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Growth of a fur seal population

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The Antarctic fur seal *Arctocephalus gazella* is a polygynous Otarid in which a single pup is produced annually by cows over the age of 2 years. Following exploitation to the verge of extinction, a small breeding colony was discovered at Bird Island, South Georgia, in the 1930s. Up to 10000 pups a year were produced in the early 1960s and by 1975 the figure had reached an estimated 90000. The rapid population increase has resulted in the colonization of extensive breeding areas on the adjacent mainland of South Georgia with incipient colonies springing up on more distant parts of the island, and also in the South Sandwich, South Orkney and South Shetland Islands.

Age determinations from the teeth of 195 breeding cows reveal a low mean age, early first breeding and a predominance of the younger age groups relative to the age structure of a stable population of northern fur seals *Callorhinus ursinus*. Annual adult cow survival is estimated at 89.8%, while that of first-year animals is about 64.5%.

A decline in the rate of population increase is forecast within ten years and an outline for investigating the most likely factors influencing such a change is suggested.

Introduction

Arctocephalus gazella is the Antarctic representative of a genus containing all eight of the mainly allopatric southern fur seals (Repenning *et al.* 1971). These seals are valued for their furs and all species were heavily hunted in the late eighteenth and nineteenth centuries. *A. gazella* was among those exploited to the verge of extinction and the substantial recovery it is making at South Georgia is a good example of the trend prevailing among the southern fur seals. The situation at South Georgia is particularly suitable for study for three reasons: firstly, there is a background of existing knowledge of both the biology of the animals and the previous history of the population recovery (Bonner 1968); secondly, the colonies are very accessible; and thirdly, the animals show little fear of man and so are very easy to observe.

South Georgia is a long, narrow mountainous island 170 km long and up to 50 km wide (figure 2). It lies about 2000 km east of Cape Horn but well within the Antarctic Convergence. It is beyond the normal extent of winter pack-ice, and the currents flowing from the southwest produce upwellings in the region of the island and consequent high marine production (Hardy 1967). Before their exploitation, large numbers of the larger plankton-eating whales were found in the waters around South Georgia.

The work on which this paper is based was carried out on Bird Island (figure 2) in the summer seasons of 1971, 1972, 1973 and 1975 (southern summers are designated by the calendar year in which they begin), and also from Elsehul on the mainland of South Georgia in 1972 and 1975. In addition, surveys by helicopter and by ship have been carried out around the South Georgia coastline, and most parts have been visited since 1970.

This paper deals with the increase in total fur seal numbers, the extension of the breeding areas on South Georgia, and the structure of the breeding cow herd. It also identifies and estimates the factors determining the numbers of pups born, allowing both a better under-

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standing of the mechanism of the increase itself, and also comparison with future work in order to elucidate the factors influencing the eventual stabilization of the population. For the purposes of this paper, the South Georgia population is considered to be closed, although colonies on the South Orkney, South Shetland and South Sandwich Islands probably derive from South Georgia (Laws 1973) and may receive an increasing proportion of emigrants. The intensive study of the northern fur seal *Callorhinus ursinus* at the Pribilof Islands provides many useful comparisons.

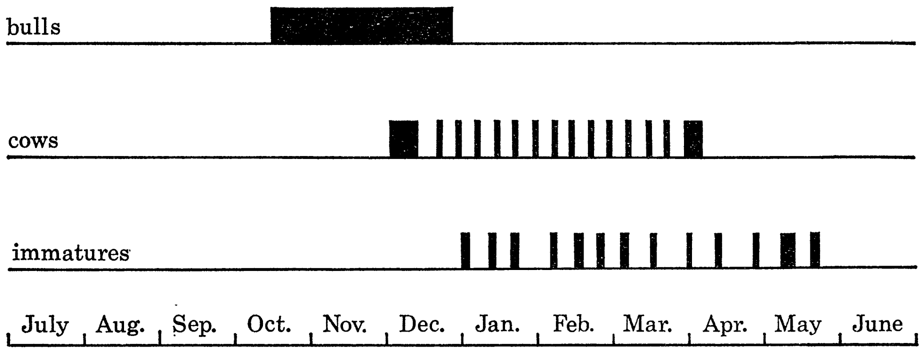

FIGURE 1. Schematic representation of colony attendance by *A. gazella* during the year.

