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Population development of harbour seals in the Wadden Sea after the 1988 virusepizootic

by

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ABSTRACT

The mortality as a result of the 1988 virusepidemic amongst harbour seals in the North and Baltic Seas is estimated at 60% in the entire Wadden Sea. In the years 1989-1994, a prosperous recovery of the population has been observed which is reflected in the high post-epizootic average annual rate of increase. The average rate of increase for the entire area was 15%, the highest was recorded in The Netherlands (average 18%) and the lowest in Denmark (average 12%). This rate of increase is significantly higher than in the pre-epizootic period 1976-1987, when the population increased at around 9% per year. The difference in increase is partly attributed to a considerably lower initial juvenile mortality after the epizootic. Present first year mortality is approximately equal in all regions and estimated to be around 40%, whereas it was estimated to be 60% in the seventies. Post-epizootic reproductive rate

in The Netherlands is significantly higher (respectively 20% on average compared to 12-14% before 1988, it is somewhat higher in Niedersachsen (20 respectively 16%), slightly lower in Schleswig-Holstein (23 respectively 20%), whereas it did not change in Denmark (average 17%). It is hypothesised that the improved reproductive rate in The Netherlands might be a result of selective mortality during the epidemic, which affecting within the adult female segment predominantly those that did nor reproduce.
It is emphasised that though the population is recovering well, its present size (almost 9000 animals in 1994) is still only one quarter of the estimated reference figure. Whether the recovery will continue at its present rate, will depend on environmental conditions in the area, such as pollution and disturbance. Furthermore an eventual recurrent flickering of the epidemic can not be excluded.

INTRODUCTION

The harbour seal population in the Wadden Sea can be regarded as a discrete population, with insignificant exchange with other North Sea or Baltic stocks. The different subpopulations have been drastically depleted in the past as a result of overhunting (Reijnders 1992). After hunting was stopped in the last area in the Wadden Sea in 1976, the population recovered clearly (Reijnders *et al.* 1990). However, as a consequence of a virusepidemic in 1988, this recovery was interrupted and the population is assumed to be reduced by approximately 60% (Schwarz & Heidemann 1994). In order to provide favourable conditions for a successful recovery of the Wadden Sea population, it was planned to design a long term conservation and management plan (CWSS 1992). The development of that plan and implementation of related studies required close cooperation between the countries involved, and a comprehensive 5-years research plan was drafted. Through these studies it became clear that in the years after the epizootic the population recovered prosperously as was reflected in the high post-epizootic rate of increase. This paper discusses the population development and the course of the parameters population size, reproductive rate and initial juvenile mortality, for the entire population as well as for the different subpopulations.

METHODS

surveys

The basic data for the analyses in this paper originate from census results obtained during aerial surveys carried out in the period between 1989 and 1994. Traditionally, each of the countries bordering the Wadden Sea carried out these surveys in their own region, namely Denmark, Schleswig-Holstein, Niedersachsen and The Netherlands. For this project the survey flights were synchronised and designed to cover all the haul-out sites within each of the regions under, as far as possible, similar tidal stages within one flight. Usually 8-10 flights per year have been carried out in each region. The main data were collected during the pupping season, therefore four to five flights were performed between June and July to obtain the pupping curve (Reijnders 1978). Information on the distribution and number of harbour seals in the Wadden Sea was also collected during these flights, but additional flights proved indispensable to complete the information on animals hauled-out during the moult (August).
Surveys were carried out simultaneously in all regions, preferably when low-tide occurred

around mid-day, and weather conditions were suitable. Notwithstanding, in some cases conditions were such that in a region alternative days had to be found.

data processing

maximum number of seals

For each region the maximum number of seals counted was used as a minimum estimate for a specific year as it can be expected that some individuals are not hauled out and thus missed during the survey. The annual figure for the minimum estimate of the harbour seal population in the entire Wadden Sea, was derived from the sum of the minimum estimates of the regions.

reproductive rates

Accordingly, the reproductive rate for the separate regions is expressed as the percentage of the maximum number of pups observed per maximum total number of seals observed. For the entire Wadden Sea, the respective maximum numbers of pups are added and expressed as a percentage of the summed maxima for each region.

