POLISH POLAR RESEARCH	19	3–4	235–247	1998

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Seasonal numbers of five species of seals in Admiralty Bay (South Shetland Islands, Antarctica)

ABSTRACT: The paper presents the results of seven-year survey of Antarctic seals along the western shore of Admiralty Bay, King George Island, South Shetland Islands. Five species were monitored during seven of the eight years, between 1988–95, excluding 1993. Numbers of elephant seals and Antarctic fur seals showed strong annual cycles, fur seals with two seasonal peaks. These of the other three species were more irregular. Fewer Weddell seals were seen in 1994 and 1995 then during the period 1988–92; with this exception, no overall trend in numbers was apparent during the period 1988–95.

Key words: Antarctica, pinnipeds, year-round monitoring.

Introduction

There have been multiple but infrequent summer pinniped censuses in the South Shetland Islands, for example by Laws (1953), Aguayo (1970), Krylov and Medvedev (1972), Müller-Schwarze *et al.* (1978), Vergani *et al.* (1987), Bengtson *et al.* (1990) and Vergani and Stanganelli (1990).

This paper reports a long-term census of five species occurring along the western shore of Admiralty Bay, King George Island. Monitoring began in 1977 after the establishment of *H. Arctowski* Station (Fig. 1) (Presler 1980, Myrcha and Teliga 1980, Woyciechowski 1980, Krzemiński 1981, Jabłoński *et al.* 1987). Systematic counts have been carried throughout the years since 1988, between Point Thomas and Patelnia Point (Fig. 1) (Sierakowski 1991, Lesiński 1993, Rakusa-Suszczewski and Sierakowski 1993, Ciaputa 1996).

Preliminary analysis of results from the five years (1988–1992) was presented by Rakusa-Suszczewski and Sierakowski (1993) identifying species that were recorded each year: southern elephant seal – *Mirounga leonina* (Linnaeus, 1758), Weddell seal – *Leptonychotes weddelli* (Lesson, 1826), crabeater seal – *Lobodon carcinophagus* (Hombron et Jacquinot, 1824), leopard seal – *Hydrurga leptonyx* (Blainville, 1820) and Antarctic fur seal – *Arctocephalus gazella* Peters, 1875. One Ross seal – *Ommatophoca rossii,* (Gray 1844) was observed in 1992. This study presents a seven-year data set, drawing attention to species – specific patterns in local abundance.

Methods

Data collection

The method of counting was established in 1988, and used in subsequent years (Rakusa-Suszczewski and Sierakowski 1993). Seals were counted at ten-day intervals throughout the year, along a 15 kilometre stretch of the western shore of Admiralty Bay, including pack ice when present, between Point Thomas and Patelnia Point. The greater part of the censused area, between Rakusa Pt. and Patelnia Pt., forms part of Site of Special Scientific Interest – SSSI No.8 (Fig. 1). For elephant seals and Weddell seals, the two species breeding in this area, numbers of new-born animals – pups – were noted.

To the data reported by Sierakowski (1991), Lesiński (1993), Rakusa-Suszczewski and Sierakowski (1993) and Ciaputa (1996) we now added those from 1995, making a seven-year series.

Data analysis

The data series have been analysed using the Time Series Analysis module of the statistical package STATISTICA 4.3. Series were regarded as consisting of three different components: seasonal (denoted as S_t, where t stands for the particular point in time), trend-cycle (TC_t) and random, error or irregular components (I_t). As the data were collected at ten-day intervals, for all the five species an annual cycle length of 360 days was assumed. Since the numbers for each species did not start each season at zero the classical multiplicative model was applied:

$$X_t = TC_t \times S_t \times I_t, \text{ where } X_t = \text{observed value X at time t.}$$

A moving average was computed for each of the species series, with window width equal to the length of one year – here 36. Within each moving average series all within-year variability (seasonal and irregular) was eliminated. The observed series was divided by the moving average values. The seasonal component (S_t) was then calculated as the medial average for each point of the season. The original series was adjusted by dividing it by the seasonal component. The combined trend-cycle component (TC_t) was approximated by applying to the seasonally adjusted series, a five point (centred) weighted moving average smoothing trans-

