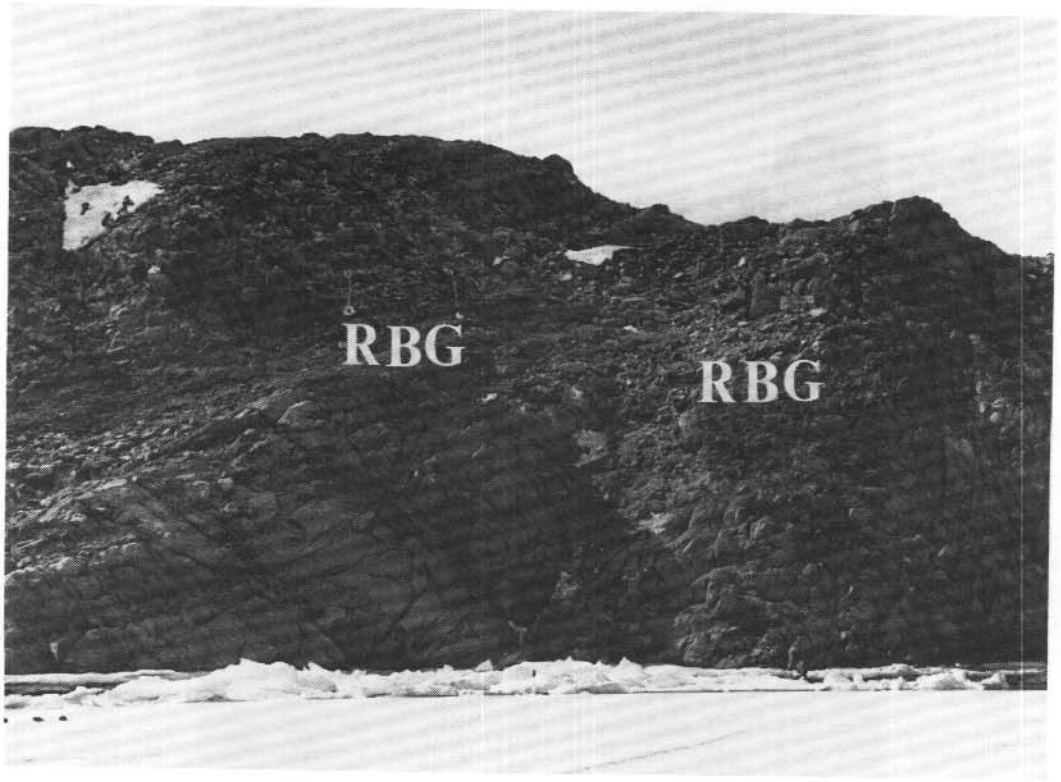


Plate 13. Filla Island. A low ridge separates F2 and F3. F3 contained nests of Antarctic petrels and fulmars with some cape petrels in the upper right corner and one cape petrel nest half way across the base of the colony. RBG 2F is below and to the right of the cape petrels which occupied the best approach to this colony. RBG 2P is to the left and slightly higher than RBG 2F. The count can only be made by moving over the face.

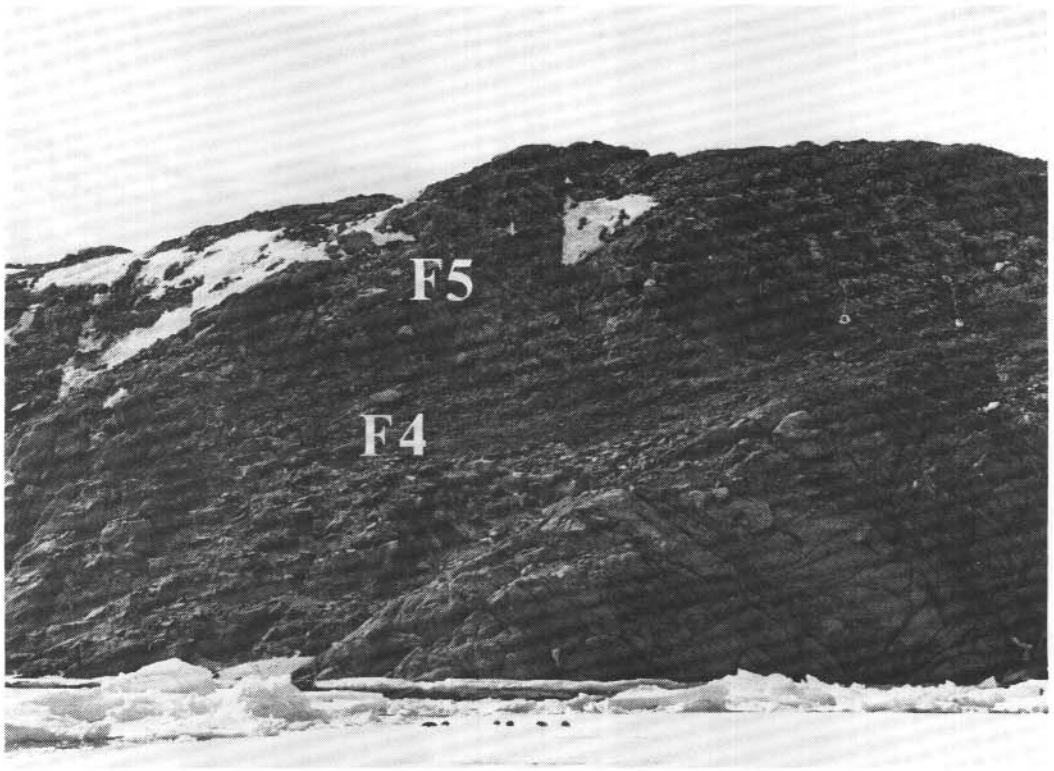


Plate 14. Filla Island. F4 and F5 could both be easily distinguished from the sea ice in late 1983. They were not so easily separated when the observer was actually among the birds so they were counted together. In 1985, however, they were counted separately as the Antarctic petrels provided a lower boundary for F5. F5 contained both Antarctic petrels and southern fulmars; F4 had only fulmars.