initial juvenile mortality

A method to estimate initial juvenile mortality in harbour seals is described in detail in Fransz & Reijnders (1978) and in Fransz (1979). In their recruitment model, the time from the first pup reported to the moment the maximum number of pups was observed (t_{max}) and the total length of the whelping period (l_r) were used to provide a first estimate of the juvenile mortality (M). Around this first estimate a series of different values for M were tried in the model to generate a curve with the best fit to the field data. It is emphasised that after approximately four weeks of age the pups are weaned and do not haul-out as frequently as during the lactation period. Furthermore, after about 4-5 weeks of age it becomes gradually difficult to distinguish pups from yearlings and therefore this age group was not counted separately any more. After six weeks of age, many pups leave the breeding area and might haul-out less frequently than before. Due to these factors, juvenile mortality could be overestimated if the basic model was run for a period extending four weeks after the start of the whelping season. The model was therefore modified, taking into account the potential bias in relating pups observed, to survival of pups. However, it becomes gradually complicated to quantify the possible error introduced and therefore the model was generally applied only for at most 7 weeks after the start of the whelping season. The observations on the abundance of pups in the course of the whelping season, carried out in the different regions of the Wadden Sea during 1989-1994, formed the basic material used in the recruitment model. Data for the entire Wadden Sea were obtained by using the pup-curves for each region. At a given Julian day, the number for each region was taken from the respective curve and added to provide the sum. The length of the whelping period for the entire Wadden Sea, was obtained by the ending date of the last starting whelping period in a region and that was compared with the date of the region where the whelping period started first.

RESULTS

population development

During the study period, from 1989 to 1994, a total of 237 aerial surveys were carried out

in the different regions of the Wadden Sea.
The annual maximum number of harbour seals counted in the Wadden Sea are shown in figure 1. The sum of the different regions indicates a minimum estimate of the actual size of the harbour seal population in the Wadden Sea. It is evident that the total numbers observed increased substantially since 1989. By 1994, a total of almost 9000 animals were reported, more than twice the number observed in 1989. The annual instantaneous rate of increase was on average 15%. The highest rate was observed among the stock in The Netherlands (18%), and the lowest in Denmark (12%).

