Results of the fourth seal survey in the King Haakon VII Sea, Antarctica

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The fourth in the series of annual seal censuses in the King Haakon VII Sea, Antarctica, was conducted in January and February 1977. An area of 288 km² of pack ice was studied. Estimates of crude density for Weddell and leopard seals were similar to values obtained in the previous censuses, but estimates for crabeater and Ross seals were lower than recorded previously. It appeared that the density of these two species decreased eastwards from Trolltunga. Crabeater seals were the most abundant species, followed by Ross seals. Weddell and leopard seals were equally the least abundant species. In terms of biomass per unit area, crabeater seals were the largest contributors, followed in order of importance by Ross seals, Adélie penguins, leopard seals, Weddell seals, and emperor penguins. Species group sizes, diurnal rhythm, and distribution according to ice floe size and surface topography and pack ice concentration, were similar to that which occurred during the previous censuses.

Die vierde van 'n reeks van jaarlikse volkstellings in die Koning Haakon VII See, Antarktika, is gedurende Januarie en Februarie 1977 uitgevoer. 'n Oppervlakte van 288 km² bedek met pakys is gesensus. Skattings vir ru-digtheid vir die Weddell- en luiperdrob was soortgelyk aan die waardes bereken gedurende die vorige volkstelling. Die waardes bereken vir die krabeterrob en Ross rob was egter laer as dié voorheen bereken. Dit wil voorkom asof die digtheid van hierdie twee spesies ooswaarts van Trolltunga afneem. Krabeterrobbe was die mees algemene spesie, gevolg deur Ross robbe, Weddell- en luiperdrobbe. Weddell- en luiperdrobbe was gelykwaardig die raarste spesies. In terme van biomassa per km² het die krabeterrob die grootste bydrae gelewer, gevolg in volgorde van belang deur Ross robbe, Adélie pikkewyne, luiperdrobbe, Weddell robbe en emperor pikkewyne. Die groepsgrootte, daaglikse ritme van voorkoms en verspreiding van die spesies volgens ysblok grootte en oppervlakte topografie, en pakys konsentrasie was soortgelyk aan die inligting ingewin gedurende die vorige opname.

Introduction

The fourth seal survey in the King Haakon VII Sea, Antarctica, took place between 20 January and 8 February 1977, during the course of the annual relief of SANAE. Information similar to that obtained during the previous three surveys (Hall-Martin, 1974; Wilson, 1975; Condy, 1976) was obtained, and the seal censuses were conducted largely in an area not investigated previously.

Methods

Observations were made from the bridge of the M.V. *RSA*, 10 m above the waterline. As the ship steamed through the pack ice, pack ice concentration within 100 m of the ship was recorded every 30 minutes, and ship's position noted every 20–40 minutes. A Redifon RSN 1 satellite navigational aid was used to obtain positional fixes, and these were cross-checked with fixes obtained on a continuous basis from an Omega navigational system. Pack ice concentration was recorded in tenths (0,0 = open water, 0,5 = 50 per cent ice coverage excluding brash ice, 1,0 = solid sea or bay ice). The species, group sizes, and sex (when possible) of all seals within 200 m either side of the ship were recorded. In addition the size (< 500 m², 500–1000 m², > 1000 m²), and surface topography (smooth or hummocked), of ice floes occupied by seals were recorded, as well as pack ice concentration within 100 m of occupied floes. Ocean depth beneath the ship was recorded whenever the ship passed within 200 m of an occupied ice floe, using the ship's echo-sounder.

The limits of the 200 m census strips, on either side of the ship, were determined using a sighting board similar to that described by Siniff, Cline & Erickson (1970), but sighting distances and sighting angles could not be measured. The width of the census strips was chosen on the basis of standardization with the technique used by Siniff *et al.* (1970).

