

ARE BLUE MUSSELS *MYTILUS EDULIS*
IMPORTANT PREY FOR HERRING GULLS
LARUS ARGENTATUS AFTER A 20 YEAR
DECLINE IN MUSSEL STOCKS?
INVESTIGATIONS ON SPIEKEROOG

ZIJN MOSSELEN NOG BELANGRIJK ALS VOEDSEL VOOR
ZILVERMEEUWEN NA DE AFNAME IN DE AFGELOPEN 20
JAREN? EEN ONDERZOEK OP SPIEKEROOG

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This study investigates if Blue Mussels are an important prey after a decline in mussel stocks over the last 20 years. It is based on the analysis of pellets collected in July and August 1994 from the breeding colony of Herring Gulls *Larus argentatus*, located on the Ostplate of Spiekeroog. The pellets were analysed to determine the proportion of Blue Mussels *Mytilus edulis* in the food. In total, 47% of the food in the pellets consisted of Blue Mussels. In August, mussels provided significantly more of the food than in July. This may be related to the larger size of seed mussels in August and to the extremely high numbers present in 1994.

INTRODUCTION

At the East Frisian coast the breeding population of Herring Gulls *Larus argentatus* has increased during the last 20 years (Exo 1994). Herring Gulls are omnivorous and individuals living in the Wadden Sea area partly feed on prey items of the tidal flats such as Blue Mussels *Mytilus edulis* (Leege 1917, Meijering 1954, Spaans 1971, Wietfeld 1977, Vauk & Prüter 1987, Dervedde 1993). As the mussel stocks have decreased during the last 20 years (Michaelis *et al.* 1995), it was of particular interest to investigate whether Blue Mussels are still an important prey for Herring Gulls in this area. Herring Gulls regurgitate indigestible components of their food as pellets. These are taken as a basis for the analysis of food. This study aims to assess the frequency of Blue Mussels as food both in isolation and in combination with other items. The Herring Gull colony on the East Frisian island of Spiekeroog was used to provide the data.

Table 1. Number of pellets (n) collected in July and August 1994 and classification of sites 1-4 to western (W) and eastern (E) side of the Ostplate of Spiekeroog.

Tabel 1. Aantal braakballen (n) verzameld in juli en augustus 1994 en de toewijzing van de verzamelplaatsen 1-4 aan respectievelijk de westzijde (W) en de oostzijde (E) van de Oostplaat van Spiekeroog.

Date	site	E-W	n	date	site	E-W	n
14 Jul 1994	4	W	24	5 Aug 1994	1	E	74
20 Jul 1994	1	E	148	5 Aug 1994	2	E	23
27 Jul 1994	3	W	20	5 Aug 1994	3	W	15
27 Jul 1994	4	W	22	5 Aug 1994	4	W	8

METHODS

Pellets were collected in July and August 1994 from the breeding colony of Herring Gulls situated on the Ostplate of Spiekeroog. Studied nest sites were marked and, on each visit, all pellets were removed. The four study sites were in the dunes at regular distances along the five km east-west-extent of the Ostplate. For the analysis of regional differences, the two easterly sites were compared with the two westerly. The dates, at which pellets were collected, are shown in Table 1. The position of the nest sites studied was determined from a survey of all breeding species, carried out by the Staatliches Amt für Insel- und Küstenschutz, as Lesser Black-backed Gulls *Larus fuscus* also occur on the Ostplate of Spiekeroog. However, in the west, it is possible that some Lesser Black-backed Gull pellets were included in the analysis.

The percentage volume that Blue Mussels contributed to the pellets was determined. For the statistical comparisons, pellets were grouped in three categories: group one pellets did not contain Blue Mussels, group two contained Blue Mussels and other food items and group three contained only Blue Mussels. On average, the proportion of Blue Mussels in the mixed pellets amounted to about 50% of the total volume and this figure was used in the calculations. The relative frequency of Blue Mussels in the pellets at different sites and at different times was compared by the two-sample *t*-test with unknown and possibly unequal variances (Sachs 1992). It was assumed that the proportion of Blue Mussels in the pellets represented the relative proportion of Blue Mussels in the food of Herring Gulls. The other food items in the pellets were classified by eye, thus neglecting prey items with very small undigestible components.