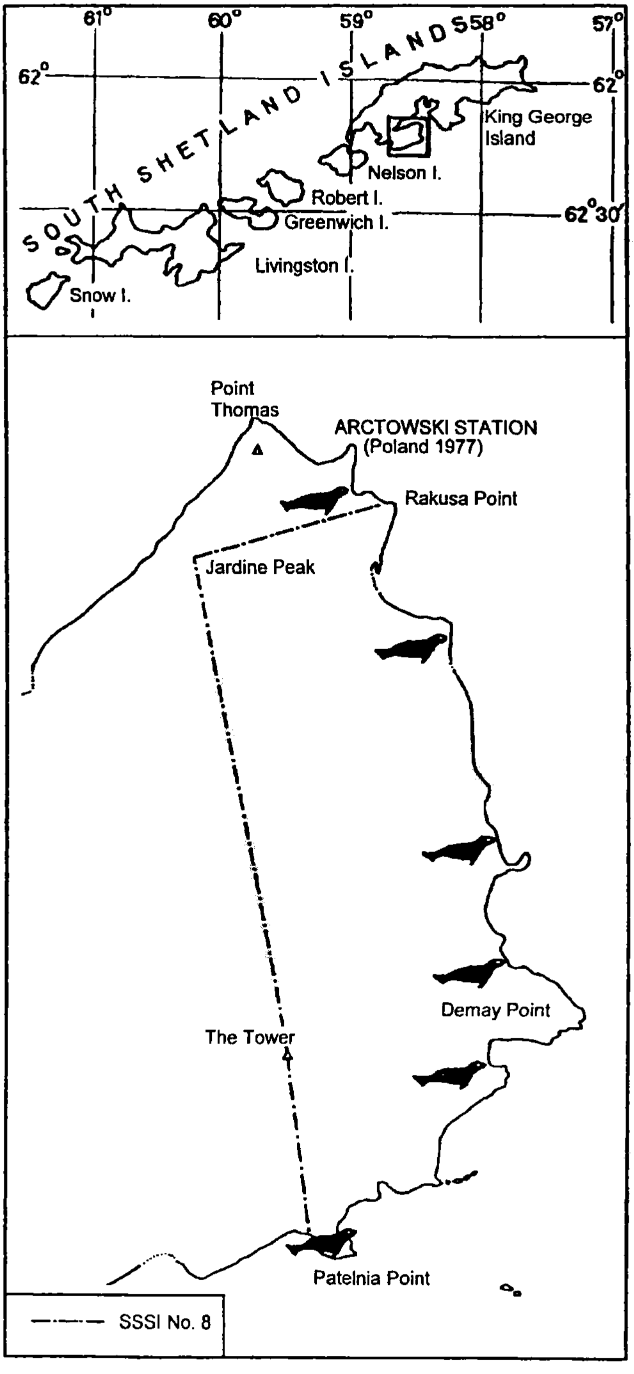

Fig. 1. Study area – western shore of Admiralty Bay (SSSI No. 8). — Sites with the largest seal concentrations were marked with seal symbol.

formation. Finally, the random or irregular component (I_t) was isolated by dividing the seasonally adjusted series by the trend-cycle component.

Results

Seal numbers in 1995

Of the five species recorded all varied considerably throughout the year (Table 1).

Table 1

Numbers of seals of five species observed in the Admiralty Bay region between January and December 1995.

