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A METHOD TO QUANTIFY FEEDING OF SEABIRDS ON DISCARD FROM THE SHRIMP FISHERY IN THE NORTH SEA*

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ABSTRACT

Re-catch experiments employing a stow net, which was towed behind a shrimp vessel, showed that the proportion of discarded roundfish preyed upon by gulls ranged from 68 to 90% during daytime.

1. INTRODUCTION

The feeding of seabirds on discards from the fisheries is a worldwide phenomenon (BOSWALL, 1960; HUDSON & FURNESS, 1989; WASSENBERG & HILL, 1990; HILL & WASSENBERG, 1990). However, the evaluation of the ecological implications is difficult, since reliable estimates of the intake from this food source compared to the total consumption in a defined area are rare (FURNESS, 1986; HUDSON & FURNESS, 1988). They do not exist for the shrimp fishery in the Wadden Sea (BERGHAHN, 1990). Counts of successful predation in that area are highly over- or underestimated by the enormous numbers preying within a very short time interval of only a few minutes in a concentrated flock. In this investigation, a method was developed to overcome these problems for the quantification of feeding by seabirds on the floating discards from the brown shrimp (*Crangon crangon*) fishery in the North Sea.

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2. STUDY AREA AND METHODS

The research area was the Heverstrom in the North Frisian Wadden Sea between Nordstrand and Eiderstedt Peninsula. The investigations were carried out during five cruises on a shrimp vessel chartered exclusively for this programme.

A specially designed 7 × 3 m (width × height) stow net (Fig. 1) with an iron frame and a small mesh size (from the opening to the codend: 16/14/12/10 mm) was equipped with 2 buoys in order to keep the upper edge above the water surface. It was towed at a distance behind the normally operating shrimp vessel. Defined numbers of smelt (*Osmerus eperlanus*) and 0-group whiting (*Merlangius merlangus*) were discarded through the outlet of the shaking sieve within short time intervals. Discards which were not removed by seabirds between the vessel and the stow net could be recaptured. Each experiment lasted 2 to 5 min.

Before the start of the experiments, at least two 30-min hauls at a speed of ~ 5.5 km·h^{-1} (3 knots) were carried out in order to see whether smelt and whiting other than those discarded were caught with the device. Re-catch efficiency of the stow net for discarded smelt and whiting was determined in the very beginning of the cruises, before the seabirds had recognized the opportunity. Thus, a defined number of fish was discarded, and the number re-caught with the stow net at various distances from the vessel was recorded.

The birds in the surroundings of the vessel were counted as often as possible during all the different fishing procedures. The birds were usually counted in tens (normal count), but in some cases individually (real count). The deviation of normal counts to real counts was never more than ±20%. The number of individual species were counted directly, or in the case of small gulls, estimated using frequent sample counts.

3. RESULTS

No other smelt and whiting were caught with the stow net in the long hauls when no fish were discarded. Moreover, discarded re-catches looked quite different from specimens caught for the first time in syn-

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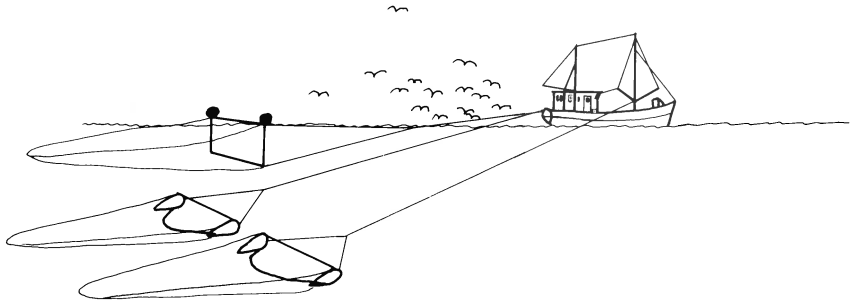

Fig. 1. Discard re-catch device.

chronous catches with the beam trawls. Therefore, one can fully exclude the possible existence of specimen other than the discarded ones in the re-catch experiments.