Adult Herring Gull *Larus argentatus* feeding on Blue Mussels (drawing F.J. Maas)

RESULTS

Blue Mussels were the most frequent food component occurring in 72 % of the pellets (Table 2). In 23% of the pellets they occurred as the only food item and in 49% mixed with others (Table 3). In total, 47% of the indigestible remains in the pellets consisted of Blue Mussels. The constituents of the pellets varied with the time of collection. In the west, Blue Mussels contributed 23% in July and 52% in August to the total volume (Table 3); the difference was significant ($P=0.004$). In the east, the proportion of Blue Mussels was 42 % in July and 70% in August (Table 3); the difference was highly significant ($P<0.001$). Results from the western and the eastern sites were compared. In July, the difference was highly significant ($P<0.001$), however, in August it was not ($P=0.07$). Apart from Blue Mussels, pellets contained remains of other marine organisms, mainly barnacles and crabs. Terrestrial food items, in general, occurred less often (Table 2).

DISCUSSION

In this study, it was found that, in total 47% of the food items in the Herring Gull pellets consisted of Blue Mussels, and this prey species occurred in 72% of all pellets. The only report which can be compared with the present one, because the presentation of the data allowed calculations according to the new method, is that of Wietfeld (1977), who collected pellets during one summer month in 1975 and in 1976 on the Großer Knechtsand, situated in the Elbe-Weser estuary (Lower Saxony). In that study in 1975, 15% of the pellets consisted of Blue Mussels and they occurred in 28% of the pellets. In 1976, the figures were 49% and 71%. These last figures are almost identical with the present results of 47% and 72%.

The proportion of Blue Mussels was relatively high during the Spiekeroog study. The high proportion of mussels in Spiekeroog pellets may be explained by the very large spatfall of Blue Mussels in 1994. The abundance of Blue Mussels of suitable size (Meire 1993) will have influenced the birds' diet. Local differences occurred on Spiekeroog: in the east the proportion of Blue Mussels was higher than in the west, perhaps because, in the east, mussels occur very close to the island. Herring gulls can fly long distances for feeding, but prefer food resources close to the breeding area (Goethe 1956, Camphuysen 1995). In August, mussels provided more of the food than in July, both at the western and eastern sites. Meijering (1954) also found an increase of pellets

Table 2. Frequency of occurrence of prey types encountered in the Herring Gull pellets collected on Spiekeroog in 1994 (n = 334).

Tabel 2. Voorkomen van prooiotypen in de op Spiekeroog in 1994 verzamelde braakballen van Zilvermeeuwen (n = 334).

Prey type <i>Prooi</i> soort	Frequency (%) <i>frequentie</i> (%)
Blue mussels <i>mosselen</i>	71.6%
vegetation <i>plantaardig materiaal</i>	34.1%
Barnacles <i>zeepokken</i>	32.0%
crabs <i>krabben</i>	22.0%
garbage <i>vuilnis, afval</i>	14.1%
bones (mammal) <i>botten van zoogdieren</i>	7.5%
bones (fish) <i>graten van vis</i>	6.9%
other bivalves <i>overige tweekleppigen</i>	3.0%
feathers <i>vogelveren</i>	2.4%
bones (birds) <i>botten van vogels</i>	0.9%
grit, stones <i>steentjes</i>	0.6%
starfish <i>zeesterren</i>	0.3%
insects <i>insecten</i>	0.3%

with Blue Mussels on Spiekeroog later in the summer, probably due to the larger size of seed mussels at that time. More Blue Mussels were offered to chicks in the second part of the study period while crabs were more frequent in the first (Hilgerloh unpubl.). These items were brought to the colony and not taken away when the chicks did not eat them completely.

In the pellets, apart from Blue Mussels, barnacles occurred quite often (Table 2) presumably because they were attached to the larger mussels. However, there were also pellets with barnacles alone which must have been taken on purpose. This confirms my own observations at different sites in the Wadden Sea (Hilgerloh unpubl.). Apart from Blue Mussels and barnacles, crabs were found frequently in the pellets (Table 2). The dominant prey item can differ from place to place and from year to year at the same locality. In the tidal flats, the commonest food items seem to be Cockles *Cerastoderma edule*, Blue Mussels and crabs (Ehlert 1961, Wietfeld 1977, Noordhuis & Spaans 1991, Dervedde 1992). Young gulls are often fed with fish (Spaans 1971, Furness *et al.* 1992), and fish may predominate in the food of adults at sites away from the tidal flats (Harris 1965, Löhmer & Vauk 1969, 1970). In contrast to chicks, adults do not digest fish bones or do so only partly (Spaans 1971). Terrestrial food items occurred less often in the pellets. The presence of

