This paper not to be cited without prior reference to the author.

Institute of Marine Research
Sea Mammal Section
Bergen

Report SPS 8910
Bergen, 14.11.89

A note on stock size development of harp seals in the Barents Sea and White Sea.

by

Øyvind Ulltang

Institute of Marine Research
Pb. 1870, 5024 Bergen, Norway

Introduction

As discussed in the report of the ICES Working Group on Harp and Hooded seals (Anon 1990), some drastic event must have led to a significant increase in natural mortality of the Barents Sea and White Sea harp seal stock if the decrease in the population of breeding females from about 140000 in 1985 to about 71000 in 1988 as measured by the Soviet aerial photographic surveys is real. One contributing factor may have been a substantial mortality in fishing gears during the years of harp seal invasions to the Norwegian coastal waters. In this paper stock size development consistent with the aerial surveys is calculated by a simulation model, showing the size of extra natural mortality which has to be added to conventional values if survey estimates of stock size are taken at their face values.

The model

The population model and notations used are identical with what was presented in two working papers to the ICES Working Group on Harp and Hooded seals (Ulltang, 1989 a and b). The starting year for the simulations was 1967. Catches of one years old and older seals (C_{1+}) were distributed on age groups in proportion to their abundance (i.e. exploitation rate $u = C_{1+}/N_{1+}$ for all 1 year old and older seals). Starting population for a given level of pup production in 1967 was constructed in a similar way as explained in Ulltang (1989a) for the West Ice harp seal stock in 1946, taking into account the variable pup catches during the years 1962-1966.

Biological parameters

The following values for the biological parameters were used:

Natural mortality on one years old and older seals: $M = 0.1$

Natural mortality first year of life : $M_o = 3M = 0.3$

Proportion recruited (p_i, i = age) to the breeding stock:

$p_{i\leq 4} = 0$, $p_{i=5} = 0.1$, $p_{i=6} = 0.5$, $p_{i\geq 7} = 1$.

Fertility rate : $f = 0.94$

These are identical to the parameter values used in one set of runs for the West Ice harp seal stock in Ulltang (1989a).

Results

Figure 1 shows the results when starting with a pup production in 1967 of 110000. This is a level similar to what was estimated by Benjaminsen (1979) by the survival index method for 1964-1965. During the 1970es, pup production increases by a rate of about 2.1% per year, which is lower than calculated by Benjaminsen (1979) using more optimistic values of biological parameters. Pup production reaches a level of about 136000 in 1980, similar to the USSR aerial estimate of 139000 breeding females, and stays at a rather stable level until 1985 when pup production is calculated to 138000. The USSR survey gave an estimate of about 140000 in 1985. Thus, while the population parameters used by Benjaminsen (1979) would predict a further increase in population from 1980 onwards, the present simulations show a rather stable stock during the period 1980-1985 consistent with the USSR aerial survey estimates. Up to 1985 the development is "normal" in the sence that no extra natural mortality is required for explaining observed development.

From 1985 onwards, constant natural mortalities will give a slight decrease in pup production to about 131000 in 1988 (Run (1), figure 1). Run (2), figure 1, shows the result if an extra natural mortality coeffisient of 0.02 in 1985, 0.3 in 1986 and 0.15 in 1987 is added for all age groups (Table 1). Pup production will then decrease to about 81000 in 1988. This is still somewhat above the USSR aerial estimate of 71000, but satisfactorily close for the purpose of the present exercise. Table 2 shows the detailed results of run (2) for the period 1980-1990.