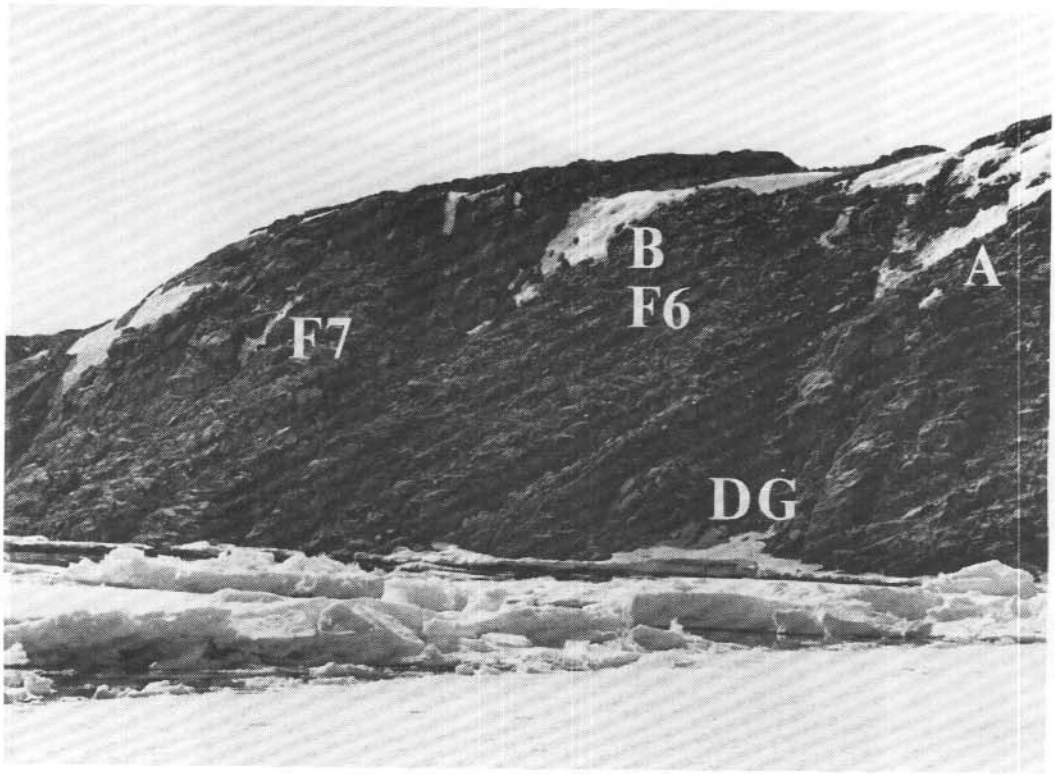


Plate 15. Filla Island. The best approach to both F6 and F7 is from the top rather than by a traverse from F4 and F5. The two colonies were easily differentiated from the sea ice and on the ground in the 1983/1984 season. However, due to less snow in 1984 the dividing line at snowpatch B was difficult to pick in the 1984/1985 season when birds moved into this area. There was also a movement of birds into snowpatch A and 'dark gully' (DG) in the 1984/1985 season.

Plate 16. Filla Island. F8 extends from the skyline of F9 back towards F7 to a slight gully crossed by rock striations, a feature unusual on this side of Filla Island. Between the top and the sea the rock is very broken and crumbly. To get a good count it is necessary to scramble along the face.

Plate 17. Filla Island. Skua Gully (SG) is a readily identifiable feature on the south-western side of the peninsula of Filla Island. F9 occupies the eastern side of the gully and extends to the skyline where subjective judgment decides where F8 begins. The count can be made from the western side of the gully with the aid of binoculars.

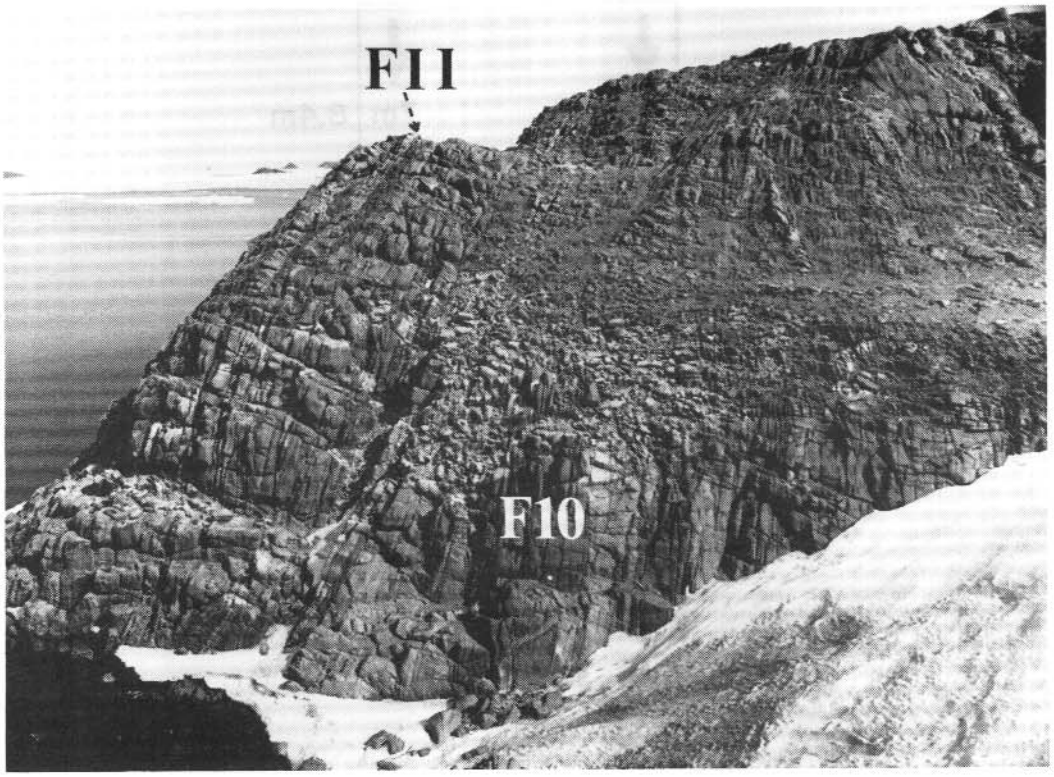
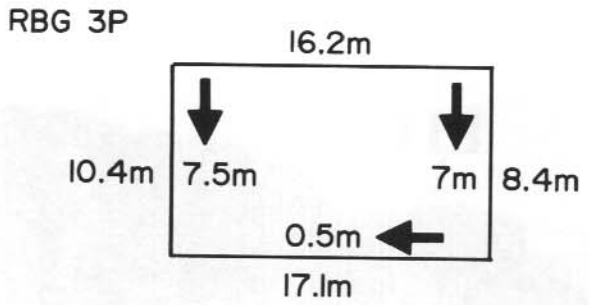
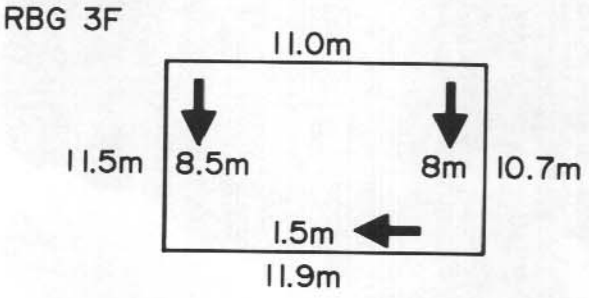


Plate 18. Filla Island. F10 occupies the eastern side of Skua Gully and can best be counted from F9. F11 extends from F10 to the end of the island. Counting is difficult involving much scrambling around the cliffs.