Month	Ten day period	Elephant seal	Crabeater seal	Weddell seal	Leopard seal	Antarctic fur seal
I	1	603 (20)	2	8	6	0
	2	548 (8)	0	12	4	6
	3	581	0	13	3	28
II	1	713	0	8	3	834
	2	506	0	9	1	1709
	3	252	0	8	2	1251
III	1	229	0	7	2	1181
	2	262	0	3	1	989
	3	302	0	8	2	407
IV	1	388	0	7	0	139
	2	343	0	7	0	129
	3	315	1	5	0	86
V	1	231	0	0	0	47
	2	195	0	8	0	38
	3	144	0	5	0	12
VI	1	179	1	8	0	10
	2	138	0	5	0	468
	3	27	0	2	0	115
VII	1	13	0	0	0	4
	2	0	0	2	0	0
	3	0	0	0	0	2
VIII	1	0	0	0	0	5
	2	0	0	0	0	1
	3	0	0	0	0	0
IX	1	0	4	0	0	0
	2	0	10	4 (2)	0	0
	3	0	16	11 (4)	0	0
X	1	62 (3)	9	7 (7)	3	1
	2	205 (84)	23	9 (5)	77	0
	3	267 (190)	12	7 (2)	2	1
XI	1	222 (234)	3	6	2	0
	2	253 (232)	0	13	0	1
	3	391 (208)	1	7	3	0
XII	1	523 (193)	0	11	2	0
	2	592 (181)	0	10	2	0

Numbers in brackets represent numbers of pups which were counted separately from adults.

Elephant seals. — Numbers were highest from December to mid- February, the peak of adult abundance occurring early in February, when 713 individuals were recorded. They decreased during March, after the moulting season, increased slightly in April, then fell toward zero between May and the second half of July. Elephant seals were absent from the study area until the end of September, and began returning in early October. The first neonate was recorded on 5th October; the highest number (234) of pups, in early November.

Crabeater seals. — Numbers were highest during September and early November. The highest number, 23 seals, was recorded in mid-October. Therefore few of this species were seen.

Weddell seals. — This species was present throughout the year except from early July to early September. The first pup was noted on 19th September. The highest number of pups, 7, was recorded at the beginning of October. The highest number of adults, 13, was observed at the end of January and again in the mid-November.

Leopard seal. — Small numbers of this species occurred from January to March. None was recorded during the six months – April to September. October was remarkable for the appearing of 77 in the mid-monthly count; observed in the lagoons near penguin rookeries. Small numbers were again recorded in December–November.

Antarctic fur seal. — Individuals of this species, almost all immature males, were most commonly observed at the closer to Bransfield Strait end of the transect, from Demay Point to Patelnia Point. Two peaks were recorded; the highest in mid-February, and a smaller in mid-June. No breeding was reported.

Discussion

The seven-year database

Pinniped species composition was stable, excluding the recording of one Ross seal. Two species, the elephant seal and the Weddell seal, had breeding sites within the study area. Antarctic fur seals do not breed in Admiralty Bay.

Mean periods spent by each of the five species in the Admiralty Bay region and their mean abundances differed amongst the species. Pinnipeds were generally present in this region from mid-July to mid-May (Fig. 2).

The numbers of individuals of the five pinniped species varied both seasonally and multi-annually.

Elephant seals. — Annual mean adult elephant seal abundance equalled 206 individuals (95% confidence interval – 179–232), and reached a maximum above 750 twice. The maximal number of observed individuals oscillated within

