EFFECT OF FOOD SHORTAGE ON THE REPRODUCTIVE OUTPUT OF COMMON EIDERS *SOMATERIA MOLLISSIMA* BREEDING AT GRIEND (WADDEN SEA)

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Oosterhuis R. & Van Dijk K. 2002. Effect of food shortage on the reproductive output of Common Eiders *Somateria mollissima* breeding at Griend (Wadden Sea). Atlantic Seabirds 4(1): 29-38. *Following a food-induced major mortality of Common Eiders* Somateria mollissima *in the Dutch Wadden Sea in winter and spring 1999/2000, the reproductive output at Griend was evaluated in comparison with previous seasons. In 2000, the number of breeding pairs showed a decline of 38% and female Common Eiders commenced breeding some 2-3 weeks later than in three previous years. Mean clutch size in 2000 (4.6 eggs clutch^{-1}) was similar to 1999 (4.9 eggs clutch^{-1}), but the hatching probability declined from 0.41 in 1999 to 0.18 in 2000. In 2000, the majority of the nests were deserted prior to hatching, often a few weeks after incubating had started. The number of chicks hatched in 2000 was only a quarter of that in 1999. Observations elsewhere in the Dutch Wadden Sea indicated similar poor breeding results. We suggest that a food shortage in winter and spring was the principal cause for the low reproductive output of Common Eiders in 2000. Adult females probably failed to accumulate sufficient energy stores needed for their prolonged fast during laying and incubation.*

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INTRODUCTION

In winter and spring 1999/2000, an estimated 21 000 Common Eiders *Somateria mollissima* died in the Dutch Wadden Sea. The dead birds were in a very poor condition, and a shortage of the harvestable fraction of the food supply was suggested as the principal cause of the emaciation (Camphuysen *et al.* 2002; Van den Berk *et al.* 2000). Common Eiders are specialised feeders on large benthic invertebrates, mainly blue mussels *Mytilus edulis* and common cockles *Cerastoderma edule* (Swennen 1976). Recently, cut trough shells *Spisula subtruncata* in the adjacent North Sea coastal zone have been used as an alternative prey in some years (Leopold *et al.* 2001).

Adult female Common Eiders prepare for breeding by storing extensive body reserves which are subsequently utilised during egg-laying and incubation (Milne 1976; Parker & Holm 1990). Females fast during incubation

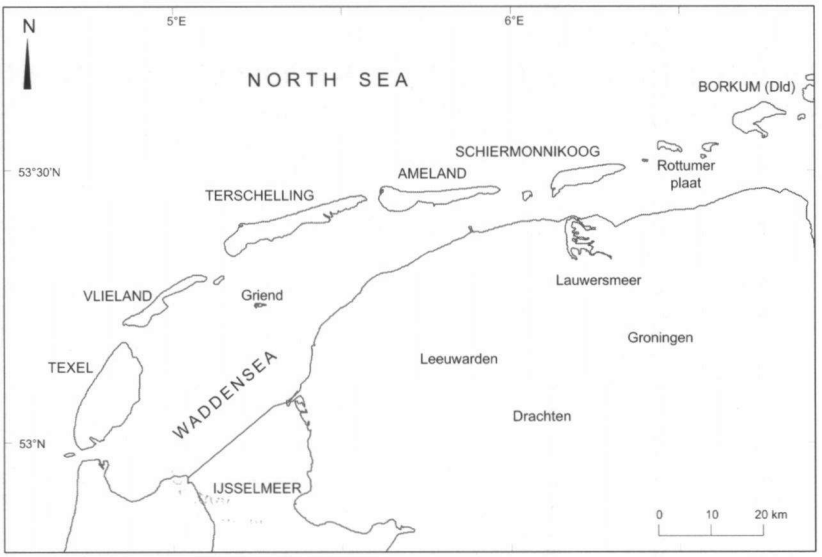


Figure 1. Map of the (Dutch part of the) Wadden Sea showing the location of Griend and other sites mentioned in the text.
Figuur 1. Kaart van de Waddenzee met de ligging van Griend.

and leave the nest only occasionally to preen or to drink some water (Parker & Holm 1990; Swennen *et al.* 1993). Hence, foraging conditions prior to the breeding season can be a critical factor influencing breeding success (Erikstad *et al.* 1993; Christensen 2000). The effect of the possible food shortage is evaluated in this paper by comparing reproductive output of Common Eiders nesting at the island of Griend prior to and following the major mortality.

