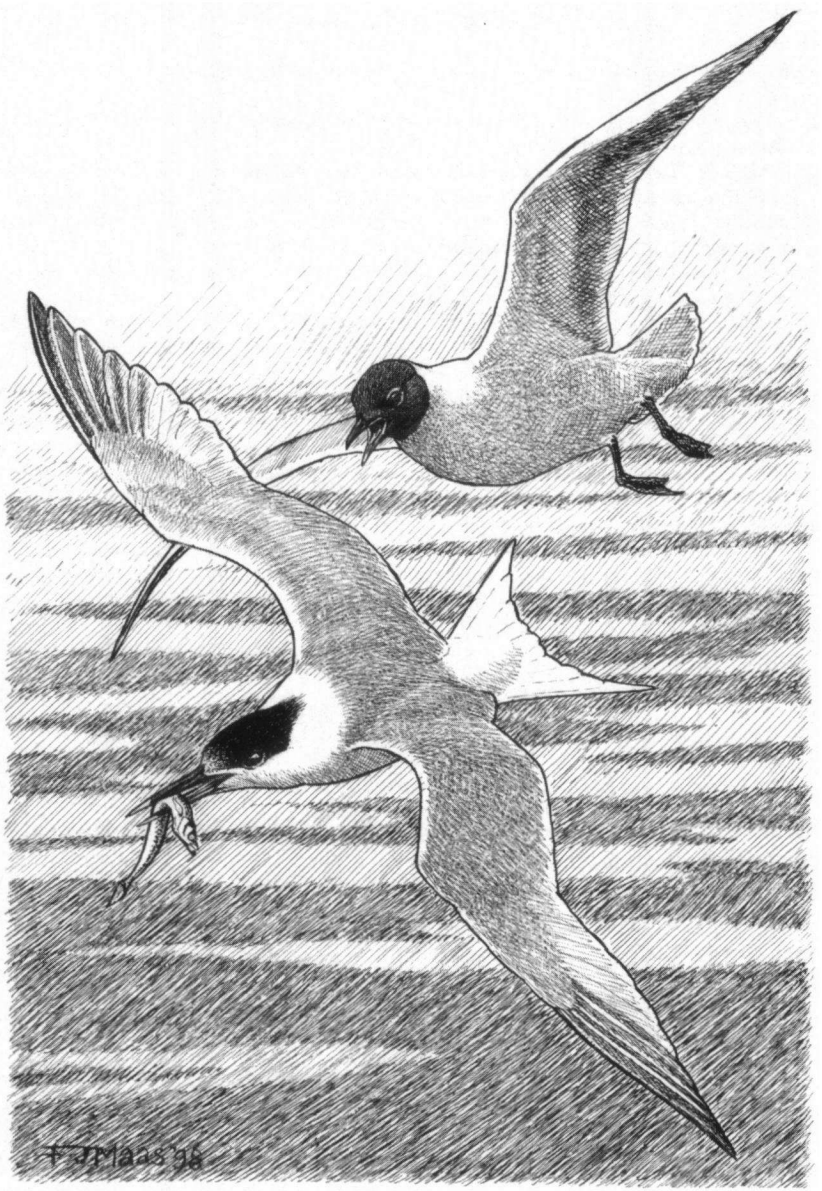

Sandwich Tern attacked by Black-headed Gull *Grote Stern aangevallen door Kokmeeuw* (F.J. Maas)

DIET OF SANDWICH TERNS *STERNA SANDVICENSIS* ON JUIST (GERMANY)

HET VOEDSEL VAN GROTE STERNS OP JUIST (DUITSLAND)

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ABSTRACT

The diet of Sandwich Terns Sterna sandvicensis *breeding on the East Frisian Wadden Sea island Juist was studied between 18 and 23 June 1997. The colony was established in 1994 and comprised 1460 pairs in 1997. 72.5 % of 1025 prey items recorded were sandeels, 27.0 % clupeids and 0.5 % other, not identified fish species. Prey size ranged from 5 to 16 cm in sandeels (mean = 10 cm; n = 242) and from 5 to 15 cm in clupeids (mean = 9 cm; n = 113), calculated prey mass from < 0.5 to 13 g in sandeels (mean = 4 g) and from 1 to 27 g in clupeids (mean = 6 g). Black-headed Gulls stole fish in 11 % (n = 148) of the returns of Sandwich Terns carrying fish. Successful kleptoparasitism by Black-headed Gulls* Larus ridibundus *was observed only in the breeding colony. Sandwich Terns obviously foraged only in the open sea north of Juist but not in the Wadden Sea south of the island.*