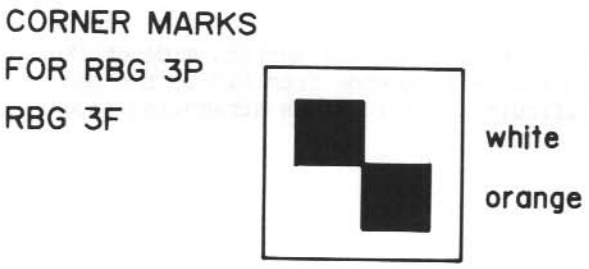


Figure 7. Dimensions and corner marks for Reference Breeding Groups on Buchan Island.

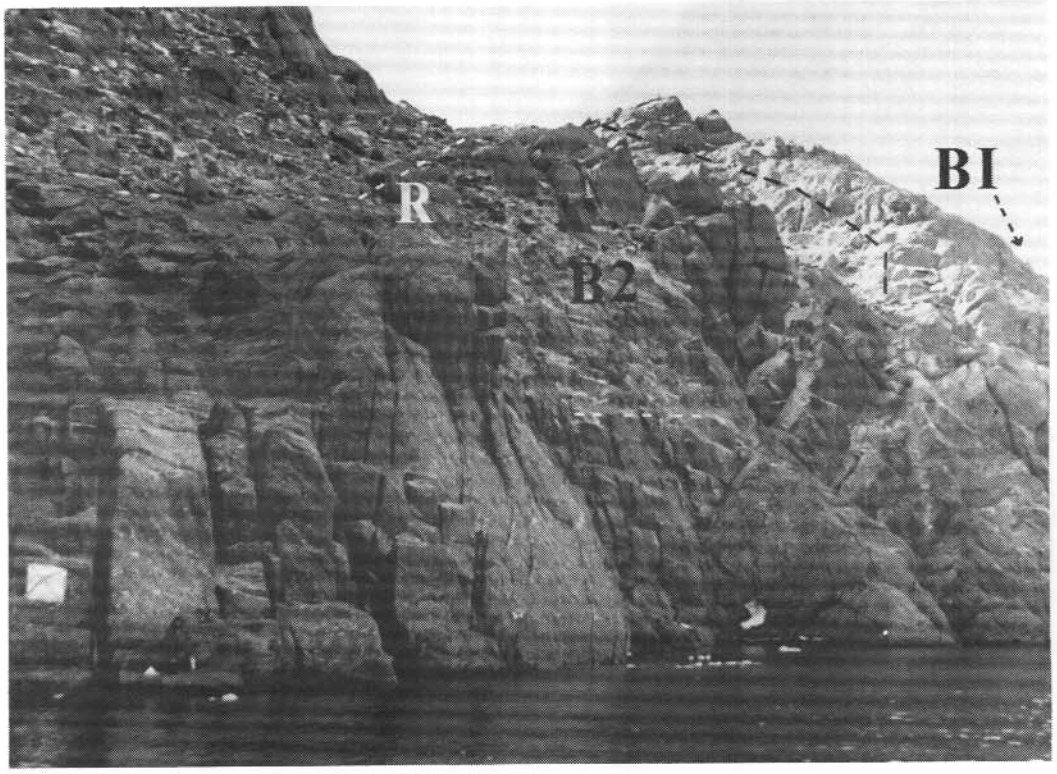


Plate 19. Buchan Island. B2 is located on a face and in a gully to the right of the landing gully and is best counted from the bottom and top of the ridge (R) as the top of the gully is obscured from the 'natural' counting spot. B1 is at the extreme eastern side of the island and is reached from above B2.