Groups of seals were defined on the same basis as described by Siniff *et al.* (1970). Recording was done continuously throughout the study period, except for three separate 24-hour periods. The data on species density were not corrected for diurnal activity and are therefore crude estimates. Diurnal haul-out patterns of crabeater seals were studied during the three 24-hour periods, during which time the ship's engines were stopped and the ship allowed to drift with the pack ice. Every hour during these periods general pack ice concentration within a radius of 500 m of the ship

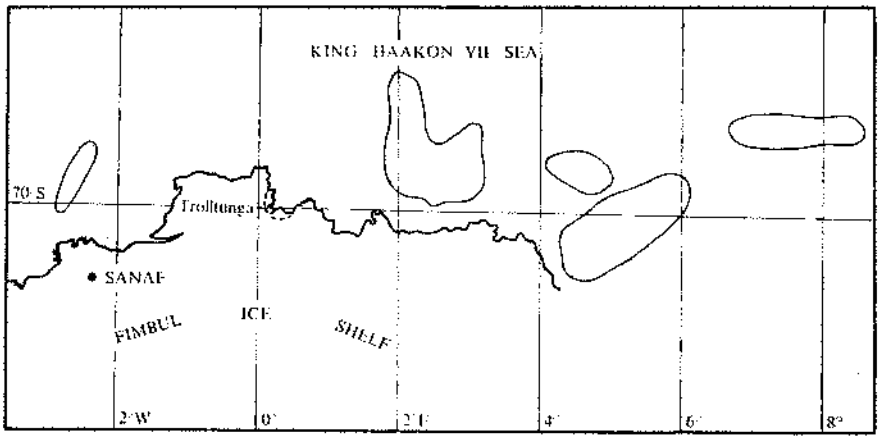

Fig. 1. Areas surveyed.

was recorded, and all seals within sight (approximately 1000 m of the ship), were identified and recorded.

Results and discussion

Population density and species composition

The results of the strip censuses are given in Table 1, and the areas surveyed are shown in Fig. 1. The estimates of crude density for Weddell and leopard seals are similar to those obtained previously (Hall-Martin, 1974; Wilson, 1975; Condy, 1976), but the estimates for Ross seals are lower than the values obtained during the previous censuses. The difference may be due to different pack ice conditions, but it is of interest to note that Hall-Martin (1974) and Wilson (1975) conducted their censuses west of Trolltunga (see Fig. 1), between longitudes 1°–6°W, while this and the 1976 census (Condy, 1976), were largely conducted east of Trolltunga, between longitudes 0°–9°E. In 1976 56,2 per cent of the area surveyed occurred east of 0°, and in 1977 74,4 per cent occurred east of 0°. The estimated crude densities of crabeater and Ross seals was higher in 1976 (1,49 and 0,24 km^2 respectively) than in 1977 (Table 1), giving the impression that seal densities decrease eastwards from Trolltunga.

Hall-Martin (1974) drew attention to the unusually high density of Ross seals off the Fimbul Ice Shelf, in the King Haakon VII Sea. Even though the estimated density from this study was the lowest recorded in all four censuses done so far, they were still more abundant than recorded in the Weddell Sea by Siniff *et al.* (1970), and Erickson, Siniff, Cline & Hofman (1971).

Crabeater seals comprised a higher proportion of all seals counted (87,3 per cent) in 1977 than in any of the previous censuses, while Ross seals comprised the lowest proportion (9,6 per cent) recorded so far. Hall-Martin (1974) recorded 80,6 per cent crabeater seals and 16,8 per cent Ross seals, Wilson (1975) recorded 58,5 per cent and 32,4 per cent respectively. As has been indicated, it appears that seal abundance decreases eastwards from Trolltunga, and it appears that of all four species, Ross seals show the biggest decrease.

Biomass

During the 1977 censuses, records were also kept on the number of emperor penguins (*Aptenodytes forsteri*) and Adélie penguins (*Pygoscelis adeliae*) occurring within the census strips (Condy, 1977). The crude density of seals and penguins, their overall species composition, and biomass are given in Table 2. In terms of biomass and biomass per unit area, crabeater seals are not surprisingly by far the largest contributors, but it is of interest to note that Adélie penguins are ranked third in importance, having a larger biomass than leopard seals, Weddell seals, and emperor penguins.

Distribution of seals in relation to pack ice concentration

Most pack ice concentrations were encountered during the census cruises (see Table 1), and mean pack ice concentration was 0,48 ±0,25 tenths. Most seals observed during the census cruises and other unrelated cruises were seen in relatively open pack ice concentrations (Table 3), and Ross seals were almost equally common in open pack ice (0,3–0,4 tenths), as in close pack ice (0,7–0,8 tenths). Results from the previous surveys (Hall-Martin, 1974; Wilson, 1975; Condy, 1976) have also shown that Ross seals are common, in the areas surveyed, in open pack ice, in contrast to some earlier beliefs (Eklund & Atwood, 1962; King, 1964; Ray, 1970) that they occurred mainly in close pack ice. It has already been noted (Condy, 1976) that the abundance of Ross seals in the King Haakon VII Sea appears not to be related entirely to pack ice conditions.