METHODS

The study was conducted at Griend (53°15'N, 05°15'E; Fig. 1), a National Nature Reserve in the centre of the western Dutch Wadden Sea (Veen & Van de Kam 1988). The Vereniging Natuurmonumenten manages the island. It became a Ramsar site in 1980 and forms part of the Wadden Sea Special Protection Area, designated under the EC Wild Birds Directive in 1991 and the EC Habitats Directive in 1996. Griend is uninhabited and has no public access throughout the year. The vegetated part covers about 55 ha. Griend supports

large numbers of colonial nesting gulls and terns, and their numbers and breeding success are monitored annually. Two wardens reside permanently on the island during the breeding season. In 1999 and 2000, special attention was paid to the breeding biology of the Common Eider (Oosterhuis 2000). The study periods were 21 April to 15 July 1999 and 11 April to 18 July 2000. Some additional data for 1997 and 1998 were derived from warden reports (Brenninkmeijer & Van Tienen 1997; Van Tienen & Baarspul 1998).

Systematic beached bird surveys were carried out each year in the first week after the arrival of the wardens. In 2000, the survey was also subsequently carried out on a weekly basis. All corpses were recorded and marked by clipping the primaries to avoid double counts during later surveys. We used some additional ringing data of Common Eiders found dead on the island before the wardens arrived.

The number of breeding pairs of Common Eiders was mainly assessed by recording all nests found. The construction of a new sand dyke in 1988 led to an increase in the surface of Griend and subsequently to a considerable increase in suitable breeding habitat. It became difficult to find all nests and since 1989 a varying percentage, depending on the amount of time spend in the field, has been added for undiscovered nests. In 1999 and 2000, the wardens searched two to three times per week for nests of scattered breeding species by visiting different parts of the island. All nests of Common Eiders were marked by an inconspicuous thin, 1 m long yellow stake placed 1 m north of the nest. Nests were visited 3-4 times (on average every 10 days) and to avoid disturbance, known nests were approached carefully. Only when there was no female present was the nest checked to determine whether the eggs had hatched, had been taken by predators, or if the nest had been deserted. Nest survival rates were estimated using the Mayfield method (Mayfield 1975). Nests were considered successful if at least one egg had hatched. We used a breeding period of 32 days (egg laying 5 d, incubation 27 d). Females with freshly hatched ducklings assemble along the beach, which was checked daily for Common Eiders with ducklings. The small size of Griend together with the excellent view from the wardens house made this check both easy and reliable.

RESULTS

In 1999, 23 dead Common Eiders were found in the first week after arrival, about the same number as in 1997 (27) and 1998 (31). About 10-20 dead individuals were subsequently recorded during the 1999 breeding season. In 2000, large numbers of dead Common Eiders were found on the beach when the wardens arrived on 11 April and 334 corpses were counted in the first weeks after arrival. Later that season, 52 new dead birds were found; 29 in the first half

Table 1. Ringing details of Common Eiders (all ringed as nestlings) found dead on Griend.
Tabel 1. Ringgegevens van doodgevonden Eiders (alle als kuiken geringd) op Griend.

Ring #	Ringing place	Ringed	Found dead	Sex
Arnhem 7.070.969	Vlieland, NL, 53°15'N; 04°56'E	1979	18 Feb 2000	m
Arnhem 7.073.841	Schierm.'oog, NL, 53°28'N; 0°613'E	1980	08 Mar 2000	m
Arnhem 7.074.174	Terschelling, NL, 53°24'N; 05°29'E	1980	27 Jan 2000	f
Arnhem 7.074.621	Terschelling, NL,53°24'N; 05°29'E	1981	02 May 1999	m
Arnhem 7.077.673	Terschelling, NL,53°24'N; 05°29'E	1984	13 Apr 2000	m
Arnhem 7.078.706	Terschelling, NL, 53°27'N; 05°25'E	1985	16 Apr 2000	m
Kalø 460830	Samsø, DK, 55°53'N; 10°37'E	1995	16 Apr 2000	m
Helsinki DX 017.168	Porvoo, Finl., 60°07'N; 25°25'E	1999	21 Feb 2000	f

of May, 15 in the second half of May, 4 in June and 4 in July. The majority of the birds found in May and June were freshly dead. None of about 300 dead Common Eiders examined had oil in their feathers. All checked corpses were severely emaciated with severe atrophy of the breast muscle. Seven ringed birds were found in 2000, while only one ringed bird had been found in 1999 (Table 1). All were ringed as nestlings, six at various colonies in the Dutch Wadden Sea, two were from Finnish and Danish breeding populations.