The extra mortality added corresponds to the following figures for extra mortality in terms of number of seals:

1985 : 11462
1986 : 143127
1987 : 55499

It should be noted that in the simulation model the start of the year is set at the start of the breeding/hunting season. Thus, for example 1985 in the model starts at breeding season 1985 and ends at the start of the breeding season in 1986. By comparing the figures above with the number of seals drowned in fishing gear and recorded for compensation in the Norwegian governmental programme the calendar years 1986, 1987 and 1988, we get the following figures for the ratio (extra mortality in simulation/numbers recorded for compensation):

1985/86 : 2.60
1986/87 : 2.55
1987/88 : 2.58

A more accurate comparison could be made by using monthly statistics of numbers recorded for compensation, but this was not considered worthwhile for the present exercise since it is the accummulated number of seals dying between breeding season in 1985 and 1988 which is of primary importance for the results. The exercise shows that an extra mortality of about 2.6 times the number recorded for compensation is sufficient for explaining the decrease observed in the USSR surveys between 1985 and 1988.

Conclusion

The present paper claims in no sence to describe the "true" development of the White Sea harp seal population. Its only purpose is to show that

a) Values of population parameters which has been used for other harp seal populations give a stock development consistent with Benjaminsens' (1979) estimates of pup production in the 1960es and estimates of number of breeding females from the USSR aerial surveys in 1980 and 1985.

b) An extra mortality (distributed over all age groups) between the breeding seasons in 1985 and 1988 of about 2.6 times the number of seals drowned in fishing gear and recorded for compensation in the Norwegian governmental programme gives the decline observed by the USSR aerial surveys from 1985 to 1988. It is not considered unrealistic that the real number of seals which drowned in fishing gears or died of starvation during the invasions to Norwegian coastal waters 1986-1988 is of this magnitude or even higher.

References

Anon. 1990. Report of the Working Group on Harp and Hooded seals. Bergen, 16-19 October 1989. ICES C.M. 1990/Assess:

Benjaminsen, T. 1979. Pup production and sustainable yield of White Sea harp seals. Fisk.Dir. Skr. Ser. HavUnders., 16:531-539.

Ulltang, Ø. 1989a. Simulations of development in stock size and pup production for harp seals in the Greenland Sea ("West Ice") 1946-1989. WP SEA-16 to ICES Working Group on Harp and Hooded Seals, October 1989. 15 pp. (mimeo)

Ulltang, Ø. 1989b. Stock projections for Harp seals in the Greenland Sea 1990-1999. WP SEA-19 to ICES Working Group on Harp and Hooded Seals, October 1989. 17 pp. (mimeo)

TABLE 1

Instantaneous natural mortality coefficients used in Run (2).

AGE	YEAR 1967-1984	1985	1986	1987	1988-1989
0	0.3	0.32	0.6	0.45	0.3
1 and older	0.1	0.12	0.4	0.25	0.1

TABLE 2

SIMULATION 1980 - 1990,
Run (2).
LISTING OF: Total population

AGE	YEAR 1980	1981	1982	1983	1984	1985
0	136278	140405	140563	139701	137386	138413
1	73867	65106	72897	63687	63169	57148
2	65546	66465	57036	63599	54899	55773
3	54543	58977	58226	49761	54823	48472
4	48864	49077	51667	50799	42895	48405
5	44800	43967	42994	45077	43790	37873
6	38492	40310	38517	37510	38857	38663
7+	266228	274182	275512	273974	268504	271378
N_{1+}	592342	598087	596852	584409	566939	557715

AGE	YEAR 1986	1987	1988	1989	1990
0	132241	97415	80761	77093	75036
1	62496	36432	35071	21367	34154
2	48168	40768	26718	29821	18543
3	47010	31422	29899	22718	25879
4	40855	30666	23044	25423	19715
5	40799	26651	22490	19594	22062
6	31922	26614	19545	19123	17004
7+	261324	191294	159811	152507	148943
N_{1+}	532576	383849	316580	290556	286304