Distribution of seals in relation to ocean depth

The mean ocean depth beneath ice floes occupied by

Table 1

Census results from the King Haakon VII Sea, Jan/Feb 1977.

Strip No.	Date	Time (local)	Starting position	Finishing position	Area censused (km^2)	Ice concentration (mean ±S.D.)	*Seals counted						Strip density (seals/km^2)
							C	R	W	L	Un	Total	
A	20/1/77	08h00–15h54	70°01,4'S, 02°22,6'W	69°46,8'S, 02°09,5'W	15,50	0,48 ±0,06	14	2	1	2	0	19	1,23
B	21/1/77	04h00–15h20	69°21,3'S, 02°02,7'E	69°52,6'S, 02°17,1'E	31,62	0,43 ±0,18	56	3	1	0	0	60	1,90
C	22–23/1/77	16h40–12h40	69°51,7'S, 02°06,2'E	69°36,4'S, 03°56,9'E	49,29	0,65 ±0,27	55	7	2	1	2	67	1,36
D	23/1/77	14h00–18h43	69°55,2'S, 04°01,0'E	69°56,4'S, 04°24,7'E	8,04	0,64 ±0,19	12	6	1	0	0	19	2,36
E	24–25/1/77	21h00–23h10	69°56,2'S, 03°56,4'E	69°46,6'S, 06°21,9'E	75,14	0,42 ±0,21	54	3	0	0	0	57	0,76
F	27–28/1/77	19h04–12h00	69°36,1'S, 06°57,7'E	69°36,1'S, 09°33,7'E	50,20	0,31 ±0,26	56	7	0	1	0	64	1,27
G	8/2/77	08h22–13h45	69°59,2'S, 02°56,9'W	69°19,6'S, 01°37,1'W	38,80	0,36 ±0,25	89	8	0	1	0	98	2,53
H	8/2/77	16h15–19h15	69°25,8'S, 00°33,2'W	69°09,1'S, 00°14,4'E	19,93	0,45 ±0,18	8	2	0	0	0	10	0,50
Total	20/1–8/2/77	94 hours, 17 minutes			288,52	0,48 ±0,25	344	38	5	5	2	394	1,37
						Species density (seals/km^2)	1,19	0,13	0,02	0,02	0,01	1,37	
						Species composition (%)	87,3	9,6	1,3	1,3	0,5	100,0	

*C = Crabeater seals, R = Ross seals, W = Weddell seals, L = Leopard seals, Un = Unidentified.

Table 2

Characteristics of seals and penguins in the King Haakon VII Sea in 1977.

Species	Number counted	Species composition (%)	Density (per km²)	Mean body mass (kg)	Species biomass (kg)	Biomass (kg) per km²
Crabeater seal	344	28,6	1,19	*193,0	66 392,0	230,4
Ross seal	38	3,2	0,13	*173,0	6 574,0	22,8
Leopard seal	5	0,4	0,02	*272,0	1 360,0	4,7
Weddell seal	5	0,4	0,02	*246,0	1 230,0	4,3
Emperor penguin	39	3,2	0,14	†25,5	994,5	3,5
Adélie penguin	774	64,2	2,69	†4,5	3 483,0	12,1
Total (combined)	1205	100,0	4,18		80 033,5	277,7

*From Laws (1977). †From J. Prévost (*pers. comm.*).

crabeater seals in the census strips was 1021 ± 345 m (n = 268, range 250–1650 m), 635 ± 361 (n = 37, range 200–1580 m) for Ross seals, 732 ± 485 m (n = 5, range 150–1400 m) for Weddell seals, and 817 ± 229 m (n = 5, range 500–1025 m) for leopard seals. Of the 37 observations for Ross seals, 25 (67,6 per cent) occurred when ocean depth was ⩽ 800 m, while only 62 (23,1 per cent) of the crabeater seal observations occurred at ⩽ 800 m. Further data are required to clarify the pattern, but it appears that Ross seals were concentrated in areas where ocean depth was relatively shallow, in comparison to the distribution of crabeater seals. Ocean depth data at sites occupied by Weddell and leopard seals were too few for comparative purposes.

