Management of North Sea Harbour and Grey Seal Populations

Proceedings of the
International Symposium at
EcoMare, Texel, The Netherlands
November 29 - 30, 2002

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EcoMare

Editorial Foreword

(Photo: EcoMare)

In the framework of the Trilateral Wadden Sea Cooperation the conservation and management of the Wadden Sea harbour and grey seal populations are of high importance. With this publication the proceedings of the second International Symposium on Management of North Sea Seal Populations, which was organized by and took place at EcoMare on Texel, the Netherlands in November 2002, are presented.

Regarding seals, the year 2002 was a remarkable year; it was the first year of the new "Seal Management Plan 2002 - 2006", which was adopted by Denmark, Germany and the Netherlands at the Trilateral Governmental Wadden Sea Conference in Esbjerg in Denmark in 2001. This Management Plan is based on the Seal Agreement, which was concluded between the three Wadden Sea states in 1991. The current Seal Management Plan was drafted on the basis of an evaluation and assessment of the status of the harbour and grey seal populations in the Wadden Sea compiled by seal experts and representatives of the competent seal management authorities of the four Wadden Sea region in 2001. The report of the Trilateral Seal Expert Group including the current Seal Management Plan was already published in Wadden Sea Ecosystem No. 15 in 2002.

Secondly, 2002 was marked by the mass mortality of seals in Northwest Europe, which was caused by the second outbreak of the phocine distemper disease among seals 14 years after the first epidemic of the same disease in 1988. According to this incident, several contributions of the present issue are dealing with the epizootics 2002 and 1988 and possible consequences for the populations. Management polices for the harbour and grey seal populations as well as the role of research, information, education and seal rehabilitation were also discussed by the participants of the first International Symposium on the Management of Seal Populations, which also took place at the Wadden Sea and North Sea Center EcoMare on Texel in April 1996. The contributions of the first symposium were published in the Wadden Sea Newsletter 1996 - No. 2.

Bettina Reineking
Common Wadden Sea Secretariat
May 2003

K.-E. Heers

Contents

(Photo: K.-E. Heers)

Introduction to the International Symposium on Management of North Sea Harbour and Grey Seal Populations

Jan Kuiper, EcoMare, De Koog, Texel, NL & Jens A. Enemark, Common Wadden Sea Secretariat, Wilhelmshaven, FRG

Introduction

In 2002, it was 50 years ago that the first seal rehabilitation center in Europe started on the island of Texel in the Texel Museum, a museum on the natural history of the island and the predecessor what nowadays is EcoMare. On this occasion, it was decided to organize a meeting on the management of seal populations in the international Wadden Sea and the adjacent North Sea. In 1996, EcoMare organized the first symposium on the management of North Sea seal populations and in the meantime many things happened. Firstly, further scientific research on seals was performed, which was useful to communicate with a wider audience. Secondly, the last two Trilateral Wadden Sea Ministers Conferences in Stade (1997) and Esbjerg (2001) continued to discuss seal management so that in 2001 an updated Seal Management Plan "Conservation and Management Plan for the Wadden Sea Seal Population 2002 – 2006", in accordance with the Agreement on the Conservation of Seals in the Wadden Sea was adopted.

The 2002-year-symposium was partly sponsored by the Dutch Ministry of Agriculture, Nature Management and Fisheries.

The Current Trilateral Seal Management Plan

The Seal Management Plan (SMP) contains provisions on the protection of habitats, research and monitoring, taking and exemptions for taking and public information. Already in the SMP, which was adopted at the Leeuwarden Conference in 1994, the ministers reaffirmed that the rehabilitation and release of seals is not necessary from the biological and wildlife management point of view, and it was decided "to reduce the number of seals taken from and released to the Wadden Sea to the lowest level possible". In the current SMP 2002 – 2006, this strong reconfirmation is amended by the term "taking into account that ethical considerations, legislation, as well as management practices differ in the three countries. In Denmark (no rehabilitation at all) and Germany (see "Heulerrichtlinien"), state agency guidelines have been developed for handling seals that resulted in a reduction of the numbers of animals taken and released. In the Netherlands, a Scientific Seal Platform, installed by the Minister of Agriculture, Nature Management and Fisheries, studied the development of the seal population in the Netherlands and also paid attention to the question of seal rehabilitation. The Platform weighing the pros and cons

concluded that there could remain a role for seal rehabilitation in the Netherlands, but did not reach an unanimous conclusion on the intensity of these activities. Further discussion seemed useful, because the responsible authorities had to make a final decision on this topic.

PDV Epidemic

During the preparations of the symposium the second outbreak of the Phocine Distemper Virus (PDV) occurred. In May 2002, the first casualties were found on Anholt, the same Danish island where the first PDV epizootic in 1988 started. In June, the first dead seals were found in the Dutch Wadden Sea and afterwards PDV spread out along the coasts of the entire Wadden Sea and North Sea. First results of research of this second PDV outbreak were included in the symposium. The program was set up in close co-operation with Dr Peter Reijnders of Alterra, Texel. Also because of the PDV outbreak most attention was paid during the symposium to the harbour seal.

Results and Conclusions

Härkönen, Sweden, and Reijnders, the Netherlands, showed that the harbour seal populations after the 1st PDV outbreak had been very fit ones. Reproduction rates were higher than before, first-year mortality and overall mortality had dropped. A population increase at near maximum speed was the result. They expect that the 2002 PDV outbreak probably does not change this picture. Future population development depends on the frequency of possible future mass mortalities and also on the distribution of casualties over the population. Siebert, Germany, presented a valuable summary of all kind of diseases found in seals in Schleswig-Holstein during the last decades. Osterhaus, the Netherlands, went into more detail on the causes of the 2002 mortality and clearly showed that the PDV was the cause.

Fedak, United Kingdom, and Brasseur, the Netherlands, gave an overview of recent studies on the behavior of harbour and grey seals. Many seals had been followed by satellites and the studies showed how the seals behaved in relation to their feeding areas. Interference with fisheries and other activities at sea were discussed. Bosch, the Netherlands, discussed the trilateral and national policies behind the seal population management, as adopted by the different Wadden Sea countries and strongly promoted an open discussion between all stakeholders. This was also forced by Stafleu, the Netherlands, who gave a lecture on the ethical aspects of seal management including seal rehabilitation. He proposed to invite Bosch as a representative of the responsible authorities to take a decision in case the open discussion does not lead to an unanimous conclusion in all aspects.

These proceedings present the contributions of the different speakers during the symposium. The article of Jensen, Denmark, regarding the nature management debate was included to give a more complete view on the international discussion which is ongoing on the pros and cons of seal rehabilitation. Furthermore, an updated version of the article 'Phocine distemper epidemic amongst seals in 2002' by Reineking, which was published in the WSNL No. 2 in 2002, is completing the contributions.

As a result of the overall discussion at the end of the symposium, the following was stated; there was general agreement that the seal populations in the North Sea region developed very well during the last 14 years after the 1st PDV outbreak in 1988, which is in line with the TSEG-plus Report on Common and Grey Seals in the Wadden Sea, March/June 2001 (Wadden Sea Ecosystem No. 15 – 2002) as well as with the outcome of the Scientific Seal Platform in the Netherlands. Although the 2002 outbreak has resulted in huge numbers of dead seals (about 50% mortality is expected) the situation of the remaining seals is probably such that the populations will again increase rapidly to the old level. Seal rehabilitation to help the populations to survive is absolutely not necessary. Apart from a series of disadvantages, seal rehabilitation on a low level also has some advantages. The different ranking of these advantages and disadvantages by different stakeholders results in different standpoints ranging from a strong pro to a absolute contra. In the trilateral Seal Management Plan, adopted at the last Wadden Sea Ministers Conference (2001), the framework in which seal rehabilitation and other activities should be handled are given, which should be implemented by the national authorities of the three Wadden Sea countries.

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Development of Populations of Harbour Seals and Grey Seals in the Wadden Sea and the North Sea since 1988

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Abstract

The total number of grey seals (*Halichoerus grypus*) in the North Sea and the Wadden Sea amounts to about 62,000 animals. The mean rate of increase over the last 15 years was 6.5% per year. Decreasing trends are suggested in the main populations at the islands off the Scottish coast, while increasing numbers are noted further south. Counted numbers of harbour seals *(Phoca vitulina)* before the 2002 epizootic exceeded 57,000, which suggests a "true" number at about 88,000 animals in the year 2001. Growth rates of harbour seal populations varied both regionally and in time. Scottish stocks were declining at -4% to 0%, while the stock in the Wash, United Kingdom, was increasing at 5.8% per year. The growth rate in the Wadden Sea, the Skagerrak, and Kattegat populations decreased from initially 16% per year to 10% or less up to the year 2001. Perturbed age structures are strongly indicated in all populations. Recurrent epizootics will dramatically increase the risk of quasi-extinction of harbour seals, and the high rate of population increase between epizootics provides protection for reaching undesired low population levels.

Introduction

Since the 1988 epizootic, major efforts have been made in the North Sea area to monitor abundances and trends in populations of grey and harbour seals. The most common method to estimate numbers of grey seals is to count numbers of pups present at breeding sites and extrapolate to total numbers by multiplying with a factor between 4 and 5. A more precise estimate can be achieved if the age structure of the population is known. Another problem here is that the mean weaning time of pups is about 17 days, and the span of the breeding season is six weeks or more at most sites. Nevertheless, when surveys are carried out systematically, and at the same time of the pupping season at each locality, this type of data is valuable for analyses of population trends.

Surveys of harbour seals attempt to estimate total numbers of hauled out animals, either during the whelping season or the peak moulting season. Several independent studies have shown that counts during the moult encompass between 60% and 65% of the "true" population size. These counts have provided time series of data, which can be used to evaluate the population status in terms of fecundity, and age specific mortality rates. The main aims of this compilation is to discuss which type of information can be extracted from time series of seal counts, and to identify factors that confound analyses of trends. A related matter is how such data can be used for evaluations of the future development.

Abundance Estimates Prior to the 2002 Epizootic

Grey seals

The estimated total population of grey seals in the North Sea area amounted to about 62,000 up to the year 2001. The vast majority of grey seals are distributed in the UK, and especially at the Orkneys, Shetland, and the Isle of May. Grey seals are also found along the English east coast; Farne Islands, Donna Nook, Scorby Sands, and in Cornwall. The largest group of grey seals in continental Europe is found in the Dutch Wadden Sea, but they also occur in Normandy, Schleswig-Holstein, the Kattegat-Skagerrak and the Norwegian west coast.

The British stocks have been increasing at about 6.5 % per year over the past 15 years, while grey seals in the Netherlands have been increasing by more than 20% per year, a fact which is only possible with extensive immigration. Numbers in other North Sea areas have been stagnant or weakly increasing.

Harbour seals

The main concentrations of harbour seals in the North Sea area are in Scotland (the Shetlands, the Orkneys, the Moray Firth and the Firth of Forth), the Wash, the Wadden Sea (Fig. 1), the Kattegat, the Skagerrak, and the Norwegian west coast. Smaller populations occur in France, the Limfjord and the delta area in the Netherlands. Counted

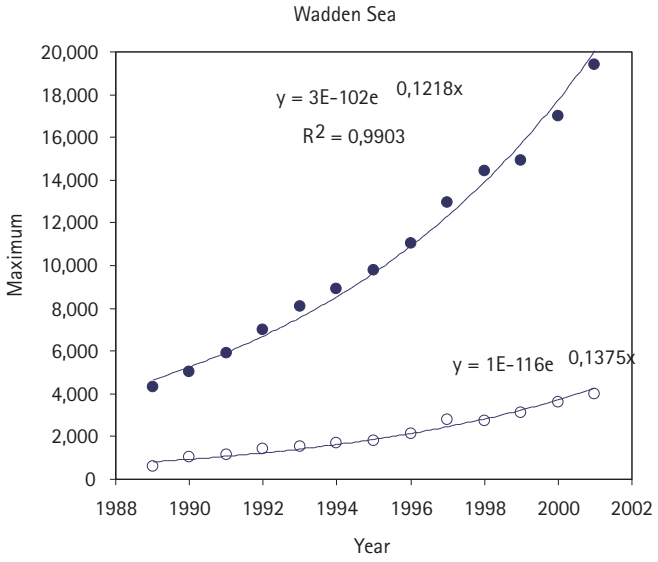

Figure 1:
Fitting the exponential growth model ($N_{t+1}=N_t*e^r$) to observed population counts of harbour seals in the Wadden Sea. (Data from the Common Wadden Sea Secretariat).

numbers in the years before the epizootic amounted to about 57,000, which corresponds to "true" total numbers at about 88,000.

Analyses of Trends

Counts of harbour seals have been made annually in most areas, and such counts have been used for analyses of trends. The most common method of trend analysis involves a linear fit to log-transformed data or the equivalent of fitting data to the exponential equation (Fig. 1): $N_{t+1}=N_t*e^r$, where N is the population size, t the time, and r the intrinsic rate of increase. The curve fit is based on the following basic assumptions:

- data are normally distributed,
- data are independent,
- all individuals are equal (no sex, no age),
- no spatial structure,
- no transient dynamics,
- populations far from carrying capacity.

We know that most of these assumptions are invalid for harbour seal populations after the 1988 epizootic. We shall in more detail explore the effects of transient dynamics in relation to trend estimates. The age structure of the surviving population in 1988 was estimated for the Kattegat and the Skagerrak populations, which were found to be severely perturbed (Fig. 2). Projections based on these age structures showed that the growth rates in these populations would fluctuate considerably over the first five years, after which more stable rates of increase were projected when the populations attained stable age structures. Effects of these transient dynamics on abundance estimates was considerably enhanced by the fact that different segments of the population haul out at different frequencies (Härkönen et al. 2002). Consequently, survey results of the hauled out population just after 1988 were strongly biased compared with the stable age distribution (Fig. 3).

One important prediction from this finding is that the rates of increase in populations affected

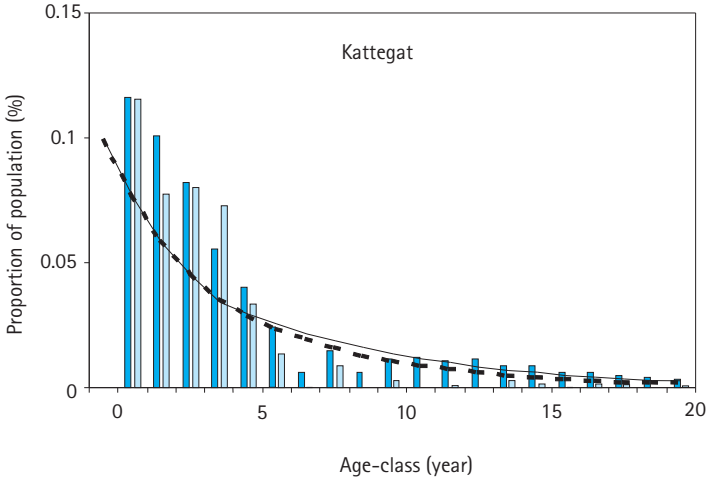

Figure 2:
Age structure of harbour seals in the Skagerrak and the Kattegat after the seal epizootic in 1988 compared with the stable age distribution. (Härkönen et al. 2002).

by the epizootic should show considerable variation; high rate of increase just after the epizootic, and considerably lower with time. Let us see what happened.

The Observed Rate of Increase in Populations of European Harbour Seals

By using a sliding window of seven years and fitting observed counts in the Skagerrak and the Kattegat to the exponential equation, it is found that the intrinsic rate of increase initially exceeded the mean growth rate in the Skagerrak, and that considerable fluctuations occurred in the Kattegat (Fig. 4). In the Skagerrak the intrinsic rate of increase during the first 7-year period was 0.17, compared with 0.12 in the last 7-year period.

Similar patterns are expected in other populations if the age structures were perturbed in a similar fashion as in the Skagerrak and the Kattegat. Using the same technique, we analyze the counted numbers of seals from the Wadden Sea in the period 1989 to 2001. Here two data sets are available i.e. total numbers hauled out during the moult, and numbers of counted pups. It is evident in both cases that the rate of increase is falling with time and show considerable variation (Fig. 5).

Mean Annual Rate of Increase after 1988 in the North Sea Area

The general pattern in the rate of increase in the North Sea area shows that decreasing or stationary populations are found in the north east. Populations in the Wash, the Limfjord and the Norwegian populations showed weak annual growth rates at 5% to 8%, whereas the populations along continental Europe increased at more than 10% per year.

The Maximum Rate of Increase in Seals

There is an 'upper ceiling' for the rate of population increase, that can be found by choosing all as large as possible parameter values in the life history matrix. In harbour seals this upper rate of increase is regulated by some specific physiological constraints. The trait of a single annual offspring gives one important limitation. A second factor limiting population growth is the age at first parturition.

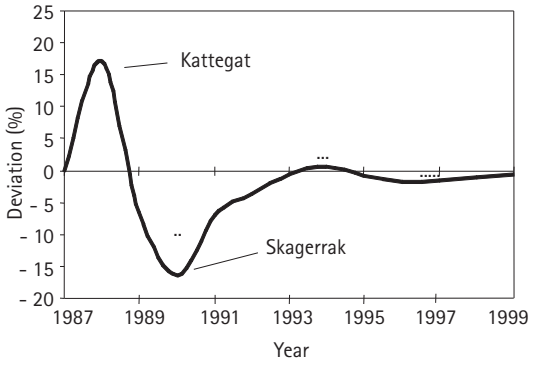

Figure 3: Surveys carried out before and after the epizootic in 1988 are not directly comparable, owing skewed post epizootic age structures, and the fact that different segments of the population haul out at different frequencies. Therefore, survey results first overestimated, and then under-estimated the actual population sizes as compared with the stable age structure. (Härkönen et al. 2002).

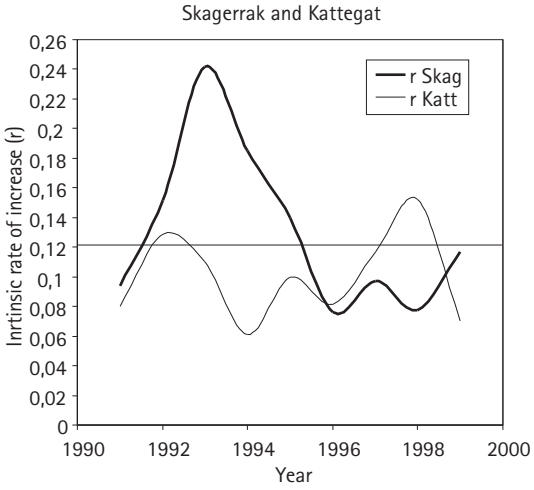

Figure 4: The observed rate of increase changed in the Skagerrak and the Kattegat in the period 1988–2001 as a consequence of transient dynamics of the age composition coupled with behavioral differences among population segments. The rate of increase was estimated by fitting the exponential model using a sliding window of seven years.