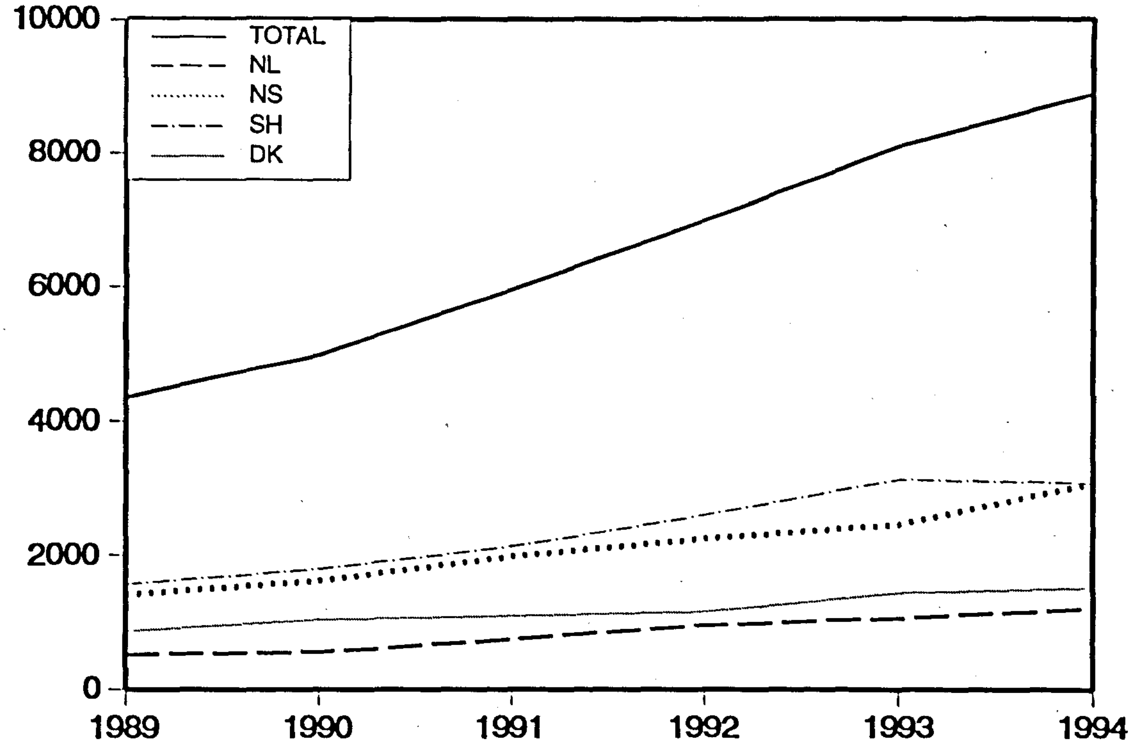

Figure 1: Annual maximum numbers of harbour seals registered in the different regions of the Wadden Sea.

reproductive rates

The reproductive rates, expressed as the ratio of the maximum numbers of pups counted per maximum number of seals (including pups) counted, are given for the different regions and the whole area in figure 2. Aside from the year 1988 where in some regions the epidemic had a direct effect on numbers born, the figures are approximately equal in all regions and fluctuate around 20%. The figures for Denmark are somewhat lower than in other regions.

initial juvenile mortality

For different reasons, logistics and inclement weather conditions, not all the surveys in each of the different regions provided each year adequate results to reliably run the recruitment model. Therefore it is decided to use, as an example, the best data set for each region for one given year. Those are: The Netherlands - 1993, Niedersachsen - 1992, Schleswig-

Holstein - 1994, Denmark - 1993.
These are complemented by data for the total Wadden Sea in the years 1993 and 1994. The results are shown in figure 3. The corresponding data on length of the whelping period, relative mortality and initial juvenile mortality are given in Table 1.

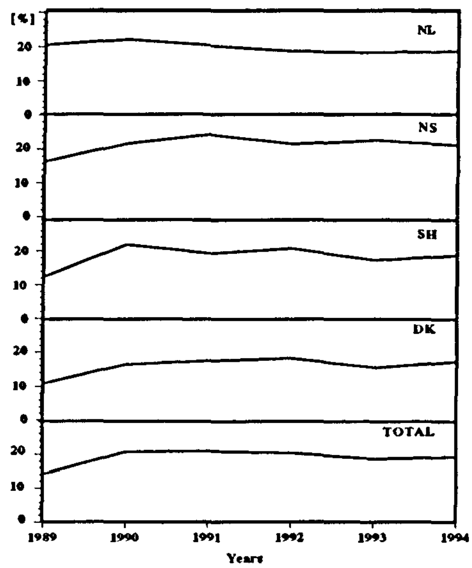

Figure 2: Percentage of pups from maximum numbers of harbour seals (including pups) in the different regions of the Wadden Sea.

Table 1. Length of whelping period (l_r); rel. mortality rates (M); initial juvenile mortality in the first seven weeks after the start of whelping (ΣM); in different years for the seal stocks in different regions and for the population in the entire area.

Area, year	l_r (days)	M (day^{-1})	ΣM (%)
NL 1993	37	0.022	33
NS 1992	35	0.024	36
SH 1994	37	0.020	31
DK 1993	34	0.024	37
Wadden Sea 1993	44	0.020	34
Wadden Sea 1994	44	0.020	34

DISCUSSION

population development

During the study period the maximum number of harbour seals observed in the Wadden Sea more than doubled, from initially 4400 in 1989 to 8882 in 1994. The annual instantaneous rate of increase was on average 15%. The highest rate was observed among the stock in The Netherlands (18%), and the lowest in Denmark, where it was 12%.