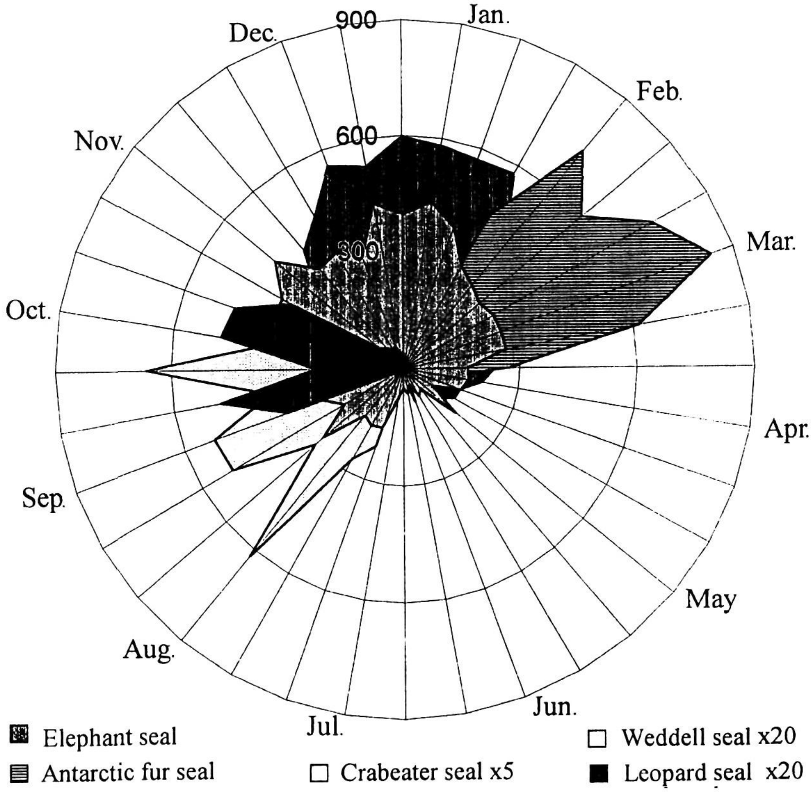

Fig. 2. Mean time spent in the Admiralty Bay region and mean abundance of five pinniped species in 1988–92 and 1994–95. (For the aim of presenting all the five species on the same scale mean numbers of individuals were respectively multiplied by: crabeater seal – 5, Weddell seal – 20 and leopard seal – 20).

a range of 10% from year to year. Between years changes in numbers were not significant similarly to the previous study from the Admiralty Bay region (Rakusa-Suszczewski and Sierakowski 1993).

The maximum number of observed elephant seal pups equalled 318 (Fig. 3a). Annual maximum number of pups constituted on average 22% (95% confidence interval – 12–32%) of the maximum number of observed elephant seals (calculation: max. number of pups / (max. number of pups + max. number of adults) × 100%), alike the 18% (95% confidence interval – 6–31%) calculated for the data presented by Rakusa-Suszczewski and Sierakowski (1993). On the western coast of King George Island, at Stranger Point, the maximum number of pups in the total population constituted 46% (recalculated from Vergani and Stanganelli 1990) and on Kergulen Island – 43% (recalculated from Bester 1982).

Numbers of adult elephant seals were found to be regularly seasonally fluctuating. In the seasonal cycle elephant seal abundance reached a maximum in