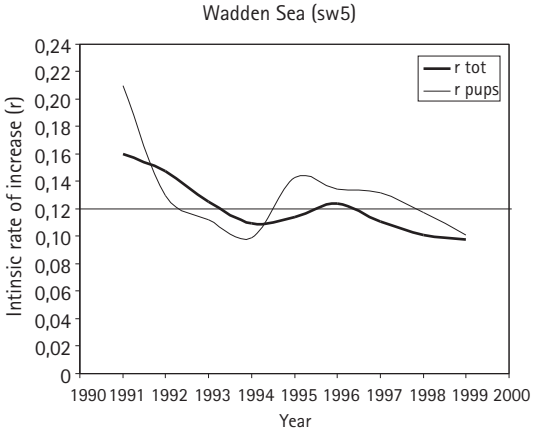

Figure 5: The observed rate of increased of harbour seals showed large variations in the Wadden Sea, and exceeded the maximum long-term rate of increase at 0.12 (13% per year), especially in the beginning of the time series. Thus, perturbed demography is strongly indicated also in the Wadden Sea. (Data from the Common Wadden Sea Secretariat).

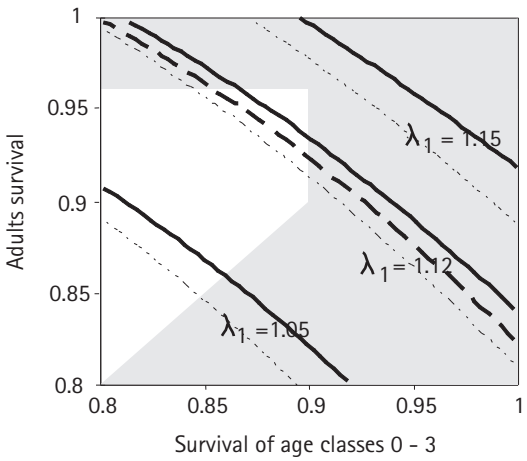

Figure 6: The maximum long-term rate of increase in harbour seal populations can be found by setting mortality and fecundity rates at their maximum values. Possible combinations of annual juvenile and adult survival and three realistic fertility rates (full bold line = 0.85, broken bold line = 0.90 and thin broken line = 0.95) for intrinsic growth rates ranging between 1.05 and 1.15. Since combinations in the shaded area are not probable, the intrinsic rate of increase is indicated to be below 1.13. i.e 13% per year. (Härkönen et al. 2002).

Using 4.0 years for the age at first parturition is on the 'safe side' for harbour seals, since reported values range between 4.6 and 5.5 years. The age at first parturition varies among populations, but also within the same population with time, which tends to increase the long-term mean age at maturity. In the models of population increase "fecundity" is referring to the proportion of the adult female segment that successfully gives birth to a pup. Abortions, resorbtions and senescence affect the mean fecundity rate, and all these factors will contribute to lower mean fertility rates of females to values considerably below 100%. Thus, although fertility rates of up to 96% have been reported, the long-term fertility rates are likely to be considerably lower, especially when we include females in age classes 4 and 5. Under the conditions out-lined above, the maximum annual capacity of increase in seal populations would be about 19% if both juvenile and adult survival rates were 100%. Realistic values of juvenile and adult survival rates reduce the maximum rate of increase to less than 13% per year (Fig. 6). Thus, in most seal populations with stable age structures the intrinsic rate of increase cannot exceed 1.13.

However, it is obvious from Figures 3 and 4 that short-term rates of increase can temporarily exceed this maximum long-term growth rate. Such fluctuations in the rate of increase are indicative of unstable population structures, but can also occur in populations affected by migrations. It is therefore important to note that using data on the observed rate of increase can lead to severe biases in further modellings.

Features indicative of unstable population structures are:

a) When the observed rates of increase exceed the upper maximum limit for the intrinsic rate of population increase as calculated from the life history matrix, where survival and fecundity rates are set at the highest possible values (Fig. 6).
b) When the observed growth rates deviate significantly from the intrinsic rates of increase, in other ways than exceeding the long-term maximum rate of increase, as calculated from high quality data on vital parameters from that specific population.
c) When increasing spatial resolution in the analysis reveals regional differences in population growth rates.
d) When observed rates of increase change with the start value in time series analyses (Figures 3 and 4).

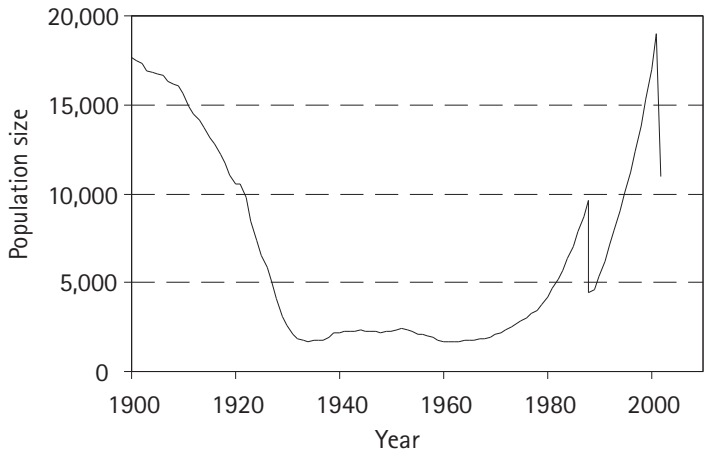

Figure 7: Estimated numbers of harbour seals in the Kattegat and the Skagerrak during the 20th century. It is obvious that the exponential phases comprise a minor proportion of the total time.

Long-term Consequences

Population analyses are often focused on the exponential phase (Fig. 1), but in a longer perspective, a number of factors will influence the realized rate of increase. Let us look at an illustrative example: Available data from the Kattegat and the Skagerrak shows that the harbours seals have had dramatic declines and peaks over the past century. Numbers of seals in the area amounted to about 17,500 in the beginning of the 20th century, after which intensive hunting resulted in a rapid decline to about 2000 seals. After hunting was prohibited in the 1960s and 1970s, the seal stocks showed exponential rates of increase until 1988, when 58% of the seals died. A new exponential phase occurred in the period 1989-2002, after which a new mass mortality resulted in a more than 50% decline. We also know that also within periods of seemingly exponential growth, the rate of increase will vary among years (Fig. 7)

One lesson from these observations is that a number of events will eventually affect the mean rate of increase, and that it is hazardous to use specific observed values of population parameters for evaluations and predictions of future developments. One way to handle this is to use the frame work of ecological risk analysis.

Estimating the Risk for Quasi-extinction

The probability that the population declines to a certain fraction of its initial size is called the quasi-extinction probability. The fraction can be chosen to any level, but can be set at e.g. 1%, 10% or 50%, depending on the scenarios that are interesting to explore from biological or ecological points of view. The analysis as such is based on the variation in growth rate of the population, which includes effects of intrinsic and environmental stochastisity, and the mean growth rate itself. Also the effects of catastrophic events can be included is such analyses.

At the observed epizootic mortality rate, the risk for quasi-extinction will increase with epizootic frequency (Fig. 8). At the observed frequency of 14 years, the risk of declines to 10% will increase from an insignificant risk at 0.0001 to a considerable risk at 0.18. Such a high risk is worrying, since most populations are spatially structured, which can lead to enhanced effects due to e.g. demographic stochastisity.

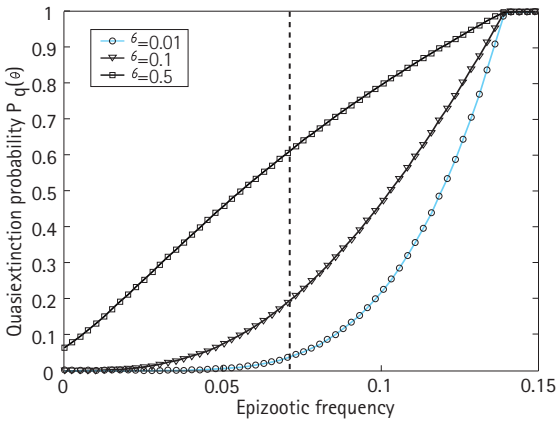

Figure 8:
The probability of quasi-extinction as a function of epizootic frequency, assuming a mortality rate at 58%. For the frequency of 0.07 (14 years) the risk for declines to 10% of initial size is increased from negligible levels to 0.18, which is a considerable risk for quasi extinction.

Conclusion

Detailed information about vital parameters are required to render more fine scale evaluations of population trends possible. However, some characteristics of unstable population structures, such as fluctuating rates of increase, or declines in the same parameter, can be used to identify unstable conditions. It could also be dangerous to use fixed data on vital parameters in evaluations of the status of populations, since these will change with time.

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Dead harbour seal
(Photo H.H. Dietz)

The Phocine Distemper Virus Outbreak of 2002 amongst Harbour Seals in the North Sea and Baltic Sea: Spatial and Temporal Development, and Predicted Population Consequences

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Introduction

An unusually high mortality amongst harbour seals started on Anholt in April/May 2002. This appeared to be the start of a virus epizootic caused by a phocine distemper virus (PDV), like in 1988 (Jensen et al. 2002). The epizootic spread in summer northwards and leaped to the western part of the Wadden Sea in mid-June, from where it spread eastwards throughout the Wadden Sea (Reineking 2002a). The first victims in the UK were found in mid-August in the Wash (SMRU 2002).

In the North Sea and Baltic Sea together at least 22,500 seals were found dead (Reineking 2002b). It is the intention of this paper to discuss the spreading of the disease in space and time, for the different areas in the North Sea, with additional reference to the duration of the epizootic. Furthermore, differences in mortality pattern, duration of the epizootic, and relative mortality will be specifically elaborated for the Kattegat/Skagerrak area and the entire Wadden Sea (Denmark, Schleswig-Holstein, Lower Saxony and the Netherlands). Finally, the possible population consequences of this renewed and perhaps to be expected future recurrent PDV-outbreaks will be addressed by modelling how harbour seal population growth in the Wadden Sea will be affected under different scenarios for mortality, probability of infection and frequency of occurrence. Emanating intriguing management questions and particular implications for future persistence of the population and related anticipatory conservation management will be addressed.

Spatial and Temporal Development of the Epizootic

The first unusual mortality amongst harbour seals was reported from Anholt (Danish Kattegat) on May 4th 2003. An overview of the spatial and temporal spreading is given in Figure 1. Details on the chronology of the first occurrence of unusual mortality have been given by Reineking (2002a).

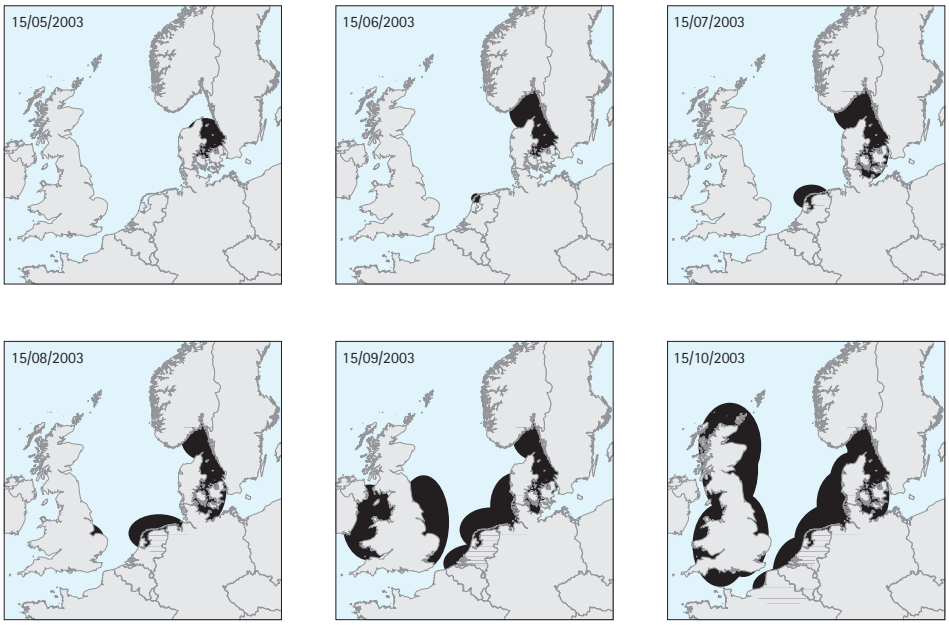

Figure 1:
Spatial and temporal spreading of the PDV epizootic amongst harbour seals in the Baltic and North Sea in 2002.

In the context of this paper it suffices to present the general pattern (in monthly intervals) and focus on the geographical spreading.

The disease spread rather quickly from the Danish Kattegat to the north. Within about a month, seal deaths were reported from nearly all sites in the Kattegat/Skagerrak area and the Oslofjord. Rather intriguing is the isolated observation of the first case (with confirmed PDV) in the Wadden Sea, notably in the western part of the Dutch Wadden Sea (Reineking 2002a). Such an isolated case is remarkable given our knowledge about dispersal patterns of harbour seals in the Wadden Sea (e.g. Nørgaard 1996) and assuming infected harbour seals are the vectors for the disease. An explanation may be provided by considering that another carrier has brought the disease to the Dutch Wadden Sea, either of anthropogenic or marine animal (e.g. grey seal) origin. Irrespective the origin, this pattern is in contrast with the pattern found in 1988, where the epizootic spread along the northern coast of Denmark into the Danish Wadden Sea. From the Wadden Sea onwards it arrived in different areas in the Wadden Sea, and the general pattern was rather a north-west and east-west spreading throughout this area. Striking is the observation that the population in the Limfjord was affected only on September 16th 2002. This indicates that this seal stock has little exchange with the Kattegat/Skagerrak colonies, at least not in the summer. The subsequent spreading of the disease after the Wadden Sea to the Wash and later on to Scotland, Wales, N-Ireland and the Republic of Ireland, as well as from the Wadden Sea to the Delta area (SW-Netherlands) and further on to the Belgium and French coastal waters, is rather similar to what was observed during the 1988 epizootic (Dietz et al. 1989).

Temporal and Spatial Pattern in Registered Seals Found Dead

It is obvious that the number of reported dead seals is strongly influenced by the timely accuracy and consistency of the reporting system over time, and moreover by environmental conditions. In the latter category is particular the wind, direction as well as force, of direct influence on the drift of the moribund and dead seals. The raw reporting data are therefore rather variable and to account for the largely unknown influence of the afore mentioned factors, the data have been transformed into 3-day moving averages. The moving averages of the daily number of seals found dead, expressed as a percentage of the estimated total population, are given for the Dutch, Lower Saxon, Schleswig-Holstein and Danish part of the Wadden Sea in Figure 2.

The influence of wind direction and force is e.g. demonstrated by the unlikely drop in animals found dead in the Netherlands, around September 1st, followed by an increase in the 3rd week of September. In the neighbouring area Lower Saxony, a similar pattern is seen though less dramatic. In addition the daily numbers of seals found

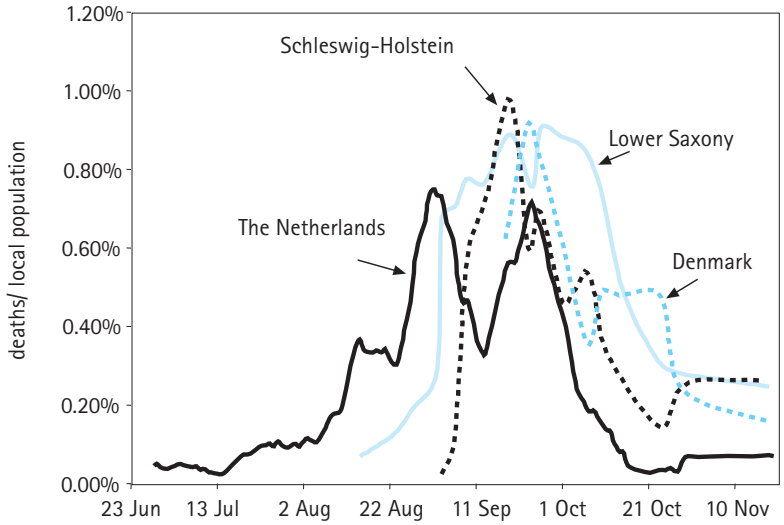

Figure 2:
Moving averages of the number of seals found dead in the Wadden Sea, expressed per local population size, for the Netherlands, Lower Saxony, Schleswig-Holstein and Denmark, from June until November 2002.

dead stayed high for a longer period compared to the other regions in the Wadden Sea. This could be explained by the prevailing, strong south-easterly winds during the first two weeks of September. These might have blown a large part of the drifting dead and moribund seals offshore. Changing winds (north-westerly) in the second half of September would blow the corpses back. In practice this means that dead seals were more likely to drift away from the Dutch/Lower Saxon Wadden Sea into the North Sea early in September, and that later in September the situation returned to former conditions. It is therefore postulated that a larger proportion of the animals found dead late September early October, actually died in the first half of September and drifted into the North Sea. Lower Saxony is the region that probably received dead seals from both the Netherlands and from Schleswig-Holstein and Denmark. This is supported by the finding that after such a period of offshore winds, the animals found dead were usually in a worse condition (longer time to death) than those found in earlier periods (M. Stede, pers. comm.), indicating they had drifted some time at sea before arriving at the coast and being collected.

The other conclusion drawn from the data in Figure. 2, is that the maximum percentage of daily deaths per total population, never exceeded 1%, and was rather equal amongst the four regions. This may indicate that no real outburst or strong pulses in mortality did occur.

Duration of the Epizootic and Severity of the Death Toll

Besides the question about the duration of the epizootic, it is in view of the future of the population, essential to assess how many animals in the population became victim of the epizootic. Both aspects, duration of the epizootic and extent of mortality, have been investigated by expressing the numbers of animals found dead over time, as a percentage of the local population size. The patterns have been synchronised by taking the start of the epizootic in each region as day zero. To address these questions of time span and severity on a more European scale, a comparison with the findings in the Kattegat/Skagerrak area have been incorporated. By the time these analyses were carried out, the epizootic still continued in England, Scotland and Ireland and virtually only stopped around mid-December (SMRU 2003). Those data could therefore not be included here. The transformed data on seals found dead (percentage of the population) are given in Figure 3 for the Wadden Sea and the Kattegat/Skagerrak area. It can be deduced that the duration of the epizootic differs between the Kattegat/Skagerrak plus Netherlands and Lower Saxony, Schleswig-Holstein and Denmark. For the entire Wadden Sea, the Netherlands and Kattegat/Skagerrak it lasted about 130 days, for Schleswig-Holstein and Denmark around 70 days, whereas Lower Saxony lies

in between with around 105 days. Under the assumption that in the third and fourth quartile of September a considerable portion of the animals from Schleswig-Holstein and Denmark (and to a lesser degree from the Netherlands) may have ended up in Lower Saxony, it may be possible that this event has lead to some extension of the duration in Lower Saxony and in turn a reduction in Schleswig-Holstein and Denmark. Even in case this supposition is correct, the afore mentioned considerable difference in duration of the epizootic between the Netherlands and Kattegat/Skagerrak versus Schleswig-Holstein, Denmark and Lower Saxony would still exist.

