Published on paper: 1991. Published online: 2024-10-19.
ISSN 1502-4873 (paper). ISSN 1891-5396 (electronic).
doi: https://doi.org/10.5324/fn.v12i0.6056.

Demographic Parameters for Norwegian Grey Seals *Halichoerus grypus*

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Wiig, Ø. 1991. Demographic parameters for Norwegian Grey seals *(Halichoerus grypus). Fauna norv., Ser. A 12,* 25—28.

Demographic parameters for Norwegian Grey seals are estimated based on samples collected at breeding grounds. The material seems to be biased towards females with pups. In order to get more representative material and thereby more reliable estimates, it is suggested that new material is collected during the moulting season in the spring.

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INTRODUCTION

The management of coastal seals in Norway is under revision. A committee established by the Ministry of Fisheries has proposed that the seals shall be managed according to a plan aided by a population model simulating the results of different strategies (Anon. 1990).

In order to simulate the development of Norwegian populations of Grey seals, estimates for annual survival and reproductive rates are needed. These values do, however, not exist. The only material available from the Norwegian coast from which the estimates might be made, is sampled from different breeding grounds. The aim of the present paper is to estimate survival and reproductive rates from the given material as a first contribution to a better understanding of the population dynamics of Norwegian Grey seals.

MATERIAL AND METHODS

The present study is based on 77 male and 166 female Grey seals captured along the Norwegian coast between Trøndelag (64°N) and Lofotodden (68°N) in the period from 1982 to 1984. They were all killed at the breeding grounds between September and November. Jaws and reproductive organs were sent to the Institute of Marine Research, Bergen.

In order to age the animals, their jaws were boiled for about 1 hour to allow the canine teeth to be easily extracted. Sections, 0.2 mm thick, were cut from the teeth using a modification of the double-bladed cutting machines described by Khuzin (1967). The sections were mounted on glass microscope slides. Cementum growth layers were counted in transmitted light, using a binocular dissecting microscope or a microprojector.

If adult survival is constant beyond a specific age, and if survival to this age does not vary greatly with population size, the number of animals in successive age classes (t) of a random sample for such a population should follow a negative exponential curve ($y = ke^{-xt}$) (Harwood & Prime 1978). The exponent (-x) for a stationary population will be equivalent to the instantaneous mortality rate (m) which equals the natural logarithm of the annual survival rate (Chapman & Robson 1960). If the population is not stationary the rate of increase of the population must be added to the exponent, to give the true instantaneous mortality rate.

Ovaries were fixed and stored in 4% formalin. After fixation they were cut in about 2 mm thick sections along the longitudinal axis to expose the cortex and most of the medullar tissue, as described by Øritsland (1964). An indication of sexual maturity is ovulation (McLaren & Smith 1985), which in pregnant females results in a *corpus luteum* (CL) which turns to a *corpus albicans* (CA) after birth (Øritsland 1964, Boyd 1984). In order to assess the reproductive status of the hunted

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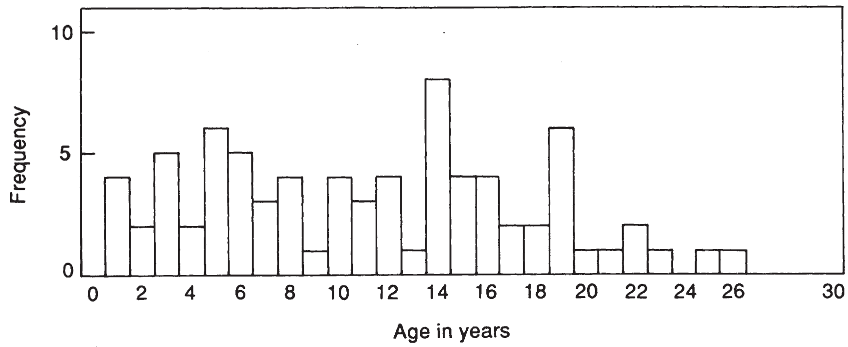

Fig. 1. Age distribution of male Grey seals sampled along the Norwegian coast.

females, the ovaries were inspected for occurrence of CL and CA. The occurrence of a CL was considered to mean that the female had a pup the year of sampling, and the occurrence of a CA was considered to mean that the female had a pup one year before sampling.

RESULTS

The male age data (Fig. 1) does not follow an exponential decreasing distribution and a negative exponential function was not fitted to these data.

The female age data (Fig. 2) indicates that the youngest age classes are underrepresented in the sample and that the females are not fully recruited to the breeding population until the age of about nine years. The negative exponential function fitted to the age distribution for animals older than eight years gave -x = -0.105, $r^2 = 0.81$.

According to Wiig et al. (1990) the number of Grey seal pups born at Froan, the largest breeding locality in Norway, increased in mean about 6.5% in the period 1973 to 1983. This is similar to the annual increase of 6—7% recorded for British Grey seals by Summers (1978). Based on this rate of increase for Norwegian seals, the survival rate for females older then 8 years is estimated at about 0.96.

The youngest animals classified as having a pup, were four year old. From the age of six all the females seem to have a pup the year of sampling. The pupping rates the year before sampling based on CA were, however, less than one. These rates were pooled in larger age classes (Table 1). No significant difference was found in pupping rates between these classes ($\chi^2_3 = 3.91$, P>0.05).

