Is Food Shortage the Cause of Eider Duck Mortality?

Shellfish and Crab Abundance in the Dutch Wadden Sea 1994 - 1999

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Introduction

Increased Eider duck (*Somateria mollissima*) mortality in winter 1999/2000 raised questions about food abundance and availability. Eiders found dead showed clear signs of starvation and it was hypothesized that there was a lack of available food (Camphuysen, 2000). Other potential causes, such as diseases or pollution, have also been considered (van den Berk et al., 2000). Some authors have presented parasite infestation as a possible cause of mortality (Borgsteede, this volume).

The dynamics of important prey abundances over a period of 6 years are presented in this paper and are based on annual surveys conducted over the entire Wadden Sea and near shore coast. The dominant prey species are mussels (*Mytilus edulis*), cockles (*Cerastoderma edule*), trough shells (*Spisula subtruncata*) and shore crabs (*Carcinus meanus*) (Leopold et al., 2000). This paper addresses the question as to whether the abundance and quality of prey species showed abnormalities in 1999/2000 and to what extent this could be considered a possible explanation for increased Eider duck mortality. As no extensive information is available on food preferences of starving Eider ducks (Leopold et al., 2000), data on the total amount of shellfish and additional data of year or size class and quality, are presented here as an indication of the amount of prey available.

Materials and Methods

In the framework of an analysis of Eider duck mortality causes, shellfish and crab data from the Wadden Sea and near shore coast were worked out for the period 1994 -1999.

Mussels

Data on mussel stocks were derived from annual surveys of wild sublitoral and litoral mussel beds, and from market delivery data of consumption-sized mussels. Sublitoral mussel surveys are carried out in March on a quantitative basis in the framework of mussel seed inventory. In Septem-

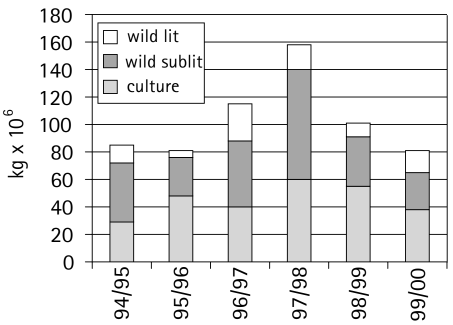

Figure 1: Standing stock of mussels 1994 - 1999: wild sublitoral stocks, estimated stocks on culture plots and wild litoral stocks.

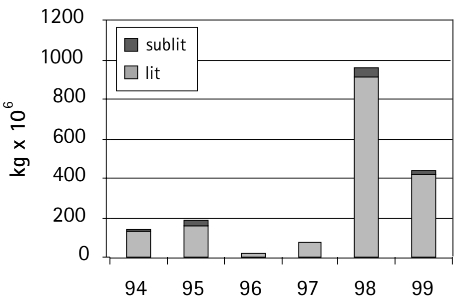

Figure 2: Standing stock of cockles 1994 - 1999 in litoral and sublitoral Wadden Sea areas.

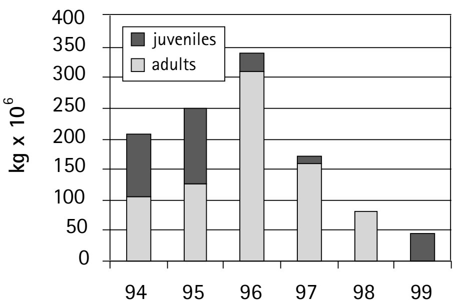

Figure 3: Standing stock of juvenile and adult Spisula 1994 - 1999 in sublitoral off-shore beds, including the North Holland coast.