INTRODUCTION

In the southern North Sea, Sandwich Terns *Sterna sandvicensis* typically occur at the border between the Wadden Sea and the open sea (Camphuysen & Leopold 1994, Garthe *et al.* 1995). On a large scale, this species is therefore considered to be an 'inshore' species (Garthe 1997). At a smaller scale, however, its distribution differs substantially from the other tern species being more orientated towards the sea and occurring in much lower densities close to the mainland coast (Garthe *et al.* 1995, unpubl. data). Although 8000-9000 pairs breed along the German North Sea coast - the highest population size this century (Südbeck & Hälterlein 1997) -, only one study has focused to some extent on the diet of Sandwich Terns (Gorke 1990). We therefore investigate in this paper the diet at a well-accessible colony in the German Bight. This colony

was established in 1994 with 700 pairs (Hälterlein & Südbeck 1996). Colony size increased in subsequent years: 1071 pairs in 1995 (Südbeck & Hälterlein 1997), 2370 pairs in 1996 and 1460 pairs in 1997 (P. Südbeck pers. comm.).

METHODS

This study was conducted on Juist, one of the East Frisian Islands (Germany), from 18 to 23 June 1997. Juist is situated between the Wadden Sea south of the island and the open sea north of the island. The colony was located in the saltmarshes ('Gemeindeheller') east of the main settlements. The nests are on the upper beach wall between the saltmarshes and the Wadden Sea. Most nests contained chicks which were mostly between 1 and 3 weeks old. Black-headed Gulls (*Larus ridibundus*) bred in a few hundred pairs around the Sandwich Tern colony.

We observed Sandwich Terns returning to the colony sitting on the saltmarshes some 200 m off the colony. Field effort covered all times of day and all stages of the tides. The species of fish carried by Sandwich Terns were identified by binoculars when the birds flew in few meters height over or beneath us. Fish length was estimated as multiples (to the nearest tenth) of bill length. The mean bill length of 54.6 mm was taken from Brenninkmeijer & Stienen (1994). Prey mass was subsequently calculated for sandeels *Ammodytes* spec. and Sprat *Sprattus sprattus* using the length-mass-relationships given in Harris & Hislop (1978). Attempts by Black-headed Gulls to steal fish from Sandwich Terns were quantified when (1) the terns flew over the saltmarsh from the Dunes in the north of the island towards the colony (up to 500 m; by binoculars) and (2) when the terns tried to land and to feed their chicks (by telescope).

RESULTS

The prey of Sandwich Terns consisted mainly of sandeels (72.5 %; Ammodytidae) and clupeids (27.0 %; presumably Herring *Clupea harengus* and Sprat *Sprattus sprattus*; n = 1025 prey items). Only 0.5 % were attributed to other, not identified fish species. In less than 1 % of the feeding flights did Sandwich Terns carry two fish, all other times only one fish per time. The size of the prey ranged from 5 to 16 cm in sandeels (mean 10 cm; n = 242) and from 5 to 15 cm in clupeids (mean 9 cm; n = 113; Figure 1). The calculated prey mass ranged from < 0.5 to 13 g in sandeels (mean 4 g) and from 1 to 27 g in clupeids (mean 6 g). From 72 randomly selected feeding flights of Sandwich Terns over the saltmarshes from the Dunes towards the colony, 61 were conducted without

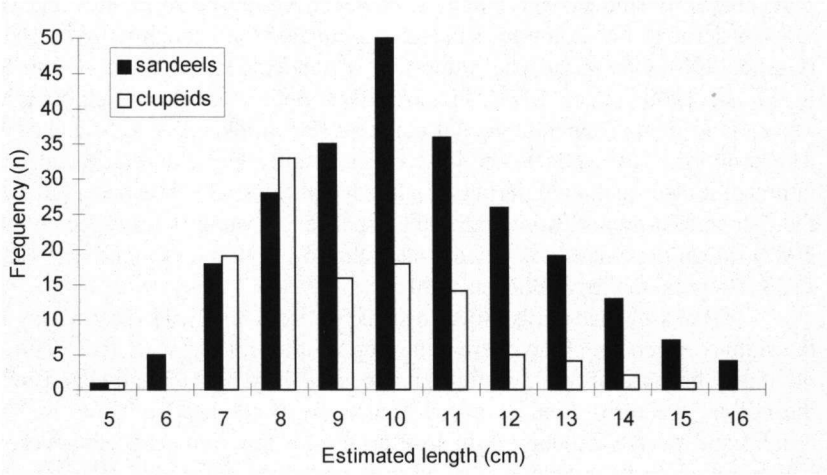

Figure 2. Length distributions of sandeels and clupeids caught by Sandwich Terns on Juist.