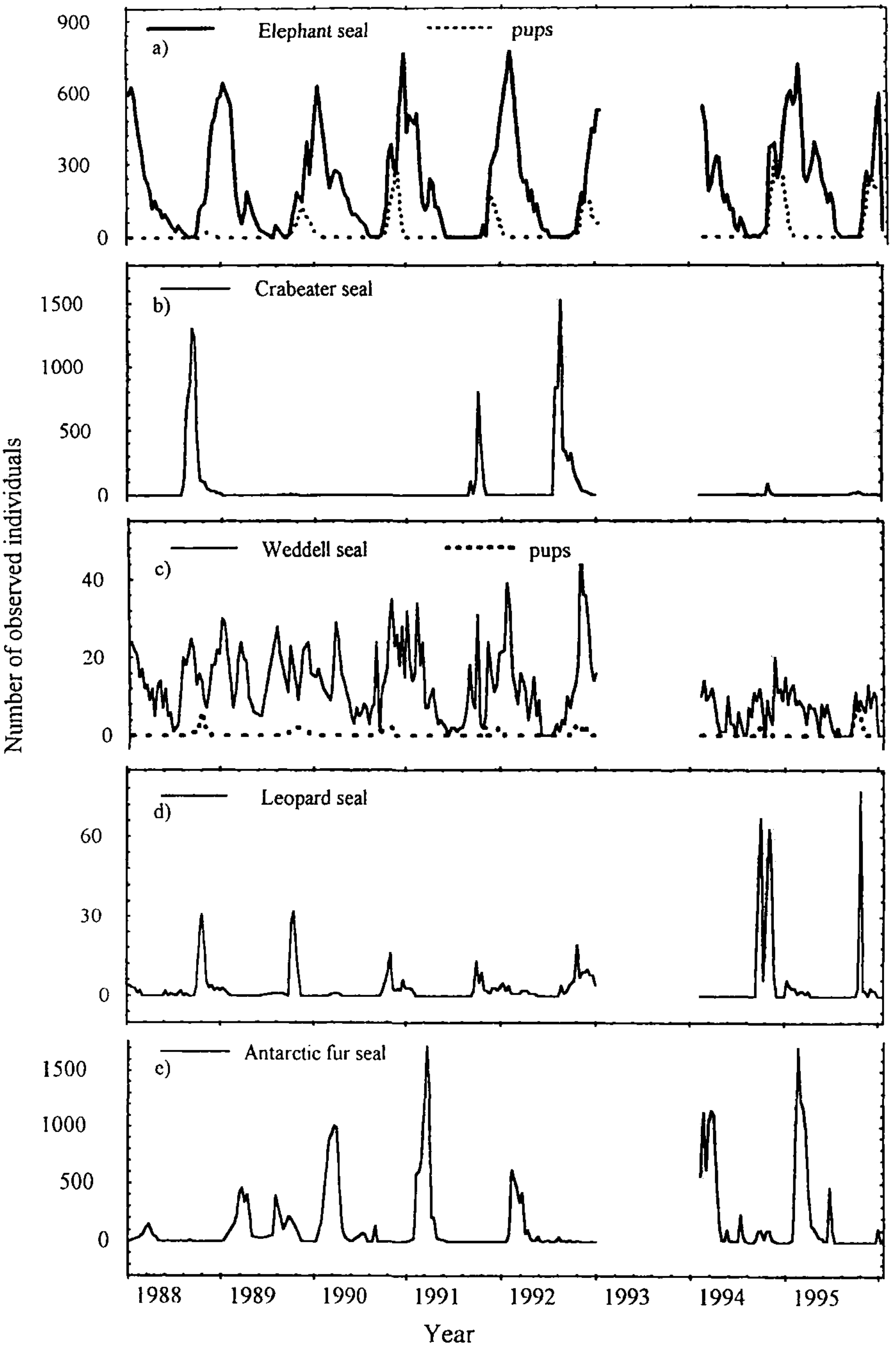

Fig. 3. Long-term changes in numbers of five species of seals in the Admiralty Bay region. (a) Elephant seal, (b) crabeater seal, (c) Weddell seal, (d) leopard seal, and (e) Antarctic fur seal. Numbers of pups are not included in numbers of adults.

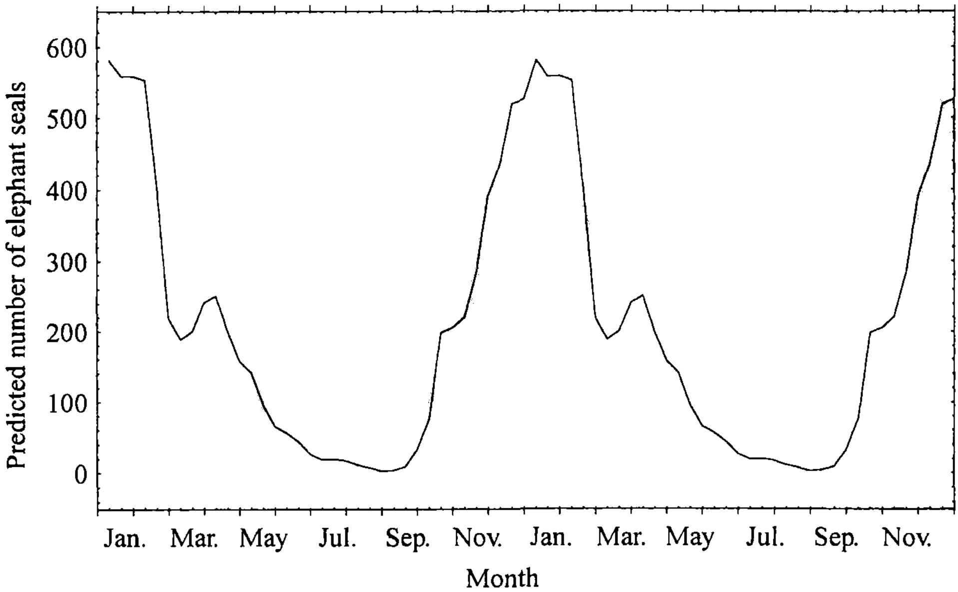

Fig. 4. Predicted year-round cycle of elephant seal numbers in the Admiralty Bay region based on a seven-year study.