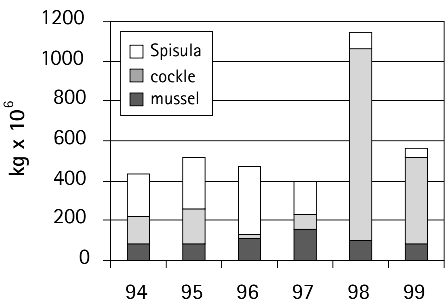

Figure 4: Total shellfish standing stock 1994 - 1999 in the Wadden Sea area.

ber, a qualitative check for mussel seed is carried out. Sampling is done from a commercial vessel using a suction dredge with a sampling width of 20 cm, and a mesh width of 5x5 mm, to a sediment depth of 10 cm, a distance of 100 m. The sampling surface is 20 m^2. Samples are sieved onboard over a 5x5 mm mesh, then sorted by size and finally, their fresh weight is determined. The surveys in the subtidal areas are restricted to the western part of the Dutch Wadden Sea as no subtidal mussel stocks of any importance occur in the eastern part. Litoral mussel stocks are surveyed along with the annual cockle survey in April-May on all tidal flats in the Dutch Wadden Sea. Dispersed stocks are sampled as part of the cockle survey, while mussel beds are quantified on the basis of aerial photography, followed by work carried out on the ground. Data concerning the stock of mussels on culture plots are calculated on the basis of both market delivery and mussel seed fishery data. As limited information is available on the activities of mussel farmers who transplant their stocks, standard conversion factors were used for growth from seed to half-grown mussels to consumption mussels. As these conversion factors may differ in time, the presented estimates of the stock of mussels on plots should be interpreted with care. All mussels are traded through an auction, where data are collected on the total deliveries, size range, flesh content, amount of barnacles on the shells and other tarra; hence, an extensive database is now available on consumption mussels.

Cockles

Annual surveys of cockle stocks are carried out in April-May at approximately 1,500 stations in the intertidal and shallow subtidal zones of the Wadden Sea. A stratified survey design is applied, which is based on information from fishermen on the occurrence of cockle beds. Data from sampling stations are multiplied with the surface corresponding to the stratum of that station. Cockles, together with mussels, *Macoma balthica* and other bivalves, are sampled with a special device, which collects 0.1 m^2 of sediment to a depth of 10 cm, then sieves it over a 5x5 mm mesh, and finally, the fresh weight is measured per year class. A new sampling device has been used since 1998 that collects samples of 0.4 m^2. Extrapolation of standing stock data from spring to September is based on conversion factors for growth and mortality per year class. For conversion from total fresh to flesh weight, a flesh weight of 15% is assumed. Additional data on the flesh content were derived from routine measurements of harvested cockles in the final fishing period at the end of November.

Spisula

Surveys of *Spisula* have been conducted in May-June in the coastal zone since 1995. The islands in the Wadden Sea's offshore, ca 300 stations, are sampled on a grid system with various density strata, using sampling equipment that dredges over 150 m to a sediment depth of 7 cm and a width of 10 cm, i.e. the sample surface is 15 m^2. The mesh width is 5 mm. Samples including Spisula and other benthos are sorted per year class and fresh weight is then determined. The standing stock is calculated according to the surface belonging to the various sampling strata. Results of the surveys from the following spring season are used to determine the autumn data.

Shellfish quality

Data on shellfish quality are only available for harvested mussels and cockles. Meat yields and average sizes are available from landing statistics for cockles, while for mussels, information is also available on the presence of barnacles and other tarra.

Crabs

Annual demersal fish surveys have been carried out in September-October along the North Sea coast since 1970. Beam trawls are 3 m wide, sampling period is 15 min. and on average 200 stations are sampled in the Dutch Wadden Sea and offshore of the islands. Fishing is done at different depths and samples are clustered in 3 depth strata. The mesh size is 20 mm (Boddeke, 1970) and samples are sorted onboard. Data on *Carcinus maenas* and *Liocarcinus holsatus* have been used for the purpose of this study. The data are expressed per m^2 as the method does not allow extrapolation to total area, hence no standing stock data are available.