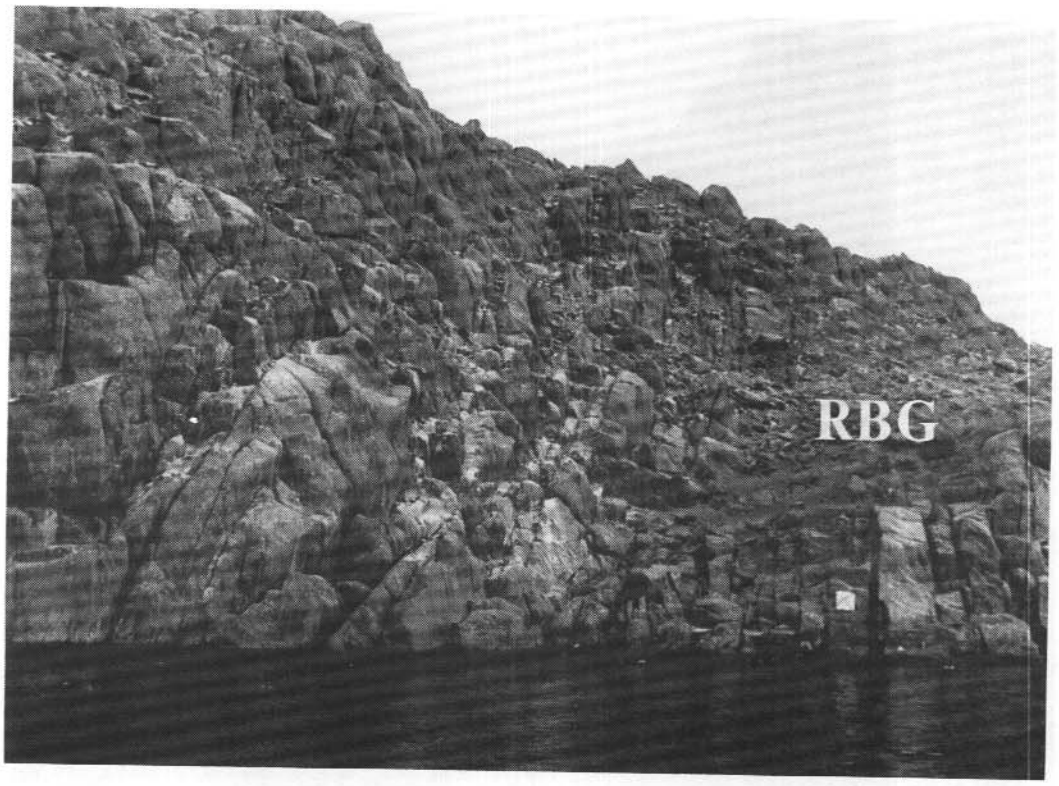


Plate 20. Buchan Island. B3 extends up the gully above the landing site and onto the cliffs to the left. It contains RBG 3P and included the largest colony of Antarctic petrels.

Plate 21. Buchan Island. B4 adjoins B3 but on the reverse slope leading down to a gully.

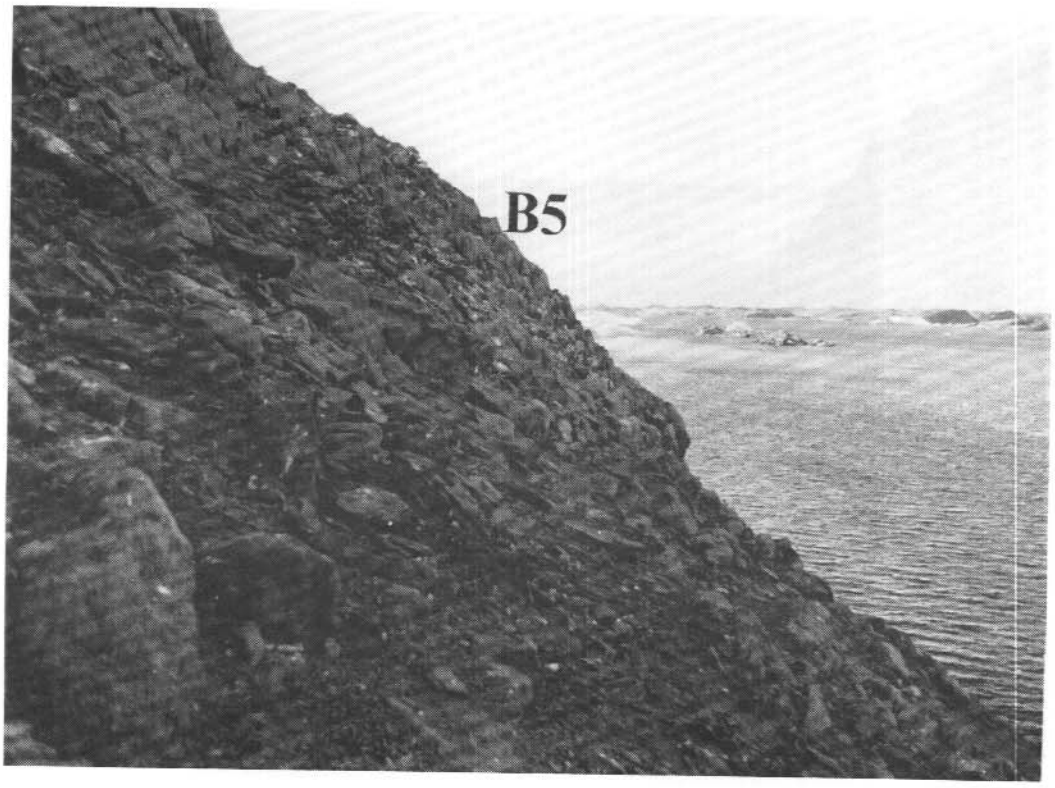


Plate 22. Buchan Island. B5 is west of B4, just east of the entrance to the inlet which leads to B6.

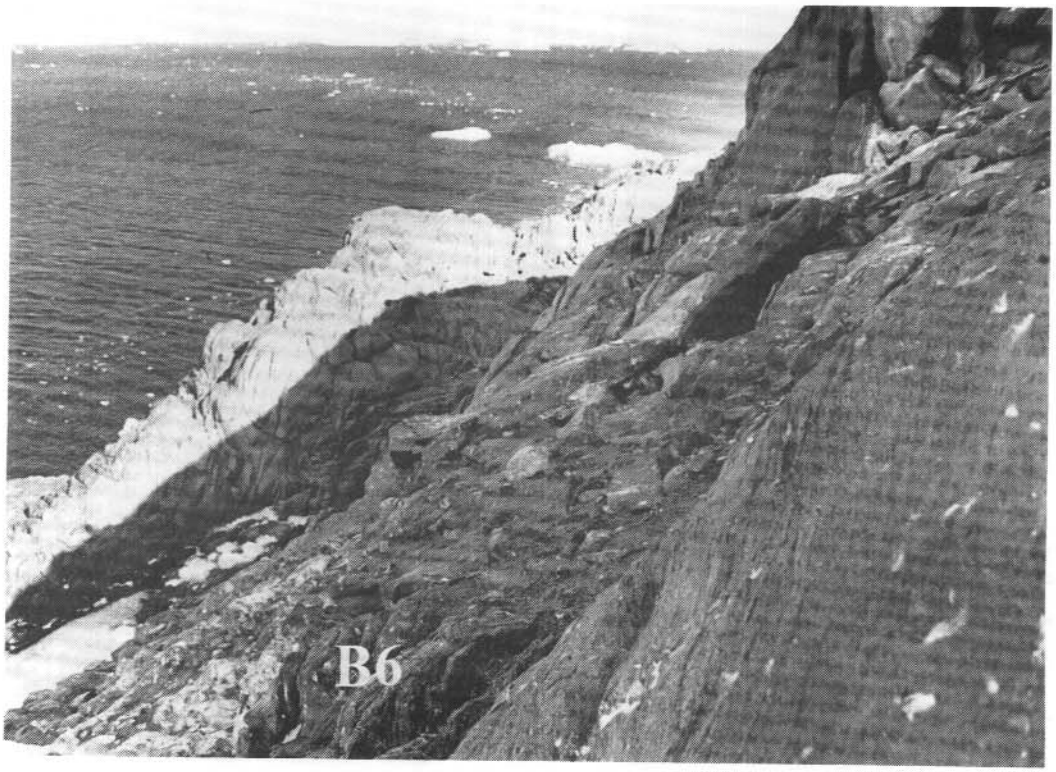


Plate 23. Buchan Island. B6 is at the south-western end of Buchan Island at the end of an inlet. Without ropes and protection it must be counted from above, though this is unsatisfactory because birds nesting lower down cannot be seen.