Common Eider nests were widely distributed all over the island. The construction of a new sand dyke in 1988 led to a considerable increase in the surface of Griend and subsequently to an increase in the number of breeding Common Eiders (Fig. 2). A maximum of 68 breeding pairs were recorded in 1999. In 2000, the number of breeding pairs had fallen to 42 pairs, a 38%

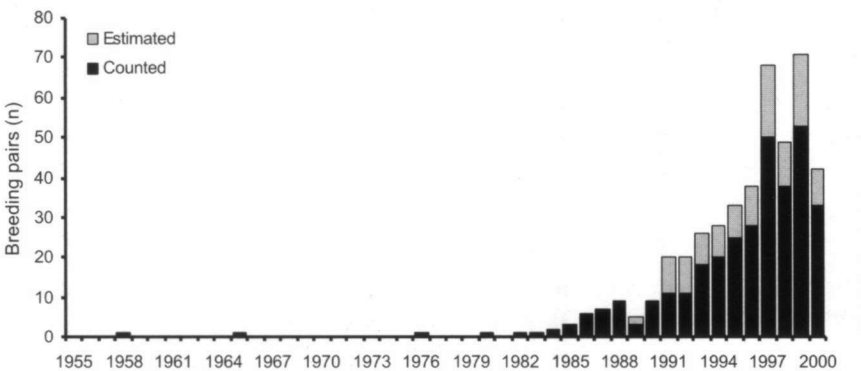


Figure 2. Number of breeding pairs of the Common Eider at Griend in 1955-2000.
Figuur 2. Aantal broedparen van de Eider op Griend tussen 1955 en 2000.

Table 2. Number of breeding pairs and reproduction data of Common Eiders at Griend. [1]calculated data.

Tabel 2. Aantal broedparen en reproductiegegevens van Eiders op Griend. [1]berekende gegevens.

Parameter	1999	2000
Number of breeding pairs	68	42
Laying date of first egg[1]	2 April	21 April
Date of first chicks	4 May	22 May
Mean clutch size (n = 25 / 21)	4.9	4.6
Range	3-6	3-6
n nests observed	21	31
n failed clutches	5	21
n nest days	176	376
Daily survival rate (p)	0.9724	0.9471
Hatching probability (%)	40.8	17.6
n chicks born[1]	136	34

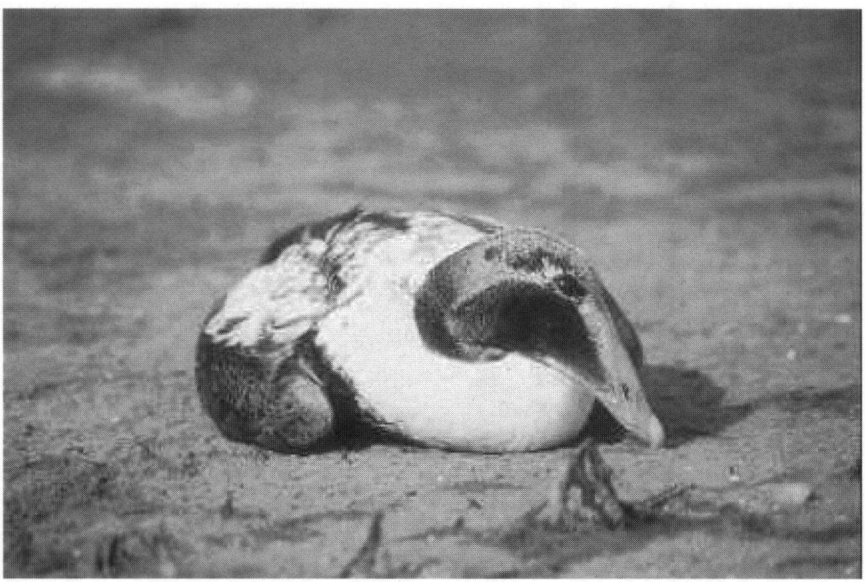
decline. The first nests were found on 21 April 1999 and on 24 April 2000. In 1999, the wardens arrived on 21 April, so nests started earlier could not have been found in that year, while in 2000 the wardens arrived on 11 April. In 1999, the first female with four freshly hatched ducklings was observed on 4 May, a similar date to 1997 (1 May) and 1998 (28 April). In 2000, the first female with five freshly hatched ducklings was observed on 22 May suggesting that egg-laying commenced 2-3 weeks later than in three previous years.

