WEDDELL SEAL HARVESTING AT SCOTT BASE, McMURDO SOUND, ANTARCTICA, 1970-76

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SUMMARY: Weddell seals *(Leptonychotes weddelli)* have been killed annually since 1956 at Scott Base, McMurdo Sound, Antarctica, to provide food for the resident husky dogs. Between 1970 and 1976 personnel of Antarctic Division, DSIR, killed 399 seals, recorded infonnation on their physical characteristics and collected jaws and reproductive organs (females only). Data made available to the Zoology Department, University of Canterbury, for analysis included 321 seal data-sheets, 186 lower jaws and 103 sets of female reproductive organs.

The overall sex ratio of seals killed was 1: 1. Mean ages of males ranged from 6.75 years (1972) to 13 years (1975), with an overall mean of 10.4 years; mean ages of females ranged from 7.82 years (1973) to 12 years (1974) with an overall mean of 9.87 years. In the four seasons with adequate sample sizes (15 + animals) the proportion of animals 10 years and older in the samples ranged from 28% (1972) to 65.7% (1976).

The mean body lengths of males declined from 260.63 cm in 1970 to 239.8 cm in 1976. Lengths of females fluctuated from year to year between values of 258.25 cm (1974) and 249.28 cm (1975). The thickness of subcutaneous fat on the chest of males in the years 1974-76 ranged from 4.43 cm to 5.16 cm; that of females varied from 4.98 cm to 5.78 cm. The overall pregnancy rate was 65%, with a range from 55% (1974) to 76.5% (1976).

Comparison with data from seal kills in 1957, 1962-64 and 1966-68 (Stirling, 1971a) suggests that in the 1970-76 period the Weddell seal population of eastern McMurdo Sound was close to stability, but fluctuating slightly from year to year, probably in response to changes in availability of food and other resources.

INTRODUCTION

Weddell seals *(Leptonychotes weddelli)* in McMurdo Sound, Antarctica, have been harvested annually since 1956 to provide food for dog teams at Scott Base, Ross Island. Seals are killed in late January or early February, when the bulk of the adult (> 3 years old) population is concentrated on the sea ice in front of Scott Base. From 1956 to 1965 the collection of data on the physical characteristics of the dead animals was rather haphazard, but since 1966 information has been recorded more systematically and jaws (for ageing) and female reproductive organs have been collected.

Stirling (1971a) analysed the data available from the seal kills of 1957, 1962-64 and 1966-68 and discussed population aspects of the harvesting. On the basis of evidence from sex ratios, age structure, size, fatness and pregnancy rates he suggested that in 1968 the Weddell seal population of eastern McMurdo Sound was approaching stability, after passing through phases of decline (1957--60) and rapid expansion (1961-65) since harvesting began. Stirling (1971a) recommended that data from seal kills should continue to be recorded fully so that future changes in population parameters could be recognised and documented.

The policy of recording data from all seal kills has continued, as Stirling (1971a) recommended, and it is the purpose of this paper to present data from the seal kills of 1970-1976 inclusive and to comment on the current status of the population.

MATERIALS AND METHODS

In the seven seasons from 1970 to 1976 inclusive, official figures show that 399 Weddell seals (200 males: 199 females) were killed for dog food by personnel of Antarctic Division, DSIR (Table 1). From these specimens, 321 seal data-sheets (134 males: 173 females: 14 sex unknown), 186 lower jaws (92 males: 81 females: 13 sex unknown) and 103 sets of female reproductive organs were received by the Zoology Department, University of Canterbury. No jaws or uteri, and only ten data sheets, were received from the 1971 kill, so that season is excluded from all analyses except that concerning the number and sex of seals killed. Only 13 jaws (from 52 seals killed) Were received in 1974, and only 6 jaws (from 52 seals killed) and no uteri in 1975 (Table 1).

