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Comments on new estimates of production and sustainable yield of harp and hooded seals

by

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Introduction

This paper comments on two others: (1) "The Survival of Year-classes and Estimates of Production and Sustainable Yield of Northwest Atlantic Harp Seals" by T. Benjaminsen and T. Øritsland, ICNAF Res. Doc. 75/121, and (2) "Additional Data on the Sex Ratio, Age Composition and Mortality of Newfoundland Hooded Seals, with an Estimate of Pup Production and Sustainable Yield" by T. Øritsland and T. Benjaminsen. Ibid 75/122.

Production of Harp and Hooded Seals, First Method

1. Harp Seals

In their first method the authors use age samples of moulting narp seals collected at Newfoundland in the consecutive years 1968-1974 (their Table 2). An index of survival is constructed (their Table 3) for year classes 1954 to 1972 inclusive using each year's sample and taking a weighted mean for each year-class. The index is expressed as:

$$\frac{\text{year-class strength as percent of sample}}{\text{year-class strength as percent of smoothed total sample}}$$

Values range about a mean of 1.00 (= an average or normal survival) between figures of 0.68 and 2.02.

These values are then plotted against pup catch (their Figure 2) and total production estimated as the intercept of zero survival on pup catch, the method devised by Sergeant (1972).

Using this method the authors obtain estimates of pup production in the 1960's of about 400 thousand, about 30% more than obtained by Sergeant (1972).

What is the source of this discrepancy?

I believe the error introduced by Benjaminsen and Øritsland to be a smoothing of the age frequencies due to their using back ages of animals, aged as old as 15 years.

Clearly, in any age determinations, such smoothing will occur, due to some proportion of incorrect aging. Such errors will increase with age and produce increased smoothing of the frequency as ages increase. The authors have included in their study (their Table 3), for example, year classes as old as 1954 studied in 1968 to 1969, and thus 14 to 15 years old.

Now, if such smoothed results are plotted on a graph of survival index against catch, the result will be to lower the high values and raise the low values of survival index, that is to decrease the slope of the fitted line. Thus, according to the degree of smoothing, almost any intercept is possible, and thus almost any estimate of production above the true estimate.

This method, in fact, must increase estimates of production above the true estimate to the degree that smoothing of age determination has occurred.

Two pieces of evidence strengthen the conclusion that the authors have smoothed in this way. (1) Their Table 3 indicated a survival index of 1.00 (= normal survival) for the 1956 year-class after the very high catch in 1956 of 341,000 young harp seals. Their analysis, however, was based on age samples taken in 1968 to 1971, that is with animals of this year class ages 12 to 15 years old. In fact, age samples taken shortly after this catch (e.g. that shown for 1958 in Sergeant 1965, Fig. 19, p. 460) had consistently shown a marked reduction in this year class after such a high catch, as might have been expected. The method as used by the Norwegian authors is therefore insensitive at older ages. (2) In the 1960's there was no limit to the catch of young harp seals. The fleet, especially that from Norway, was powerful and experienced. Yet in no year of the decade did the catch exceed 280,000 young harp seals - the catch in 1967. This makes estimates of production of 375 - 450,000 for this decade improbable since surely catches in excess of 300,000 would have been attained at least once, as they were during the 1950's. In fact, as claimed by this writer (Sergeant, 1972), a considerable decline in production must have occurred through the 1960's to a level of about 300,000 by the end of the decade.

I believe that most accurate age determination can be achieved between ages 2 and 5 years; some confusion is possible between 1 and 2 years, and at ages greater than 5 years inaccurate age determinations and hence smoothing of frequencies increases. With this perspective I have re-analysed the Norwegian data of 1968-1974 using age 1-5 (Table 1). A regression of survival at age (as percent of sample) is plotted against catch directly (Table 2). The best plot is probably that based on 2 year animals, with median year 1969, since for this age only year classes 1968 and 1972 are both included giving two points of low catch (117 and 156 thousand young). Survival indices for these two years are very similar (Table 1). Moreover the correlation coefficient for the 2 year regression line is the highest of the five (Table 2). The production estimate derived from this fit (Table 2) is 313,500 young seals for median year 1969. The correlation coefficient is lowest for 1 year olds, probably because of great variations in selection of 1 year olds in different years. (This selection depends to a great degree on the dates in April when catching of moulting animals has started, due to segregation of young bedlamers early in April.)