Results

Standing stocks

The total standing stock of mussels consists of sublitoral mussels in wild beds and on culture plots, predominantly located in the western Wadden Sea, and littoral mussel stocks in the eastern Wadden Sea. In autumn 1999, a stock of $38*10^6$ kg fresh weight of mussels on culture plots, $27x10^6$ kg wild sublitoral mussels and $16x10^6$kg littoral mussels was observed. The total amount was similar to the 1994 and 1995 figures, but below the average of $103x10^6$kg over the study period (Fig. 1).

In autumn 1999, the stock of cockles (Fig. 2) was relatively high at $434x10^6$kg. Almost all cockles are littoral and distributed on tidal flats along the whole

Wadden Sea. The highest densities are found in the east.

The Spisula stock (Fig. 3) that extends along the North-Holland coast has shown a decrease over time, and in autumn 1999 it consisted almost completely of juveniles. These are considered to be 'uninteresting' to Eider ducks. Spisula stocks offshore from the islands also showed low values in 1995 and stocks along the North-Holland were dominant between 1994-1996.

These results show that in autumn 1999, the total stock of shellfish (Fig. 4) had relatively high values, in comparison with the previous period and that cockles were the dominant species.

Fig. 5a shows the average densities of crabs in the Wadden Sea and the offshore area over time. The shore crab's highest densities were in 1999. This was especially the case in the western Wadden Sea and the adjacent part of the North Sea (Fig. 5b). This figure also shows that the distribution of crabs over the depth strata followed a similar pattern throughout the study period.

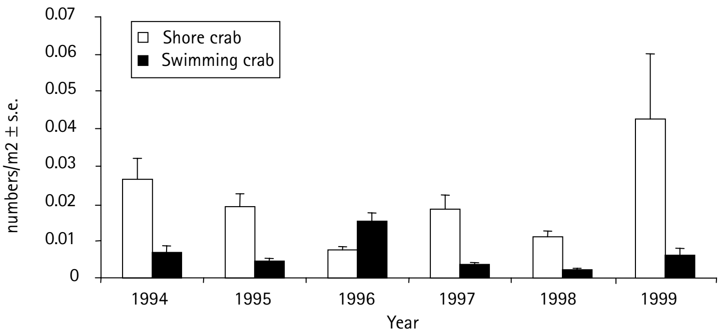

Figure 5a: Densities of shore crabs and swimming crabs 1994 - 1999 as sampled during demersal fish surveys at ca 200 stations in the Wadden Sea area.

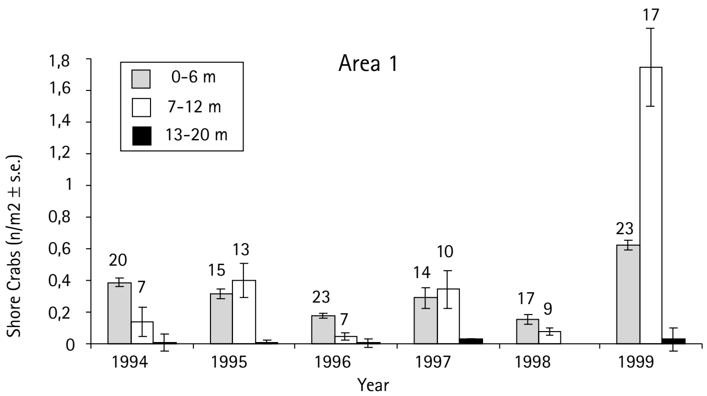

Figure 5b: Densities of shore crabs at stations in different depth strata in the western Wadden Sea in the period 1994 - 1999, with number of stations per stratum.

Shellfish quality

The flesh content of mussels harvested in autumn 1999 from the main production area was 28%. This is close to the average value of 29% over the period 1994-1999. In 1994 and 1995, higher values of flesh content were recorded. Market deliveries from the most westerly area, which is predominantly used for the culture of juvenile mussels, showed a flesh content of 22% in 1999. This value was lower than in previous years. In 1999, mussels from both areas had a higher than average fresh weight (including the shell) of about 20 gram per mussel. Fouling with barnacles on mussels harvested in autumn 1999 amounted to 35 - 45 grams per 2,5 kg of mussels in comparison with values of 3-33 grams that were recorded in previous years.