Figuur 2. Lengteverdeling van zandspieringen en haringachtigen gevangen door Grote Sterns op Juist.

any attack by Black-headed Gulls. During the remaining 11 flights, Black-headed Gulls vainly tried to steal fish from Sandwich Terns. Most Sandwich Terns were attacked by Black-headed Gulls when they landed in the colony carrying fish and trying to feed their chicks. In 17 of 148 randomly selected occasions (11 %), these actions were successful. In a further case, a Sandwich Tern stole fish from a conspecific after colliding in the air by chance.

Although not sampled extensively enough to allow detailed analysis, flight activity (birds carrying fish) was by far the highest in the early morning hours and relatively low in early afternoon. Fish-carrying Sandwich Terns were noticed almost until complete darkness. Virtually no Sandwich Terns were detected foraging in the Wadden Sea, even during high tide, to the south of Juist. Whereas most terns flew directly over the dunes from northwest to northeast, some birds came along the island from west.

DISCUSSION

The selection of prey species by Sandwich Terns on Juist fitted well the typical pattern found in this species (Nehls 1982). Thus, fish other than sandeels and clupeids are generally represented in less than 1% of the diet (Nehls 1982). The

percentages of sandeels and clupeids, however, varied between sites and years. On Norderoog, for example, sandeels dominated only slightly over Herring (Gorke 1990). On Griend, the proportion of sandeels lay between 31 and 64 % in the late 1960s (Veen 1977), in 1992-1993, both sandeels and clupeids were represented in approximately equal numbers (Brenninkmeijer & Stienen 1994). The proportion of sandeels on Juist is remarkably high for the Wadden Sea, although it also fluctuated during the six days of the study. The observed size of the fish carried around were within the usual range found in this species (Nehls 1982). Mean prey sizes coincided well with those found on Griend in 1992 and 1993 (Brenninkmeijer & Stienen 1994).

Black-headed Gulls failed to steal fish from Sandwich Terns away from the colony when the terns were returning to the colony with fish. This was obviously because of the high flight manoeuvrability of the Sandwich Terns. In the colony the terns tried to avoid attacks by Black-headed Gulls by flying around and over the colony (which often took a few minutes). However, they had to return to their chicks at some time and could not avoid all interactions with the gulls. The intensity of kleptoparasitism and its success generally depends on breeding stage and chick age, fish length, wind speed and time of day (Fuchs 1977, Gorke 1990, Brenninkmeijer & Stienen 1994, Ratcliffe *et al.* 1997). The overall precentage of successful attacks by Black-headed Gulls on Juist (11 %) was in the range of other, more comprehensive studies. In detail, it was higher compared to studies on the Sands of Forvie in Scotland (1 to < 6 % during the same chick stage; Fuchs 1977) and at Coquet Island in England (Ratcliffe *et al.* 1997), similar to that on Norderoog in Germany (ca. 9-15 % during the same chick stage; Gorke 1990) and less than that on Griend in The Netherlands (14-19 %; Brenninkmeijer & Stienen 1994).

The location of Juist is different from many other islands housing Sandwich Tern colonies in so far that it builds the border between the Wadden Sea and the open sea. It was most obvious that foraging took place only on the seaward site of the island. This coincides well with observations of Veen (1977), where the terns breeding on Griend foraged near the West Frisian islands Terschelling and Vlieland, although birds from the same colony on Griend nowadays appear to forage more in the Wadden Sea (Brenninkmeijer & Stienen 1994). Detailed mapping of the distribution at sea have not been conducted yet but crude estimates suggest that the Sandwich Terns in the German Bight usually do not fly much further than 20-30 km (Garthe 1997) from the colony. The directions of Sandwich Terns varied during the study, suggesting that prey availability and preferred feeding sites also varied, probably in connection with tide, weather and time of day (cf. Veen 1977, Brenninkmeijer & Stienen 1994).

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ZUSAMMENFASSUNG

*Die Nahrung von Brandseeschwalben (*Sterna sandvicensis*) wurde auf der ostfriesischen Wattenmeer-Insel Juist vom 18. bis 23. Juni 1997 untersucht. Die Kolonie entstand 1994 und umfaßte 1997 rund 1460 Paare. Von 1025 Beuteobjekten entfielen 72,5 % auf Sandaale (Ammodytidae), 27,0 % auf Clupeiden (vermutlich Hering* Clupea harengus *und Sprotte* Sprattus sprattus*) und 0,5 % auf andere, nicht bestimmte Fischarten. Die Beutegröße betrug 5 bis 16 cm bei Sandaalen (Mittelwert = 10 cm; n = 242) und 5 bis 15 cm bei Clupeiden (Mittelwert = 9 cm; n = 113), die daraus berechnete Beutemasse 0,3 bis 13 g bei Sandaalen (Mittelwert = 4 g) und 1,0 bis 27 g bei Clupeiden (Mittelwert = 6 g). Lachmöwen stahlen den zurückkehrenden Brandseeschwalben den Fisch in 11 % von 148 untersuchten Fällen. Erfolgreicher Kleptoparasitismus durch Lachmöwen (*Larus ridibundus*) wurde nur direkt in der Brutkolonie beobachtet. Die Brandseeschwalben suchten offensichtlich nur in der offenen See nördlich von Juist, nicht aber im Wattenmeer südlich der Insel nach Nahrung.*