The other notable aspect visible in Figure 3 is the differences in rate of increase in % found dead in the respective regions. Again Kattegat/Skagerrak and the Netherlands are similar, but different from both Schleswig-Holstein and Denmark, being similar as well, and Lower Saxony is again somewhat in between. These differences could be explained by the time the disease arrived and the numbers of vectors carrying on the disease by infecting conspecifics. As elaborated in an earlier section of this paper, the first observation of dead seals and victim of the PDV, in the Wadden Sea was in the Netherlands and from there it spread to Lower Saxony, and arrived rather late in Schleswig-Holstein and Denmark. The infection in the Netherlands can actually be considered as a point source. By the time the disease arrived in Lower Saxony, there were more vectors (infected seals) that entered different colonies in Lower Saxony, creating different focal infections thereby enhancing the spread (speed) of infection in that region. Subsequently, an even larger source of vectors reached the (more) different colonies in Schleswig-Holstein and Denmark, leading to even more focal infections and a quicker spread of the disease throughout the entire populations in those regions. The fact that the rate of contact among individuals determines the level of exposure to the virus (Kennedy 1990), corroborates this hypothesis. Possible differences in herd size between the different regions does not play a role here because this proved to have had hardly any effect on the cause of the 1988-epizootic (Heide-Jørgensen & Härkönen 1992) and furthermore, by the time the epizootic started in Schleswig-Holstein and Denmark, the number of seals hauled-out were lower compared to the summer period (Drescher 1979, Tougaard 1990). This change in behaviour counteracts the rate of contacts between individuals. The number of animals found dead and expressed per total population varies from just below 30% in Schleswig-Holstein and Denmark, to just 40% in Lower Saxony. In the other areas (Kattegat/Skagerrak, the Netherlands as well as the entire Wadden Sea) this amounted to approximately 35%. As mentioned before, the percentage for Lower Saxony may be artificially increased respectively reduced for Schleswig-Holstein and Denmark. It is therefore justified to conclude that in most areas the numbers of seals found dead and reported, amounted to around one-third of the respective populations increase.

It is complicated to assess the actual number of seals that died and hence what portion of the population fell victim to the PDV-epizootic. Modelling (Harding et al. 2002) and surveys late au-

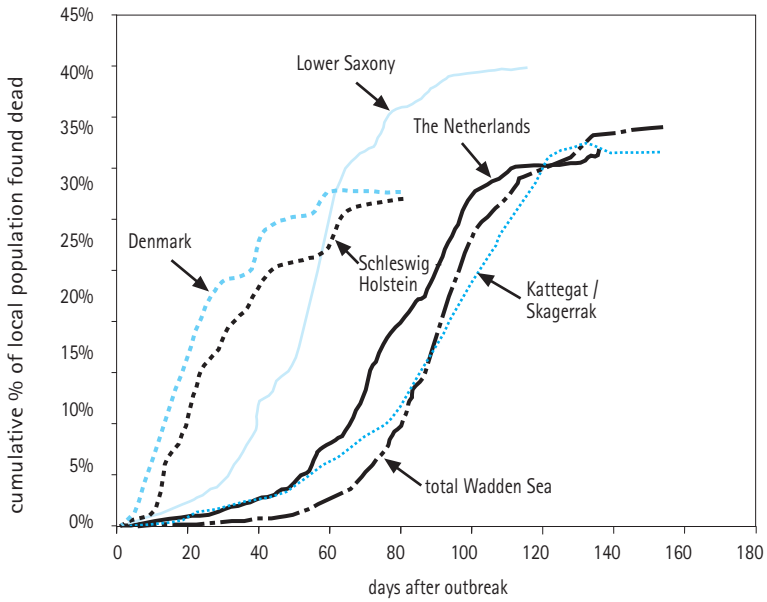

Figure 3:
Cumulative number of seals found dead, expressed as a percentage of the local population, since the start of the epizootic in the Netherlands, Lower Saxony, Schleswig-Holstein, Denmark, the entire Wadden Sea, and the Kattegat/Skagerrak area in 2002.

tumn in Kattegat/Skagerrak area (T. Härkönen pers. comm.) revealed that around 53% of the population in those areas had died because of the disease. For the Wadden Sea, our preliminary modelling shows that this percentage ranges from 48-52%. Aerial surveys in 2003 will bring the required data to enable more conclusive remarks about the actual impact. Nevertheless it can be prudently concluded that the epizootic in 2002 was slightly less severe (5-7% probably lower) compared to the 1988 epizootic. Assuming that the survivors of the 1988 epizootic were all immune, it has been calculated that this difference maybe largely attributed to the number of those survivors still alive in 2002.

Consequences for the Wadden Sea Population on Longer Term

To assess the longer term consequences of the 2002 epizootic on the harbour seal populations in the Wadden Sea, we modelled the population development for the next 35 years. Two scenarios are distinguished: a scenario where no recurrent PDV-epizootic would occur and a scenario where recurrent epizootics with different cycle length would occur. These calculations on population development are not meant to predict exactly the actual development, they are rather used to demonstrate the magnitude of effect on the populations when different scenarios would be operative.

The modelling is based on the population parameters obtained over the past years since the last epizootic (Reijnders et al. 1997, Reijnders & Brasseur 2003, Reijnders et al. 2003) and it is assumed that the combination of parameters found in the period 1990-2002 are also valid for the period of our calculations. The epidemiological modelling is based on the method used by Grenfell et al. (1992) and Heide-Jørgensen & Härkönen (1992), whereby the specific parameters for the Wadden Sea population (population size, mortality due to the epizootic, intrinsic growth rate, *per capita* birth rate, *per capita* death rate) as elaborated in Reijnders & Brasseur (2003) have been applied.

Population development has been calculated for scenarios where the epizootic cycle length would be respectively two, seven and 14 years, and a scenario where no epizootic would occur. The results are shown in Figure 4a-d. The cycle of two years has been chosen because it was calculated that only after this point of time a new epizootic could theoretically happen. The period of 14 years being a representation of the period between the last two epizootics, and seven years is the mid-value thereof.

Figure 4a shows a rapid recovery of the population to its pre-epizootic level of around 27,000 seals and a level of approximately 70,000 would be reached in 35 years. Under the two-year cycle (Fig. 4b), the epizootic would finally damp out and the population will slightly decrease and amount to approximately 15,000 animals in 2038. The 7-

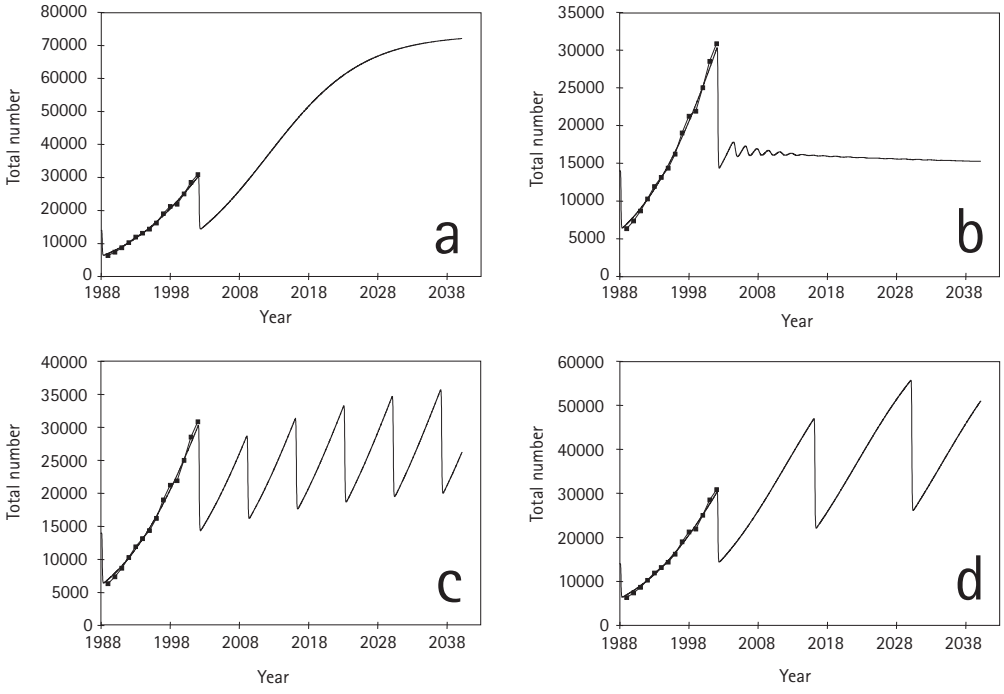

Figure 4: Modelled developments of the population of harbour seals in the entire Wadden Sea: from 1989-2001 based on actual counts (black squares), the epizootic in 2002, and from 2002 onwards under different scenarios for recurrency of PDV-epizootics. Fig.4a: with no epizootic after 2002, fig. 4b-d: with an epizootic cycle length of respectively 2, 7 and 14 years.

year cycle (Fig. 4c) would result in an overall slight increase and the 14-year cycle (Fig. 4d) would result in a stronger overall increase.

It is emphasised that all the shown population developments, with the exception of the two-year cycle, can only be realised if our estimates about density dependent regulation are correct. These are based on the estimated disease free equilibrium of the population (see Grenfell et al. 1992), on the growth rates observed between 1990 and 2001 (Reijnders & Brasseur 2003), and subject to the assumptions that the *Allee Effect* (Emlen 1984) will hold here as well. Taking into account the scientific debate (Murray 1994, Sinclair & Pech 1994, Morris 1996) on density dependence in e.g. time and space, related to environmental stochasticity, compensatory processes, we still continue further modelling to obtain the range of confidence intervals around the estimated carrying capacity given the variance in the data used under the afore mentioned assumptions.

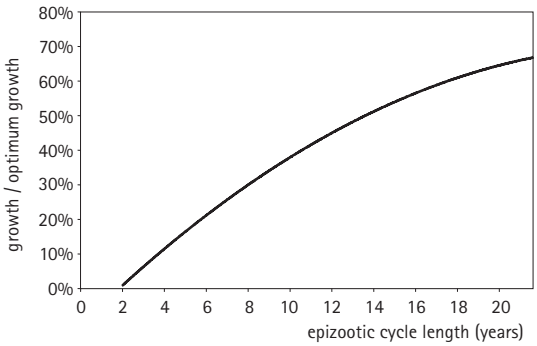

Figure 5: Modelled net growth expressed as percentage of growth if no epizootic would occur, in relation to epizootic cycle length.

Irrespective of the exact final population size reached after 35 years, it is obvious that under the assumed scenarios different net, long-term population growth rates will be achieved. The implication of these differences are analysed by expressing the net growth rate found under a given scenario, as a percentage of the growth rate when no new epizootic would occur. The results for scenarios ranging from 2-20 years are given in Figure 5. The conclusion from this figure is that under all the tested scenarios the net growth rate would be considerably below the value reached if no epizootic would occur. If the interval of 14 years between the last two epizootics is taken, the net population growth would have been around half of what it would have been without a new epizootic.

The relevant question in this respect is, what the chances are for recurring epizootics. It is suggested that infectious diseases of wildlife will emerge in the future (Daszak et al. 2000), including in the marine environment (Harvell et al. 1999). These are brought about by both climatic changes as well as anthropogenic factors, including (un)intentional global transport of species and inherent pathogenic commensals. This observation, the elegant study by Harding et al. 2002 who expressed the consequences of PDV-epizootics amongst the harbour seal population in the Kattegat/Skagerrak in terms of an increased quasi-extinction risk, and our results on the reduced growth rate in the Wadden Sea harbour seal population caused by recurrent epizootics, have large consequences for future management of those populations. In designing management plans for harbour seals in both the Wadden Sea and the Baltic Sea, it has to be taken into account that these populations are subject to unexpected and timely unpredictable events such as epizootics. Any other factor that reduces population growth *viz.* size - e.g. hunting, culling or resource limitation - will put the population now at a higher risk (such as extinction, inbreeding) than hitherto assumed on the basis of predicting the impact of a single intervention.

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Harbour seals
(Photo: Svend Tougaard)

Habitat Use of Harbour Seals in Relation to Recreation, Fisheries, and Large Infra-structural Works

Sophie M.J.M. Brasseur, Alterra, Texel, NL & Mike Fedak, NERC Sea Mammal Research Unit, St. Andrews, UK

Technological advances have lead to a rapid growth in the information available about the distribution and behavior of seals, both on land and at sea. This information is necessary to understand their interactions with the environment and human activities, but it is far from sufficient to establish which features of their areas of activity are important or how changes to these (whether natural or anthropogenic) will affect them. For this, we need to learn more about the environment they utilize. We also need to develop the analytical means to integrate the diverse information on environmental conditions and disturbance with the information we have on distribution and behavior and to combine these into models that allow rigorous testing of relationships and will allow us to make predictions about the consequences of changes.

Here we present an overview of the currently available information about seal movements and behavior in the Dutch North Sea and relate this to what (little) we know about the places seals go to undergo the various stages in their life history and how they react to disturbance. Harbour seals haul out to rest, moult and suckle their young on tidal sandbanks. They mate in waters around these locations but may feed far (>100 km) from their haul outs, often diving to near the seabed. The immediate effects of disturbance at haul out sites are relatively easy to monitor; not so the effects at sea. The population consequences of such disturbance are even more difficult to assess and the amassed effects of disturbance on land and at sea are virtually unknown. Furthermore, we know almost nothing about the extent to which populations can accommodate to such disturbances. Our talk will make all to clear how much more we need to know to convincingly establish the potential consequence of human exploitation of marine resources on marine mammals.

In the Dutch waters, Alterra has carried out research on the relation between habitat use of harbour seals on the one hand and recreation, constructions in the sea and fisheries on the other. The basic question in these projects is how the interaction affects the seals' in terms of (spatial) resources and finally the consequences for the population. As we are only beginning to understand the seals' habitat use, only a few resources can be identified. Of these, haul out sites, providing space to rest, give birth and suckle, are probably the only resource which has extensively been identified and analyzed (examples: Härkönen et al. 1999; Brasseur et al. 1996, Watts 1992, 1996).

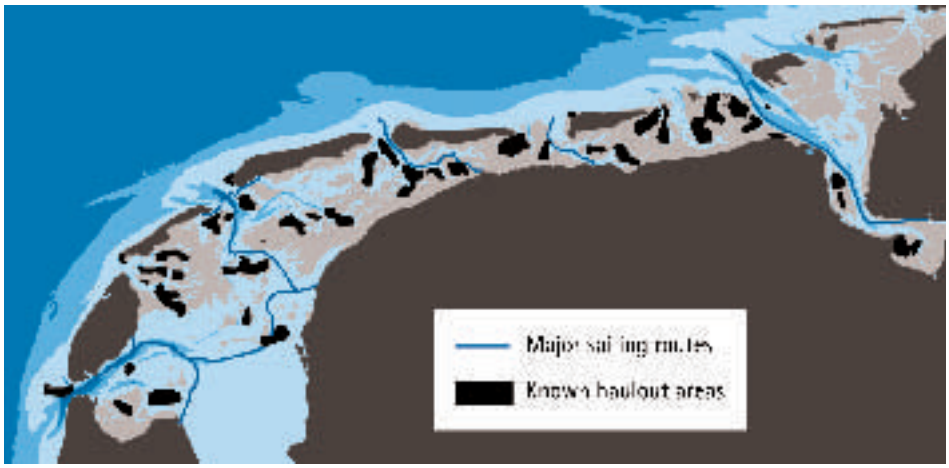

Figure 1:
Distribution of haul out areas in the Dutch Wadden Sea; major sailing routes.

Even there, many questions remain unanswered. The other main resource, which can be identified, is foraging area. Furthermore, as the seals mate underwater it is probable that specific areas are needed for mating. Routes of migration between the different areas could also be considered as a resource which can be affected by human activity.

The main problem in the research on the interaction between human activity and seals' habitat use is the difficulty to measure in the correct spatial and temporal scale.

Human Activity, Haul Out and Disturbance

In the Netherlands, seals mostly haul out quite predictably during low tide, as most of the haul out sites are then available. Harbour seal haul out sites are scattered throughout the Wadden Sea (Brasseur & Reijnders 1995; Fig. 1). However, not all seals haul out at once. Most of all the need for the individual seal to haul out plays a role. Furthermore, both spatial and local environmental factors influence this. For example, local geographical differences cause a variation in the availability of haul out sites, weather, both temperature and precipitation influences the seals' willingness to get out of the water. On top of this, seasonal patterns in the seal's biology have a strong influence on the seals drive to haul out; mothers and their pups using the tidal haul outs simply have to haul out every low tide to suckle, though it still remains unclear why, seals haul out more frequently during moult in late summer.

Additionally, human activity can affect haul out by, for example, disturbing the sites. In spring and fall of 1992, distances were measured at which the seals would react and subsequently flush as a result of an approaching disturbance source (Brasseur & Reijnders 1994). An experiment was designed to test the effect of sources which were frequently used in the Dutch Wadden Sea area. Five different sources were tested: pedestrians, canoes, rubber dinghies, sailing yachts and motor boats. After the disturbance had left the recovery (seals coming back on the sand) was timed.

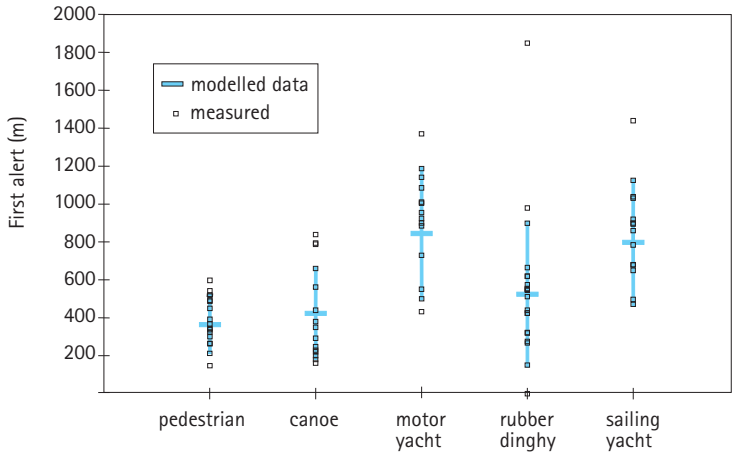

Figure 2:
Distances at which seals first react as a result of approaching human disturbance sources. (Brasseur & Reijnders 1994).