The flesh content of cockles was approximately 15% by the end of November 1999, and this showed no significant difference when compared to other years. These data show that there was no abnormality in the quality of the cockles. For the mussels on the other hand, there are indications of relatively high barnacle fouling and lower flesh content in the most westerly area.

Discussion

The total shellfish stock did not show abnormally low values in autumn 1999, and the stock was dominated by cockles. In conjunction with their large abundance, the distribution of cockles was not restricted to specific areas of the tidal flats. Densities were in fact higher in the eastern Wadden Sea (Smaal et al., 2000). There was no difference in the quality of the cockles compared to other years. The dominant year class was 3-year-old cockles from the 1997 cohort but there is no evidence that this is a possible limitation for Eider ducks (Leopold et al., 2000). It is therefore concluded as unlikely that the cockle stock in 1999 proved to be a limited food resource for the Eider ducks in comparison to previous years.

The largest mussel stocks are found in the western Wadden Sea. Wild sublitoral beds and culture plots for seed mussels are dominant in the most westerly part, while the area near the island of Terschelling is most important for the culture of consumption mussels. The total amount of harvested mussels from the Wadden Sea in 1999/2000 was $45x10^6$ kg. This is a higher value than between 1995/96 -1997/98, similar to 1994/95 and lower than in 1998/99 (Smaal et al., 2000), and it shows that there are no abnormalities in both total stock and harvest. Not all mussels are harvested, as the culture cycle is two years. The amount left over during wintertime can be estimated on the basis of the harvest of the following season. Until December 2000, a total amount of $27x10^6$ kg was registered at the auction as harvest from the Wadden Sea. These data show that this amount of mussels has survived the 1999/2000 winter, thereby we can assume that growth has compensated for mortality loss. The flesh content of mussels harvested from the western area was lower than before and there were more barnacles on the shells. The question therefore, is whether the quality of the mussels may have limited their availability as prey for the Eider ducks. The flesh content of 22% may be lower than before, but it is higher than in natural mussel stocks. The larger amount of barnacles can be considered a limiting factor, as shown by Swennen (1976). However, it should be considered that the average value of 1.6% can be based on one market delivery with relatively high values of barnacle fouling and other deliveries with lower values or no fouling at all. In addition, an average amount of 0.3 grams of barnacle per mussel can be considered as low and it has been observed that Eider ducks are able to consume mussels with limited barnacle fouling (G. Nehls, pers. comm.). It can therefore be concluded that the mussel stock has shown no dramatic abnormalities during the winter of 1999/2000. The Spisula stock consisted of juveniles, which are not considered to be suitable prey for Eider ducks (Leopold et al., 2000). There is an abnormality for the Spisula stock in autumn 1999. Low Spisula stocks offshore from the islands have been observed between 1994-1996, but prey was available along the North Holland coast during this period. Eider ducks were regularly observed offshore from the Wadden Sea islands, in 1999/2000 (Berrevoets et al., 2000). Owing to their small size, however, it seems likely that Spisula stocks could not serve as a primary food resource for the Eider ducks in 1999/2000. The total stock of shellfish was high in 1998 and 1999, and dominated by cockles. As there is limited information on food preferences of Eider ducks, it can only be concluded that our data do not show clear signs of limited shellfish stocks in 1999/2000 in comparison to previous years.

For the shore crab, the data clearly show high values in autumn 1999. This species is considered as prey for the Eider ducks, particularly juvenile ducks that prefer prey with a relatively weak shell or cuirass. Crabs also host the parasite *Profilicollis botulus*. High crab abundance in autumn may induce extensive parasite infestation of Eider ducks evolving into an epidemic and subsequent mass mortality (Borgsteede, this volume).

Conclusions

As no dramatic abnormalities in shellfish abundance and quality could be found in autumn 1999, food shortage is not the most likely cause of the increased Eider duck mortality episode in 1999/2000. An alternative explanation for the mass mortality may be found in the abnormal crab abundance and subsequent high risk of parasite infestation.

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