January when moulting females and young males were present (Fig. 4). The second, smaller peak was observed at the beginning of April which represents adult males peak haul out for moulting.

According to Vergani and Stanganelli (1990) *M. leonina* numbers in the Stranger Point region, varied significantly from year to year in the period 1980–1988. Analysis of the presented data-base, collected in consecutive years, shows very stable elephant seal abundance and does not support the previous result. Boyd *et al.* (1996) gives a similar estimation to the one presented here of the elephant seal population trend on South Georgia over the last 45 years.

Crabeater seal. — The mean abundance of this species amounted to 52 individuals per year (95% confidence interval - 26–78). The maximal number of observed crabeater seals was 1527 (Fig. 3b).

L. carcinophagus numbers recorded during this study varied greatly which was noted both after 5 (Rakusa-Suszczewski and Sierakowski 1993) and 7 years of monitoring. The time series analysis results confirmed the irregularity and the lack of a stable seasonal cycle in crabeater seal occurrence in this region. The annual maximum numbers of observed crabeater seals showed a wide range of variation (1–1527 individuals.

The pack-ice zone is the preferred habitat of crabeater seals and most sightings occurred within it or near its edge (Siniff *et al.* 1970). Therefore, the number

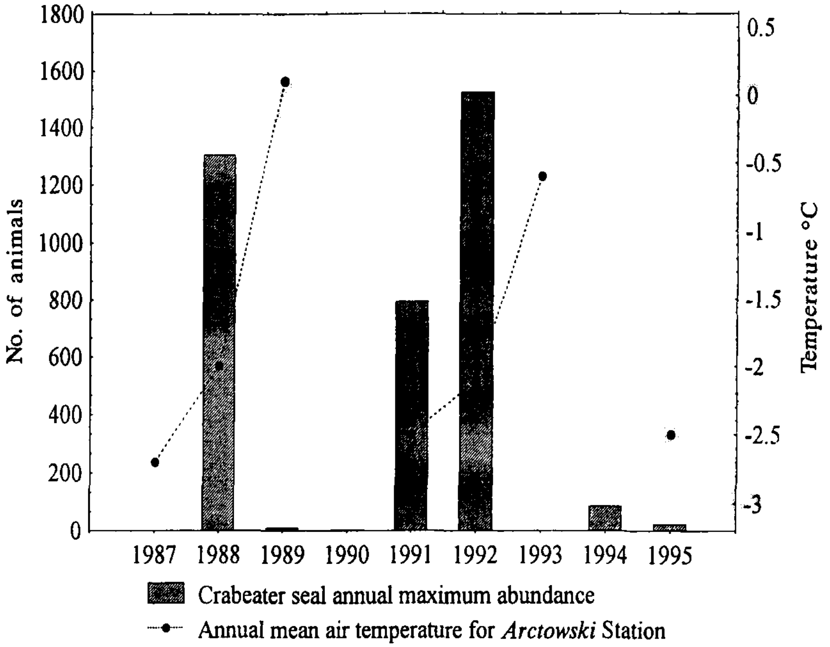

Fig. 5. Mean annual air temperatures and maximum numbers of crabeater seals recorded in Admiralty Bay between 1987–1995.

of crabeater seals observed in Admiralty Bay depends on if pack-ice enters the bay. Entry of the pack-ice was related to the currents in Bransfield Strait and pack-ice formation itself, dependent on temperature. The mean air temperature in the region of *Arctowski* Station for the decade 1978–87 was -1.8°C (Martianov and Rakusa-Suszczewski 1990). We hypothesise, that like in 1989, in the years of high mean annual air temperature, above the long-term mean, crabeater seal abundance would be low or they would be absent (Fig. 5).

Another hypothesis which could explain the irregular pattern of observed crabeater seal numbers was presented by Testa *et al.* (1991) who noted that quasi-cyclic patterns in crabeater seal cohort strength seem to be related to large scale oceanographical changes – El Niño Southern Oscillations (ENSO). Since they concluded that after 1976 the cycle of crabeater seal abundance lengthened to 8 years, our data series was too short to enable comparisons.