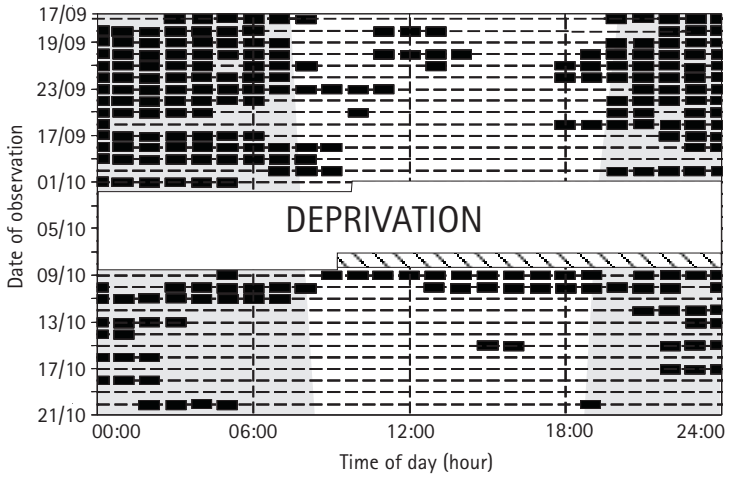

Figure 3:
Daily haul out pattern of three seals in captivity; effect of a seven day deprivation of haul out possibilities. Black blocks: at least one animal hauled out (Basseur et al. 1996).

Typically large noisy sources resulted in a reaction at larger distances (Fig. 2). This occasionally exceeded one km. These differences were also seen for flushing distances. Recovery however, was better for the fast sources, though none of the sources realized more than 20% of the seals came back within one tide.

Though flushing into the water does not seem to be a problem for these aquatic animals, there are indications that the seals have drawbacks from this kind of disturbance. This is certainly detrimental for seal pups that are limited to suckle during low tide. Such a disturbance can cause them to miss a whole tide, thus 50% of their daily portion. As the seals are weaned after less than four weeks, several disturbances can easily affect their weaning mass and thus their survival probability. Even adult seals have been proven to need to haul out (Brasseur et al 1996). When deprived, the seals would compensate by hauling out more afterwards (Fig. 3). These arguments were enough to justify protection of hauled out seals throughout the Dutch Wadden Sea area and in the southern Delta area. Distances measured in the experiment were used to determine the size of the protected areas.

Around Haul Outs

Haul out sites are important, however time spent on the sandbanks only represents part of the time in a seal's life. Seals are not limited to their haul out sites; the water around these sites can be of great importance, even during high tide when haul out sites are not in use. This was demonstrated in the Delta area in the southern Netherlands. There, a strong debate was raised as to keeping an area around seal haul outs closed for public, or opening it to pass through during high tide, when seals are not seen.

An experimental season was organized, sailing through during high tide in the summer of 2000 (Reijnders et al. 2000, Brasseur & Reijnders 2001). Both during the experiment and before and after seals were tagged with satellite tags to observe their habitat use. During the experiment the tagged seals showed a 50% reduction of the use of the area compared to the seals in other years (Fig. 4). As a result it was chosen not to reopen the area to the public.

Effect on the Population

As shown above, it is possible to demonstrate that seals change their behavior as a result of human presence; however, connecting this to consequences for the population still proves to be very

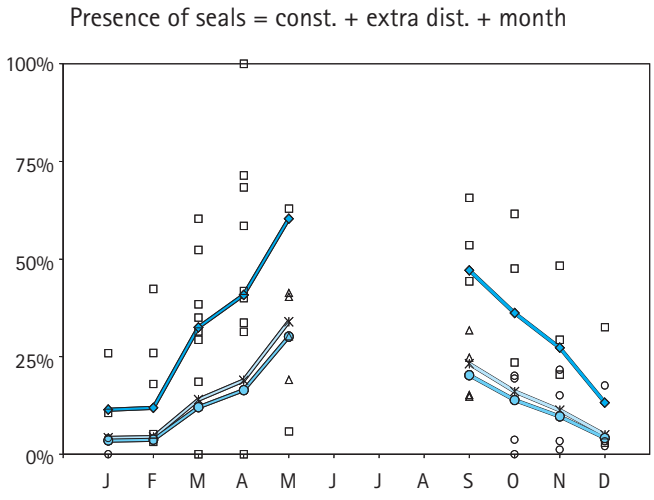

Figure 4:
Percentage of tagged seals present in the Oliegeul Area (Southern Netherlands). Before, during and after change of human use.

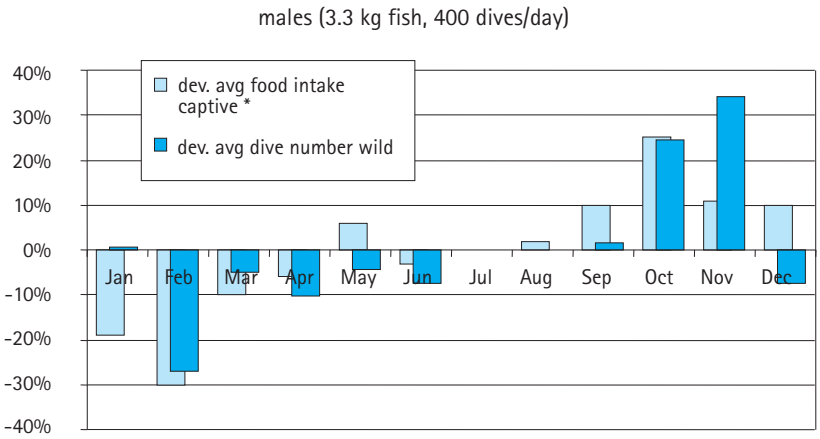

Figure 5: Comparison of seasonal variation in food intake of a male seal in captivity to male diving frequency in the wild (data Kastelein; R. v.d. Zwaag; Brasseur & Reijnders pers. comm.).

complex. We do have indications, for example: One could argue that the relatively high youth mortality observed in the Wadden Sea (˜35% vs. ˜25% elders) is an indication for the fact that the disturbance level is still quite high (P.J.H. Reijnders pers. comm.).

A more direct connection could be demonstrated when for example disturbance would have consequences for the food intake of the animals, thus their survival. This is a difficult measure in the field as the seals are seldom seen, let alone seen feeding. However, telemetry techniques might be of some help. In an effort to demonstrate such effects, monthly variation in food intake in captivity (Kastelein 1998; R. van der Zwaag pers. comm.) is shown beside dive effort in wild animals (Fig. 4). The latter was measured with satellite linked dive recorders, SDR's. Seals seem to show more (deep) dives in periods where more food is needed (Sept-Nov) whilst in the early spring and summer less dives than average are carried out, corresponding to a reduced need for food.

Going back to the experimental opening of the area in the Dutch Delta, the number of dives/day in a situation without disturbance, during the disturbance and after the disturbance was compared. These data suggest that there is more diving activity during and after the experiment, than before. This would indicate that there are energetic consequences to the disturbance and seals have to feed more to compensate for this change in human activity in the area. However, this is only a tentative to demonstrate such an effect and more data is needed to test the actual effects of such a disturbance. Let alone to relate this to survival of the animals.

Beyond Haul Out, Management Consequences

Despite recapture of tagged seals hundreds of km away from their tagging sites (Wipper 1975), and

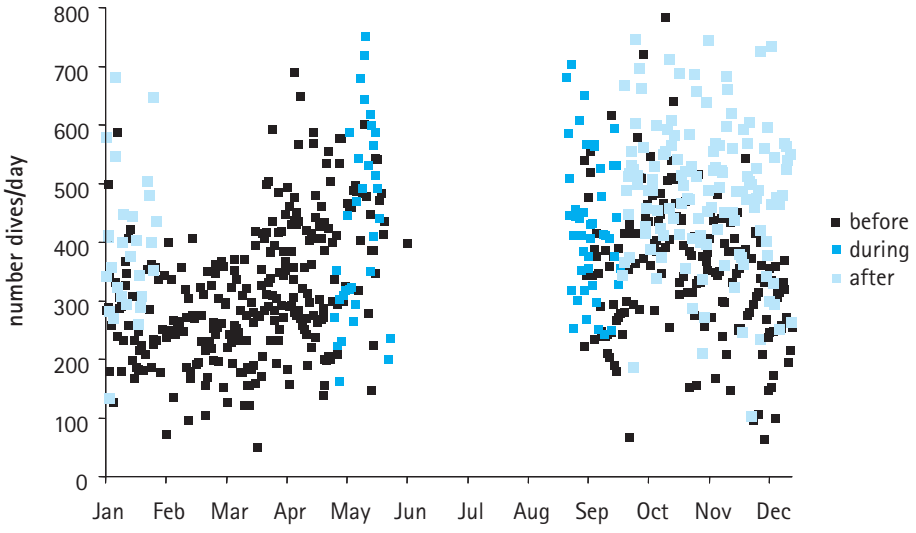

Figure 6: Number of daily dives in relation to disturbance.

in lack of more detailed information, the general view until the early 1980's was that the harbour seals were quite sedentary having a home range of some tens of kilometers at the most. Short range VHF telemetry in the 1980's and 1990's did somewhat "enlarge" the knowledge on the size of the seals' range but was often limited to the reach of the land based reception. Seals often swam out of range, and following the seals at sea was a difficult task. Only a few studies showed that this species regularly ranged over larger distances (Thompson 1993, Nørgaard et al. 1992). Consequently, the management of the seal populations, even now, is generally based on the seals' haul out sites and at the most a small area around it.

Some of the most exciting results of satellite based telemetry are that the harbour seals' range is much larger than previously thought. Ranges in some cases are only slightly smaller than those seen in grey seals (Brasseur & Reijnders 2001, Reijnders et al 2000, Brasseur & Reijnders unpublished data). As the tags are equipped with sensors and data loggers, which enable us to determine, to a certain extent, dive depths and dive frequencies, it is also possible to create a general image of the behavior of the animals at large. However, it is still too coarse to determine if the animals are for example feeding in the area or not. On top of that, relatively small sample sizes and large individual differences in behavior blur the insight to detect a general pattern. In the near future models on the seals' distribution based on the telemetry data are needed. It is still to be seen whether the available information on the environment including depth, sediment type and other abiotic factors is detailed enough to create an image of the habitat the seals use at sea. If so, the challenge of determining the critical (feeding)habitat of the seals, to ultimately determine overlap with fishery, is only of value if adequate data on the seals' prey is present.

Finally, in light of enormous changes expected in the use of the North Sea, such as large-scale wind farms and artificial islands, the most difficult challenge will be to find a way to measure and predict effects of human activity at sea on the seal populations.

Figure 7:
Plot of locations of seals tagged with satellite tags.

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Monitoring the Health Status of Harbour Seals: Pathological Investigations before and during the PDV-virus Outbreak

Ursula Siebert, FTZ Büsum, FRG

Abstract

A health monitoring program for seals was established for Schleswig-Holstein, Germany, as consequence of the first PDV-seal-die-off. The investigations showed that the health status of the seal population in Schleswig-Holstein has been improving since the first seal die-off in 1988/89. No unusual findings were seen at necropsies or medical examinations prior to the second epizootic. But throughout the systematic monitoring investigations it was known that the seal population became naive for PDV. The monitoring program in Schleswig-Holstein is an important instrument to evaluate the health status of the seal population.

Introduction

The Schleswig-Holstein Wadden Sea in Germany was littered with seal carcasses during the first seal die-off in 1988/89. Therefore, a health monitoring program for seals was established for Schleswig-Holstein that was based on three pillars: investigations on dead seals, investigations on seals captured alive, and investigations on seals rehabilitated at the Seal Station Friedrichskoog.

Methods

The investigations on dead seals includes a full necropsy, histology, bacteriology, mycology, parasitology, virology, serology and age determination. On a sporadic basis, toxicological investigations, analyses for toxic algae, genetic investigations, an examination of the stomach content and of the reproduction status are performed. In addition samples are taken for different research programs, museums etc.

Seals captured alive at sand banks and seals from the seal station are weight and measured. Sex, estimated age and blubber thickness are recorded. Blood is taken for blood status and chemistry, serology, hormone profiles, and toxicology. Bacteriological, mycological, parasitological, cytology and virological investigations are performed. Furthermore samples for immunological investigations and stress research are preserved.

Results and Discussion

Pathological findings

The pathological findings after the first seal die-off in 1988/89 included frequently large skin wounds, infection of the umbilicus with associated septicemia, reduced fitness and a high percentage of serologically PDV-positive animals.

The majority of pathological lesions was found in the respiratory tract consisting of pulmonary edema, emphysema and congestion, and parasitic infestation with associated bronchopneumonia (Fig. 1). The type of bronchopneumonia varied from catarrhal to granulomatous and necrotizing depending on the species of bacteria that caused the secondary infections. Yearlings were most commonly affected by bronchopneumonia. In contrast to findings in harbour porpoises (Siebert et al. 2001), bronchopneumonia is often associated with severe interstitial emphysema. The parasitic infestation and associated lesions were milder in older seals (Lehnert 2001).

Parasitic infestation of the digestive tract by nematodes, acantocephalans or cestodes was frequently found but mainly associated with only mild lesions. In a few cases older animals showed se-

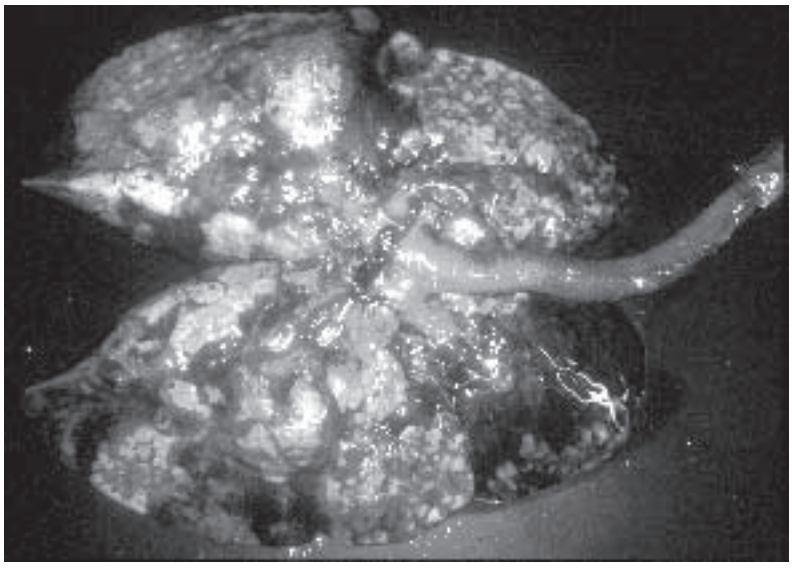

Figure 1: Parasitic infestation with associated bronchopneumonia in the respiratory tract of a harbour seal.

vere hemorrhagic enteritis due to *Clostridium perfringens* infection resulting in intestinal displacement.

Common pathological findings in newborns included marked emaciation, purulent dermatitis, skin wounds and septicemia. Infection of the umbilicus and polyarthritis were seen less frequently in recent years.

Occasional findings were dystocia with fetuses up to 14 kg in weight, severe bacterial infection of the eye or severe dermatitis due to foreign bodies such as nets, plastic rings etc.

The pathological findings during the first months of 2002 did not change compared to other years before the second seal die-off. The general impression of the population was that it appeared to be in a good health status. This conclusion was also supported by the clinical examination of seals that were captured alive.

Bacteriology

Several potentially pathogenic bacteria have been isolated from organs and swabs originating from dead and living seals in the past. *Clostridium perfringens* and *Escherichia coli* are commonly associated with enteritis and septicemia. *Staphylococcus aureus* and Streptococci cause frequently bronchopneumonia, abscessation, dermatitis and septicemia. The pathogenic potential of *Erysipelothrix rhusiopathiae* for seals remains undetermined.

Streptococci were further identified and characterized (Vossen 2002). Based on culture, biochemical, serological and also molecular tests, the bacterial cultures were identified frequently as Streptococci phocae. DNA-„fingerprints" showed an obvious distinction of isolates from the North and Baltic Sea, but a partial equality between isolates from seals and harbour porpoises from the North Sea. The occurrence of both animal species in the same habitat might have caused a transmission of the group L-streptococci (Vossen 2002).

First results of bacteriological investigations of the seals of the PDV-epizootic indicate that *Bordetella bronchiseptica* was found for the first time during the monitoring activities and was frequently present in different organs. Also more animals seemed to suffer from a septicemia due β-hemolytic Streptococci.

A total of 38 *Brucella* strains were isolated in organs of 21 out of 193 investigated seals. They were predominantly isolated from the lung. A further characterization of the Brucella-strains was performed using phaentypic properties. To determine whether brucellae might be more widely distributed among the harbour seal population of the German North Sea, serum samples from 234 free ranging harbour seals were screened using a standard serological technique. 37 serum samples turned out to be positive resulting in a seroprevalence of 15,8% percent. In certain cases, titers as high as 1:2.560 and 1: 10.240 were recorded.

The number of positive Brucella results provides strong evidence of an infection in the German North Sea. However, although the isolation of Brucella species from different marine mammal species and the serological data suggests that Brucella infection may be present in a wide range of marine mammals, the significance of the presence of Brucella species in marine mammals is unknown. *Brucella maris* is pathogenic for humans but no serious sickness occurs. Nevertheless, the health implication of this potential zoonotic infection should be taken into account by all those involved in marine mammal research or rehabilitation.

Parasitology

Several species of parasites were isolated from the investigated animals, including cestodes, nematodes, acanthocephalans and ectoparasites (Anaplura). Nearly 50% of the investigated seals in 2002 were tested PDV-positive. No difference in parasitic infestation between PDV-positive and –negative animals was noted. This suggests that the health status of seals infected with morbillivirus is deteriorating very fast so that there is no time for an increased infestation with lung nematodes prior to death. The comparison of parasitic infection in animals from previous years proves difficult, because – in contrast to the last years – the majority of the investigated animals consisted of adult seals.