After the virus epidemic in 1988, which affected all European harbour seal populations, different annual rates of increase were observed: Heide-Jorgensen *et al.* 1992 reported in the Skagerrak / Kattegat ca. 8% and in the Wash the population increased only by a few percent annually.

Among the harbour seal population of the Wadden Sea, such a high rate of increase was not observed before. After a similarly low population status during the late 1970's, the entire population increased only at 9% per year, despite full protection from hunting (Reijnders *et al.* 1990). This increase was different in the several subpopulations, 12% in Denamrk (Tougaard 1989, Bøgebjerg *et al.* 1991), 8% in Schleswig-Holstein, 7% in Niedersachsen and 8% in The Netherlands.

reproductive rates

Before the epidemic substantial differences in reproductive rates were persistent among the different areas of the Wadden Sea, ranging from 12% in The Netherlands to 22% in Schleswig-Holstein. In recent years pup percentages are more close.

Especially in The Netherlands the reproductive rate is significantly higher than before. This holds, but to a lesser extent, also for Niedersachsen. An explanation might be that a selective mortality occurred during the epidemic. The data collected by the project participants on animals found dead during the epizootic, do for most regions not indicate a sex-specific mortality besides for Denamrk where 65% of all dead seals were males. Apart from a high mortality of the yearclass 1988, neither an agegroup-specific mortality is assumed as *e.g.* illustrated by Schwarz & Heidemann (1994). However, that does not preclude the possibility that amongst the adult females, the animals which died were predominantly those not reproducing due to impairment by pollution (Reijnders 1986). During the harbour seal epizootic in the North Sea, high mortalities were observed in the colonies in which pollutant levels were higher (Hall *et al.* 1992, Simmonds *et al.* 1993). Given these findings and the fact that pup production was too low in The Netherlands and in Niedersachsen and pupping and lactation are considered an important route to excrete contaminant residue levels, it is postulated that the epidemic might have been selective for nonbreeding adult females. This is supported by the observation that also an absolute improvement of pup production occurred. Even if the size of the largely killed yearclass 1988 is taken into account, more pups are born with the same number of animals in the post-epizootic years compared with the pre-epizootic period.

As the first yearclass was almost totally lost during the epidemic, the improved reproductive rate could be partly of an arithmetical nature since the denominator in the division is smaller than before. However, that contribution can only be marginal. Before the epidemic, the 1 year old animals would constitute 9-10% of the population and that missing compartment only brings pup production up by < 2%. The pup percentages are expected to level off within a few years because of gradual changes in the population structure, in particular an increase in the proportion of immature animals. When these ageclasses enter the reproductive segment of the population, pup percentages might either increase or decrease further, depending on the levels exposure of these animals to environmental pollutants causing reproductive failure.

initial juvenile mortality

The simulation model is based on the assumption that the births are normally distributed over the whelping season. The data points on the right side of the curves (the end of the whelping season) fit less accurately the curves than the data points in the left side (the beginning of the whelping season). This is due to the stronger influence of mortality and furthermore there is a larger possibility to underestimate the number of pups due to changes in haul-out behaviour and dispersal during the second part of the whelping period. However, the fit is considered good enough to conclude that the distribution of births is in agreement with the provision to follow a Gaussian frequency distribution. The recruitment curves are based on: 1) the assumption about normal distribution of whelping; 2) a limited set of available data points; 3) estimates for the length of the reproduction period.
Although the method is not particularly sensitive to small changes in the these parameters, it is emphasized that the outcome should be used tentatively.