TABLE 1. *Numbers of Weddell seals killed at Scott Base for dog food each year from 1970 to* 1976 *inclusive, and numbers of data sheets, jaws' and uteri supplied to the Zoo logy Department, University of Canterbury, by Antarctic Division, D.S.I.R.*

Year	No. of seals killed*				No. of data sheets				No. of jaws				No. of uteri	No. of foetuses	% pregnant
	♂♂	♀♀	Total	%♂	♂♂	♀♀	?	Total	♂♂	♀♀	?	Total			
1970	40	27	67	60	32	25	2	59	32	24	2	58	25	15	60.0
1971	35	16	51	69	0	10	0	10	0	0	0	0	0	0	0
1972	30	42	72	42	12	15	2	29	12	13	2	27	15	10	66.66
1973	26	26	52	50	26	26	8	60†	23	17	8	48	26	18	69.2
1974	24	28	52	46	20	38	1	59†	4	9	0	13	20	11	55.0
1975	20	32	52	38	20	32	0	52	3	3	0	6	0	0	0
1976	25	28	53	47	24	27	1	52	18	15	1	34	17	13	76.5
TOTALS	200	199	399	50	134	173	14	321	92	81	13	186	103	67	65

* Official figures from Antarctic Division, D.S.I.R.

† More data sheets received than there were seals listed as killed.

The seals killed each February supposedly constitute a random sample of the population present at the time, because the culler walks a transect and kills seals in the order in which they are encountered, without regard to sex or size. The sample taken is not, however, representative of the whole Weddell seal population of eastern McMurdo Sound, because the seals that congregate in late summer near Scott Base are predominantly older animals (> 3 years old). For all seals killed, the sex, body length (measured in a straight line from nose to tail) and thickness of subcutaneous fat on the chest (1974 onwards) were recorded, and the lower jaws and reproductive organs (females only) collected.

Seals were aged by counting incremental growth lines in the dentine of the lower canine teeth, using the method described by Stirling (1969). Pregnancy rates were determined by noting the presence of extra-embryonic membranes or foetuses in the uteri. Some pregnancies could have been missed using this method because embryos do not implant until two or three months after mating, i.e., not until early to mid-February.

RESULTS AND DISCUSSION

Sex and age structure of the seals killed

The overall sex ratio for the total number of seals killed in the seven seasons from 1970 to 1976 inclusive was 1: 1. This differs markedly from the ratio of 2 or 3 females to 1 male recorded by Stirling (1971a) for the 1966 and 1967 seasons. However, Stirling's estimates were based on data from field observations as well as from seal kills, so the sex ratios are not directly comparable.

Considering the seal kills for each year separately (Table 1), it is clear that males predominated only in 1970 (60% males) and 1971 (69% males). This could be a consequence of the fact that only females

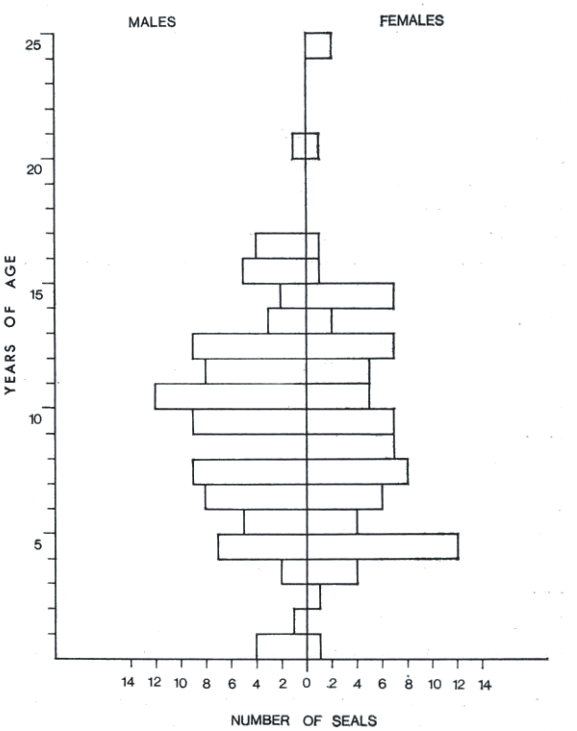

FIGURE 1. *Age structure of Weddell seals killed at Scott Base, McMurdo Sound, 1970-76.*