Virology

Parapoxvirus

In 2000, Parapoxvirus induced lesions were the first time seen in Schleswig-Holstein. They were found in the rehabilitated pups at the seal station. The disease outbreak was characterized by lesions of the skin and mucosa of the oral cavity (Fig. 2). Using electron microscopy typical parapoxvirus particles were observed. The presence of parapoxvirus was confirmed by PCR (Polymerase-Chain-Reaction-method) and nucleotide sequencing. The results of our analysis provide evidence for inclusion of the seal parapoxvirus as member of a separate species within the genus *Parapoxvirus*. This year during the seals epizootic, the first potential case in a wild harbour seal was found on the coast of the Baltic Sea (Becher et al. 2002).

Morbillivirus

Morphological, immunohistological and serological results obtained from seals investigated during previous years did not reveal any evidence of a morbillivirus infection in the seal population in Schleswig-Holstein. Antibody-titers were constantly decreasing resulting in a highly susceptible seal population.

In August 2002, the PDV-epizootic reached Schleswig-Holstein. About 3,600 animals were found dead but probably more were drifting ashore due to strong east winds during September and October. Seals of different gender and age were examined using histologic, immunohistologic and molecular techniques Pathomorphologically, an interstitial and purulent pneumonia associated with a marked alveolar edema and emphysema were seen. Lymphoid tissues exhibited lymphocytic depletion and viral inclusion bodies were detected in cells of various organs including lung, liver, intestine and brain. Immunohistochemistry using a cross-reactive monoclonal antibody against canine distemper virus revealed a systemic spread of morbillivirus antigen to different tissues. Nucleotide comparison by PCR revealed a homology of more than 97% with the strain isolated in 1988.

Conclusions

In summary, it appeared that the health status of the seal population in Schleswig-Holstein had been improving since the first seal die-off in 1988/89. This may be partly due to less antropogenic disturbances since the National Park Schleswig-Holstein Wadden Sea was established.

Unusual findings that may have warned of an up-coming second epizootic were not seen during necropsies or medical examinations prior to the outbreak. The animals showed a degree of lesions that was considered "normal" for wild animals and were mainly in a good nutritional state. However, by systematically monitoring the population, it was obvious that the seal population became naive for PDV based on decreasing PDV-specific antibody titers. The pattern of pathological findings during the die-off changed due to PDV and different age class mortality.

The monitoring program in Schleswig-Holstein is an important instrument to evaluate the health status of the seal population. Nevertheless it is important to improve and re-evaluate the monitored parameters by continuous research programs.

Due to the established stranding network and support from different agencies it was possible to manage the high number of carcasses in Schleswig-Holstein without risk for the public. The previous investigations allowed to recognize the outbreak fairly early and to judge the health status and the cause of death quickly. From the scientific point of view the monitoring program will be extremely interesting in the coming years in order to understand how the population recovers after the second seal die-off.

Figure 2:
The Parapoxvirus induced lesions of the skin and mucosa of the oral cavity of harbour seals.

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Re-emergence of Phocine Distemper in the Harbour Seal Population of Western Europe

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In 1988, about 18,000 harbour seals (*Phoca vitulina*) in northern Europe died during an outbreak of an infection with phocine distemper virus (PDV), a newly-discovered morbillivirus (Osterhaus & Vedder 1988; Cosby et al. 1988). Clinical signs in affected seals were observed mainly in the respiratory and nervous systems. Because of the immunosuppressive nature of phocine distemper, secondary infections with a variety of viruses and bacteria occurred. This phenomenon obscured the primary cause of the epidemic, and delayed its initial diagnosis (Heide-Jørgensen et al. 1992).

Phocine distemper virus is closely related to, and needs to be distinguished from, canine distemper virus (CDV), which is an important infectious disease of domestic dogs and a variety of other carnivores. It is known that CDV can be transmitted from dogs to seals, resulting in high mortality. For example, we were involved in the diagnosis of CDV infection as the cause of increased mortality of Caspian seals (*Phoca caspica*) in the Caspian Sea. In spring 2000, over 10,000 Caspian seals were estimated to have died along the Kazakhstan coast alone. The primary cause of this die-off was CDV, based on virologic and pathologic analyses. A possible source of this infection was terrestrial carnivores, e.g., feral dogs or wolves (Kennedy et al. 2000).

In addition to PDV, several other viruses have been isolated due to examination of seals through the stranding network of SRRC Pieterburen: seal herpesvirus type 1 infection was found as a cause of pup mortality and respiratory disease (Osterhaus et al. 1985); seal herpesvirus type 2 infection was found in absence of clinical disease (Harder et al. 1996); seal parapoxvirus and seal orthopoxvirus infections were found in seals with pox (Osterhaus et al. 1990, 1994); and influenza B virus infection was found in possible association with respiratory disease (Osterhaus et al. 2000). Such virus infections are important not only for seals under rehabilitation, but also for the free-living population.

Following the 1988 phocine distemper epidemic, the northern harbour seal population grew rapidly. In the Wadden Sea, for example, estimated numbers increased from around 4,000 in 1989 to 17,000 in 2000 (Tougaard et al. 2000). However, starting in May 2002, unusually high mortality was observed on Anholt, an island on the east coast of Denmark, and in Sweden. By the second half of June, sick or dead seals with clinical signs reminiscent of phocine distemper were found on the coast of the Netherlands. These signs included respiratory distress, subcutaneous emphysema, nasal and ocular discharge, fever, diarrhoea, and nervous signs. Together with colleagues from Denmark, we performed necropsies on seven of these seals, and examined tissue samples for the presence of morbillivirus nucleic acid by RT-PCR. The samples from four animals were positive, and phylogenetic analysis of the PCR products showed that seals from the Netherlands and Denmark were infected by the same virus, which closely matched (>97% homology) those of PDV isolates from 1988. In addition, serum samples from three seals had IgM antibody to morbillivirus, indicating recent infection. Together, these findings indicated that PDV infection was the cause of the ongoing harbour seal mortality in northern Europe (Jensen et al. 2002).

Since then, the infection spread to the Wadden Sea, the Baltic Sea, and the coast of the United Kingdom, with more than 21,000 harbour seals recorded dead by the end of October (Reineking, 2002). In the Netherlands, we have continued to collect and examine seal carcasses, relying mainly on the stranding network of the SRRC. Of a total of 59 seals examined so far, 63% had pulmonary consolidation and emphysema, consistent with phocine distemper. Histologically, the main lesions were broncho-interstitial pneumonia and lymphoid depletion. Evidence of current or recent morbillivirus infection was confirmed by RT-PCR (22% positive), morbillivirus-specific IgM (34% positive), and morbillivirus-specific IgG (59% positive). The most common secondary bacterial infection was *Bordetella bronchiseptica*, which was found in 50% of seals examined.

In the near future, we are planning to examine over 1,100 seals collected along the coast of the Netherlands during the 2002 epidemic. The main

research goals are to investigate the source of the virus, the epidemiology of the outbreak, the contribution of anthropogenic factors, infection risks for humans and animals, and other factors that affect the habitat of seals. The organisations participating in this necropsy session and related research projects include the SRRC Pieterburen, Erasmus MC Rotterdam, Ehime University (Japan), University of Groningen, ID Lelystad, RIVM Bilthoven, Dutch Wildlife Health Centre Utrecht, University of Valencia (Spain), University of Aberdeen (Scotland), University of Utrecht, Wageningen University, Danish Veterinary Institute (Denmark), and the Royal Veterinary Institute Copenhagen (Denmark).

In conclusion, our studies show that:

- PDV infection has re-emerged in the harbour seal population of Northern Europe after absence of 14 years;
- the PDV of 2002 is genetically similar to that of 1988;
- comparison of PDV between the Netherlands and Denmark indicates that seals from widely separated areas are infected by the same virus;
- results of postmortem examination indicate that PDV infection is the primary cause of ongoing harbour seal mortality in Northern Europe.

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Harbour seals on a sandbank (Photo: Svend Tourgaard).

Seal Management Policies Around the Entire Wadden Sea

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Policy in General

A quotation, which is often heard is: "Is this policy, ... or did they think about it?"

Many people think about development of policy in the following sequence:

1. science,
2. political advice,
3. political power,
4. regulation.

This is, however, not a very applicable effective sequence. Lots of scientists/experts dealing with seals are present at this symposium, but there is no scientist on policy here today. If you are interested in the subject of effective policy, I recommend an interesting book by Professor Van Dinten "With a sense for reality".

Van Dinten states that giving meaning to policy problems along the mentioned sequence (analysing scientifically followed by using political power) is internally oriented. Also a public campaign is an internally oriented regulation measure.

The internal line leads from rationalisation and convincing to power and construction. A symposium like this is an example of the rationalisation and convincing part of this line.

According to van Dinten the internal approach is complementary to the externally oriented approach. Externally oriented approaches give meaning to what social groups value. It is important that social groups recognize a problem as urgent. A social group might not feel the urgency for regulation by the government. The external approach also means that ethical and cultural values are taken seriously. It should be the ambition of the policy maker that the policy process guides the energy of social groups, to contribute to the policy. If the policy maker forgets the external approach, he will encounter lots of unnecessary resistance or total failure of the policy.

Trilateral Seal Management

Regarding seal management in the Wadden Sea, Denmark, Germany and the Netherlands have been cooperating for more than 20 years.

The main goal of the seal policy is the protection of the seal population. In the nineties a trilateral Seal Management Plan, according to Article IV of the Agreement on the Conservation of Seals in the Wadden Sea, which entered into force in 1991, was established, containing several provisions and actions regarding:

- legal protection of the seals itself,
- habitat protection: e.g. closed areas for resting and raising of pubs, and

- generally stricter policies on water pollution,
- research and monitoring,
- public information to raise public awareness, and
- taking and exemptions of taking, e.g. reduce number of taking and releasing seals.

This was a rather successful policy, if you look at the provisions taken, the fulfilment of the actions in the different countries, and of course, the development of the seal population itself. Only in the Netherlands, the rehabilitation of seals was not reduced. How could the policy on seal management (except for the last bullet) be successful? In my judgement, it was successful because it was in line with the external values that social groups gave to the seal. Thanks to these joint external values, rather strict measures, like closing large areas for the public, could be carried out.

The seal became the ambassador of the entire Wadden Sea. In the Netherlands, the rehabilitation centres EcoMare and Pieterburen played a very important role for the last decades in creating this ambassador function. In almost every school, the pupils hear lectures on seals by their fellow schoolmates. These lectures were, and still are, mainly based upon information of the rehabilitation centres. So the public, including schoolchildren, is informed very broadly on the value of nature protection in general, the threats to the seals in particular, but also on the seal rehabilitation itself.

In Germany and Denmark, information and educational programs are given e.g. by the governments, targeting children and the public, in general and inform about conservation and management of seals as living resources and a natural asset. The programs are focussing on the habitat requirements of seals, human behaviour in seal areas, what to do when a dead or weakened seal is found, as well as the trilateral cooperation on the protection of seals. Rehabilitation is mentioned as an exception from the general management guidelines in order to satisfy human needs to nurse and help individual animals, which has nothing to do with wildlife management in general. Therefore, in Denmark, the rehabilitation of seals stopped in 1995.

Seal Rehabilitation in the Netherlands

Why the policy on reduction of numbers of rehabilitated seals was not very successful in the Netherlands? As a matter of fact, an eye catcher in the public discussion in the Netherlands is the rehabilitation, which should be diminished. It has to do with the origin of the external value for the support of the seal protection. The driving force is the rehabilitation itself, which could flourish so well because it was combined with human tendency for caring for individual animals. This tendency is a typical Dutch cultural phenomenon, which is much broader than taking care of seals. People, who find seals and bring them to Pieterburen can be seen as a social group with their own ethical values, which fit into a general Dutch cultural pattern. It concerns deep emotional values if you regard the decision: should a diseased or weakened seal live or should it die. It is difficult to guide this energy to support a reduction of the rehabilitation, but a start has been made.

In the Netherlands, a seal platform was established in 2000, in which Dutch experts and also representatives of rehabilitation centres participate. Although differences remained, the platform resulted in joint conclusions, also on rehabilitation. For as far as I am concerned, we will continue to utilise the energy of the rehabilitation centres to support the overall policy. Rehabilitation centres should fulfil an important role in this context, but with respect to rehabilitation we are not that far yet.

Trilateral Policy in 2001

The trilateral seal management was revised during the last Governmental Wadden Sea Conference in Esbjerg in 2001 by adopting the Conservation and Management of the Wadden Sea Seal Population 2002 – 2006, in short "Seal Management Plan, SMP". The main line was continued. The cooperation proved it's value also during the Phocine Distemper Virus (PDV) disease in 2002, which resulted in the mortality of roughly halve of the seals.

Interesting in the revised Seal Management Plan, is an addition with respect to diminishing the rehabilitation rate" ...taking into account ethical considerations...". This addition is valuable and necessary, because the cultural and ethical values in the Netherlands are different from the Danish and German values, particularly with respect to the drive for caring for individual animals. With respect to rehabilitation, before 2001, the trilateral policy did not take sufficiently into account the external values, which social groups give to the policy in the Netherlands.

So, international policy can be very effective, but it can also be splitting if you ignore the fact that those external values vary from country to country. In Esbjerg 2001, this was taken into account for the future.

Conclusions

1. Policy is more than science and using political power. External factors such as ethical and cultural values are essential for solid policies.
2. The trilateral seal management was pretty successful, also because it was in line with the external values.
3. The reduction of rehabilitation in the Netherlands was not very successful because it was not in line with the external values among social groups.
4. Trilateral policy on seal management is now aware of ethical and cultural differences, in particular in the case of seal rehabilitation.

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The Public Debate in the Netherlands – The Ethics of Seal Population Management

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Abstract

In the Netherlands, seals that are lost or ill are sometimes rescued and taken into shelters (also called: seal stations, rehabilitation centers) where they are cured and afterwards reintroduced into their natural environment. Recently, this practice has been criticized because it is thought to interfere with the wildness of the animals and the population. The moral assumptions behind the arguments of both the proponents and opponents of sheltering are analyzed within a morally pluralistic framework. It is concluded that sheltering on a too large scale would be contrary to the efforts of the last few decades to maintain an independent or wild seal population, which means that a certain amount of caution is called for. However, in the current situation there is no decisive reason to completely prohibit shelters either. Good arguments can even be given in favor of sheltering. It also becomes clear that the acceptability of sheltering seals depends on the specific circumstances in which an animal is encountered.

Introduction

In the Netherlands, there are many initiatives by civilians to help needy animals from the wild. One way of helping is to temporarily take animals to so-called shelters, where they are cured and afterwards reintroduced into their natural habitats. There are licensed shelters for all sorts of wild animals in the Netherlands but in this paper, we concentrate on this 'seal debate'. Our purpose is to analyze the moral dimensions of this sheltering practice. Is it acceptable, from a moral point of view, to take seals out of their natural habitat and bring them under human control, even if it is only temporarily? And if we deem it acceptable, does this also mean that we even have a duty to do so?

The Seal Debate

The first seal rehabilitation center in the Netherlands (and probably in Europe) was established on Texel in 1952. In 1971, a second center was founded in Pieterburen. The seals and the Wadden Sea have come to be regarded as inextricably linked and seals have now become the 'face' of this nature area. (The seal shelters greatly expanded in the 1970s, when the seal population was rapidly declining due to water pollution). During the first decades of seal rehabilitation seals were not returned to their natural habitat since hunting was still not prohibited. From the early 70s onwards, ill or injured seals, but also pups that are lost, are taken into shelters, where they are cured or raised and afterwards they are returned into their natural habitat. Presently, shelters also serve an educational function; research is done into the causes of the illness and the public is informed about the seals and the Wadden Sea ecosystem. The motivation for founding the seal shelters was twofold: on the one hand the founders of the shelters were moved by the plight of the suffering animals and on the other hand increasing the awareness of the declining situation of the seals was of importance. In the 70s another argument was also that every seal that was rescued, contributed to the preservation of the seal population.

Over the years the situation has changed, however. The seal population is no longer endangered; it seems to be thriving and can even survive the recent serious epidemic of Phocine Distemper Virus. It appears that while the two motivations for sheltering seals - saving the population and helping the individual seal - used to reinforce each other, this is no longer the case. In other words, while the interests of individual seals and their population used to coincide, they now seem diametrically opposed. This has caused critics to call for closing down the seal shelters. They argue that the Wadden Sea is perhaps the only bit of wild nature left (at least in the Netherlands) and that we should interfere with it as little as possible. Moreover, they point out that risks are involved in sheltering seals and returning them to the wild. Viruses could be transmitted through the shelter and introduced into the wild population. Another risk is that of unintended genetic selection: the population could be weakened by artificially keeping alive the weak individuals, which will go on to

Gerrit and Annie de Haan, founders of the seal rehabilitation on Texel, feeding orphaned seals (Photo: EcoMare archive).

mate and pass on their genes. Defenders of seal shelters, on the other hand, argue that it is an illusion to think that there are wild nature areas left in the Netherlands. There is human influence everywhere, either directly (e.g. tourism) or indirectly (e.g. pollution) and they think that we have the duty to help animals that are disadvantaged by our actions. Moreover, they point out that when one encounters an animal in distress, one cannot (and ought not) simply close one's eyes and step over it.

Theoretical Background

In the seal debate we can see an opposition between those who focus on individual animals and those who focus on populations or ecosystems. This opposition has been a topic of discussion in animal and environmental ethics for three decades now. It reflects the ongoing debate between pathocentrists and ecocentrists. This debate can be situated within the non-anthropocentric approach to ethics, which seeks to counter the traditional human-centered orientation to ethics. An underlying assumption of non-anthropocentrism is that even though humans are the only beings that can value animals and nature, they can value animals and nature for what they are in themselves and not merely for the purpose they serve for human beings. All non-anthropocentrists wish to extend the moral community to include certain groups of non-humans. They disagree, however, about what entities should be included, and therefore should be taken into account when moral decisions are made. Pathocentrists take awareness as the basis of moral status, and therefore focus on the interests of individual animals. Peter Singer (Singer 1975) and Tom Regan (Regan 1983, 1993) are well known defenders of this position.

Ecocentrists, on the other hand, hold that ecological relations determine the worth of their parts and therefore, that the interests of 'wholes', such as ecosystems, deserve priority over the interests of the animals within it. According to ecocentrists, our ethics should be informed by an understanding of the ecological processes in nature. In ecology, attention shifts away from the individual organism to the large whole within which this individual operates, i.e. the species, the ecosystem, and the specific relations and processes that exist within the biotic community. The core notion of ecocentrism is that of 'internal' relatedness, according to which all organisms are not simply interrelated with their environment but also constituted by those very environmental relationships.