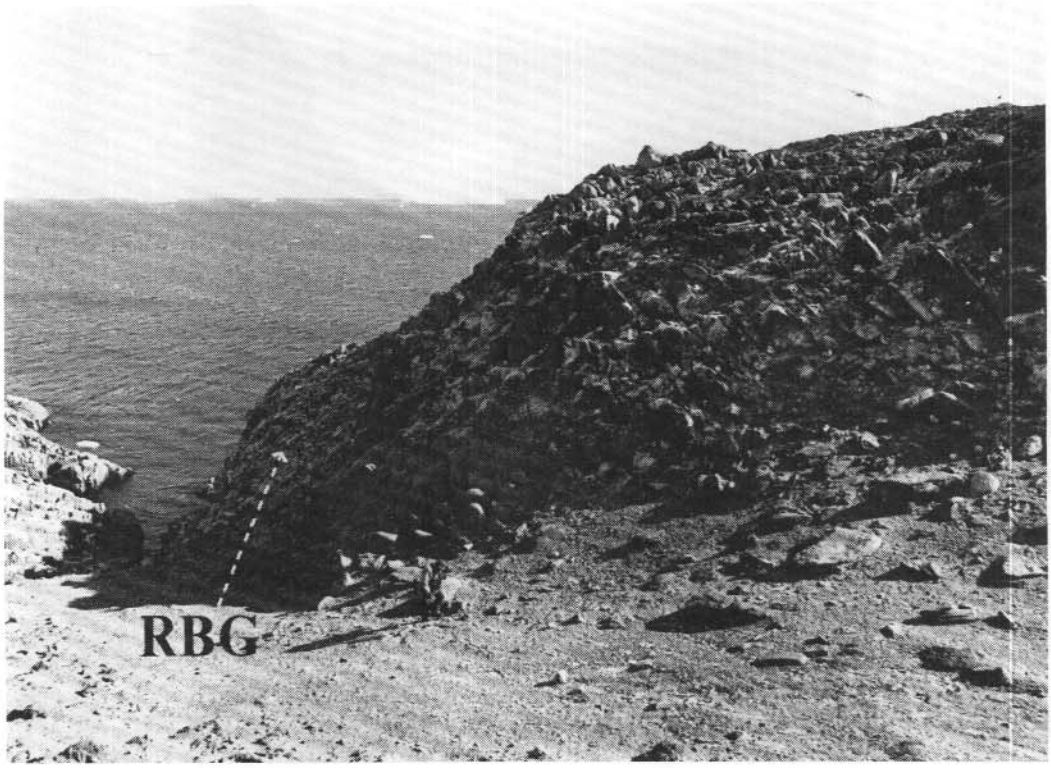


Plate 24. Buchan Island. B7 is in the gully leading up from the northernmost inlet on the south-western side of Buchan Island. It includes RBG 3F and can easily be counted from the southern side of the gully.

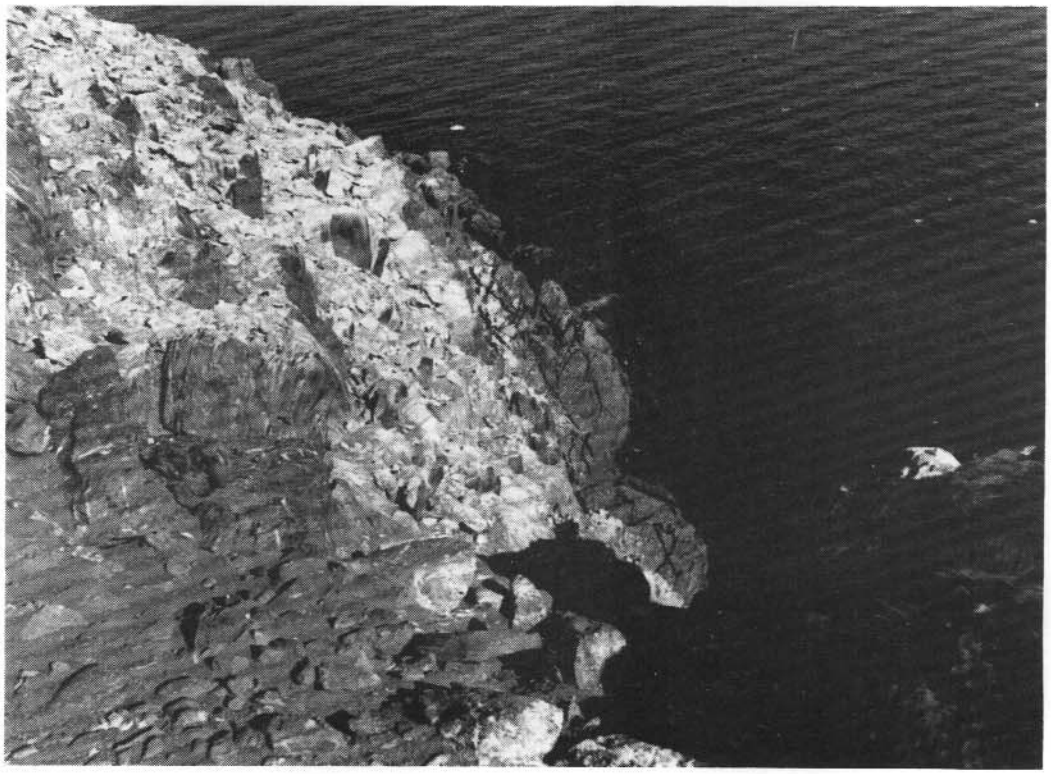


Plate 25. Buchan Island. B8 adjoins B7 on the north-western side.