2. Hooded Seals

In Res. Doc. 75/122 Øritsland and Benjaminsen have performed the same operation for hooded seals, and obtained the same error, an increased estimate of production, due to smoothing. However, since mostly recent year classes were involved, the error is not so great as in the example of harp seals discussed above. I have replotted their results for females aged 5 years (approximately the age at full recruitment to maturity, and thus in the samples), with data shown in Table 3. There are only 4 points in the analysis but the spread of catches is wide and the correlation is also good (corr. coeff. = -0.962) with an estimate of production of 26,200 young hood seals. (The same analysis is not performed for males which do not recruit fully till 8 or 9 years.) The Norwegian authors' estimate was near 32,000. The present quota of 15,000, of which about 10,000 is taken as young seals, seems prudent until good estimates of natural mortality are obtained for this species. The Norwegian investigators assume natural mortalities of 10% in the first year and 8% thereafter, or about the same as estimated till recently for harp seals. But the hooded seal is a more rapidly maturing and rather short-lived species. Its natural mortality rates must therefore be somewhat higher than those of harp seals.

Production of Harp Seals, Second Method and Calculation of Sustainable Yield

In their second method, the Norwegian authors back-calculate production of year classes 1960-1967 using (a) age frequencies to give the numbers of 7 year old adults as a proportion of total adults, (b) an estimate of the absolute numbers of adults taken from Allen's (1975) life table, (c) estimates of mean total annual mortality of 12 and 13% for the up to 10 years of calculations. The production estimates obtained are close to those given by the first method and are therefore assumed to lend credence to the two estimates.

The method appears to be tautological, or circular. Allen's (1975) calculated number of adults is itself based on assumptions about mortality rates. The new paper back-calculates from this number, again using two arbitrary mortality rates..

Summary

Recent estimates of production of harp seals at Newfoundland by Norwegian investigators have been higher than hitherto determined. Study of their methodology indicates considerable smoothing, due to the use of high ages in which errors of age determination are inevitably great. Re-analysis of their data using lower ages only brings the estimate of production back to previous estimates for the late 1960's of no more than 310,000 young harp seals. A simple model using arbitrary mortality rates appears to confirm the enlarged estimate of production but the arguments appear to be circular.

A new analysis of production of hooded seals by Norwegian investigators as close above 30,000 is reduced to 26,000 by re-analysis of their data. Their estimate of more than 50% of production as yield based on assumed natural mortalities of 10% in the first year and 8 thereafter, seems high. Retention of a quota of no more than 15,000 hooded seals seems prudent until a model of population turnover is developed.

Acknowledgment

I am grateful to Mr. T. Øritsland for sending me unpublished age frequencies of hooded seals for analysis.

References

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Table 1. Numbers and percent of one to five year old Harp seals in Norwegian age frequencies 1968-1974 taken from Front moulting seals, and catch of young of the same year-classes. Data from Benjaminsen and Øritsland, MS 1975, Tables 2 and 3.

Year Class	Sample year 1968	1969	1970	1971	1972	1973	1974	Catch x 10^{-3}
1963	30 4.2	-	-	-	-	-	-	278
1964	27 3.8	39 4.2	-	-	-	-	-	273
1965	42 6.0	30 3.2	29 5.6	-	-	-	-	190
1966	74 10.5	34 3.7	30 5.8	18 3.5	-	-	-	257
1967	135 19.2	42 4.6	33 6.4	19 3.7	9 6.6	-	-	280
1968	-	371 40.5	109 21.2	43 8.5	24 17.7	293 18.5	-	156
1969	-	-	132 25.6	66 13.0	9 6.6	173 10.9	67 5.8	235
1970	-	-	-	239 47.1	9 6.6	188 11.9	65 5.7	222
1971	-	-	-	-	12 8.8	232 14.7	86 7.6	211
1972	-	-	-	-	-	171 10.8	227 19.9	117
1973	-	-	-	-	-	-	360 31.6	98
N	702	915	515	507	135	1581	1138	

Table 2. Estimates of production of young from regression of catch of young on percent age group. Data from Table 1.

Age group (yrs)	Median year	Estimated Production $\times 10^{-3}$	Correlation coefficient
1	1970	192.5	-0.033
2	1969	313.5	-0.872
3	1968	264.4	-0.363
4	1967	271.3	-0.660
5	1966	287.6	-0.770

Table 3. Survival index of 5 yr. old female Hooded Seals from Norwegian samples of whelping females at Newfoundland, 1971 to 1974.

Sample year	Sample size	5 yr. olds %	Year-class	Catch of Young $\times 10^{-3}$
1974	576	16.7	1969	8.8
1973	199	22.1	1968	1.2
1972	583	13.6	1967	8.4
1971	368	9.2	1966	16.8