These two positions seem mutually exclusive; either we give priority to individual animals or to species or ecosystems. The continuous disagreement between the different approaches first and foremost seems to be about what is ultimately valuable. For one this ultimate value might be pleasure or the avoidance of pain, for another it is life and for yet another it is diversity. Moreover, the dispute seems to depend on different worldviews. When we stick to the traditional pathocentristic outlook, we naturally focus our attention on different aspects of the world than when we adopt a ecocentric worldview. However, if we look at the arguments of both pathocentrists and ecocentrists at least intuitively there is something to say for each of them. We all know that animals can suffer and most of us condemn it if an animal is hurt for no good reason. At the same time, there is a widely shared concern about species becoming extinct and ecosystems being destroyed. Likewise, when we look at the arguments of the parties in the seal debate, we can see that there is something to say for each of them. Both positions seem to represent part of the 'moral truth'. Therefore, we have examined whether a pluralistic approach could help to bring the two parties closer to each other.

Pluralism

According to pluralism, in morality we are dealing with a plurality of values, ideals or principles that are irreducible to each other or to one overarch-

ing value, ideal or principle. The diversity of existing values can, in other words, not be explained with reference to one general value. This means that there is not one leading value or norm that can determine what is morally required in all circumstances. According to pluralists, from the fact that there is no overarching value, it follows that it is not possible to make an a priori ranking of all values or principles. There is no single scale by which to measure different types of values. For instance, in some situations we value freedom higher, while in other situations we may value equality more. From the absence of a single ranking system, pluralists conclude that 'reasonable disagreement' can exist: two people can completely disagree, but both adopt a defensible point of view, because on a fundamental level they hold different values-rankings. In the case of abortion, for instance, pro choice and pro life groups can both argue from a defensible point of view, but nevertheless never come to agree. The first group emphasizes freedom of choice (of the mother) whereas the second group attaches more importance to the right to life (of the fetus). It does not follow, however, that every point of view regarding abortion is reasonable. Pluralism need not slide into relativism. The standpoint that abortion is only justifiable when the fetus has a severe abnormality is reasonably defensible, but the standpoint that abortion is only acceptable in the case of female fetuses is not, for example.

Pluralists allow for the possibility of rational disagreement about moral issues and therefore do not strictly require uniquely right solutions to moral dilemmas. While pluralists emphasize the possibility of reasonable disagreement, they do not think that this circumstance excludes all discussion. On the contrary, pluralists underline the importance of critical discussion, because the dilemma-like character of many moral problems makes this necessary. Many pluralists think that through critical discussion, conflicts can be solved by looking for shared values. Shared values can often facilitate compromises that do justice to the opinions of both parties in the conflict.

With regard to the question what entities deserve moral care, a pluralist might say that not one characteristic determines moral status, but several characteristics. For example, not only 'sentience', but also 'having a good of its own', 'life' or 'psychological complexity' can be the basis of attributing moral status. This may mean that individual animals, species, and ecosystems all deserve to be taken into consideration in our moral deliberations. As it is not possible to determine in an a priori fashion which value deserves priority, it cannot be determined beforehand which of these categories should be valued higher. In the case of conflict between two categories – for instance between individual seals and the population or ecosystem – it depends on the context which interest is awarded priority. This means that it is possible that in one case an ill seal should and in another case an ill seal should not be rescued. This decision depends on the nature of the situation; for example, is the seal in need of care because of human influences or not? Can the animal be rescued easily or does sheltering cause a lot of stress for this particular animal? Pluralist will look at the case at hand and examine which values and principles have a bearing on it. Which of these deserves priority needs to be argued for each type of dilemma separately.

A plurality of values can be discerned in the seal debate. Both the pathocentric and the ecocentric perspectives are present, although they are not as strictly adhered to as their theoretical descriptions would suggest. Even though there is a tension between the two perspectives, they do not seem completely mutually exclusive. In the Netherlands, the seal rehabilitation center in Pieterburen argues from the individualistic perspective and EcoMare argues more from the ecocentric point of view. Policymakers take generally the more ecocentric point of view. Researchers and animal and nature organizations show a more variable picture, with emphasis on the necessity of prevention and on the educational function of seal shelters. Research of the Center for Bioethics and Health Law of the Utrecht University showed that field workers have initially been motivated by feelings of sympathy for individual animals, but are gradually become more aware of the 'bigger picture' of the population and ecosystem. Another finding of the research was that those that are furthest removed from the animals – and therefore from the conflict between helping an animal in distress and not interfering with nature – have the most extreme opinions, in favor of the ecocentric perspective.

As was already mentioned above, pluralists try to find shared values and opinions in order to accommodate (reasonable) moral disagreements. From a pluralistic point of view, an interesting outcome of the research was that there are two assumptions that are shared by all the respondents. First, all agreed that if the practice of sheltering seals would have detrimental effects on the seal population or species or on the Wadden Sea ecosystem, it should be stopped immediately. Sec-

Harbour seal (Photo: Salko de Wolf, EcoMare).

ond, an important overlap in values between proponents and opponents of sheltering is found in the importance attached to independence or wildness. After all, it is part of the inherent logic of sheltering seals that this sheltering is only temporary; the purpose is to cure and reintroduce them into their own wild habitat. The final goal of these efforts is the maintenance of an independent seal population in the Wadden Sea, even if the direct goal is to minimize the suffering of the seals. For if the ultimate goal would be to minimize suffering, the seals should perhaps be kept in the shelters - where they run less risk of disease or injury - for the remainder of their lives. However, from the moment that the animal is cured, it is apparently considered to be in the best interest of the individual animal and the population alike that the animal leads a natural life in the wild. This is supported by the facts that the length of stay in the shelter is kept to a minimum and that the animal is (generally) not monitored after its reintroduction in the wild.

Wild Versus Domesticated

How can we explain the apparent contradiction between the general agreement on the importance of wildness and the disagreement about the correct treatment of the seals? One starting point is that there is a *moral* difference between wild and domesticated animals. Domesticated animals are dependent on humans for their existence and welfare and this creates a *prima facie* moral responsibility to treat them well on the basis of the fact that we attribute moral status to animals. The relationship of humans with wild animals is different, because wild animals have an independent and spontaneous origin and development. Therefore, humans do not have to care for them in the same way as for domesticated animals and hence humans do not have the same responsibilities towards them. In opposition to monistic theories, such as those of Singer or Regan, who argue that all animals should be treated equally, pluralistic theories can deal with the idea that we are justified to treat wild and domesticated animals differently. As we have more interactions with for example pets, and farm- and laboratory animals, we are 'closer' to these animals and we have positive obligations towards them, whereas we only have the obligation not to interfere towards wild animals. There are of course also practical differences between our treatment of wild and domesticated animals. Domesticated animals are 'individualized' and countable, they are part of our households, whereas wild animals usually live in larger areas where they are part of a larger context, a population and ecosystem. This makes it more difficult to monitor and help wild animals and to do so without disrupting natural processes. It seems, then, that the individualistic approach of animal ethics which is derived from humane ethics is not appropriate for understanding and valuing our moral obligations towards wild animals. But does this mean that none of the principles of animal ethics can be appealed to in the case of wild animals?

Not necessarily; these principles merely apply in a less stringent form. Recall that the central idea of many pathocentric theories is that animals deserve moral consideration, because they share certain morally relevant characteristics with

humans. One sufficient characteristic is sentience, but other characteristics that are often put forward in the ethical literature are 'consciousness', 'having a good of its own', and in the case of wild animals also 'independence'. Apart from the last one, these characteristics are shared by wild and domesticated animals. If we look at these characteristics, it appears that respecting the moral status of domesticated animals means that we should care for their well-being and possibly their integrity. In the case of wild animals, this holds as well, as they also possess characteristics such as consciousness and therefore the capacity to suffer. All else being equal, this would mean that we should care for their well-being too. However, there is an additional characteristic that we should take into account, namely independence. Wild animals have an interest in being treated well, but also in being left alone to lead an independent life. These interests can coincide, but as the seal issue illustrates, under certain circumstances they can also be opposed to each other. This is exactly where the different parties in the seal debate disagree. Some place a higher priority on our duty to care, or beneficence, and others on our duty to not interfere.

Principles

In our view, four principles form the core of a moral theory regarding the aid to wild animals. We have already noted two of them: beneficence and respect for wildness or independence. These will have to be balanced against each other in concrete cases. We will argue that in general, but not always, respect for wildness deserves priority. There are however, two more considerations that still leave room for sheltering animals: the second chance argument and the principle of restitutive justice. Beneficence is the underlying moral principle that gives rise to a duty to care for animals in distress. This duty contends that people that are confronted with suffering animals have a duty to help in an appropriate way. Of course, this does not have to entail personally helping the animal. A coincidental passer-by will usually lack the expertise for this. But according to this principle, one does at least have a duty to notify the appropriate authorities who do possess this expertise. The duty to care is even laid down in Dutch law: article 36 states that every person has the duty to give an animal in need appropriate care. This principle is drafted with domesticated animals in mind, but it is explicitly stated that it applies (to some extend) to wild animals as well. For the application of this principle in the context of sheltering seals, a thorough discussion is needed about the questions when wild animals are 'in need' and what is 'appropriate care'. It is obviously not the intention of the drafters of the law that an organization like 'veterinarians without borders' is founded, that searches for all sick, lost and old seals with the purpose of treating them with the latest veterinarian technologies. On the other hand, it is also clearly not the intention of the law that wild animals like seals can by definition never be in need of help. Article 36 could be interpreted as not allowing people to walk past a wounded animal in complete disregard of its suffering. It is left open, however, what specific action is demanded by law. It has to be noted that from a moral point of view, it is not always clear what action the principle of beneficence requires either. Most wild animals will experience a great deal of stress when they are in contact with humans and are being sheltered and treated. In order to prevent unnecessary suffering, this has to be weighed against the advantages for the animal, meaning the chances of success of curing the animal and its chances of survival after reintroduction.

But there are other restrictions to the principle of beneficence as well. As we saw before, the duty to care for wild animals should not be interpreted so strictly as to call for the sheltering of all animals in distress, or even preventatively sheltering all animals, if this would on the whole amount to less suffering. Apparently, the good life for an animal is not considered to exist solely in the presence of positive and the absence of negative experiences. It is generally agreed that the lives of wild animals are fulfilling, or worth living, when they are free and independent. This consideration is voiced by the principle of respect for wildness or independence. The value of wildness is the ultimate justification for sheltering and reintroducing seals in their natural habitat. As previously stated, the ultimate goal of sheltering seals is to maintain an independent seal population in the Wadden Sea, in which individual seals can live independently and continue their natural life cycle.

Even though this principle seems quite straightforward, respect for wildness is interpreted differently by proponents and opponents of sheltering. According to opponents, respect for wildness implies that, under normal circumstances, human intervention should be limited, because intervening *in itself* interferes with respect for wildness. People who take the ecocentric perspective argue that wild animals not only have the 'right' to lead an independent wild life, but also to die in the

wild. Proponents of sheltering, however, connect the principle of respect for wildness to the principle of beneficence by arguing that with our help, animals that are diseased or wounded will be enabled to lead a fulfilling wild life. According to this 'second chance argument', seals that have been plainly unlucky deserve a second chance to live an independent life in the wild. Helping animals is in this context regarded as supporting their wildness, rather than undermining it. People could be seen as merely another resource for the seals, especially in a densely populated country like the Netherlands, where nature and culture are intertwined. The proximity of people does not only have to be a disadvantage for wild animals, as it creates certain opportunities for the animals to survive as well. This complies with the idea that people should be allowed to give the seals a second chance, under the condition that this does not interfere strongly with their independent existence. The conflict between opponents and proponents of sheltering, then, seems to be influenced by the question what constitutes a wild animal's wildness or independence. Opponents seem to assume that an animal can only be wild and independent if all contact with humans is avoided. Wildness in that sense is a state almost independent of the animals; their wildness is solely dependent on whether they happen to encounter humans. Just as is the case with the concept of naturalness, we, on the other hand, think wildness is not an 'either/or' option, but is a matter of degrees. An animal can be considered more or less wild, dependent on certain characteristics, such as its ability to survive independently and the exercise of its species-specific characteristics. We suggest that if an interference with an animal's life can be shown to have no effect on its behavior or functioning in the wild, its wildness has been respected. In our opinion, respect for wildness does not, therefore, *by definition* mean non-interference. We need to formulate criteria for deciding when an animal's independence or wildness has been violated. In the absence of decisive objections, there seems nothing wrong, then, with giving wild animals that are just unlucky a second chance. This consideration explains why many people find it less justified to shelter old, ill seals than young ones that are simply lost. In the case of old, ill animals many would rather help by humanely killing them, as is the common practice in Denmark concerning *all* ill seals that are encountered in the wild. In the case of pups, many people feel that if they can easily be helped they should be given a chance to lead a fulfilling wild life.

Even though respect for wildness demands that we interfere in the lives of wild animals as little as possible, we have seen that there can be exceptions for individual animals, provided that their independence is not violated by our actions. Another condition that is generally shared is that the population and ecosystem should not be harmed by sheltering. This seems to give primacy to an ecocentric framework. However, this can also be argued from a pathocentric point of view when we acknowledge that individual animals are dependent for their survival on their population and ecosystem. When the latter are unhealthy, so will be the individual animals within it. So, even though the interests of the population and ecosystem have priority in this specific case, all other things being equal, there should still be room for sheltering, within defined boundaries. This conclusion is supported by an additional argument, based on the principle of restitutive justice. This principle entails that if people are either directly or indirectly responsible for an animal's suffering, they have a duty to at least try to reverse this consequence by appropriate aid, care, sheltering, or prevention. Most people are more willing to help animals that are victims of oil spills than animals that are injured in battle with other animals, for instance. Would not the ecocentric hands-off policy, be inconsistent if we allowed animals' lives to be causally influenced by human activities only in a negative way, but not in a positive way? Ecocentrists might respond that we should focus on prevention, but we can hardly rule out any negative interferences with the situation of wild animals.

A Practical Model

In order to structure the seal debate and to facilitate policy workers' decision making regarding the acceptability of sheltering we have drafted a 'decision making model' that incorporates all of these considerations. This model can be used by a single person that wants to form her own opinion, but is preferably used as an aid for a critical discussion. The model is meant to structure the argumentation about the acceptability of sheltering in such a way that all relevant arguments come to the light and to determine where exactly lie the disagreements between different parties in the debate.

First, it has to be determined whether the shelter in question complies with certain conditions that always have to be fulfilled. These are:

- the condition that the animal can not be helped in another way that causes less suffering (for instance by helping on the spot),

Release of seals (Photo: Salko de Wolf, EcoMare).

- that the shelter possesses sufficient expertise and means, and
- that the interests of the shelter itself are acceptable.

For instance, it would be unacceptable when animals are sheltered with the purpose of selling them when they are cured. Then, there are some questions that should establish whether the independence of the animal and its population are guaranteed. For instance, it is deemed unacceptable if the animal stays more than a third of its life in the shelter or if a situation is created where the population could not survive in the long run without the shelter. Finally, there are some questions that have to be scored on a scale from one to ten. This is because the answers to these questions can be understood gradually. For instance, an ill animal can be considered more or less in need of help. If the animal is more in need of help a score closer to one should be given and if the animal really needs no help a score of ten is appropriate. Other questions in this model are:

- does the suffering have natural or human causes?,
- to what extent is the population threatened?,
- does the animal suffer as a result of the sheltering (stress)?,
- how great is the chance that the animal is cured and will survive after reintroduction into the wild?,
- to what extent will the sheltering violate the animal's or population's wildness or independence?,
- how natural is the ecosystem?,
- are there risks of sheltering involved for the population or ecosystem?,
- what role does the animal play in sheltering the public?, and
- what are the possible negative consequences if the animal is *not* sheltered?

The model should not be viewed as a mathematical method of objectively determining the acceptability of the shelter in question. The scores do not lead to a clear position for or against sheltering. They merely serve to point out which factors are considered important. For instance, when someone gives a very high or low score on any given question this is a sign that apparently a certain factor is very important to that person. The function of the model is therefore to facilitate the (pluralistic) discussion and to provide food for thought.

Conclusion

In summary, we can say there are two issues that most people in the debate agree on: first, the final goal of sheltering is reintroduction into the wild, and second, the practice of sheltering should not harm the population or ecosystem. This means that in our decision making regarding the acceptability of sheltering, the interests of the population and ecosystem should be awarded priority. It has to be noted, however, that this principle could work in favor of sheltering as well, in case the population or species is threatened with extinction, for instance. It was also argued that the principle of respect for wildness should deserve priority over the principle of beneficence. However, under the condition that wild animals would not

become dependent on human aid, there is room for beneficence. This is especially the case when humans are responsible for the suffering of the animal. Criteria need to be formulated for determining which actions interfere with an animal's independence and wildness. We can conclude that sheltering on too large a scale is not preferable. This would be contrary to the efforts of the last decades to maintain an independent or wild seal population in the Wadden Sea. Also, the larger the scale of the sheltering, the higher the risk of bad consequences for the ecosystem or population. However, all else being equal, we see no reason at the moment to completely prohibit shelters.

To return to a question asked at the start of this paper, if sheltering is deemed acceptable, even if it is to a limited extent, does this also mean we have a duty to do so? As we saw, according to the principle of beneficence we have a *prima facie* duty to help animals in need. This duty can be overridden by the duty to respect wildness. As we also saw, however, there can be different interpretations of the question when an animal is in need and what constitutes help. Besides sheltering, help could also be interpreted as prevention, humane killing when an animal has no chance to survive on its own, or helping on the spot. Sheltering animals should therefore be regarded as permissible, but not obligatory. However, when someone is directly responsible for an animal's suffering, according to the principle of restitution, this person does have a duty to help the animal in one of the ways noted above.

From this account, it once more becomes clear that the acceptability of sheltering animals is dependent on the specific circumstances in which an animal is encountered. Besides the factors mentioned in the foregoing, there are some supplementary motivations that can influence the decision whether or not to allow sheltering. These motivations are not weighty enough to tip the scale in one direction or the other, but they can be a contributing factor to the decision making process in cases where the solution is not straightforward. Most of these motivations have to be discussed in the light of specific cases. These motivations are first, that sheltering seals has contributed towards the public's consciousness of environmental problems and the importance of nature conservation. In this respect, seals have become the 'ambassadors of the Wadden Sea'. Moreover, the shelters offer the possibility to do scientific research in order to monitor the health of the population and the causes of disease. The expertise that is built up in the shelters can be used in the case of catastrophes such as oil spills in the Wadden Sea or elsewhere. One last argument that can be given in favor of (limited) sheltering is that if shelters would not exist, many people who encounter ill animals will try to rescue the animals themselves, which will cause even more stress and suffering due to their lack of expertise.