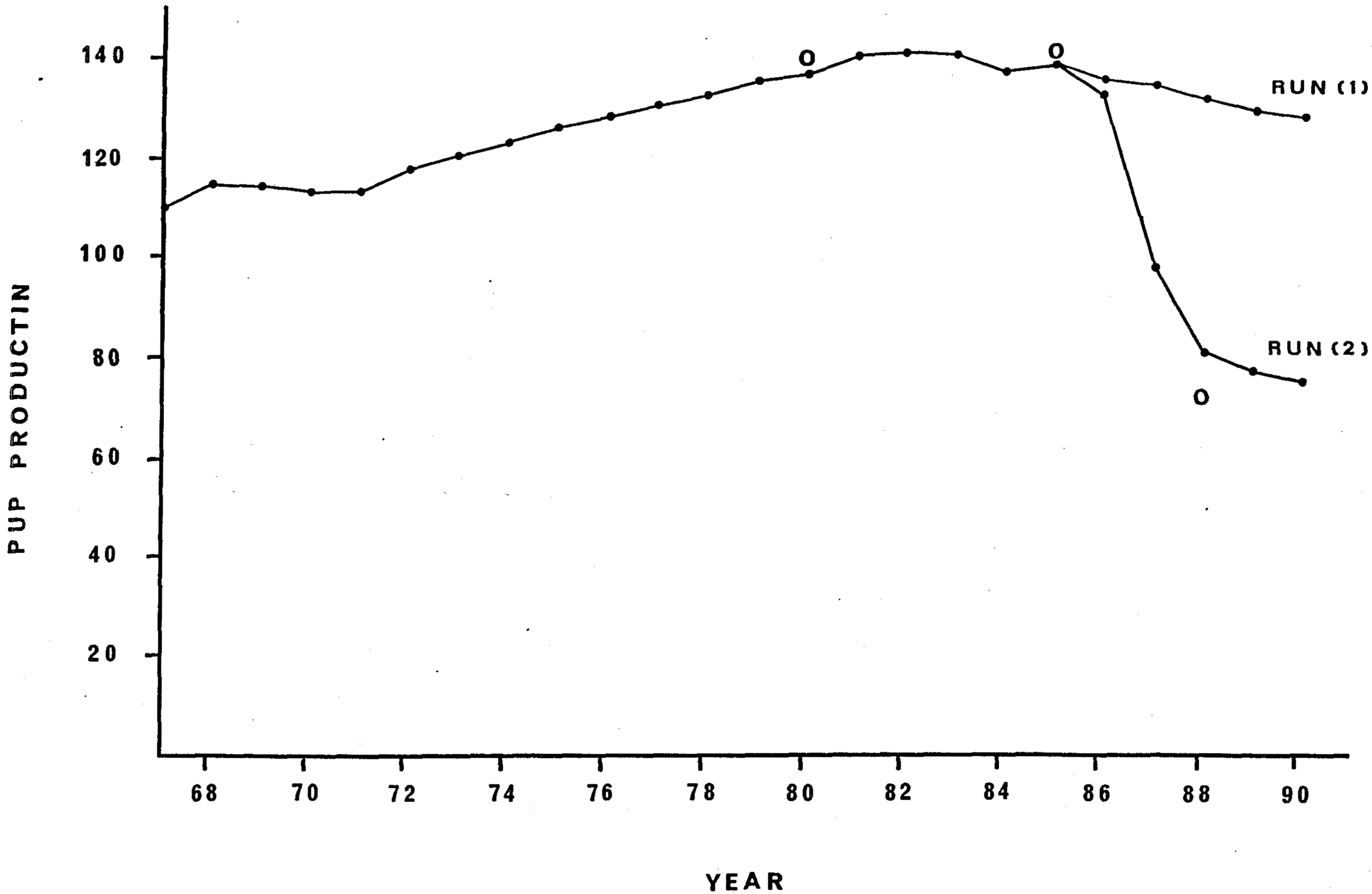

Figure 1. Calculated pup production 1967 - 1990.

(1): Constant natural mortalities.

(2): Higher natural mortalities 1985-1987.

o : Estimated number of breeding females from USSR aerial photographic surveys.