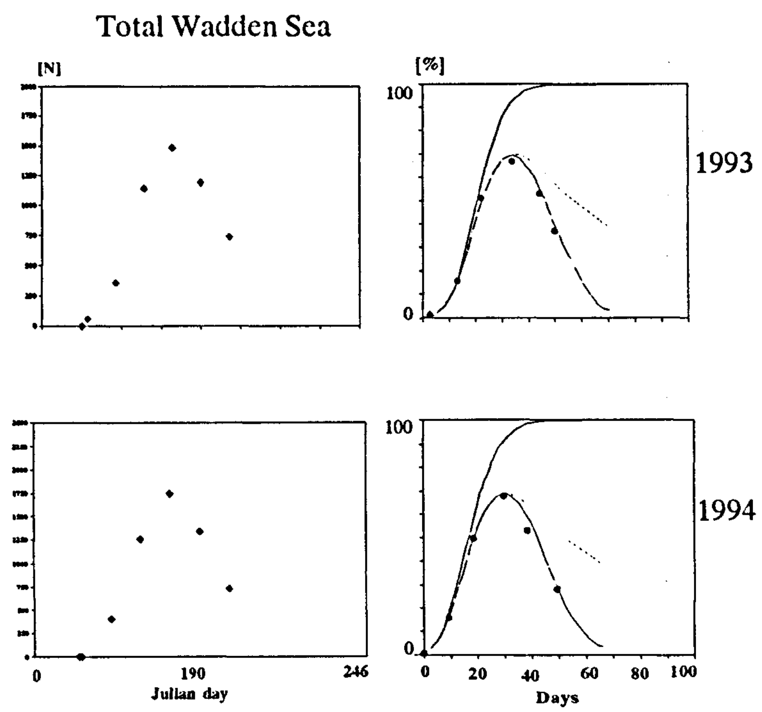

Figure 3: Number of pups counted during the aerial surveys (left hand diagrams) and recruitment curves based on the recruitment model calculations (right hand diagrams). Full line = number of pups born; dotted line = number of surviving pups; dashed line observable number of pups; * aerial survey data.