A. gazella and *C. ursinus* are the only fur seals which inhabit polar waters, *A. gazella* breeding on oceanic islands in the southern Atlantic and Indian oceans while *C. ursinus* is restricted to the north Pacific. These two species are of similar size, although in common with other polygynous Otarids, there is a marked sexual dimorphism. Bulls reach over 200 kg, compared with the normal adult cow weight of less than 50 kg. Typically for high latitude breeders, both *A. gazella* and *C. ursinus* have well-synchronized reproductive cycles (figure 1). Territorial bulls are the first ashore and they eventually maintain harems of about ten cows. Pupping takes place about 2 days after the cows first haul out, and mating occurs about a week later. Soon after this the bulls abandon their territories, but the cows continue to suckle their pups, between feeding trips to sea, for about 4 months (figure 1). While this is a long lactation period for a seal, it is the shortest for fur seals, with the exception of *C. ursinus*. All age classes spend the majority of the year at sea, but the only indication of the seals' movements is a single recovery of a nine-month-old tagged pup near Cape Horn (Payne, in prep.). In *C. ursinus* there is an extensive migration southwards for well over 2000 km, and an analagous northward migration is possible in *A. gazella*.

Breeding takes place at traditional sites on land, in contrast to the sea-ice chosen by most other Antarctic seals. Since pupping and lactation require a minimum of about 4 months, only coasts which are consistently clear of pack-ice for this period are eligible as breeding sites for the fur seals. Rock or shingle beaches with easy access to the sea but above the reach of storms are preferred for pupping.

The available information on feeding indicates that krill (euphausiids) is the predominant food at South Georgia although some squid and perhaps a little fish are also eaten (Bonner 1968; Payne, unpublished information). Since the lactation period is quite long, an adequate food supply within the feeding range of the cows from the colony is an essential requirement.

2. Expansion of breeding areas

The first indication of fur seals breeding at South Georgia following their exploitation came in the 1930s when the *Discovery* investigations team visited Bird Island. Thirty-eight fur seals were seen on their first visit in February 1933, and in late 1936 12 of the 59 fur seals present were pups (Bonner 1968). This is an unusually low proportion, particularly as many immature animals are normally at sea at this season, and it implies the existence of another colony nearby as suggested by Bonner. No further observations are available until Bonner (1958) found thriving colonies on both Bird Island and Main Island in the Willis group, in late 1956. In each of the following seasons until 1963/4, visits were made to Bird Island and the pups were counted, with numbers doubling over this period. By 1963/4, most suitable areas on Bird Island were occupied by breeding seals and the nuclei of further colonies had been established on the adjacent mainland of South Georgia (figure 2). When work on the fur seals was resumed at Bird Island in 1971, and extended to mainland South Georgia in 1972, almost all suitable areas on Bird Island had been colonized, as had such large stretches of the mainland coast (figure 2) that pup production there already exceeded that on Bird Island.

While rising density has accounted for much of the continuing increase in numbers between the seasons 1972/3 and 1975/6, since 1970 a considerable number of incipient colonies have arisen away from the dense centres of population. Nearly all these are at the western end of South Georgia, up to 35 km from the main concentration, but some are at the opposite tip of the island, another 125 km distant (figure 2 and Appendix 1). These incipient colonies contribute less than 2% of the pup totals, but they probably represent the foci of further large-scale recolonization.

3. Population increase

(*a*) *Methods*

Pups are born within a short period at the same time every year. Over 90% of births occur within a 3-week period (figure 3), and in 3 years the date by which 50% are born has been found to vary by not more than 1 day. Thus, a high proportion of all pups born are available for a count made at the end of the 3-week period. This technique worked well in the early years, but as density increased it became apparent that an increasing undercount was occurring, as represented by the difference between the totals of counted and estimated live pups shown in figure 3; an undercount is also implied by the pattern of uncorrected counts in figure 4. To compensate for this density-dependent variation in counting efficiency, a 'capture–recapture' method derived from that used by Chapman & Johnson (1968) for northern fur seals *C. ursinus* was put into effect. This involved marking a known number of pups and establishing, by means of randomized 'recapture' counts, the proportion of the population carrying marks a month later. Since the most stringent precautions cannot ensure a random distribution of marks (the incidence of marks at recapture differs significantly from the binomial distribution, $\chi^2 = 215.0$, $P < 0.001$), the randomization of the sampling is essential to validate the method. In five instances, observers independently counted the number of marked pups present in each of many blocks of 25 animals, allocating the blocks to the beaches in proportion to the overall distribution of pup numbers. Observers checked between 140 and 200 blocks in an area where nearly 8000 pups had been counted, and the mean of their results corresponded closely with a cross-check derived from the individual examination of the heads of 1000 pups for the visibility of the