Weddell seal. — In the years 1988–95 (excluding 1993) the mean abundance of adult Weddell seals was estimated as 12 (95% confidence interval – 10–13). The greatest number was 49 (Fig. 3c).

Results of the multi-year monitoring implied an increasing range of Weddell seal numbers in the Admiralty Bay region in the years 1988–1992 and much lower range in the period 1994–1995 (Fig. 3c). No trend was detected in this population changes (Lesiński 1993, Rakusa-Suszczewski and Sierakowski 1993, Ciaputa 1996). Testa *et al.* (1991) related fluctuations in Weddell seal numbers to the Southern Oscillation Index. They presented data showing that Weddell seals undergo fluctuations in reproductive rate every 4–6 years.

During this study the maximum number of pups, 7, was recorded (Table 1). Annual numbers of Weddell seal pups were low and varied between 2–7 individuals, similar to those reported by Rakusa-Suszczewski and Sierakowski (1993). The two highest numbers of pups were recorded in 1988 and, after 7 years, in 1995. As with the findings of Testa and Siniff (1987) there was no correlation between the number of new-born pups and number of adults; the highest number of pups was recorded when the numbers of adults were the lowest in the entire data set (see Fig. 3c).

Leopard seal. — In the years 1988–95 (excluding 1993) the annual mean of leopard seals in the Admiralty Bay region equalled 4 specimens (95% confidence interval – 2–5). The greatest count of this species equalled 77 animals. There were significant changes of maximal abundance in some years. The lowest value of the annual maximum was six times smaller than the highest one (Fig. 3d).

In the Antarctic Peninsula region leopard seals were found to be feeding mainly on krill but also take penguins and crabeater seal pups (Siniff and Stone 1985). In Admiralty Bay leopard seals occurred irregularly and only for a short period, and their presence was related to the crabeater seals arrival and penguin breeding season (Lesiński 1993). There was no correlation between leopard seal and crabeater seal numbers recorded in this study. Since crabeater seals do not breed in this region and most of the sighting occurred close to penguin colonies it is more likely that leopard seal abundance was related to penguin or krill availability.

During this study counts of leopard seals were low, only up to thirty animals, except for the last years when the numbers increased to almost eighty. However, no multi-year trend nor cycle within the series was found. A recent hypothesis has related leopard seal abundance to the extent of pack-ice in addition to krill abundance and availability (Testa *et al.* 1991). Unfortunately no ice data from Admiralty Bay for this study period were available.

Antarctic fur seal. — Annual mean fur seal abundance in the Admiralty Bay region equalled 145 (95% confidence interval – 103–186), and the highest number of individuals exceeded 1700 in two years (Fig. 3e).

The maximum number of observed fur seals was changing considerably year by year. There was a twelve fold difference in fur seal abundance in Admiralty Bay between the highest (in 1991) and the lowest (in 1988) count.

Autocorrelation and partial autocorrelation analysis results suggested that the seasonal variation in *A. gazella* numbers was cyclic. Applying Seasonal Decomposition Analysis, the pattern of the Antarctic fur seal annual cycle was obtained (Fig. 6).