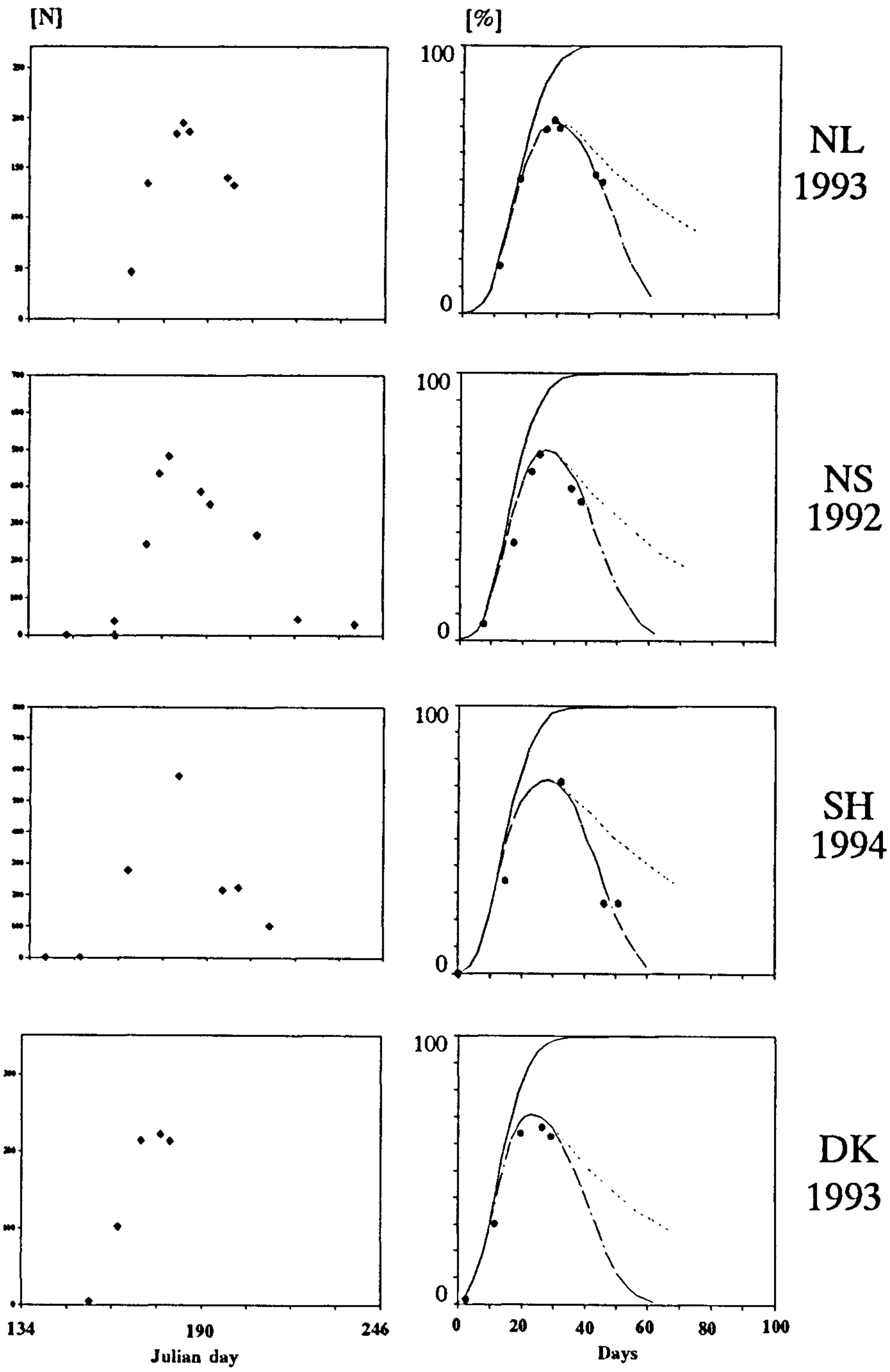

Figure 3: continued.

It appears that there is little variation in the mortality rates between the different areas as well as between each of the areas and the total Wadden Sea. On average, the initial juvenile mortality - up to 7 weeks after the start of the whelping season - amounts to approximately

34%. Given an unknown additional mortality during the rest of their first year, compared with data from other harbour seal populations presumably around 7%, it is assumed that the first year mortality in the harbour seal population in the Wadden Sea is around 40% nowadays. Drescher (1979) and Reijnders (1978) estimated first year mortality in the 1970s to be 55-60%. Dreschers calculations were not based on the recruitment model and he found a post-breeding first year mortality of around 20%. If the data from the 1970s are applied in the revised model, the initial juvenile mortality does not diverge from the present one. However, when the 20% post-breeding mortality is added, the overall first year mortality in the 1970s amounts to 55%. This does concur with Dreschers independently obtained figure. Reijnders (1978) probably underestimated post-breeding mortality. This implies that the present post-epizootic first year mortality is considerably lower compared with the 1970s. However, it is still higher than in other harbour seal populations. For the Swedish westcoast, Härkönen (1987) assumes 30-35%, Bigg (1969) quotes 25% for British Columbia and Boulva (1973) reports 25% for Sable Island (east Canada). It is possible that disturbance might contribute to the comparatively high mortality among harbour seals in the Wadden Sea (Drescher 1979; Reijnders *et al.* 1981; Vogel 1994; Brasseur & Reijnders 1994).

prospects

It is emphasized that the population is recovering well, however its present size (nearly 9000 in 1994) is still only one quarter of the estimated reference figure (Reijnders 1992). Whether it will continue to recover at its present rate will depend on the pressure of environmental conditions, such as pollution and disturbance, whilst an eventual recurrent flickering of the epidemic can not be excluded either.

REFERENCES

BIGG, M.A. 1969. The harbour seal in british Columbia. Fish. Res. Bd. Can. Bull. 172.

BOULVA, J. 1973. The harbour seal (Phoca vitulina concolor) in eastern Canada. Dalhousie Univ., Nat. Lib. Ottawa, Canada: 1-134 (thesis).

BØGEBJERG, E., S. TOUGAARD, J. MADSEN & N. NØRGAARD 1991. Status of the harbour seal *Phoca vitulina* in the Danish waters, 1976-1989, and short term effects of the epidemic in 1988. Dan. Rev. Game Biol. 14: 1-16.

BRASSEUR, S.M.J.M. & P.J.H. REIJNDERS, 1994. Invloed van diverse verstoringsbronnen op het gedrag en habitatgebruik van gewone zeehonden: consequenties voor de inrichting van het gebied. IBN-rapport 113.