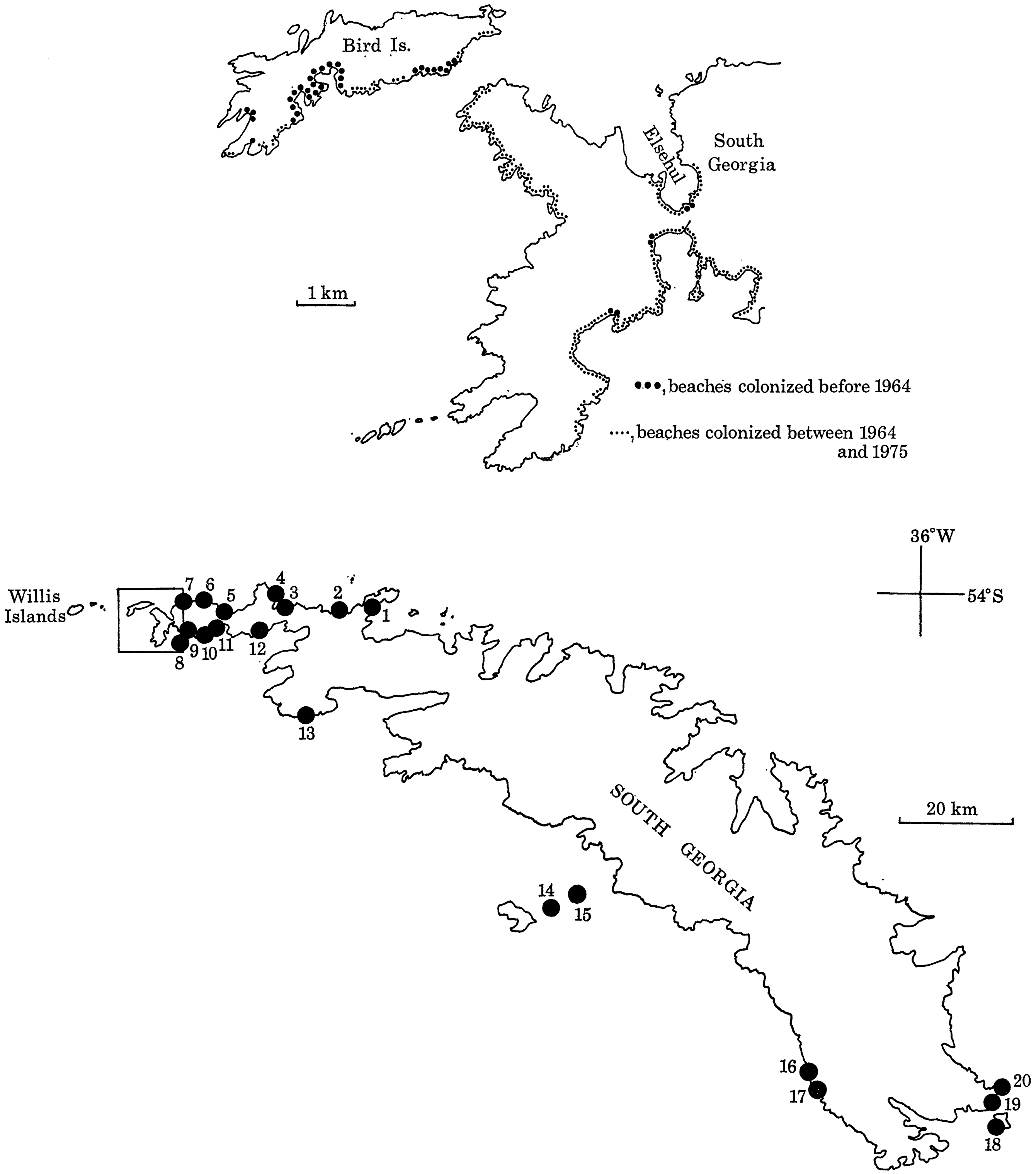

FIGURE 2. Recent changes in the breeding distribution of *A. gazella* at South Georgia showing detail of the main concentration at the northwestern end of the island. Data for numbered sites are given in Appendix 1.

patches of sheared fur. For the purposes of calculation, the median value from the five sets of results has been used.

The degree of undercount of live pups (K) can be estimated by adjusting the 'capture–recapture' estimate of the live population at the time of marking ($\bar{N}$) for the mortality (for which there is adequate data) which has taken place since the counts were made. Thus,

$$\bar{N} = N_c\left(\frac{K, N_m - A}{N_m}\right) \quad (1)$$

yields

$$K = \frac{\bar{N}}{N_c} + \frac{A}{N_m}, \quad (2)$$

where N_c is the number of pups counted in overall area, N_m, the number of pups counted in mortality study area, A, the number of pups dying in mortality study area between the count and the date of marking.

$$\bar{N} \text{ is estimated by } \frac{M}{\bar{p}} \quad (3)$$

where M is the number of animals marked (less those lost to the area through exchange with other areas), and $\bar{p}$, the estimate of the proportion of pups marked from the recapture counts.