were killed in 1968, possibly biasing the sex ratio for the next few seasons. Since 1971, females have predominated in the samples, but not to a statistically significant extent. On the evidence of the seal kills only, there is no indication that the female to male ratio is close to the 2 or 3 to 1 recorded by Stirling (1971a).

The age structures of the samples for the six seasons from 1970-76 combined (no data for 1971), are given for the two sexes separately in Figure 1. The mean ages of seals killed are given in Table 2. The proportion of seals aged 10 years or more in each sample is given in Table 3, together with similar data for 1957 (from Balham, in Stirling, 1971a), 1962-64 (from Smith, in Stirling, 1971a) and 1966-68 (Stirling, 1971a).

in 1973 to 12 years in 1974, with an overall mean age of 9.87 years (n = 83). These mean ages are generally greater than those recorded by Stirling (1967) for the years 1966 (8.7 years for each sex) and 1967 (males 7.6 years, females 8.6 years), indicating that the proportion of older animals in the population has increased.

That there was a greater proportion of older animals in the population in 1970-76 than at earlier times is substantiated by a comparison of the proportion of seals 10 years and older at different periods over the past 20 years. Stirling (1971a) carried out this procedure to compare the age structures of populations in 1957, 1962-64 and 1966-68. He argued that the population in 1957 could be presumed to have been stable, as it had been

TABLE 2. *Mean ages of Weddell seals in kill samples for the years 1970 and* 1972-76 *inclusive*.

	MALES				FEMALES			
Year	Number in sample	Mean age (years)	Standard deviation	Standard error	Number in sample	Mean age (years)	Standard deviation	Standard error
1970	32	10.25	4.31	0.76	24	10.37	4.76	0.97
1972	12	6.75	4.51	1.3	13	8.23	4.97	1.38
1973	23	9.96	4.0	0.83	17	7.82	3.26	0.79
1974	4	11.0	2.45	1.22	9	12.0	3.35	1.12
1975	3	13.0	3.46	2.0	3	10.0	1.73	1.0
1976	18	11.5	2.95	0.69	17	10.82	5.25	1.27

TABLE 3. *Proportions of Weddell seals aged 10 years or more in kill samples from the years* 1957 *(Balham, in Stirling, 1971a),* 1962-64 *(Smith, in Stirling, 1971a),* 1966-68 *(Stirling, 1971a), 1970 and* 1972-76 *(this study).*

	MALES			FEMALES			BOTH SEXES		
Year	Number in sample	Number ≥ 10 yr	% ≥ 10 yr	Number in sample	Number ≥ 10 yr	% ≥ 10 yr	Number in sample	Number ≥ 10 yr	% ≥ 10 yr
1957	-	-	-	-	-	-	47	18	38.3
1962-64	94	23	24.5	30	9	33.3	124	32	25.8
1966-68	28	15	53.5	130	50	38.5	158	65	41.1
1970	32	16	50.0	24	12	50.0	56	28	50.0
1972	12	3	25.0	13	4	30.8	25	7	28.0
1973	23	14	60.9	17	5	29.4	40	19	47.5
1974	4	3	75.0	9	8	88.9	13	11	84.6
1975	3	3	100.0	3	2	66.7	6	5	83.3
1976	18	14	77.8	17	9	52.9	35	23	65.7