Distribution of seals in relation to floe size and surface topography

The results are given in Table 4. Once again Ross seals were observed more often on small hummocked floes, but contrary to the results from all three previous surveys (Hall-Martin, 1974; Wilson, 1975; Condy, 1976) crabeater seals occurred more often on hummocked floes than on smooth ones. There appeared to be a greater prevalence of old pack ice in the area surveyed during this study compared to the 1976 study, and is probably the reason for the change. From the results of all four surveys, it appears that Ross seals have a distinct preference for hummocked and small floes, while

Table 3

Distribution of seals in relation to pack ice concentration in the King Haakon VII Sea in 1977.

Species	Pack ice concentration (tenths)									Total
	0,1	0,2	0,3	0,4	0,5	0,6	0,7	0,8	0,9	
Crabeater seal	36	127	72	34	55	40	35	48	39	486
%	7,4	26,1	14,8	7,0	11,3	8,2	7,2	9,9	8,1	100,0
Ross seal	5	4	11	7	3	4	9	10	1	54
%	9,3	7,4	20,4	13,0	5,6	7,4	16,7	18,5	1,8	100,0
Weddell seal	0	1	2	0	2	0	1	1	0	7
%	0	14,3	28,6	0	28,6	0	14,3	14,3	0	100,0
Leopard seal	2	1	0	1	2	0	0	2	0	8
%	25,0	12,5	0	12,5	25,0	0	0	25,0	0	100,0
Total	43	133	85	42	62	44	45	61	40	555
%	7,7	24,0	15,3	7,6	11,2	7,9	8,1	11,0	7,2	100,0

Table 4

Distribution of seals in relation to ice floe surface topography and size in the King Haakon VII Sea in 1977.

Species	Floe surface topography			Floe size (m²)			
	smooth	hummocked	n	< 500	500–1000	> 1000	n
Crabeater seal	209	231	440	78	207	155	440
%	47,5	52,5	100,0	17,7	47,0	35,2	100,0
Ross seal	14	32	46	21	15	10	46
%	30,4	69,6	100,0	45,7	32,6	21,7	100,0
Weddell seal	4	3	7	2	2	3	7
%	57,1	42,9	100,0	28,6	28,6	42,9	100,0
Leopard seal	4	4	8	5	2	1	8
%	50,0	50,0	100,0	62,5	25,0	12,5	100,0

crabeater seals tend to haul out on medium to large floes, slightly favouring smooth ones.

Group size

Mean crabeater seal group size was 1,54 ± 1,02 seals per group (n = 327, range 1–8), and all other species occurred singly. The group size frequency of crabeater seals is given in Table 5. The data on group sizes are similar to that from the three previous studies (Hall-Martin, 1974; Wilson, 1975; Condy, 1976).

On two separate occasions, single Ross seals were seen occupying the same ice floes as groups of crabeater seals. In the first instance a Ross seal lay in amongst eight crabeater seals spread about a small ice floe (≃ 100 m²), and in the second instance a Ross seal occupied a small part of a floe, separated from the rest of the floe on which three crabeater seals lay, by a low ice ridge of about a metre in height.

Diurnal rhythm

Results for crabeater seals from the three 24-hour activity studies are given in Table 6. Mean pack ice concentration during study A was 0,78 ± 0,04 tenths (range 0,7–0,8), 0,32 ± 0,08 tenths (range 0,1–0,6) during study B, and 0,56 ± 0,15 tenths (range 0,3–0,8) during study C. During study A the ship drifted 11,0 km, during study B it drifted 8,0 km, and during study C it drifted 4,5 km. The studies were conducted on 21, 23, and 25 January respectively.

Between 04h00 and 17h00 there was a general increase in the number of crabeater seals hauled out, and few were seen swimming in the water. Most seals seen swimming were observed between 22h00 and 03h00 and relatively few were hauled out during this period. Although they hauled out throughout the 24 hours, there was a distinct increase in numbers hauled out between 08h00 and 15h00. The diurnal haul-out pattern is similar to that observed by Nel (1966), Erickson *et al.* (1971), and during the three previous studies (Hall-Martin, 1974; Wilson, 1975; Condy, 1976).