The mean clutch size in 2000 (4.6 eggs clutch^{-1}) was slightly lower than in 1999 (4.9 eggs clutch^{-1}; Table 2). Clutch size varied between 4.8 and 4.2 eggs clutch^{-1} in 1997 (n = 40) and 1998 (n = 27) respectively. Hatching probability declined from 0.41 in 1999 to 0.18 in 2000 (Table 2), with nest desertion being the main reason for the difference between the two years. In 2000, at least 18 nests (out of 31 nests observed) were deserted prior to hatching, often a few weeks after incubating started. These nests were covered with down but the eggs were cold and wet. We estimated (number of breeding pairs x mean number of eggs x hatching probability) that about 136 ducklings hatched in 1999 and about 34 in 2000, a 75% decline. In 1999, no predation on Common Eider chicks was seen, while 14 ducklings were seen to be taken by Herring Gulls *Larus argentatus* in 2000.

DISCUSSION

Numbers of dead Common Eiders washed ashore at Griend in 2000 were about ten times higher than normal, indicating that birds staying around Griend also suffered a substantially increased mortality as recorded elsewhere in the Dutch Wadden Sea. At Griend, no oiled birds were found and all checked birds were severely emaciated. This corresponds with Werkman (2001) and Camphuysen *et al.* (2002), who found no toxicological, bacteriological, or virological explanations for the major mortality. We have no indications that these factors could explain the increased mortality at Griend.

Although our data are based on a small number of nests (albeit a large proportion of the local breeding population), there have been no detailed studies of breeding success elsewhere in the Wadden Sea following the major mortality in 1999/2000. A combination of all our results shows that the reproductive output of Common Eiders at Griend in 2000 was much lower than in previous years.



Dying Common Eider at Griend, June 1999 Stervende Eider op Griend, juni 1999 (*R. Oosterhuis*)

Earlier studies used hatching success as it was assessed in a traditional manner: the number of nests hatched divided by the number of nests found. We recalculated our Mayfield hatching success data to estimate traditional hatching success (0.76 in 1999, 0.32 in 2000), showing that the hatching success at Griend in 2000 was also very low in comparison to several earlier studies. Traditional hatching success at Vlieland averaged at 0.85 during 1959-1979 (range 0.66-0.96; n = 13 years of study; Swennen 1983). Swennen listed hatching success for Finland, Sweden, Germany and Scotland and most figures were similar to his data and to hatching success as assessed at Griend in 1999. Relatively low values were found at Vlieland during 1962-1968, when a high mortality of (nesting) adult female Common Eiders occurred, as a result of pollution of the Wadden Sea with pesticides. Swennen never recorded hatching success as low as at Griend in 2000, but cited one value that approached our 2000 results. This result (hatching success between 0.15 and 0.57) came from a study at Amrum (German Wadden Sea) in the 1950s, when nest desertion was mainly induced by predation and frequent human disturbance.

Observations elsewhere in the Dutch Wadden Sea in 2000 indicated similar poor breeding results. At Rottumerplaat, Lutterop & Kasemir (2001) reported that Common Eiders commenced breeding approximately 1-2 weeks later than normal and the first ducklings were observed on 20 May, while this normally occurred between 5 and 10 May. The number of breeding females found at Rottumerplaat was 39% lower than in 1999 and large numbers of non-breeding adult females were observed at and around the island, a phenomenon not seen in previous years. Lower than normal numbers of breeding females were reported from standard sampling areas on Vlieland, Terschelling, Ameland and Schiermonnikoog, and field workers in these areas had the impression that the nesting season was significantly delayed and that very few ducklings were successfully reared (Dijksen & Koks 2001). Moreover, counts of adult and sub-adult males in April and May at Vlieland and Schiermonnikoog (Dijksen & Koks 2001) and at Rottumerplaat (Lutterop & Kasemir 2001) showed a lesser decrease than was found using nest counts, which Dijksen & Koks (2001) suggested as indicating that a considerable number of adult females were in such a bad condition that they were not able to breed.