SAMENVATTING

De voedselsamenstelling van Grote Sterns *Sterna sandvicensis* op het Duitse waddeneiland Juist werd van 18-23 juni 1997 onderzocht. De kolonie op Juist is in 1994 ontstaan en bestond toen uit 700 broedparen, waarna de kolonie is gegroeid tot 1640 paren in 1997. Van de 1025 prooidieren die werden waargenomen bestond het merendeel (72.5%) uit zandspiering Ammodytidae, 27.0% bestond uit haringachtigen Clupeidae en slechts 0,5% bestond uit andere, niet geïdentificeerde vissoorten. De lengte van de aangebrachte zandspieringen bedroeg 5-16 cm (gemiddeld 10 cm, n= 242) en 5-15 cm (gemiddeld 9 cm, n= 113) voor de aangebrachte haringachtigen. De daarbij behorende massa van de prooivissen bedroeg 0.3-13 g (gemiddeld 4 g) voor zandspieringen en 1.0-27 g (gemiddeld 6 g) voor haringachtigen. In 11% van de gevallen (n= 148) roofden Kokmeeuwen *Larus ridbundus* de vis van de Grote Sterns. Hoewel de Kokmeeuwen ook wel prooien in de lucht probeerden te roven, waren ze alleen succesvol wanneer een Grote Stern bij zijn kuiken wilde landen. Alle terugkerende sterns kwamen vanuit open zee, waaruit kan worden opgemaakt dat de Grote Sterns op Juist uitsluitend in de Noordzee foerageerden en niet in de Waddenzee.

REFERENCES

Brenninkmeijer A. & Stienen E.W.M. 1994. Pilot study on the influence of feeding conditions at the North Sea on the breeding results of the Sandwich Tern *Sterna sandvicensis*. IBN Research Report 94/10, Institute for Forestry and Nature Research, Wageningen.

Camphuysen C.J. & Leopold M.F. 1994. Atlas of seabirds in the southern North Sea. IBN Res. Rep. 94/6 and NIOZ-Rep. 1994-8, Institute for Forestry and Nature Research, Wageningen, and Netherlands Institute for Sea Research, Texel.

Fuchs E. 1977. Kleptoparasitism of Sandwich Terns *Sterna sandvicensis* by Black-headed Gulls Larus ridibundus. Ibis 119: 183-190.

Garthe S. 1997. Influence of hydrography, fishing activity, and colony location on summer seabird distribution in the south-eastern North Sea. ICES J. Mar. Sci. 54: 566-577.

Garthe S., Alicki K., Hüppop O. & Sprotte B. 1995. Die Verbreitung und Häufigkeit ausgewählter See- und Küstenvogelarten während der Brutzeit in der südöstlichen Nordsee. J. Ornithol. 136: 253-266.

Gorke M. 1990. Die Lachmöwe (*Larus ridibundus*) in Wattenmeer und Binnenland. Ein verhaltensökologischer Vergleich. Seevögel 11, Sonderheft 3: 1-48.

Hälterlein B. & Südbeck P. 1996. Brutvogelbestände an der deutschen Nordseeküste im Jahre 1994 - Achte Erfassung durch die Arbeitsgemeinschaft "Seevogelschutz". Seevögel 17: 5-11.

Harris M.P. & Hislop J.R.G. 1978. The food of young Puffins *Fratercula arctica*. J. Zool. 185: 213-236.

Nehls H.W. 1982. *Sterna sandvicensis* Latham 1787 - Brandseeschwalbe. In: Glutz von Blotzheim U.N. & Bauer K.M.: Handbuch der Vögel Mitteleuropas. Band 8. Charadriiformes (3. Teil): 864-911. Akademische Verlagsgesellschaft, Wiesbaden.

Ratcliffe N., Richardson D., Lidstone Scott R., Bond P.J., Westlake C. & Stennett S. 1997. Host selection, attack rates and success rates for Black-headed Gull kleptoparasitism of terns. Colon. Waterbirds 20: 227-234.

Südbeck P. & Hälterlein B. 1997. Brutvogelbestände an der deutschen Nordseeküste im Jahre 1995 - Neunte Erfassung durch die Arbeitsgemeinschaft "Seevogelschutz". Seevögel 18: 11-19.

Veen J. 1977. Functional and causal aspects of nest distribution in colonies of the Sandwich Terns. Behaviour Suppl. 20: 1-193.