Swimming seals could only be seen when they were close to the ship (within 150 m), and generally they were heard as they exhaled upon surfacing, before they were seen. It appeared that some were attracted to the ship by curiosity, spending up to 40 minutes swimming and diving around the hull. Although this may have introduced a bias in the results, the absence of observations of swimming seals between 04h00 and 15h00 suggests that fewer were in the water during this period. Groups of up to six were seen in the water beside the ship, but it appeared that such groups were loose associations, as while a few remained near the ship for some time, the remainder disappeared. Sometimes some members of such groups appeared to be playing, since they would repeatedly leap onto a floe, slide back into the water, and seconds later shoot out onto another floe and so on, carrying on for 10 to 20 minutes. During this period searches were made for leopard seals and killer whales, but no signs of their presence were ever noticed.

Table 5

Group size frequency of crabeater seals in the King Haakon VII Sea in 1977.

Number of seals per group	Observed frequency	Percentage frequency
1	221	67,6
2	65	19,9
3	26	8,0
4	9	2,8
5	1	0,3
6	3	0,9
8	2	0,6
Totals	327	100,0

Table 6

Results of the activity studies on crabeater seals in the King Haakon VII Sea in 1977.

Time (local)	Study A		Study B		Study C		Total (combined)	
	On floes	In water	On floes	In water	On floes	In water	On floes	In water
00h00–01h00	0	1	0	0	2	2	2	3
01h00–02h00	3	3	0	0	3	0	6	3
02h00–03h00	4	0	0	3	1	2	5	5
03h00–04h00	4	0	0	0	4	1	8	1
04h00–05h00	2	0	1	0	6	0	9	0
05h00–06h00	3	0	3	0	8	0	14	0
06h00–07h00	2	0	3	0	8	0	13	0
07h00–08h00	5	0	4	0	4	0	13	0
08h00–09h00	5	0	5	0	5	0	15	0
09h00–10h00	7	0	4	0	10	0	21	0
10h00–11h00	6	0	4	0	8	0	18	0
11h00–12h00	9	0	6	0	11	0	26	0
12h00–13h00	8	2	4	0	10	0	22	2
13h00–14h00	8	0	5	0	4	0	17	0
14h00–15h00	9	0	7	0	4	0	20	0
15h00–16h00	8	2	2	0	3	0	13	2
16h00–17h00	3	2	1	0	4	0	8	2
17h00–18h00	2	2	0	0	3	0	5	2
18h00–19h00	2	2	1	0	3	0	6	2
19h00–20h00	2	2	1	0	1	1	4	3
20h00–21h00	1	0	0	1	0	0	1	1
21h00–22h00	1	0	0	0	0	0	1	0
22h00–23h00	1	3	0	0	0	0	1	3
23h00–24h00	2	2	0	0	0	7	2	9

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References

Condy, P.R. Results of the third seal survey in the King Haakon VII Sea, Antarctica. *S. Afr. J. Antarct. Res.*, 6, 2-8, 1976.

Condy, P.R. Observations on penguins in the King Haakon VII Sea, Antarctica. *S. Afr. J. Antarct. Res.*, in press.

Eklund, C.R. & Atwood, E.L. A population study of Antarctic seals. *J. Mammal.*, 43, 229-238, 1962.

Erickson, A.W., Siniff, D.B., Cline, D.R. & Hofman, R.J. Distributional ecology of Antarctic seals. In *Symposium on Antarctic Ice and Water Masses*, edit. J. Deacon. Cambridge, SCAR, pp. 55-76, 1971.

Hall-Martin, A.J. Observations on population density and species composition of seals in the King Haakon VII Sea, Antarctica. *S. Afr. J. Antarct. Res.*, 4, 34-39, 1974.

King, J.E. *Seals of the World*. London, British Museum (Natural History), 1964.

Laws, R.M. Seals and whales of the Southern Ocean. *Phil. Trans. R. Soc. Lond., B*, 279, 81-96, 1977.

Nel, J.A.J. On the behaviour of the crabeater seal *Lobodon carcinophagus* (Hombron & Jacquinot). *Zoologica Africana*, 2, 91-93, 1966.

Ray, C. Population ecology and Antarctic seals. In *Antarctic Ecology*, Vol. 1, edit. M.W. Holdgate. London & New York, Academic Press, 1970.

Siniff, D.B., Cline, D.R. & Erickson, A.W. Population densities of seals in the Weddell Sea, Antarctica, in 1968. In *Antarctic Ecology*, Vol. 1, edit. M.W. Holdgate. London & New York, Academic Press, 1970.

Wilson, V.J. A second survey of seals in the King Haakon VII Sea, Antarctica. *S. Afr. J. Antarct. Res.*, 5, 31-36, 1975.