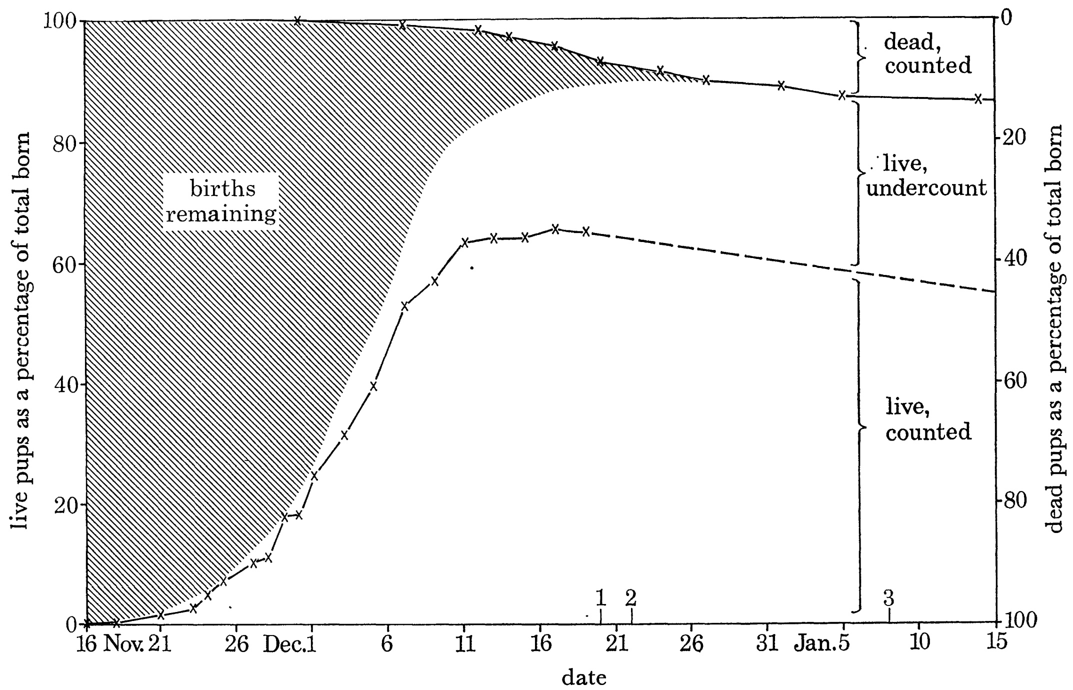

FIGURE 3. Cumulative changes in pup numbers during the season. 'Dead'+'births remaining' = total pups unavailable for counting. 'Live undercount'+'Live count' = total live pups. 'Births remaining' is an inferred quantity. Point 1 = main counts; point 2 = mean date of marking; point 3 = 'recapture' counts.

This method assumes that there is no difference in the mortality of marked and unmarked pups. In calculating K for the 1973 season, the following values were used: $N_c = 7730$, $N_m = 3031$, $A = 43.3$, $M = 3940$, $\bar{p} = 0.3339$, which yield a value for K of 1.541. Using Chapman & Johnson's first method for estimating the variance of $\bar{p}$, the 95% confidence interval for K is $\pm$ 0.082.

(b) Results

The results of the counts made on Bird Island and South Georgia between 1956 and 1975 are shown in table 1, together with the total estimated production of pups. These figures are plotted on figure 4, together with the results of the pup counts carried out in the years 1957–63. The inflexion of the count curve in the years 1960–3 may have represented the increasingly important undercount rather than any great fall-off in the rate of increase.