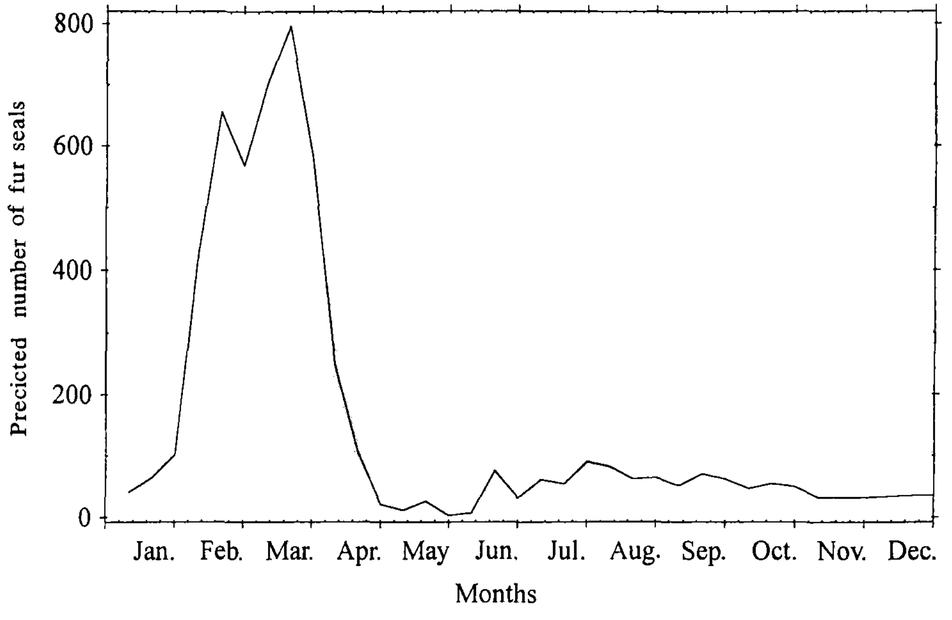

Fig. 6. Annual cycle of Antarctic fur seal abundance in the Admiralty Bay region based on a seven-year study.

According to the findings of a continuous five-year study (Rakusa-Suszczewski and Sierakowski 1993) Antarctic fur seal abundance shows two peaks in the austral autumn and winter. This result was confirmed statistically by Ciaputa (1996) and by the present analysis of the seven year database.

The findings under consideration suggest that after cessation of sealing at the end of the 19th century, Antarctic fur seal numbers in the South Shetland area have increased (Bengtson *et al.* 1990). Although, in the Admiralty Bay region (Rakusa-Suszczewski and Sierakowski 1993, Ciaputa 1996) and similarly in the Stigant Point area (Bengtson *et al.* 1990) no such trend has been recorded.

In the present study high variability in the maximal abundance of Antarctic fur seals was noted. The changes in numbers of fur seals observed in the South Shetland region could be affected by immigration (Bengtson *et al.* 1990, Whitehouse and Veit 1994).

Acknowledgements. — The authors wish to express their thanks to Professor Stanisław Rakusa-Suszczewski for enabling the study and for the encouragement during the preparation of this paper. Thanks are due to all colleagues from the Polish Antarctic expeditions who took part in collecting of the data included in the presented database and to Dr Z. Zwoliński for providing the meteorological data. For editing the English version of the text, we are indebted to Fiona Peaker B.Sc. The authors are greatly indebted to Dr. Bernard Stonehouse for helpful comments on the manuscript.

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Received October 11, 1997
Accepted October 20, 1997

Streszczenie

W pracy przedstawiono wyniki monitoringu pięciu gatunków płetwonogich występujących na zachodnim wybrzeżu Zatoki Admiralicji (fig. 1) w roku 1995 (tab. 1). Liczebność pięciu gatunków (*Mirounga leonina, Lobodon carcinophagus, Leptonychotes weddelli, Hydrurga leptonyx* i *Arctocephalus gazella*) w roku 1995 wraz z wynikami monitoringu z lat 1978–1994 (z wyłączeniem roku 1993) posłużyły do zbudowania bazy danych obejmującej siedem lat badań.

Na podstawie siedmioletniej bazy danych uzyskano schemat fenologii płetwonogich w Zatoce Admiralicji w ciągu roku (fig. 2). Zmiany liczebności płetwonogich w badanym okresie nie wskazują na występowanie trendów monotonicznych w ich populacjach. Liczebność słoni morskich (fig. 3a) wydaje się stabilna w okresie siedmiu lat i wykazuje wyraźny cykl roczny (fig. 4). Liczebność fok krabojadów zmieniała się nieregularnie (fig. 3b). Zaobserwowano niższą liczebność fok Weddella w latach 1994 i 1995 niż w latach 1978–92 (fig. 3c). Zanotowane liczebności lampartów morskich zmieniały się w sposób nieregularny (fig. 3d). Liczebność uchatek antarktycznych zmieniała się znacznie nie wykazując wyraźnej tendencji zmian populacji (fig. 3e). Analiza siedmioletniej serii danych potwierdziła występowanie dwóch szczytów liczebności: jesiennego i zimowego, w rejonie Zatoki Admiralicji (fig. 6).