Other breeding bird species at Griend showed no indications of a poor breeding season. Common Shelduck *Tadorna tadorna*, Black-headed Gull *Larus ridibundus*, Sandwich Tern *Sterna sandvicensis* and Common Tern *S. hirundo* exploit other food sources than Common Eiders and all had an average to good breeding season in both years (Baarspul & Oosterhuis 1999; Oosterhuis & Heideveld 2000). This indicates that factors like weather, human disturbance and predation had no adverse effects on the breeding results in 2000. Eurasian Oystercatchers *Haematopus ostralegus* are common breeding birds at Griend

with 440 breeding pairs in 1999 and 490 in 2000 and are specialised feeders on common cockles and blue mussels, as are Common Eiders. Eurasian Oystercatchers have experienced major mortality, reduced breeding success and population declines in and around the Dutch Wadden Sea as a result of a more or less chronic shortage of food since the early 1990s (Camphuysen *et al.* 1996; Nève & Van Noordwijk 1997; Smit *et al.* 1998; Smit *et al.* 2000), but a major mortality of this species did not occur in winter 1999/2000 and there was no reduction in reproductive output at Griend in 2000, with hatching probabilities of 0.70 in 1999 and 0.66 in 2000. However, the number of adult non-breeders waiting for a vacant territory has recently decreased sharply and the situation at Griend may have been less favourable than it seems (Van Dijk & Oosterhuis 2001).

De Vlas (1982) found evidence for a negative relationship between laying date of Common Eiders at Vlieland and common cockle resources in the Wadden Sea and indicated that common cockles are an important prey item in spring for pre-breeding females, which were supposed to quickly increase their body mass by foraging on an easily accessible prey such as common cockles of the right size. There is evidence (Swennen 1976) that Common Eiders prefer small-sized common cockles. The number of first year common cockles in the Dutch Wadden Sea was very low in the autumn of 1999 (Van den Berk *et al.* 2000), suggesting that pre-breeding females might not be able to find enough common cockles of their preferred size.

Although there may be another explanation, we believe the available information suggests a shortage of food in winter and early spring as the cause of the low reproductive output of the Common Eider at Griend in 2000. Many authors have argued that gross industrial shellfisheries in the Dutch Wadden Sea on common cockles and blue mussels and on cut trough shells in the adjacent North Sea has negative effects on the amount of food harvestable for molluscivorous birds in the Wadden Sea like the Common Eider and the Eurasian Oystercatcher (Camphuysen *et al.* 1996; Nève & Van Noordwijk 1997; Beukema *et al.* 1998; Smit *et al.* 1998; Piersma *et al.* 2001; Camphuysen *et al.* 2002). Our findings underline the need for a critical evaluation of the industrial shellfishery in the Dutch Wadden Sea, which is a National Nature Reserve, a Ramsar site, and a Special Protection Area under the EC Wild Birds Directive and under the EC Habitats Directive. Unfortunately, the breeding biology of Common Eiders in the Dutch Wadden Sea has not been studied in recent years so that the observations at Griend are rather unique. Our findings show the utmost importance of annual assessments of breeding performance and hatching success of the Common Eider, one of the most important molluscivorous bird in the Wadden Sea. Like our study, this monitoring project should follow the

standard guidelines of the 'Nestkaartenproject' of SOVON Dutch Centre for Field Ornithology.

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GEVOLGEN VAN VOEDSELSCHAARSTE IN DE WADDENZEE OP DE BROEDPOPULATIE VAN DE EIDER *SOMATERIA MOLLISSIMA* OP GRIEND

Nadat in de winter van 1999/2000 ongeveer 21 000 Eiders Somateria mollissima *in de Nederlandse Waddenzee door verhongering waren gestorven, werd het broedsucces op Griend bepaald en vergeleken met gegevens uit eerdere jaren. In 2000 daalde het aantal broedparen ten opzichte van het piekjaar 1999 met 38%. De wijfjes begonnen 2 tot 3 weken later te broeden dan in normale jaren. De gemiddelde legselgrootte (4.6 eieren per nest) week niet af van die in voorgaande jaren (4.8 in 1997, 4.2 in 1998, 4.9 in 1999), maar de uitkomstkans van de legsels daalde van 41% in 1999 naar 18% in 2000. In 2000 werden veel nesten voortijdig verlaten, vaak enkele weken nadat met het broeden was begonnen. We denken dat de ongunstige voedselsituatie in de Waddenzee de meest waarschijnlijke verklaring is voor de gevonden verschillen. Helaas werd het broedsucces alleen in de kleine kolonie op Griend bepaald. Minder exacte gegevens uit andere delen van de Waddenzee laten overigens dezelfde trend zien. We pleiten voor het starten van een monitoringproject binnen het Nestkaartenproject van SOVON om het broedsucces op meerdere locaties jaarlijks vast te stellen.*

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