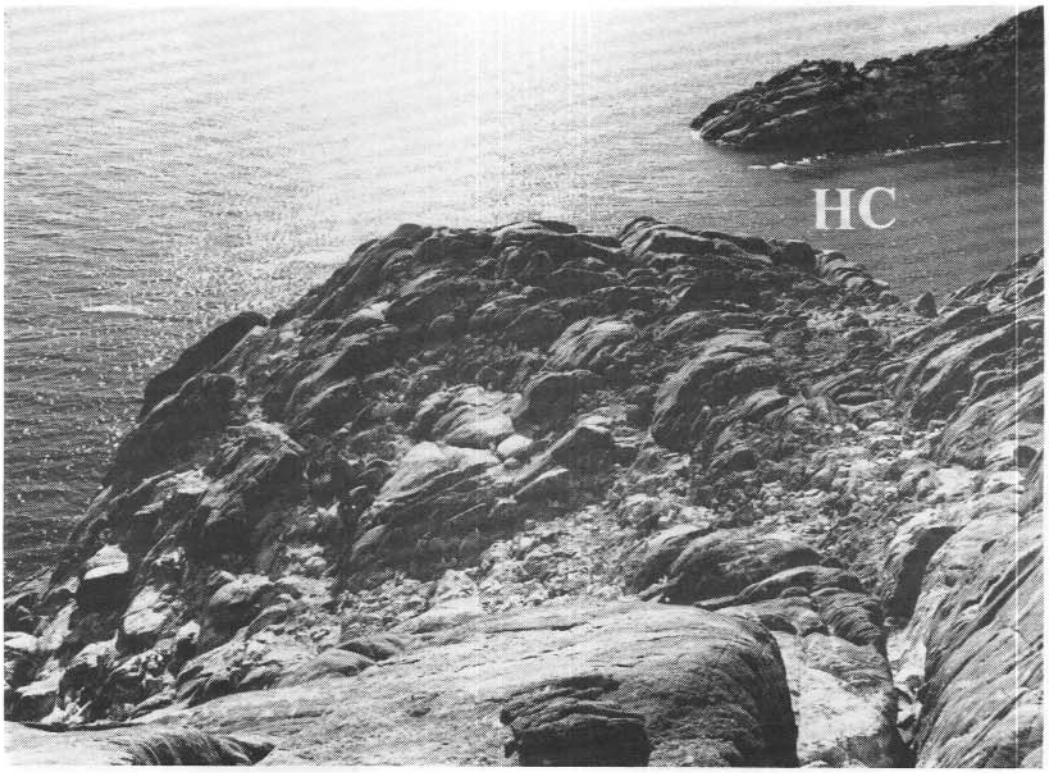


Plate 26. Buchan Island. B9 is on the north-western side of Buchan Island just before the entrance to Hannay Channel* (HC).

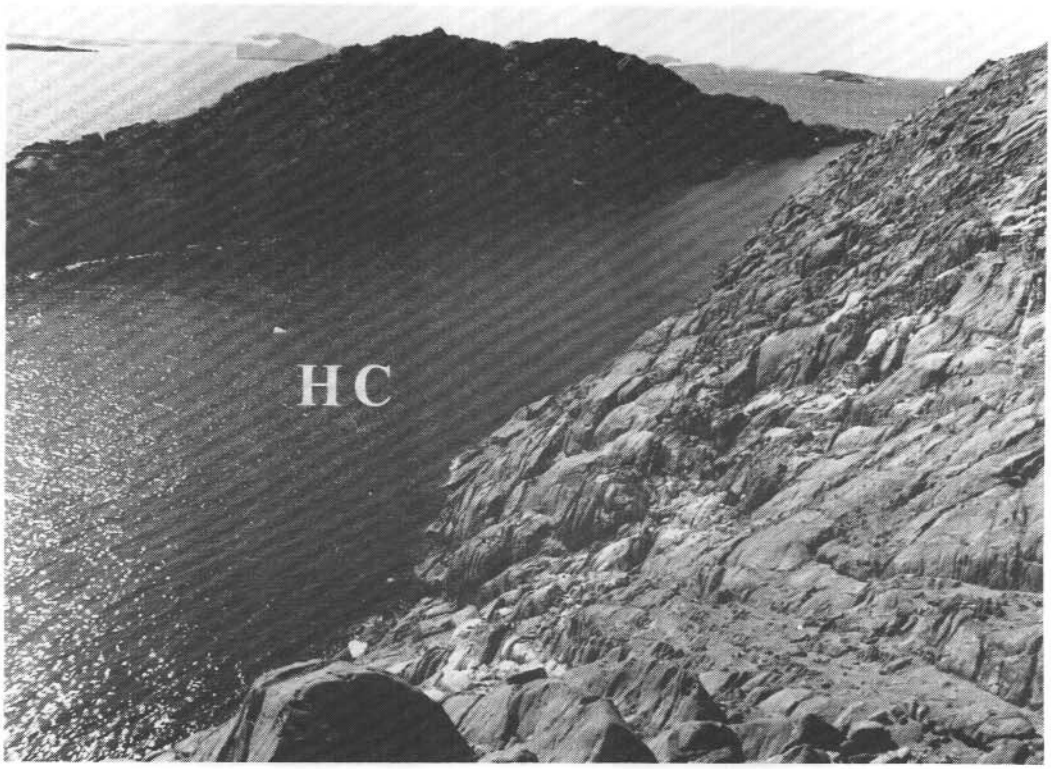


Plate 27. Buchan Island. Bl0 is in a small gully facing Hannay Channel (HC). Bl1 is the slope between Bl0 and Bl2, best counted from a boat.

Plate 28. Buchan Island. B12 is on the opposite side of the island from the campsite and comprised two nesting sites on either side of a gully.

4. RESULTS

The distribution of colonies of fulmars, Antarctic petrels and cape petrels in the Rauer Islands, based on the 1973 and 1981 surveys, is shown in Figure 2. Population estimates made in December 1981 are detailed in Table 1. Censuses conducted in this study on Hop, Filla and Buchan Islands are detailed in Tables 2, 3 and 4. Population estimates and censuses from 1981 to 1984/85 for fulmars and Antarctic petrels are compared in Tables 5 and 6. Survival of chicks, calculated from the numbers of chicks available for banding in RBGs, is detailed in Table 7.

Counts in RBGs used to convert counts of birds into estimates of nesting pairs are detailed in Table 8.

Of the ten counting units on Hop Island, all contained fulmars and only one (H5) Antarctic petrels. Of the eleven counting units on Filla Island, F2 contained only cape petrels. Of the others, all contained fulmars and all but F4 had Antarctic petrels. All twelve counting units on Buchan Island contained fulmars; B1, B3 and B4 had Antarctic petrels as well.