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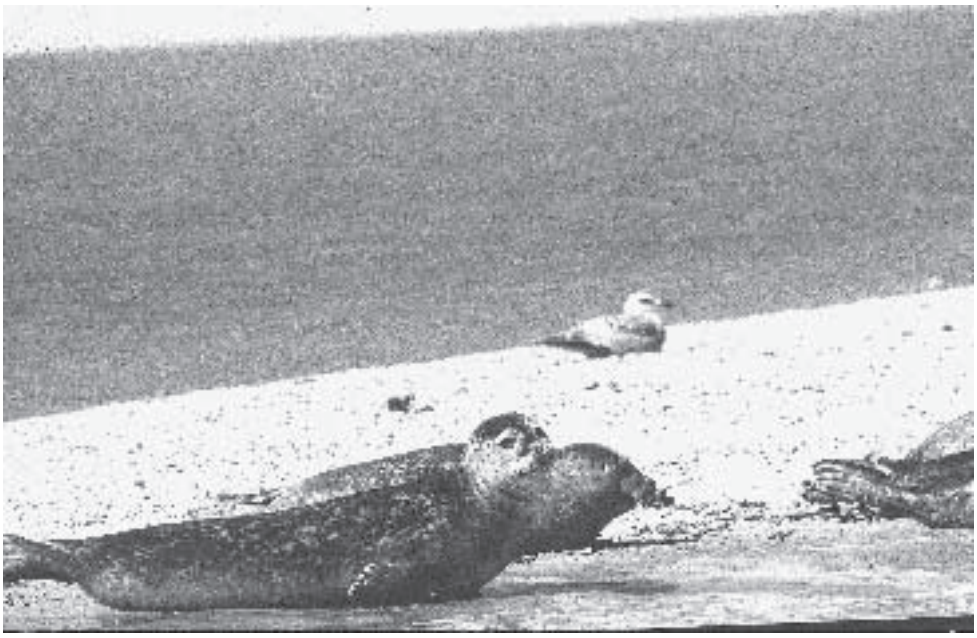

(Photo: K.-E. Heers)

Structuring Points of View in the Nature Management Debate

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Introduction

Working as an educationalist at a museum embracing both natural and cultural history, I am bombarded daily with conflicting points of view in the field of nature management. Below I have tried to structure the substance of some of these statements, hoping that such a scheme will shed some light on the fundament of our views on and expectations for nature management. A number of ordinary and well-known examples have been picked to ease the understanding of the rather imprecise expressions commonly used.

Different Point of Views

For the sake of a better overview I will structure the various opinions, views and expectations as follows:

1. Eco-biological point of view

The eco-biological point of view puts emphasis only on matters concerning animal populations, e.g. on factors that threaten these populations with decline. The life and death of the individual animal in this context is of no interest at all. Darwinism prevails: the survival of the fittest individuals are regarded as essential for maintaining a healthy population.

2. Animal protection point of view

This point of view considers the individual animal and its protection. According to the Danish Animal Protection Act §1, animals must be treated well and be protected against pain, suffering, trauma, permanent injury and any significant disadvantage. Animal protection hence deals with how well we treat the animals in human care, either as pets, for hobby purposes, in zoos or on farms.

For animals in the wild, including so-called vermin, protection regulations commonly focus on how the animals are killed during a hunt or other types of pursuit. §13 of the Danish Animal Protection Act states that putting down animals must be as quick and as painless as possible. Drowning is forbidden.

3. Animal Welfare Point of View

This point of view goes beyond mere protection. While the protection act speaks of preventing pain, suffering, trauma, permanent injury and any significant disadvantage, animal welfare also considers the natural needs of animals in human care and the fulfillment of these needs. Defining the welfare needs of wild animals is of course a much more difficult task. The setting up of nature reserves will presumably increase the welfare of animals living there. The existence of areas where

wild animals can live their normal lives without human interference must be assumed to promote the welfare of the individual animal.

4. The Ethical Emotional Point of View

In the media, terms like animal protection and animal welfare are increasingly confused with animal ethics and all three terms sometimes regarded as synonymous. Nevertheless, it is important to stress the difference between the three because they represent fundamentally different views. Whereas animal protection and welfare relate to the individual animal, animal ethics are primarily based on human self-consideration. Fortunately, for the animals this self-consideration includes the demands for proper protection and welfare measures. We dislike being confronted with such unpleasant things as cruelty to animals. Therefore our self-consideration will in most cases automatically include caring for the animal. Beside an animal protection and welfare component, animal ethics also carry demands that have roots in existential and aesthetical thoughts and human needs.

Existentialism or "the Meaning of Life"

As humans beings we have an inborn desire to understand the meaning of life – and this includes the meaning of the animals' lives. Therefore the big question of animal ethics is, what is the purpose of killing the animal? From the eco-biological point of view one would ask, if the killing is a threat to the population, or is it a sustainable cull that does not cause the population to decline in the long run? From an animal welfare point of view one would rather ask whether the kill is performed quickly and painless in a humane way.

Aesthetics

Like other animals humans are programmed to react to visual signals from our fellow creatures. We react positively to the sight of a baby seal, and as far as I understand, human reactions to snakes all over the world are negative. The rounded and soft looks of the seal pup with its large black eyes trigger our nursing instinct; otherwise we would not be human.

Animal Classification

There is no equal compassion for all animal groups and this is fair enough as long as we base our judgments on how well developed senses and behavior are in the particular animal group. Unfortunately, compassion goes along with popularity, not the level of development or presumed needs. There are beautiful or ugly, evil, stupid or cute animals to whose lives we confer a meaning.

A phenomenon within the realm of animal ethics is an inborn acceptance of discrimination. Animals are not equal. At the top of the hierarchy are domestic pets, often the objects of human care of grotesque dimensions. Hobby animals such as horses also rank very high and, increasingly during the last decades, also wild animals. Among the wild animals again there are some that are more popular than others, and no doubt marine animals in particular are the top scorers, almost placing them in a league with the holy cows of the Hindus. The wild animals for certain now have higher status than the farm animals of the good old days. On the little farm, a single milk cow could gain family status, with a proper name. Many farms have gradually turned into industrialized bio-factories with less focus and care, devaluating the animals by merely providing them with a number and thus just naming them by ciphers. Farm animals have become production animals. Lowest among mammals rank vermin, today only represented by moles and rats.

The setting up of a caste system for animals, here in the year 2002, has a very peculiar effect on the implementation of a new Zoo Act in Denmark. Education on zoo animals has to be conducted by professional biologists. These animals are wild and therefore belong to a higher-ranking caste, but what about the animals kept in *open farms* i.e. farms providing public access for visiting groups? They ought to be treated equally with the same level of public education, but on the contrary they are just production animals. The paradox exposes our bad conscience. We keep wild animals in captivity but at the same time we have no scruples when it comes to domesticated animals.

Some Examples

Bearing in mind the four points of view, one may attempt to analyze a number of simple and familiar cases.

1. Pilot whale kill

From an eco-biological angle, the Faroese slaughter of pilot whales is an outstanding case of sustainable exploitation of a marine source. The cull does not threaten the stock of pilot whales because the drive catch only exploits the accessible pods – those that approach the islands and hence can be driven ashore. From an animal protection point of view the killings are more problematic,

not so much the killing itself, by bloodletting, but the stressful drive from the time the animals are detected until they are killed at the catch site. Before the implementation of the current regulations the whales were driven towards the coast with lances and stones, clearly acts of cruelty to animals. An animal welfare point of view will regard the pilot whale cull as neutral. There is no effect on the quality of life of the wild stock as such just because some pods are driven ashore and killed. Animal ethics in the strict sense applied here will regard the killings as sheer cruelty. Had pilot whales, however, been solitary animals, public opinion would certainly be less condemning.

2. Cleaning of birds caught in oil slicks

In Denmark, cleaning and rehabilitating birds that have suffered injuries in connection with oil spills is prohibited. Nonetheless, every now and then TV stations feature the cleaning of such birds. In a biological context the cleaning is generally considered useless and very few birds survive the cleaning process. Also in an animal protection view, cleaning oil from birds may be disputed. That the bird should understand that it is suffering for its own good is of course illusory. From an ethical and emotional angle, cleaning birds trapped in oil is naturally considered compassionate and positive. We are doing something for nature instead of being inactive and we talk ourselves into the belief that the consequences of such disasters can be solved in this way.

3. Free Keiko?

A killer whale that was being kept in very poor facilities in a Mexican delphinarium has, after starring in three "Free Willy" movies, been reintroduced to its original home surroundings: an Icelandic fiord. For the fourth consecutive year, efforts are being made to encourage Keiko to socialize with local pods of killer whales, at a cost of more than £11 million. Now, the sponsorships are running out and the future looks less bright for Keiko. Looking biologically at this phenomenon, one has to admit that the North Atlantic stocks of killer whale gain nothing from this reintroduction. Even from an animal protection point of view, freeing an animal that spent 23 years of its life in captivity is very questionable. On an ethical and emotional level, there is no doubt what should be done. We give animals – or rather enforce on them – our own human needs. Therefore Keiko should be released into the sea again to "gain its personal freedom and receive enough space and company from its old kin."

4. Reintroduction of Brutalis

Brutalis was a rhino born in captivity in England. After a somewhat turbulent life in the zoos of Ålborg and Givskud in Denmark, it was released in a nature reserve in Namibia. The rhino was unnaturally aggressive and died in January 2000 after a territorial fight with another bull. The Brutalis story has a lot in common with the Keiko story. Although Brutalis didn't need training for real life. It had picked up the skills of grassing in captivity.

5. Surplus animals in zoos

In zoological gardens outside Denmark in order to avoid offspring mature animals are either sterilized or sexes are kept apart. There is e.g. a large surplus of lion cubs but many holding facilities hesitate to euthanize them because they fear to risk their *good name* in the media and public at large. Therefore, sexually mature animals often will face castration, which from an animal protection point of view can be dealt with by administering a tranquillizer, but in an animal welfare context indeed would be problematic. Ethics overrule animal welfare. Instead of being afraid to euthanize surplus cubs in a zoo one should be proud. The more cubs that are killed in the garden the better the general life of the animals in the facility must be. From an ecological point of view the way zoo animals are treated is not relevant. The only important issue here is the risky business of introducing/re-introducing animals into the wild.

6. Catch of Greenland right whales

The Alaskan Inuit have a quota on Greenland right whales although this species is listed in Appendix I of both the Washington Convention on International Trade in Endangered Species (CITES) and the Bonn Convention of Migratory Species (CMS) and in Appendix II of the Bern Convention. The reason for giving the Inuit a quota of 67 whales is that the IWC (International Whaling Commission) considers the take as non-commercial and as a subsistence catch stemming from an old tradition. This argument is not acceptable from an eco-biological point of view. Here the effect of the total mortality on the population matters, regardless of how and by whom the whales are killed. The catch itself is conducted with hand-held harpoons from small boats, as in the North Atlantic almost 400 years ago, a method that from an animal welfare point of view is very problematic. When we accept this type of whaling in spite of everything, it must be because it is conducted by indigenous people and not by a commercial whaling company.

Table1: Conclusions of the different examples regarding different point of views.

	Pilot whale kill	Cleaning oil birds	Freeing Keiko/ Brutalis	Whaling of Greenland right whales	Killing surplus animals in Zoos	Rehabilitation of seal	Seal hunt
Biologically	OK	No	No	No	OK	No	OK
Animal protection	?	No	?	No	OK	?	OK/?
Animal welfare	?	?	?	?	OK	?	?/No
Animal ethics	No	OK	OK	OK	No	OK	No

7. Rehabilitating abandoned or sick seal pups

In 1995, Denmark stopped the rehabilitation of abandoned or sick seal pups, causing an outcry in neighboring countries to the south, where seal rehabilitation centers continue to attract the attention of the media.

Unfortunately - and contrary to public belief – collecting, rearing and reintroducing sick seals to a healthy seal population is both questionable and risky, and of no benefit to the wild population. Natural selection has presumably already doomed the sick and abandoned pups, letting only strong animals that endured the first tough months of a seal's life survive.

8. Seal hunting

The Danish populations of common seal have quadrupled since they were fully protected in 1978. From an ecological point of view, reintroducing seal hunting is not a problem. If not hunted, the population will grow further until it reaches carrying capacity, most likely limited by food resources. There are no polar bears or killer whales in Danish waters to do the job.

Factors regulating the size of a population are interdependent. Hunting would be a limiting factor, but in the absence of hunting, another factor – most likely starvation - would automatically arise.

The animal protection problems in connection with seal hunting are linked to the actual killing. The use of clubs – as on the island of Anholt in the 1800s – would be the safest and most humane, but it is extremely unlikely that anyone would dare resume that old-fashioned method. Traps and gill nets can likewise be excluded since they would contravene the Animal Protection Act. If reintroduced, hunting would most likely be conducted with firearms. Animal protection aspects should be evaluated, comparing the seals' alternatives: death by firearms or by natural causes. Seals in Danish waters have no natural enemies, so their prospect – like humans' – is to die of disease, starvation or old age. Based on the many collected specimens, we have excellent knowledge of the causes of natural death among seals. There is no doubt that in the animal welfare sense, a rifle shot is much more acceptable than slow suffering death on the beach. But a seal hunt will cause problems from an animal welfare point of view. We must presume that the hunt will reduce the quality of life of the seal population due to an increased alertness among seals.

Neither from a biological nor an animal protection point of view would a sustainable seal hunt meet objections. The problems are on the ethical and emotional level, here understood as narrow human self-consideration. On this level, the biggest problem is that marine mammals have achieved sacrosanct status in the western world both with the media and the public. USA has a total import ban on marine mammal products, and all over the "civilized world" rehabilitation centers for injured or traumatized marine mammals are popping up.

Another ethical problem is of an existential nature: the meaning of life – that is, of the animals' lives. The core of recreational hunting is entertainment and thrill, and killing animals for this particular purpose is hard to understand for people outside the hunting community. In most European countries including Denmark, there are societies against recreational hunting, not because the wild population may be regulated, but because of the fun element in the hunt. It makes a difference who pulls the trigger, whether he enjoys it or is employed by the Forest and Nature Agency to do the job. Among the ethical problems is also the disposal of the carcasses. Seal meat has never been a gourmet dish and it is doubtful whether seal meat will ever be offered for sale in Danish butchers' shops. What remains is the skin, often considered a bit too fancy and therefore a little unethical.

Conclusion

For drawing a conclusion from all these aspects, see table 1. Particularly interesting is the comparison between the biological point of view and the ethical/emotional, which disagree on all eight counts.

As we can see, eco-biological and ethical considerations are often in conflict, and animal protection and welfare often go along with biology rather than with emotions. So what is the use of this exercise? Is it either one or the other?

Of course it is not. As human beings we have to consider all the angles. Prioritizing them is very important. Any regulation or management plan dealing with animals and nature should be based on biology first. Thereafter comes animal protection before animal welfare. This is also where we could stop. These three angles can be treated universally and objectively despite differences of culture and religion. The ethical emotional level is difficult to apply in a legal framework and any use of it should be avoided. Legal matters based on emotions may give the impression that "now something has been done for nature." Very often, quite the opposite is true.

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Phocine Distemper Epidemic Amongst Seals in 2002

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Introduction

In May 2002, a mortality of common seals (*Poca vitulina*) caused by phocine distemper virus (pdv) infection was observed on the island of Anholt in the Danish Kattegat area, the same island where the same pdv epizootic amongst seals also started in 1988. The virus spread to the Swedish and Norwegian coast in the Kattegat/Skagerrak area in May/June, and a shortly afterwards to the Baltic Sea, the east coast of the United Kingdom and also to the Wadden Sea. The occurrence of the pdv infection was associated with an unusually high mortality in the above areas. The pdv is very contagious for common seals, but not dangerous for humans. About 80% of the virus-infected seals died due to secondary infections from other pathogens such as bacteria, because the virus weakens the immune system. Most often the cause of death is pneumonia. In the entire affected area, in total about 22,500 dead common seals were registered between May 2002 and the end of February 2003.

In 1988, the same pd virus caused the death of a substantial part of the common seal population in Western Europe. In the following, more details are given regarding the status and development of the mortality in 2002 in comparison to the 1988 outbreak.

Development of the Seal Mortalities in 1988 and 2002

Outbreak, confirmation and end of the pd-disease

During the 1988 pdv epidemic, already in February – March 1988, the number of dead seals along the Danish Kattegat-Skagerrak area and the Wadden Sea coast in Schleswig-Holstein was approximately three times higher than the average for the same months in the previous four years. The first indication of an epizootic within the common seal population was noted by the increasing number of aborted pups on the island of Anholt in the central Danish Kattegat in April 1988.

In the beginning of May 2002, the first common seals suspected to have died of pdv were also found on the island of Anholt in the Danish Kattegat, the same island, which was the starting location of the pd epidemic in 1988. About 150 dead seals were documented on Anholt and Laesø within a short time until 27.05.2002.

Three samples of some of the first dead seals were examined at the Erasmus University in Rotterdam in the Netherlands with the Polymerase-

Dead harbour seals in Denmark (Photo: S. Tougaard)

Chain-Reaction-method (PCR) with positive results of the pd virus in mid May (Jensen et al 2002). According to the investigations at the Danish State Veterinarian Institute in Aarhus, it had definitely been confirmed since 04.06.02 that the pd virus was the cause of the mortality of common seals in the Danish Kattegat. This virus caused similar mortality in common seal populations in the past, e.g. the outbreak in 1988.

In the Skagerrak-Kattegat area, the epizootic among the seals was over by about mid September 2002, and in the Wadden Sea and most other affected areas at the end of November 2002. Only in the United Kingdom and the Republic of Ireland were the seals still dying up to the end of 2002 / beginning of 2003.

Distribution pattern

In 1988, the disease quickly spread from the Danish island Anholt to all other seal sites in the western and eastern Kattegat/Skagerrak, the Danish, German and Dutch Wadden Sea and to nearly all other seal stocks in Europe in April/May/June. Some seal stocks, for example seal colonies in the Baltic Sea and in Norway were not affected. (CWSS 1991)

In May/June 2002, there were indications that the initial phase of the pd outbreak in the Kattegat-Skagerrak this year seemed to be less severe than the outbreak in 1988. However, it was not possible to predict the pattern of this year's outbreak and the further development of the virus infection for the seal population at that time. The disease spread south and northward in the Kattegat/Skagerrak area and affected all relevant seal colonies in the area off the Danish east coast. The outbreak of the seal disease was registered on the Swedish west coast on 30.05., and ran from south to north and reached northwards the outer Oslofjord in Norway on 22.06.2002.