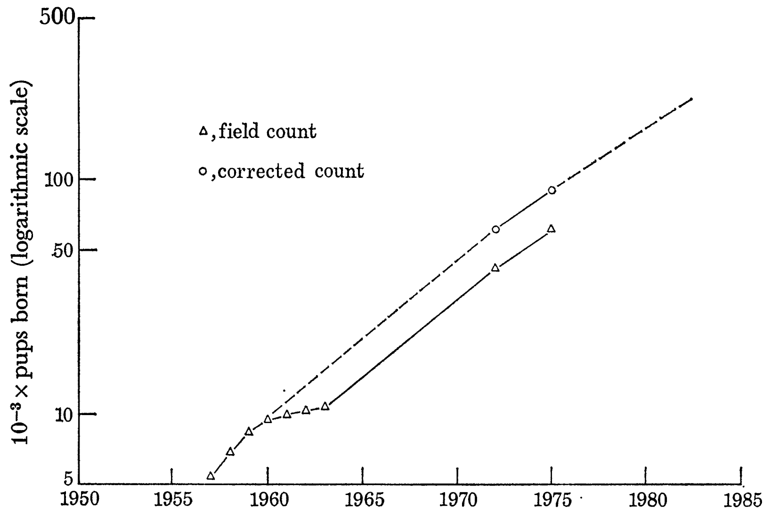

FIGURE 4. Population increase of *A. gazella* at South Georgia measured by the numbers of pups born. The correction procedures are described in §3(*a*), and the data listed in table 1.

TABLE 1. PUP COUNT DATA FOR MAIN SOUTH GEORGIA COLONIES.

(The Willis Islands colonies have been omitted due to lack of records; they may have contributed up to 2000 pups in 1973.)

year	pups counted	pups estimated
1957	5330	—
1958	6800	—
1959	8297	—
1960	9385	—
1961	9910	—
1962	10199	—
1963	10700	—
1972	43037	60000*
1975	61234	90000*

* These figures have been rounded down to take account of the many mainland beaches for which the correction factor will be an overestimate.

The most accurate count in the 1957–63 series was that of 1958 (Bonner 1968). Using this as a basepoint, the annual rate of growth of the population until 1972 was 16.8% (14.1% if the uncorrected 1972 count data are used). From 1972 until 1975, the rate of increase was 14.5%. No fresh estimate of the degree of undercount was made in 1975 (previous figures being used) and it is possible that the apparent fall in the rate of increase is for this reason. A small increase in the undercount correction factor would produce the same apparent reduction in the rate of population increase; thus, the data cannot be considered adequate to demonstrate any change in the rate of growth of the population. At 16.8% annual growth, the doubling time for the number of pup births is 4.5 years. This is a high figure for a population of large wild mammals to sustain and it seems unlikely that it will continue for more than about another 10 years. After this time, with pup production at 4.7 times its current level, a fraction of the South Georgia coastline will still be adequate to provide sufficient breeding beaches. However, historical evidence presented by Bonner (1968) indicates that the unexploited population did not occupy all apparently suitable areas. This suggests that some factor other than breeding space limited the population size, possibly the availability of food within the feeding range of lactating cows. In spite of the supposed reduction in competition for food with the decline of krill-eating whales, food availability may come into play as a regulating factor for the fur seals at South Georgia within the foreseeable future.

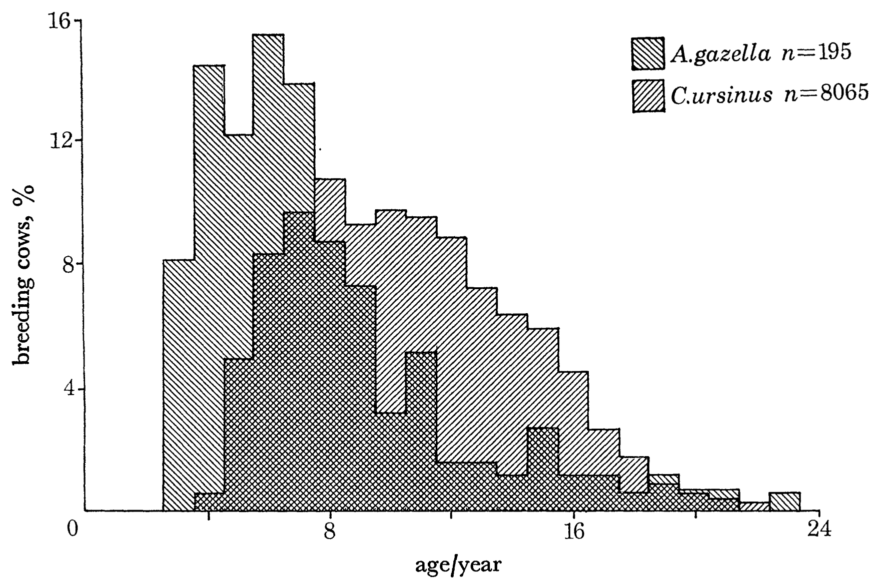

FIGURE 5. The age structure of two breeding cow herds. Lactating *A. gazella* n = 195 ashore on South Georgia in 1971–3 and pregnant *C. ursinus* n = 8065 at sea in the eastern North Pacific 1958–74 (Marine Mammal Division 1975).