Birds preying upon the discards during the five cruises comprised for more than 98% of herring gulls (*Larus argentatus*), common gulls (*Larus canus*) and black-headed gulls (*Larus ridibundus*). However, total numbers and the proportion of each species differed between each cruise, and the differences were related to the species composition of gulls resting on the nearby coastline during high tide (Fig. 2). Species present in low numbers included the common Tern (*Sterna hirundo*), the Arctic Tern (*Sterna paradisaea*) and the greater black-backed gull (*Larus marinus*).

The maximum number of birds behind the ship reached 1900, whereas the number per half hour ranged between 586 and 886 gulls (Table 1). The numbers following the ship varied, resulting from fishing activities on board, the activity of the other vessels at the time of observation and the availability of food sources other than fish discards (*i.e.* benthic invertebrates on the mudflats during low tide).

During trawling at a speed of ~5.5 $km \cdot h^{-1}$ (3 knots), a large majority of gulls remained swimming behind the vessel and the stow net waiting till the

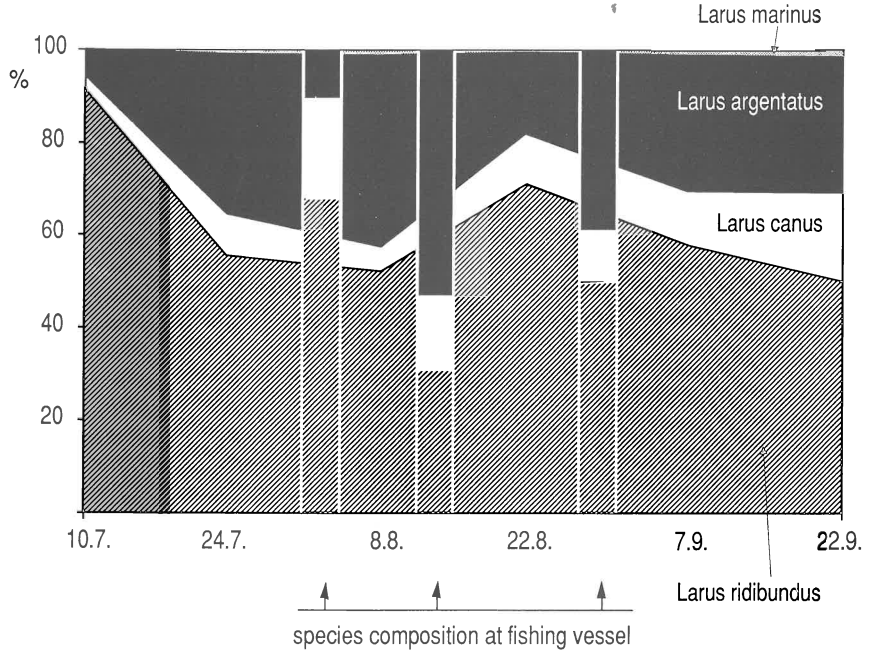

Fig. 2. Species composition (%) of gulls (4 species) during the 3 cruises in 1990 (indicated by columns and arrows) and during 6 high-tide counts in the surrounding resting areas (underlying graph). When fully covered, 3000 to 4000 gulls were counted at each of the six dates. The columns give average percentages of the same species at the fishing vessel at each of the three dates.

TABLE 1

Number of gulls per half hour joining the fishing vessel. A total of 118 counts were made.

date	*mean*	*SD*	*minimum*	*maximum*	*n (half hours)*
15-09-1988	886	566	230	1900	8
20-11-1989	586	221	50	850	15
02-08-1990	812	299	159	1100	10
13-08-1990	653	474	160	1500	7
29-08-1990	663	247	292	1200	12

beam trawls were lifted. When discards were released, the birds were first attracted by visual stimuli, the noise of the winches and the shaking sieve, or both. As soon as one bird began to prey upon discards, many other gulls immediately joined in.