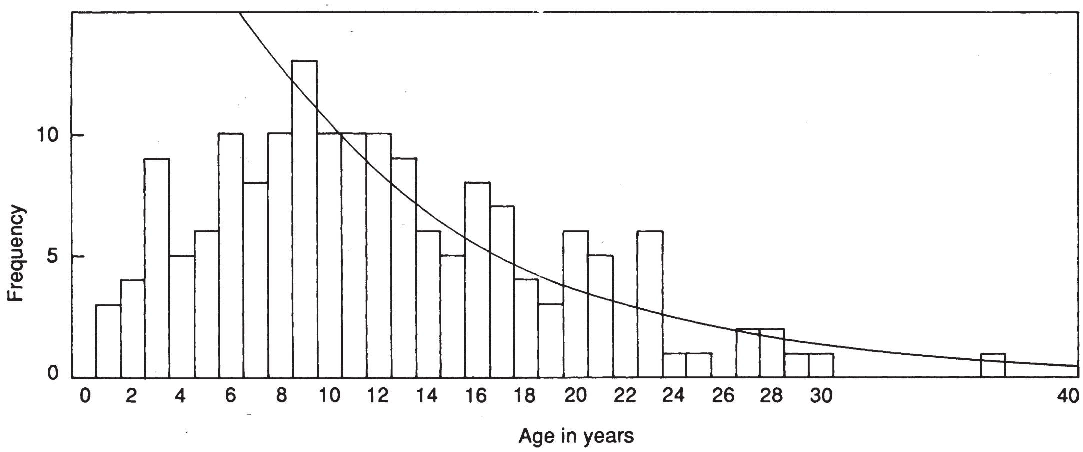

Fig. 2. Age distribution of female Grey seals sampled along the Norwegian coast. The negative exponential function fitted to animals older than eight years is shown.

Table 1. Pregnancy rates (sample size) in relation to age based on the occurrence of CL, CA (back-calculated one year) for Norwegian Grey seals hunted at the breeding ground. Data for CA from British seals recalculated from Boyd (1984) are given for comparable purposes.

Age	Norwegian CL	Norwegian CA	British CA
1	0(2)	0(4)	0(9)
2	0(4)	0(4)	0.08(12)
3	0(4)	0(4)	0.20(15)
4	0.25(4)	0.40(5)	0.50(10)
5	0.40(5)	0.88(8)	0.71(7)
6-10	1.00(44)	0.80(44)	0.70(46)
11-15	1.00(32)	0.93(30)	0.95(20)
16-20	1.00(25)	0.74(23)	0.50(10)
21-	1.00(19)	0.73(15)	0.64(28)

DISCUSSION

The total population of Grey seals in Norway is relatively small, probably between 4000 and 5000 (Wiig 1986). For the present analyses, no sample from a local population in a single year was large enough for statistical treatment. It was therefore necessary to pool all available material from several local populations sampled during three subsequent breeding seasons. The degree of intermixing between these local populations is not known. Tagging experiments performed mainly at the largest breeding ground at Froan do not indicate much emigration of adult specimens to other local populations along the Norwegian coast (Wiig & Øien 1987). In pooling all this material we must assume that population characteristics are stable among subsamples.

Survival rates for the male segment of the population could not be calculated from the present material.

The estimated survival rate for females older than 8 years is somewhat higher than the 0.94 estimated for British females older than 6 years by Harwood & Prime (1978). This high value is probably an effect of a skewed age distribution in the sample with too few individuals from about 6 to 8 years. According to Boyd (1985) British Grey seals are fully recruited to the breeding population at an age of six years. There is no reason to believe that the Norwegian population should be different from this.

The oldest female recorded in the present study was 37 years old. Bonner (1975) recorded a maximum age of 46 years in Britain.

In British Grey seals Boyd (1984) found that pregnancy one year was not influenced by pregnancy the previous year. Calculations of pregnancy rates for the reproductive cycle before the one in which the sample was obtained, appears therefore to be practical for Grey seals. Any sampling bias towards pregnant or nursing females at the breeding ground can then be ignored.

Boyd (1984) also found that the CA seems to disappear after about a year, which in the present analysis would lead to an underestimation of the pregnancy rates back-calculated from recorded CA. On the other hand the presence of a CA gives no information about the success of the pregnancy. This method will therefore tend to overestimate the pregnancy rates.

Pupping rates in British Grey seals based on occurrence of CA, recalculated from the data given by Boyd (1985) for each year class up to 5 years and the older year classes pooled, are given in Table 1. These rates are compared to the Norwegian pupping rates. Age class 3,4 and 5 were compared by Fishers exact test according to Langley (1979). None of the comparisons were significant ($P>0.05$). Comparison of pupping rates for older age classes pooled was also not significant ($\chi^2_1 = 3.05$, $P>0.05$).

Most of the material in the present analysis comes from seals which were shot at the breeding ground. All females aged six years and older had a pup the year of sampling (Table 1). In other Grey seal population the pregnancy rate has been found to be between 0.60 and 0.95 (Mansfield & Beck 1977; Harwood & Prime 1978; Boyd 1985). Boyd (1985) suggested that non-pregnant females may have a different social behaviour from pregnant females. It is also likely that nursing females are easier to catch than other females. Sampling at the breeding site will therefore lead to an overrepresentation of females with pup.

Harwood & Prime (1978) and Harwood (1981) found that British Grey seals have their first pup at an age of five years. In the material presented by Boyd (1985) females had their first pup on average one year earlier. This corresponds to that found in the Norwegian material.

The present analysis shows that age and reproductive material of Norwegian Grey seals collected at breeding grounds is biased. The estimates of female survival and reproductive rates are, however, similar to those estimated for British Grey seals. In order to get more representative and unbiased samples Grey seals should be sampled at other times of the year, preferably during the moulting season in spring when they aggregate at specific moulting grounds.

ACKNOWLEDGEMENTS

I am indebted to T. Øritsland, Institute of Marine Research, Bergen, and an unknown reviewer, for commenting on earlier versions of the manuscript, and to B. Bergflødt and K. A. Fagerheim, Institute of Marine Research, Bergen, for age and ovary analyses.

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Received 23 Sept. 1991