Table 3. Pellets with and without Blue mussels or with mixed contents in the second half of July (top) and the first half of August (bottom). Shown are the number of pellets encountered (n) and the percentage of all pellets analysed (%). The 'Total of Blue Mussels (%)' shows the percentage of Blue Mussels in the food according to calculations described in the methods.

Tabel 3. Braakballen met en zonder mosselresten of met een gemengde inhoud, eind juli (boven) en begin augustus (onder). Weergegeven zijn het aantal braakballen (n) en het percentage van alle onderzochte braakballen (%). Het 'totaal aan mosselen (%)' geeft het percentage mosselen in het dieet volgens de in de 'Methode' uitgelegde berekeningen.

Area	Pellets cont. only Blue Mussels		Pellets cont. a mixture, incl. Mussels		Pellets without Blue Mussels		Total of Blue Mussels	Pellets analysed
	x	%	x	%	x	%	%	n
Second half of July								
W	7	11	16	24	43	65	23	66
E	10	7	105	71	33	22	42	148
First half of August								
W	8	35	8	35	7	30	52	23
E	50	52	35	36	12	12	70	97
Totals	75	23	164	49	95	28	47	334

vegetation in the pellets is interpreted as a secondary effect as it ingested with other food items (Spaans 1971).

At Spiekeroog, in 1994, Blue Mussels were a more important prey than in most previous studies (Ehlert 1957, 1961, Meijering 1954, Focke 1959, Hartwig & Söhl 1979, Prüter *et al.* 1988, Dervedde 1993). According to a study done in 1949 and 1950 in a colony close to the village of Spiekeroog, Blue Mussels occurred in approximately 10% of all pellets. Further east, on the island of Mellum Blue Mussels were found in only 2% of the pellets between March and September (Ehlert 1961). Even in stomachs studied on Mellum, Blue Mussels were very rare (Focke 1959). Further east, on the island of Scharhörn, Blue Mussels were present in only 4% of the stomachs investigated (Prüter *et al.* 1988). The studies from the Königshafen of Sylt situated in the tidal flats of Schleswig-Holstein, showed Blue Mussels in 25% (Hartwig and Söhl 1979) and 45% of the pellets (Hartwig & Söhl 1979, Dervedde 1993). On Terschelling, situated in the tidal flats of the Netherlands, the percentage of pellets with Blue Mussels increased from 19% in 1966 to 38% in 1985 and to 78% in 1986 (Spaans 1971, Noordhuis & Spaans 1992). The authors explained

the increase by competition from the increasing numbers of Lesser Black-backed Gulls behind fishery vessels. In the same time the proportion of fish decreased in the food of herring gulls. This competition could not be confirmed in studies onboard fishing vessels off the Dutch Wadden Sea islands (Camphuysen 1995). The population of Lesser Black-backed Gulls increased also at the East Frisian coast; however, competition effects on the food composition of Herring Gulls are not studied here.

The high proportion of Blue Mussels in the food of Herring Gulls gives evidence of the opportunistic behaviour of this bird species taking advantage of the abundance of seed mussels. The quantitative effect of predation by Herring Gulls on the mussel populations is relatively small (Hilgerloh 1997, Hilgerloh *et al.* 1997). Thus, the increase of the population of Herring Gulls will not have caused the decrease of the mussel populations.

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SAMENVATTING

*In juli 1994 werden braakballen van Zilvermeeuwen op Spiekeroog onderzocht op de aanwezigheid van Mosselen *Mytilus edulis* (Tabel 1). In totaal bestond 47% van het in deze braakballen aangetroffen voedsel uit Mosselen en deze schelpdieren werden in 72% van de braakballen aangetroffen. Het ongewoon grote aandeel dat mosselen uitmaakten in vergelijking met eerdere studies werd wellicht veroorzaakt door de rijke zaadval in 1994. Het rijke aanbod van schelpdieren zal veel Zilvermeeuwen er toe bewegen hebben deze prooienten exploiteren.*

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