The total populations of surface-nesting petrels calculated from the maximum numbers during the censuses in addition to the 1981 estimates for islands other than Hop, Filla and Buchan Islands were in the order of 14000 pairs of fulmars, 2500 pairs of Antarctic petrels and 400 pairs of cape petrels.

TABLE 1

Estimates of population size (number of nesting pairs) of surface-nesting petrels in the Rauer Islands, 15 and 21 December 1981.

	SOUTHERN FULMAR	ANTARCTIC PETREL	CAPE PETREL
Islands north of Strelka Island	400	-	-
Buchan Island	1200	5000	200
Small island north of Buchan Island	400	-	-
Filla Island	1000	1100	40
Kryuchok Island	20	-	-
Hop Island	2330	1000	50
McNab Island	440	-	-
Group of islands west of Hop Island:			
A	900	-	-
B	150	-	-
C	150	-	-
D	950	10	25
Northern of two islands north-west of Forpost Island	730	-	-
Forpost Island	750	2	-
Total	9420	7112	315

TABLE 2

Census results for Hop Island.

	1983/1984		1984/1985	
		SOUTHERN FULMARS		
	Birds Counted	Estimated Pairs	Birds Counted	Estimated Pairs
H1 - H1	261	218	363	287
Gully 1	76	64	67	53
Gully 2	40	33	51	40
H2	-	42[1]	53	42
H3	-	97[1]	122	97
H4	734	614	1092	819
H5	63	53	185	139
H6	107	89	104	82
H7	235	197	247	195
H8	345	289	402	318
H9	79	66	98	77
H10	599	501	540	427
McNab Island	376	314	405	320
Total	-	2577	-	2896
		ANTARCTIC PETRELS		
H5	842	524	1235	903

[1] Colonies missed in 1983/84; figures are from 1984/85.

TABLE 3

Census results for Filla Island.

	1983/1984		1984/1985	
	Birds Counted	Estimated Pairs	Birds Counted	Estimated Pairs
SOUTHERN FULMARS				
F1	215	191	350	329
F3	393	343	515	477
F4	547[1]	477[1]	260	556[1]
F5	-	-	343	-
F6	465	406	511	473
F7	374	326	484	448
F8	810	707	883	818
F9	332	295	279	258
F10	190	169	264	245
F11	374	332	435	403
Total	-	3246	-	4007
ANTARCTIC PETRELS				
F1	0	0	6	5[2]
F3	199	181	300	201
F5	340	309	215	144
F6	44	40	45	30
F7	48	44	36	24
F8	94	89	138	92
F10	-	4[2]	-	10[2]
F11	144	136	269	180
Total	-	803	-	686
CAPE PETRELS				
F2	-	73[3]	-	108

1 F4 and F5 counted together.
2 Precise count.
3 Right-hand side of F2 was missed in 1983/84 so 35 pairs found in this area in 1984/85 were added to original count of 38.

TABLE 4

Census results for Buchan Island.

1983/1984

SOUTHERN FULMARS

	Birds Counted	Estimated Pairs
B1	112	83
B2	531	391
B3	52	38
B4	337	248
B5	102	75
B6	31	23
B7	876	645
B8	362	267
B9	383	282
B10	156	115
B11	197	145
B12	90	66
Total	-	2378

ANTARCTIC PETRELS

B1	3[1]
B3	778[1]
B4	46[1]
Total	827[1]

1 These counts were of chicks as adults were not present.

TABLE 5

Comparison of population estimates for southern fulmars (pairs) 1981-1984/85.

	Johnstone Jan 1981	ORF Dec 1983	This study 1983/84	This study 1984/85
		HOP ISLAND		
Hop 1	150	226	315	371
Hop 2	100	50	42	42
Hop 3	100	136	97	97
Hop 4	450[1]	499[1]	614	819
Hop 5	-	-	53	139
Hop 6	30	-	89	83
Hop 7	200	125	197	196
Hop 8	450	263	289	319
Hop 9	50	-	66	78
Hop 10	800	366	501	429
Total	2330	1665	2263	2573
		FILLA ISLAND		
F1	100	-	191	329
F2	0	-	0	0
F3	100	-	343	477
F4/5	100	-	477	556
F6	300[2]	-	406	473
F7	-	-	326	448
F8	-	-	707	818
F9	100	-	295	258
F10	200	-	169	245
F11	100	-	332	403
Total:	1000	2197	3246	4007

1 Hop 4 and Hop 5 counted together.
2 Probably F6, F7 and F8.

TABLE 6

Comparison of population estimates for Antarctic petrels (pairs) 1981-1984/85.

	Johnstone Jan 1981	ORF Dec 1983	This study 1983/84	This study 1984/85
		HOP ISLAND		
H3	-	4	-	-
H5	1000	924	524	903
		FILLA ISLAND		
F1	0	0	0	5
F3	300	238[1]	181	201
F5	100[2]	-	309	144
F6	-	-	40	30
F7	-	26	44	24
F8	100[3]	67	89	92
F10	-	0	4	10
F11	600	170	136	180
Total:	1100	501	803	686

1 Probably F3, F5 and F6.
2 Probably F5, F6 and F7.
3 Probably F8 and F9.

TABLE 7

Chick survival in reference breeding groups.

SOUTHERN FULMARS

	RBG 1F		RBG 2F		RBG 3F	
	83/84	84/85	83/84	84/85	83/84	84/85
Nesting pairs	46	54	48	63	70	-
Chicks surviving	28	22	24	21	-	74
% Success	60.9	40.7	50.0	33.3	-	-

ANTARCTIC PETRELS

	RBG 1P		RBG 2P		RBG 3P	
	83/84	84/85	83/84	84/85	83/84	84/85
Nesting pairs	112	114	69	65	-	-
Chicks surviving	64	72	48	60	-	92
% Success	57.1	63.2	69.6	92.3		

TABLE 8

Counts in RBGs used to convert total counts to estimated pairs.