The mean ages of males killed ranged from 6.75 years in 1972 to 13 years (n = 3) in 1975, with an overall mean age of 10.4 years (n = 92). Mean ages of females also varied considerably, from 7.82 years

undisturbed by man for 40 years, whereas that in 1962-64 was probably expanding, as fewer seals were being killed than in 1956-59. He assumed that the 1966-68 population was approaching the carrying

capacity of the environment and could therefore be regarded as stable, or nearly so. Continuing this line of reasoning, Stirling (1971a) postulated that the 1957 and 1966-68 populations would have been similar in age structure, with a substantial proportion of older animals, whereas the 1962-64 population would have been different from the other two, having fewer older animals. This postulation was largely substantiated when the data on age structure of the three populations were analysed and compared, although not all differences between the 1962-64 population on the one hand, and the 1957 and 1966-68 populations on the other, were sta tistically significant.

In Table 3 it can be seen that for each sex, and for the sexes combined, the trend since 1962-64 has been for an increasing proportion of the adult population to be 10 years or older, this being particularly marked from 1974 to 1976 inclusive. The difference between the periods 1966-68 and 1974-76 in the proportion of older animals in the population is statistically significant both for males (X^2 = 4.113, P < 0.05) and females (X^2 = 7.065, p < 0.01). This analysis supports the view that the population in 1976 was stable or declining, rather than expanding. Stability is the more likely, as there is no evidence that fewer young have been produced recently.

1972) from a high value of 260.63 cm in 1970 to a low of 239.8 cm in 1976, the difference between the values being statistically significant (t = 4.794, 53 d.f., p < 0.001). The mean lengths of females, on the other hand, fluctuated from year to year. In four of the six seasons females were longer than males, but there was no statistically significant difference between the lengths of the two sexes in any single year or overall.

Stirling (1971a) noted that in 1966-68 seals of both sexes were significantly shorter than in 1962-64. He argued that this was because the population was approaching stability, at or near the carrying capacity of the environment, in 1966-68, leading to increased intraspecific competition for resources and limitation of the growth of individuals; whereas in 1962-64, when the population was expanding from a reduced level, animals were able to grow larger, because competition was less intense. The data on body length from 1970-76 are not easily interpreted on this basis. The females in the six samples combined may be regarded as a homogeneous sample statistically, and their mean length of 251.78 cm in 1970-76 is significantly greater than the mean length of 239.67 cm in 1966-68 (t = 7.58, 301 d.f., P < 0.001). This could indicate that competition was less in 1970-76 than in 1966-68, perhaps because of a drop in numbers. The situation is quite different

TABLE 4. *Mean body lengths of Weddell seals killed at Scott Base in the years 1957, 1962-64, 1966-68 (from Stirling, 1971a), 1970 and 1972-76 (this study).*

	MALES				FEMALES			
Year	Number in sample	Mean length (cm)	Standard deviation	Standard error	Number in sample	Mean length (cm)	Standard deviation	Standard error
1957	20	247.39	13.43	-	36	260.4	12.47	-
1962-64	125	249.52	13.10	-	69	260.32	14.32	-
1966-68	48	230.27	13.25	-	138	239.67	14.32	-
1970	32	260.63	15.12	2.67	25	249.40	18.73	3.75
1972	9	236.11	13.87	4.62	14	252.50	17.03	4.55
1973	27	251.85	22.75	4.38	23	250.00	13.06	2.72
1974	18	251.10	14.61	3.44	40	258.25	12.54	1.98
1975	18	245.83	14.58	3.44	35	249.28	10.44	1.76
1976	23	239.80	16.90	3.52	28	251.25	8.99	1.70

Body length

The mean body lengths of seals in the samples from 1970 to 1976 are given in Table 4, together with comparative data from 1957, 1962-64 and 1966-68 (from Stirling, 1971a). From the table, it can be seen that during the 1970-76 period the mean body lengths of males declined steadily (excluding

for the males, however, as animals were particularly long in 1970 but declined appreciably in mean body length between then and 1976. The greater length of males in 1970 compared to 1966-68 (t = 7.65, 78 d.f., p < 0.001) could indicate a population decline during that period. The equally great difference between male lengths in 1970 and 1976 could indicate

a population increase, with associated increased competition for food and other resources.