On 19.06.02, the first common seal with pd was confirmed in the Netherlands. The seal was found on the Dutch Wadden Sea island Vlieland on 16.06.02 by a staff member of the Pieterburen Seal Nursery Center and transferred to Pieterburen. Since then, it had been expected that the virus would also emerge in the other parts of the Wadden Sea. However, the mortality first only started in the Dutch part of the Wadden Sea, and only later an unusual mortality and also the confirmation of pd had been registered in Lower Saxony

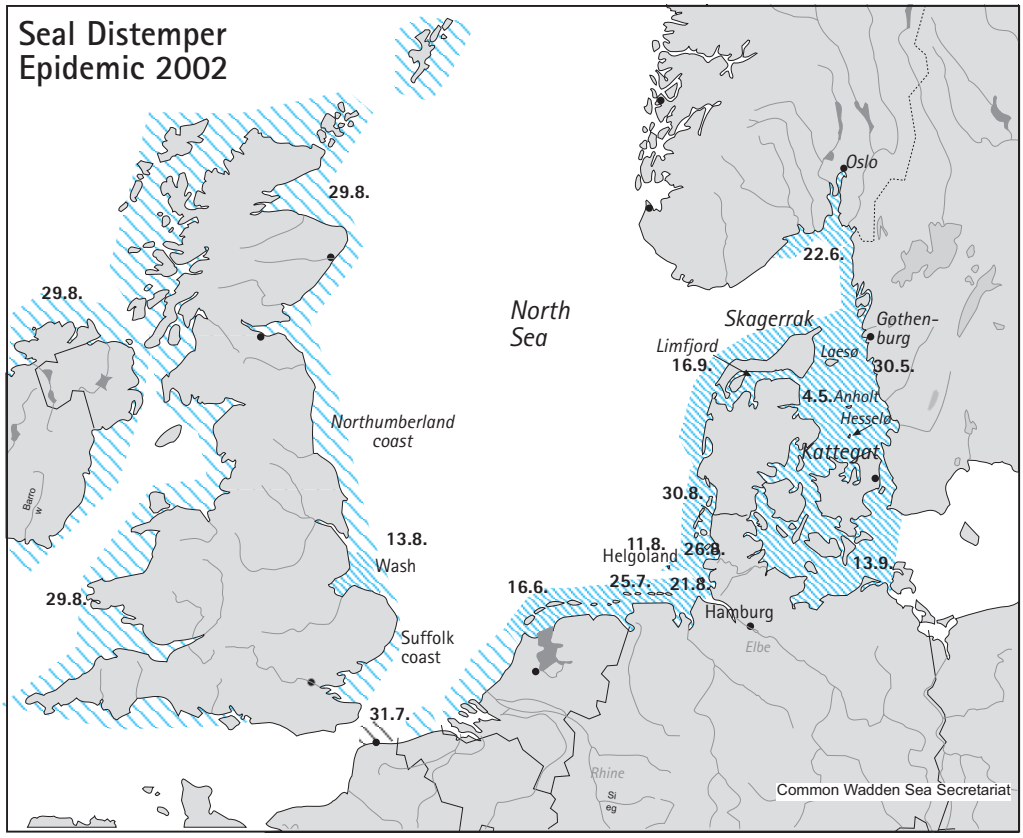

Figure 1: Map of Northern Europe – Areas marked with occurrence of phocine distemper mortality of common seals in 2002.

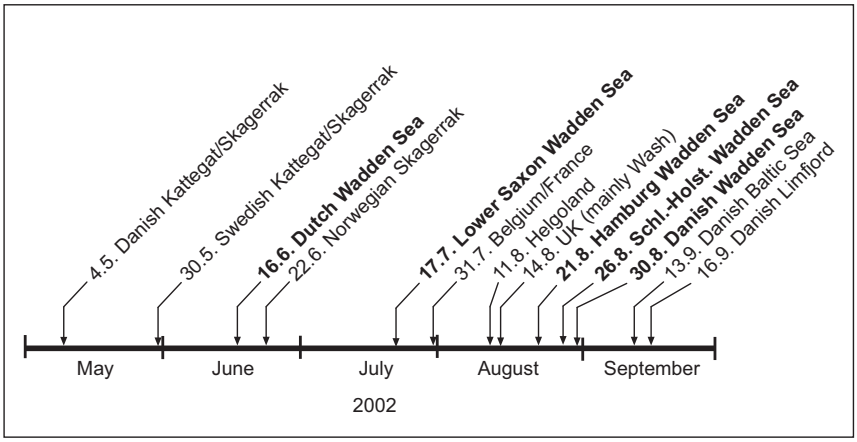

Figure 2: Chronological timetable with the date of the phocine distemper outbreak amongst common seals in the different areas in Northern Europe in 2002.

since 17.07., on the island of Helgoland since 11.08., in the Hamburg (Neuwerk and Scharhörn) since 21.08., in the Schleswig-Holstein part since 26.08., and - as the last region - in the Danish part of the Wadden Sea since 30.08.02.

Besides the Wadden Sea, also the Dutch North Sea coast of the provinces of Noord-Holland, Zuid-Holland and Zeeland, the Belgium/French North Sea coast and the United Kingdom, mainly the Wash and the Northumberland and Suffolk North Sea coast, as well as the Danish Baltic Sea and the Limfjord, DK, as the last, were pd affected areas with higher mortality amongst common seals.

In all parts with occurrence of unusual mortality, at least some samples of dead seals were tested pdv positive, and thus confirmed the pd outbreak in seals. In 2002, more or less the same areas were affected by the pd as during the pd epidemic in 1988.

Grey seals (*Halichoreus grypus*) were not as severely affected as common seals in 1988 and 2002. They were affected in the United Kingdom, however, in the entire Wadden Sea only about 22 dead grey seals were registered during the 2002 epidemic. Grey seals seemed to be less susceptible to the disease.

The distribution pattern of the seal epidemic in Northern Europe in 2002 and the first date of occurrence of the unusual mortality of common seals, which was the starting point of the outbreak of the disease in that region and at the same time the beginning of the counting of the pd mortality, are given in Figure 1 and 2.

Numbers of dead seals in 2002

In 1988, more than 18,000 seals, mainly common seals died of the highly contagious disease in northwest Europe. A substantial part of the common seal population died in the United Kingdom and the stock in the Wash declined to about 50% of its size before the epidemic. In the entire Wadden Sea, it was estimated that close to 60% of the population died as a result of the virus epi-

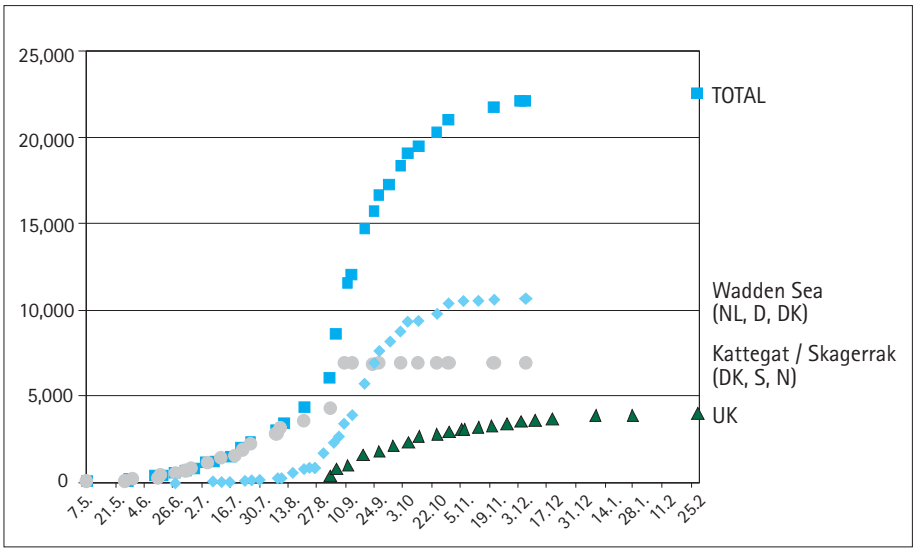

Figure 3: Development of the seal dying in the different areas in Northern Europe in terms of numbers since May 2002.

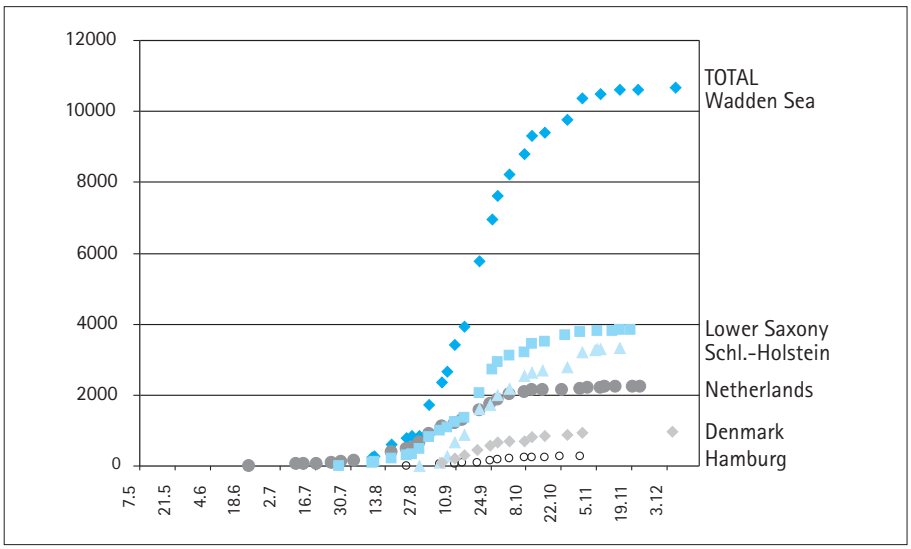

Figure 4: Development of the seal dying in the different parts of the Wadden Sea in terms of numbers since May 2002.

demic, which amounted to about 8,500 dead seals. (CWSS 1991)

The development of the seal deaths in the different areas during the epidemic in 2002/03 is given in Figure 3 and 4.

The number of registered dead common and grey seals in the different areas in 2002/03 is given in Table 1 (third column). The table also includes the first date of the unusual mortality in the different areas (second column) as well as the minimum population size of common seals in the different areas according to the results of the seal counts in the Wadden Sea in 2001, respectively according to other sources (last column).

Size of common seal populations and loss due to the pdv infection in Northern Europe

The counted numbers of common seals in the different areas during the last surveys before the epidemic, which was the minimum population size in the area, are given in Table 1 (last column).

Wadden Sea

In 1987, before the outbreak of the epidemic in 1988, the maximum number of counted common seals in the Wadden Sea was about 8,600 animals, which means that about 10,000 would have had been counted without an epidemic in 1988 (Fig. 5). The total real number of the population

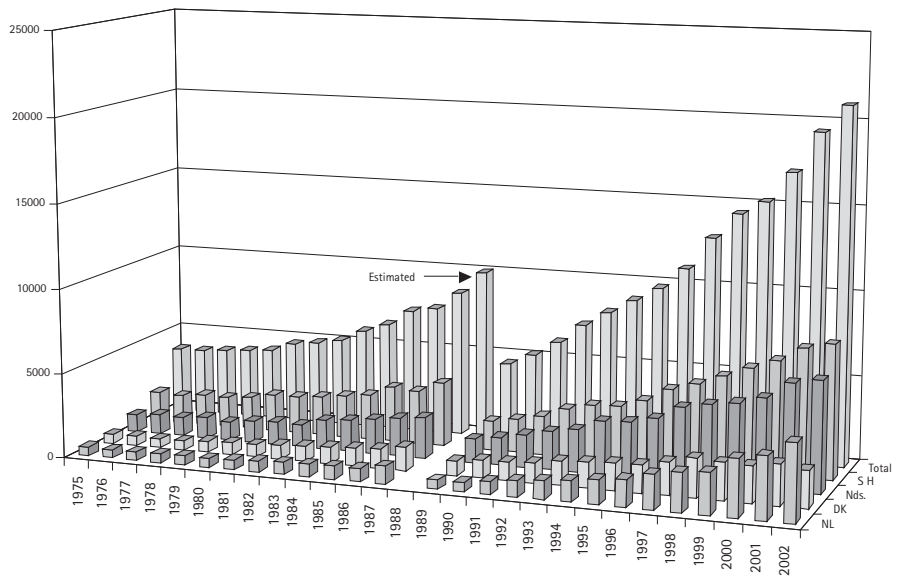

Figure 5: Number of counted common seals in the Wadden Sea since 1975.

Table 1:
Phocine Distemper epidemic amongst common seals in 2002
(Sources: First, second and third column = information supplied by countries for the Seal Reports (Reineking 2002; 2003);
Last column:
*** Trilateral Seal Expert Group (TSEG) 2001.**
**** information by Tjärnö Marine Biological Laboratory, Sweden.**
***** Laursen, K. (Red.) 2001.**
****** homepage: SMRU-UK.**

	First date of occurrence of unusual mortality	Seal Report No. 45 (April 2003) Number of dead seals (until date)		Minimum population size of common seal (number / year of counting)
		Common seal and grey seal	Grey seal	
WADDEN SEA				
Netherlands (Wadden Sea, Noord- and Zuid-Holland, Zeeland)	16 June 2002	2,244 (22.11.02) epizootic over	2	3,600 (2001)* NL-Wadden Sea
Lower Saxony	17 July 2002	3,851 (18.11.02) epizootic over	19	6,220 (2001)*
Hamburg	21 August 2002	261 (29.10.02) epizootic over	-	(488 (2001)*, included in numbers of Lower Saxony)
Schleswig-Holstein	26 August 2002	3,338 (14.11.02) epizootic over	-	7,190 (2001)*
Denmark	30 August 2002	962 (05.12.02) epizootic over	1	2,380 (2001)*
Wadden Sea Total		**about 10,656**	**22**	**20,000** (2001)* **(25,000 estimation)**
HELGOLAND	11 August 2002	**270** (30.10.02) epizootic over	-	**about 400***
KATTEGAT/SKAGERRAK				
Danish Kattegat	04 May 2002	2,049 (05.12.02) epizootic over	-	3,250 (2000)***
Swedish Kattegat / Skagerrak	30 May 2002	about 4,000 epizootic over	?	about 15,000 **
Norwegian Skagerrak	22 June 2002	878 epizootic over	?	1,200 (1996-98)****
Kattegat/Skagerrak Total		**about 6,927**		**about 19,000****
DK- Limfjord				
	16 September 2002	**365** (05.12.02) epizootic over	-	**1,631/886**** (1999/2000)
BALTIC SEA				
Danish Baltic Sea: Falster, Møn, South-Lolland incl. Oresund	about 13 September 2002	**95** (05.12.02) epizootic over	-	**270** (2000)*
German Baltic Sea coast Mecklenburg-Western Pomerania	30 August 2002	**11** (no more dead seals after 07.10.02)	-	no colonies
BELGIUM/FRANCE				
	31 July 02 (France) / 18 August 02 (Belgium)	**22** (no more dead seals after 08.11.02)	-	no colonies
UNITED KINGDOM				
England, Scotland, Wales, Northern Ireland	14 August 2002	**3,990** (no more reports after 28.02.03) epizootic over	at least **737**	**34,100****
REPUBLIC OF IRELAND				
	21 September 2002	**161** (no more reports after 03.12.2002)	at least **43**	
ALL AREAS TOTAL		**ABOUT 22,500**		

in 1988 was at least 30% higher. In the entire Wadden Sea, about 8,500 dead seals were registered in 1988, and it was estimated that about 60% of the estimated seal stock in the Wadden Sea died. (CWSS 1991)

Last year, almost 20,000 common seals were counted in the entire Wadden Sea. However, not all seals in the population are observed during surveys because they do not all rest on the sandbanks at the same time (TSEG 2001). Research has shown that the total number is at least 30% higher. This implies that it can be assumed that the size of the population was approximately over 25,000 animals. The seals were in a relatively good condition, and there were no indications of an overpopulation. For the survival of the pups after weaning, it is imperative that they built up enough reserves during the four weeks of lactation. Still normally, 30% of the pups do not survive the first year (TSEG-plus 2002).

In 2002, more than 10,600 dead seals were registered in the entire Wadden Sea. It is estimated that about 40-50% of the estimated seal stock in the Wadden Sea died as a result of the virus epidemic. The percentage may differ from region to region. It seems that the 2002 epizootic was slightly less severe than in 1988. However, the loss of seals will become more evident during the next aerial counts in 2003.

Danish and Swedish Kattegat / Skagerrak area

On the Danish island Anholt, about 800, on Laesø about 900 and on Hesselø about 700 common seals were counted during the last regular count in August 2000 (Laursen 2001). It can be estimated that the total stocks of the islands were twice as big. The total population of common seals in the Danish Kattegat and Oresund area was – according to the results of the counting in 2000 - about 3,250 animals.

According to information from the Tjärnö Marine Biological Laboratory, Sweden, in total, approximately 7,000 common seals were reported dead in the Danish-Swedish-Norwegian Kattegat-Skagerrak area, but probably in total 10,000 seals died. Thus, of those about 19,000 common seals that lived in the area in spring, slightly more than 50% died. Aerial surveys during August 2003 will provide more exact numbers.

Possible Causes of the pd epidemic

It is still unclear, why the mortality commenced in the Anholt area in 1988 and again in 2002. It is possible that the Anholt area is a virus reservoir (pdv existing e.g. in the populations of grey seals), or a new introduction of the virus took place, e.g. by another aquatic animal, or from indirect anthropogenic sources (e.g. mink farms).

The Tjärnö Marine Biological Laboratory, Sweden, stated that in all probability, the seal epizootic in 1988 started because pdv-carrying harp seals (*Phoca groenlandica*) had swum southwards, infecting common seals in the Kattegat. In 2002, there were no reports of harp seals as far south as the North Sea area. The hypothesis that harp seals spread the virus to common seals this time is therefore very weak.

The seal sites of common seals on the Danish Island Anholt are reserves with no public access and they are far away from the inhabited parts of the island with about 150 inhabitants and some 1,000 summer guests. There are only some sheep and cows on the island, however, nothing special such as fur farms. There are also grey seals (*Halichoerus grypus*) on Anholt, which migrate far away/around and rest on Anholt (no rearing area). During the 1988 disease only some grey seals were infected on Anholt. On Laesø, there are three seal sites and on the small island Hesselø, which is a seal reserve too, beside the seals, only a few summerhouses can be found.

Conclusions

Since there are obscurities regarding the cause of the disease, and there are several hypothesis being discussed currently, it seems imperative to conduct further investigations into the disease. A lot of samples were taken in 2002, for age determination, examination of the health status, genetic, virological and contaminant analysis as well as reproductive status. To gain more detailed knowledge regarding the causes of the epidemic, and to get answers on specific questions related to management and political and scientific points of view, the implementation and financing of joint international activities regarding essential investigation and research programs are necessary.

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