	1983/84	1984/85		
		HOP ISLAND		
RBG 1F Date	13.01.84	2.01.85	3.01.85	
Occupied nests	46	54	54	
No. birds : start	55	71	72	
: middle		68		
: finish	55	66		
Conversion factor	x 46/55	x 54/68.3	x 54/72	
Counting units	all	all except H4 & H5	H4, H5	
RBG 1P Date	13.01.84	10.12.84		
Occupied nests	112	114		
No. birds	180	156		
Conversion factor	x 112/180	x 114/156		
		FILLA ISLAND		
RBG 2F Date	28.12.83	29.12.83	5.01.85	6.01.85
Occupied nests	48	48	63	63
No. birds	54	54[1]	68	67
		55[2]		
		55[3]		
Conversion factor	x 48/54	x 48/54	x 63/68	x 63/67
Counting units	F1	F3-8	all except	F1
		x 48/55	F1	
		F9-11		
RBG 2P Date	29.12.83	29.12.83	14.12.84	
Occupied nests	69	69	65	
No. birds	73[2]	76[3]	97	
Conversion factor	x 69/73	x 69/76	x 65/97	
Counting units	F8, F11	F3-7	all	

1 0930 local time.
2 1600 local time.
3 1845 local time.

5. DISCUSSION

The census method used here has been used to census guillemots Uria aalge in the Firth of Clyde, Scotland, with a range of only 4% over five counts (Gibson 1950). This figure was achieved for a range of 149 to 196 birds in the total count. Gibson (1950) stated that the method is subject to greater errors when only small numbers of birds are counted. Although a far larger number of birds was counted in this study the fact that the RBGs and the rest of the colonies could not be counted at the same time could have introduced a source of error. However, there was little difference in RBG counts before and after each counting session.

The census figures for the two seasons, 1983/84 and 1984/85, differ for both species. Differences also occur between figures obtained by the Oceanic Research Foundation (Lewis and George 1984) and the authors in the 1983/84 season. Several factors could account for these differences. The cryptic nature of Antarctic petrels could lead to some being missed. Observer error could occur for a whole range of reasons and is inherent in any method. Some colonies could have been missed but this should now be avoided by documentation of the counting units. Incomplete coverage of inaccessible spots will always be a problem as the definition of 'inaccessible' will vary between observers. Time of year, weather and time of day will affect counts but this can be countered by reference to the ratio of birds to nests in the RBGs. The method of counting could account for differences between ORF's and the authors' counts; the ORF attempted to count pairs whereas the authors counted total number of birds and estimated the number of pairs.

Cramp et al. (1974) found that immature northern fulmars Fulmarus glacialis may occupy nest sites for years before actually laying. No attempt was made to check that all nests in RBGs contained eggs and it is possible that some 'prospecting' pairs may have been occupying nests. For this reason the census results are for nesting pairs rather than breeding pairs.

The nature and extent of annual differences in nesting populations will only become apparent as more seasons are censused. Some differences, however, can be noted here. The increase in fulmars on Filla Island from 1983/84 to 1984/85 may be accounted for in part by the increase in the number of nest sites available. The amount of snow on the cliffs of Filla Island was greater in the first than the second season. In the second season therefore there were more potential nest sites in gullies and snow patch areas and there was a movement of southern fulmars into these areas, especially in F6 and F7.

There was a movement of Antarctic petrels into F1 in 1984/85 and an increase in the number of Antarctic petrels nesting in F10. Continued monitoring of these sites will show whether these changes are due to annual variation in choice of nest sites or a continuing trend of population increase and colonisation of previously unoccupied areas.

Figures for chick survival to banding in the RBGs on Hop and Filla Islands differed between islands, years and species. Fulmars survived better and Antarctic petrels worse in 1983/84 than in 1984/85 on both islands.

Fulmars had a lower survival rate on Filla Island than on Hop Island in both seasons, whereas the reverse was true for Antarctic petrels. Factors affecting survival rates for these species are little known. Green (unpublished) found that south polar skuas take more fulmars per capita than Antarctic petrels. More detailed studies, including dietary work, are necessary to identify the factors involved.

REFERENCES

Alberts, F.G. (Ed.). (1981). Geographic Names of the Antarctic. National Science Foundation, Washington. 959 pp.

American Geographical Society. (1967). Soviet Geography : Review and Translation. Special Issue : Atlas of Antarctica. Pp. 259-507.

Bakayev, V.G. (Ed.). (1966). Atlas Antarktiki. Ministry of Geology, Moscow. 236 pp.

Bushnell, V.C. (Ed.). (1975). History of Antarctic Exploration and Scientific Investigation. Antarctic Map Folio Series Folio 19. American Geographical Society.

Claridge, G. (unpublished 1984). Environmental Considerations of Antarctic Operations - for helicopter crew.

Cramp, S., Bourne, W.R.P. and Saunders, D. (1974). The Seabirds of Britain and Ireland. Collins, London. 287 pp.

Falla, R.A. (1937). Birds. BANZARE Reports Series B2. 288 pp.

Gibson, J.A. (1950). Methods of determining breeding-cliff populations of guillemots and razorbills. British Birds 43:329-331.

Hansen, H.E. (1946). Atlas over dela av det Antarktiske kystland Oslo : Johan Grundt Tanum.

Johnstone, G.W., Lugg, D.J. and Brown, D.A. (1973). The biology of the Vestfold Hills, Antarctica. ANARE Scientific Reports Number 123. 62 pp.

Korotkevich, E.S. (1964). Observations on birds during the first wintering of the Soviet Antarctic Expedition, 1956-1957. Soviet Antarctic Expedition Information Bulletin 1:149-152.

Law, P. (1983). Antarctic Odyssey. Heinemann, Australia. 284 pp.

Lewis, D. and George, M. (Eds). (1984). The initial scientific reports of the Mawson Anniversary and Frozen Sea Expeditions. Oceanic Research Foundation Ltd., Australia.

McKinnon, G.W. (1965). Gazetteer of the Australian Antarctic Territory. ANARE Interim Reports Number 75. 153 pp.

Orton, M.N. (1963). A brief survey of the fauna of the Windmill Islands, Wilkes Land, Antarctica. Emu 63:15-22.

Thomson R.B. (1977). Effects of human disturbance on an Adélie penguin rookery and measures of control. In: G.A. Llano (Ed.). Adaptations within Antarctic Ecosystems. Smithsonian Institution, Washington, D.C. Pp. 1177-1180.

Watson, G.E. (1975). Birds of the Antarctic and Sub-Antarctic. American Geophysical Union, Washington. 350 pp.

Watson, G.E., Angle, J.P., Harper, P.C., Bridge, M.A., Schlatter, R.P., Tickell, W.L.N., Boyd, J.C. and Boyd, M.M. (1977). Birds of the Antarctic and Subantarctic. Antarctic Map Folio Series Folio 14. American Geographical Society.

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