COMMON WADDEN SEA SECRETARIAT, 1992. Sixth trilateral Governmental Wadden Sea Conference, 1991. Ministerial Declaration - Seal Conservation and Management Plan - Memorandum of Intend - Assessment Report. Wilhelmshaven. pp. 55.

DRESCHER, H.E. 1979. Biologie, Ökologie und Schutz der Seehunde im schleswig-holsteinischen Wattenmeer. Beitr. Wildbiol. Meldorf 1. 73 p.

FRANSZ, H.G. 1979. Estimation of birth rate and juvenile mortality from observed numbers of juveniles in a mammal population with normally dispersed reproduction. Ecol. Model. 7: 125-133.

FRANSZ, H.G. & P.J.H. REIJNDERS 1978. Estimation of birth rate and juvenile mortality from observed numbers of juveniles in a seal population with normally dispersed reproduction. ICES C.M 1978/n:7.

HÄRKÖNEN, T. 1987. Feeding ecology and population dynamics of the harbour seal (Phoca vitulina) in Kattegat-Skagerrak. Thesis Univ. Göteborg, Sweden.

HALL, A., R.J. LAWS, D.E. WELLS, J. HARWOOD, H. ROSS, S. KENNEDY, C.R. ALLCHIN, L.A. CAMPBELL & P.P. POMEROY 1992. Organochlorine levels in common seals (*Phoca vitulina*) which were victims and survivors of the 1988 distemper epizootic. Sci. tot. Environm. 115: 145-162.

HEIDE-JØRGENSEN, M.P., T. HÄRKÖNEN & P. ABERG 1992. Long-term effects of epizootic in harbor seals in the Kattegat-Skagerrak and adjacent areas. Ambio 21: 511-516.

REIJNDERS, P.J.H. 1978. Recruitment in the harbour seal (Phoca vitulina) population in the Dutch Wadden Sea. Neth. J. Sea Res. 12: 164-179.

REIJNDERS, P.J.H. 1986. Reproductive failure in common seals feeding on fish from polluted coastal waters. Nature 324: 456-457.

REIJNDERS, P.J.H., H.E. DRESCHER, J.L. VAN HAAFTEN, E. BØGEBJERG HANSEN & S. TOUGAARD 1981. Population dynamics of the harbour seal in the Wadden Sea. In: P.J.H. REIJNDERS & W.J. WOLFF (eds), Marine mammals of the Wadden Sea. Balkema, Rotterdam; 19-32.

REIJNDERS, P.J.H., E.H. RIES & I.M. TRAUT 1990. Robbenbestände. In: J.L. Lozán, W. Lenz, E. Rachor, B. Watermann & H. v. Westernhagen (eds), Warnsignale aus der Nordsee. Paul Parey, Berlin; 320-324.

REIJNDERS, P.J.H. 1992. Retrospective population analysis and related future management perspectives for the harbour seal Phoca vitulina in the Wadden Sea. Neth. Inst. Sea Res. Spec. Publ. Ser.20:193-197.

SIMMONDS, M., P. JOHNSTON & M.C. FRENCH 1993. Organochlorine and mercury contamination in UK seals. Vet. Rec. 20: 291-295.

SCHWARZ, J. & G. HEIDEMANN 1994. Zum Status der Bestände der Seehund- und Kegelrobbenpopulationen im Wattenmeer. In: J.L. Lozán, E. Rachor, K. Reise, H. v. Westernhagen & W. Lenz (eds); Warnsignale aus dem Wattenmeer. Blackwell Wissenschaftsverlag, GmbH, Berlin; 296-303.

TOUGAARD, S. 1989. Monitoring the seal (Phoca vitulina) in the Danish Wadden Sea. Helgol. Meeresunters. 43: 347-356.

VOGEL, S. 1994. Ausmaß und Auswirkungen von Störungen auf Seehunde. In J.L. Lozán,E. Rachor, K. Reise, H. v. Westernhagen & W. Lenz (eds); Warnsignale aus dem Wattenmeer. Blackwell Wissenschaftsverlag, GmbH, Berlin; 303-308.

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