4. Dynamics of the breeding cow herd

(a) *Age structure*

Animals were aged by developing the techniques used for other seals (Laws 1962) and calibrating them using 11 seals whose ages were known from tags applied to them as pups. An upper canine was selected and both cement and dentine increments proved valuable in determining age. Application of ageing procedures to a sample of 195 lactating cows selected on Bird Island by a randomized procedure (Payne 1973) allowed the preparation of the age structure shown in figure 5. A comparable structure prepared for the northern fur seal from the numbers of pregnant animals caught pelagically by the United States in the years 1958–74 (Marine Mammal Division 1975) is also shown for comparison. The East Pacific stock has fluctuated over this period, with extreme pup production estimates of 304000 and 510000 (Lander 1974), but compared to the South Georgia situation, it may be regarded as a population stable at a high level. The two species are of similar body size (Scheffer 1953; Payne, unpublished data), life history and productive life span in females (figure 1 and 5; Marine Mammal Division 1975). Of the two age structures, that of *A. gazella* has a lower mean age, a greater negative skew and is more markedly leptokurtic, precisely the characteristics that would be predicted for a rapidly expanding population relative to a stable one. These characteristics are partly the result of earlier recruitment to the breeding population and partly due to the relative abundance of the younger age classes deriving from the greatly increased pup production of recent years.

(*b*) *Recruitment*

A reliable method of identifying the newest recruits to the female breeding herd, the primiparae, is by examining the uterus. In animals more than about 2 weeks post-partum, the recently pregnant cornu is whitish and irregularly thickened while the other may be similar if the animal is multiparous, or it may be small, smooth and pink if the animal is primiparous. The method is valid if function of the cornu alternates strictly, as appears to be the rule in other seals (Enders, Pearson & Pearson 1946; Laws 1956; Rand 1955); examination of ten pairs of ovaries confirm this for *A. gazella*. Of the 13 3-year-old, 23 4-year-old and 18 5-year-old uteri examined, 13, 9 and 3 respectively were primiparous. No primiparae were older than 5 years.

The proportions of cows first pupping at three, four and five can be calculated as follows:

At age five, cows are fully recruited. Therefore (subject to sampling error) 3/18 is the proportion of new recruits = 0.1667. However, only an estimated 85% of cows breed at age five (table 2), so the true proportion of new recruits is $0.1667 \times 0.85 = 0.42$. Similarly, allowing for 15% of the previous season's breeders not producing pups, 0.285 are recruited at four and the remainder, 0.573, at 3 years old.

(*c*) *Pregnancy rate*

No direct information on pregnancy rate for fur seals at South Georgia is available due to the difficulty of sampling non-pregnant animals. From § 4*b*, estimates of pregnancy can be imputed as 57% at age three and $57+29 = 86\%$ at age four or say 77%, since not all animals breeding at three may also breed at four.

Table 2. Pregnancy rates of *C. ursinus* and *A. gazella*

(*C. ursinus* data from Table 23, North Pacific Fur Seal Commission (1965). *A. gazella* figures from data on primiparae at ages 3 and 4, otherwise extrapolated from *C. ursinus* data.)

	C. ursinus		*A. gazella*
age	East Pacific	West Pacific	South Georgia
3	0.00	0.00	0.55
4	0.04	0.50	0.75
5	0.45	0.80	0.85
6	0.75	0.85	0.90
7	0.85	0.90	0.90
8	0.85	0.90	0.90
9	0.90	0.90	0.90
10	0.90	0.90	0.90
11	0.90	0.90	0.90
12–16	0.80	0.80	0.80
17–18	0.60	0.60	0.60
19–20	0.30	0.30	0.30

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Observed pregnancy rates for the northern fur seal in the East and West Pacific respectively suggest similar patterns, but up to age eight the less numerous West Pacific population achieves equivalent age-specific rates a year earlier (table 2). The values for 3- and 4-year-old *A. gazella* coincide well with those of the youngest significant age classes in both the East and West Pacific fur seal populations, but are a year in advance of even the West Pacific population. In lieu of other data, pregnancy rates for *A. gazella* can best be assumed to be of the same general pattern as those of *C. ursinus* but incorporating the available data on age of recruitment (table 2).

(*d*) *Survival*

(i) *Adult*

The number of cows in each year class pupping in a given year is the product of the number of cows in the year class in the previous year and the age-specific survival and pregnancy rates. The data available from which survival may be estimated is the age structure for what is known to be a rapidly expanding population. Thus, by regressing the numbers in each class from 6 to 20 on age, an expression describing the decrease of numbers in each successive age class can be obtained, ignoring the effects of differing pregnancy rates. If it is assumed that survival is fairly constant over the age groups in question, and since we have already described the growth of the population over the relevant years in terms of a single rate of annual increase, then the relation will be exponential with age of the form

$$N_{t+1} = N_t \, \mathrm{e}^z, \tag{4}$$

where N_t is the number of animals at year t, e is the base of natural logarithms, and z is the mortality coefficient.