There could be many other explanations for the variations in lengths described above, including non-random sampling in some years, and more evidence is needed to resolve this interpretative difficulty .

lengths of males from 1970 to 1976 is not in accord with this explanation.

The most likely explanation is that the population is fluctuating around an essentially stable level, with consequent variation in intensity of competition for food and breathing holes. Changing ice conditions from year to year probably affect breeding success,

TABLE 5. *Mean thickness of the subcutaneous fat layer on the chest of Weddell seals killed at Scott Base in the years 1957,* 1962-64. 1966-68 *(from Stirling, 1971a) and 1974-76 (this study).*

	MALES				FEMALES			
Year	Number in sample	Mean thickness (cm)	Standard deviation	Standard error	Number in sample	Mean thickness (cm)	Standard deviation	Standard error
1957	20	4.09	1.04	-	36	4.82	1.16	-
1962-64	111	5.23	1.16	-	51	5.63	1.71	-
1966-68	18	4.34	0.95	-	93	4.77	4.77	-
1974	20	4.75	0.98	0.22	39	5.56	0.97	0.16
1975	19	5.16	0.97	0.22	32	5.78	1.18	0.21
1976	21	4.43	1.11	0.24	24	4.98	1.19	0.24

Thickness of subcutaneous fat

Table 5 gives the mean thickness of subcutaneous fat on the chests of male and female seals from 1974-76 inclusive, together with comparative data from 1957, 1962-64 and 1966-68 (Stirling, 1971a).

The pattern of change in fat thickness over the years is similar to that already described for body lengths. Stirling (1971a) showed that seals were thinner in 1966-68 than in 1962-64. This trend of reduction in fat thickness has since reversed. The thickness of chest fat of males increased from 4.34 cm in 1966-68 to 4.78 cm in 1974-76 (no significant difference) and that of females from 4.77 cm in 1966-68 to 5.44 cm in 1974-76 ($t = 4.1$, 186 d.f., $p < 0.001$). The fat thickness of males in 1974-76 is about mid-way between the values for that sex in 1966-68 and 1962-64; that of females in 1970-76 is almost up to the 1962-64 level.

Stirling (1971a) interpreted the data on body lengths and fat thickness from 1957, 1962-64 and 1966-68 as indicating that seals grew larger and fatter when numbers were increasing (1962-64) than when the population was stable (1957) or approaching stability (1966-68). The data from 1970-76 (body lengths) and 1974-76 (fat thickness) do not permit a simple, clear interpretation of the status of the population on the lines suggested by Stirling (1971a). Lengths of females and chest fat thickness of both sexes are more similar to those of 1962-64 than to those of 1966-68, indicating lessened competition in 1970-76. However, the decline in the food availability and mortality rates, and these changes are reflected in the physical growth of individuals. More evidence, preferably from field studies of the living population, is needed to resolve this question.

Pregnancy rate

Because of faulty labelling, many of the female reproductive organs could not be associated with their respective data-sheets or jaws, so age-specific analysis of pregnancy rates was not possible. However, the overall pregnancy rate for the five seasons for which data were available was 65%, ranging from 55% (1974) to 76.5% (1976). Stirling (1971b) recorded an overall pregnancy rate of 80.5 % for the 1966-68 period, a value approached only in 1976 in the present samples.

CONCLUSIONS

The evidence from the analyses of data on the sex ratio, age structure, size, fatness and pregnancy rate from 1970-76 indicates that the Weddell seal population of eastern McMurdo Sound is fluctuating about a stable level below the carrying capacity of the environment. The superior size and fatness of seals killed in 1970-76, compared to those in 1966-68, suggests that the population has probably declined slightly from the 2000 animals present in 1968 (Stirling, 1971a). Continued collection of data from future seal kills and monitoring of the live population are necessary to permit more rigorous scientific analysis of the status of the population.

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