If this relation is expressed in logarithmic form, it becomes

$$\ln (N_{t+1}) = \ln N_t + z. \tag{5}$$

This describes a linear curve with gradient z. This value may be obtained by regressing linearly $\ln N_t$ on age. Since annual survival may be defined as N_{t+1}/N_t, it follows from expression (5) that the relation between annual survival and the mortality coefficient z is that survival equals e^z.

However, apparent survival comprises the progressively smaller number of pups born in preceding years (i) as well as the declining proportion surviving from the older age classes (j). Thus,

$$ij = \mathrm{e}^z.$$

Since i can be expressed as $1/(1+\text{annual population increase})$, or 0.856, and z is estimated from the data as -0.2374, j is 0.921. This is equivalent to an annual adult mortality of 7.9% for female *A. gazella* at South Georgia. If the same calculation is repeated, allowing for declining pregnancy rates in the older animals by dividing the number in each age class by the prevailing pregnancy rate as shown in table 2, the annual adult mortality estimate is 4.6%.

(ii) *First-year survival*

For the purposes of a population model, the adult mortality rate of 7.9% annually (§ 4*d* (i)) can be extended to cover all ages from 1 year upwards. While it is likely that this will tend to underestimate mortality at either end of the age classification, in the absence of further data it is the simplest and most apt hypothesis and in a rapidly expanding population with low mortality, it is unlikely to give rise to large errors. Errors that do arise will tend to exaggerate the effect of first-year mortality, which is the highest in many comparable species. It can be estimated by calculating the number of recruits required to maintain the 16.8 % annual population increase after replacing the adults dying in the intervening year, and comparing this with the numbers of female pups born (the sex ratio of pups does not differ significantly from unity in 1756 pups examined) in the year classes contributing the recruits.

The figures can be calculated as follows:

The number of pups born in a given year is derived from the cows that survive the preceding year plus the number of primiparae in each of the three age classes contributing recruits (§ 4*b*), written as

$$N_t = N_{t-1} S_1 + P_3 + P_4 + P_5, \tag{6}$$

where N_t is the number of pups born in year t, P_3, is the number of primiparae pupping at age three, P_4, the number of primiparae pupping at age four, P_5, the number of primiparae pupping at age five, and S_1, the annual survival after age one.

The number of primiparae of age x can be calculated as

$$P_x = N_{t-x} S_0 S_1^{x-1} R_x, \tag{7}$$

where S_0 is first-year survival, R_x is proportion of year class x pupping for the first time, and N_{t-x} is calculated as number of female pups born in year t.

$$\left[\frac{1}{(1+\text{annual population increase})}\right]^x = 0.5N_t\, 0.856^x.$$

By substituting (7) into (6), and rearranging the terms

$$S_0 = \frac{\left\{\dfrac{1}{0.856\, S_1} - 1\right\}}{0.856^2\, S_1(R_3 + 0.856\, S_1 R_4 + 0.856^2\, S_1^2 R_5)}. \tag{8}$$

Evaluating this expression, using 0.921 as adult survival (from § 4*d* (i)) and the values obtained in § 4*b* for R_3, R_4 and R_5, yields an estimate for first-year survival of 0.917, equivalent to mortality of 8.3 %. This figure is very similar to the adult mortality estimate, but if the figure adjusted for pregnancy rate is used, then the first-year estimate for mortality becomes 23.9 %.

5. Discussion

By combining the records of the fur seal herd expansion (§ 2), the data supporting the 16.8 % mean annual population increase (§ 3), and the estimated values for the vital parameters, i.e. recruitment, pregnancy and survival, and examining them in the light of additional information on patterns of colonization, individual cow behaviour and mainland population statistics, it is possible to gain an insight into the dynamics of population expansion.

Information on the behaviour of individuals is largely obtained from animals tagged as pups and thus of exactly known age. Of 80 cows originally tagged and subsequently seen on Bird Island 8–16 years later, 67.5 % were breeding within 100 m of the sites at which they were tagged. Furthermore, of 22 cows observed breeding in two or three seasons, in no case did the breeding site change by more than 100 m. Thus, it appears that older cows are extremely faithful to beaches where they have previously pupped and it is the younger cows, probably mainly and possibly exclusively the primiparae, which constitute the mobile element of the female herd and are responsible for the expansion of breeding range currently observed at South Georgia and indeed throughout the Scotia Sea (Laws 1973). Such a conclusion is also supported by the initial results of a long-term study of the recruitment and subsequent survival of 16000 tagged pups (Payne, unpublished data).

Examination of the age composition of a small sample of cows collected on mainland South Georgia in 1972 by an adaptation of the randomizing method (Payne 1973) shows that all animals in an admittedly small sample are young enough to have first bred in the area as primiparae since the date of initial recolonization. However, if this is genuinely typical of the situation in the most recently colonized areas, as seems likely, the age structure of the breeding female herd on Bird Island will not be representative of the South Georgia herd as a whole. Indeed, the mean age of the Bird Island sample, 7.4 years ($n = 195$), is significantly different ($x^2 = 4.95, P < 0.05$) from that of the mainland South Georgia sample, 6.0 years ($n = 20$). The consequences of this are that the integrated age structure for the entire breeding herd will have a higher proportion of younger animals, and be more heavily skewed and leptokurtic with a lower mean, relative to the age structure of the Bird Island section of the herd. This could alter the estimate of adult survival somewhat, but since the limiting case in which adult mortality is barely exceeded by that for first-year animals has already been observed, it is apparent that at an increase rate of 16.8%, the population in its present state is subject to an annual adult cow mortality of less than 7.9%. In fact, it is normal for first-year mortality to exceed that for adults quite substantially, and using the adult mortality estimate corrected for pregnancy, first-year mortality becomes 23.9%. It is clear that at the prevailing rate of increase, both adult and first-year mortality are extremely low, but the data for estimating and apportioning these two complementary figures are at present too poor for precision.

6. Conclusion

The present relatively short-term study of fur seal population dynamics has revealed many interesting features characteristic of other seal and mammalian populations and fulfilled predictions as to features associated with expanding populations. This alone would emphasize the need for continued monitoring of selected aspects of the numerical and structural development of the population. It is important also to appreciate the opportunity that will be afforded to study the progress of expected stabilization of the population, the factors influencing the level at which this occurs, and the nature of subsequent fluctuations. Two factors can be predicted as paramount. First, increased breeding density may have a threefold effect. Reduced pup survival through increased failure to establish mother-pup bonds adequate for relocation after feeding trips seems likely to be of most consequence. Reduced pregnancy resulting from poorer coverage of cows by harem bulls is a possibility, as is delayed recruitment if virgin cows are fertilized on or near the breeding beaches. Second, decreased food availability may be accompanied by reduced pregnancy (through the inability of cows of marginal nutritional status to maintain viable foetuses), lower growth rates and poorer survival, especially in the first year. It might be possible to detect whether summer or winter food levels are most critical by examining the pattern of pup mortality on land and subsequent survival at sea, on the grounds that a winter food shortage might have relatively little effect on first-year survival in the shore-based summer phase.

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Differences attributable to the effects of high breeding density or food shortage might be distinguishable by a study of pup mortality, with continued undernutrition producing results quite different from failure of mother–pup relocation mechanisms. A study of pup mortality (currently in preparation) is clearly an important key to improving understanding of fur seal population regulating mechanisms.

Appendix 1. Numbers of fur seal pups counted at all new colonies on South Georgia outside main breeding concentrations, 1971–5

(Minimum black pup counts provided by B.A.S. personnel, not necessarily at most appropriate date.)

site	location on figure 2	1971	1972	1973	1974	1975
Rosita Hbr.	1	—	4	47	114	—
Wales Head	2	—	—	1	—	—
Right Whale Bay (S)	3	—	—	0	3	—
Right Whale Bay – C. North	4	—	—	49	105	—
Church Bay (W) (i)	5	—	—	1	—	—
Church Bay (W) (ii)	6	—	—	2	—	—
Bernt	7	—	—	6	—	—
Grassholm	8	—	—	—	—	1+
Frida Hole	9	—	—	1	—	82
Chaplin Head – Romerof Head	10	—	—	15	—	118
Schlieper Bay	11	—	—	*ca.* 35	—	—
Morsa Bay	12	—	—	0	5	—
Samuel Islands	13	—	—	1	—	—
Hauge Reef (W)	14	—	—	—	—	2
Hauge Reef (E)	15	—	—	—	—	4
'Pillar Cove'	16	—	—	—	—	1
S. of Diaz Cove	17	—	—	—	—	1
Cooper Island	18	1	—	—	*ca.* 200	—
Cooper Bay	19	6–10	—	26	—	*ca.* 50
Cape Vahsel	20	1	—	—	—	—

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