Due to this behaviour, it was possible for us to reduce the distance between the vessel and the stow net to 25 m and raise the re-catch efficiency to 100% (Table 2). Discarded whiting and smelt caught the preceeding day were stored over night in a refrigerator yet had a much higher sinking rate than freshly caught fish. In that case, re-catch efficiency was reduced (Table 2) and the catching efficiency of the birds would be underestimated.

Gulls were usually frightened in the beginning by the towing line and the stow net itself. Sometimes the birds first had to be attracted by discarding herring (*Clupea harengus*) or sprat (*Sprattus sprattus*). As soon as birds started to feed, others followed immediately. When more than 100 birds were heading for the vessel, the re-catch experiment started by discarding whiting and smelt. The birds were then eagerly feeding even when the vessel was not operating normally and persons were standing at the stern in order to count the birds.

In total, seven successful experiments were carried out with gulls feeding on the discards under optimal conditions (100% re-catch efficiency, shaking sieves switched on, fresh fish discarded; Table 3). The proportion of discards taken by the birds ranged from 68.4 to 89.8% for smelt and from 73.0 to 82.0% for whiting. No differences could be detected with regard to the application of the discard (step by step or in greater portions). The proportion of fish consumed varied between species and was different for each cruise.

4. DISCUSSION

The proportion varying between 68 to 90% is close to the estimates given by BERGHAHN (1990). It would have been higher, most likely close to 100%, if the stow net had been towed at a greater distance. Due to the effect of the stow net upon the birds, feeding started later and stopped earlier when the net came too close. This is possibly the reason why not all the fish were consumed and therefore caught by the stow net.

Only gadoids and smelt were used in the experiments. These fish are similar to clupeids in that they are very vulnerable to the catching and sieving procedure and as a result have a low sinking rate. Consequently, they are very accessible to seabirds. Many other roundfish species are much less likely to be caught since even after sieving they have a significantly higher survival rate (BERGHAHN, 1990) and try to escape into the depth as soon as they have been discarded. This partly holds for flatfish as well. Furthermore, due to the shape of the fish, seabirds prefer to feed on discarded roundfish than flatfish (HUDSON & FURNESS, 1989).

The total number of herring gull, common gull, and black-headed gull in the Schleswig-Holstein Wadden Sea amount to at least 65 000, 25 000 and 80 000, respectively, in the late summer and autumn (KEMPF *et al.*, 1989). These birds also feed intensively on natural food from the mudflats and in small tidal channels, as well as on artificial food sources provid-

TABLE 2

Re-catch efficiency of 7 × 3 m stow net towed behind an operating shrimp vessel for discarded whiting and smelt when gulls and terns were absent.

species	*length (cm)*	*quality (days old)*	*numbers*			
			discarded	*removed by birds*	*numbers recaught*	*percentage recaught*
Whiting	13-16	1	300	0	111	37
Whiting	13-16	1	300	0	167	56
Whiting	13-16	1	300	0	132	44
Whiting	13-16	1	80	3	60	78
Whiting	13-16	fresh	59	1	58	100
Whiting	13-16	fresh	103	0	103	100
Whiting	13-16	fresh	79	0	79	100
Smelt	15-20	fresh	400	0	400	100

TABLE 3

Proportions of freshly caught fish discarded from the shrimp vessel that were preyed upon by gulls on two different dates. More than 50 % of the gulls were between the vessel and the stow net. * discarded not step by step, but in 3 portions of 100 specimens.

Date	Numbers of gulls	Species of fish	Lenght of fish (cm)	Numbers		percentage preyed upon by gulls
				discarded	caught	
20-11-89	575	smelt	13 - 22	295	30	90
20-11-89	790	smelt	13 - 22	247	78	68
20-11-89	750	smelt	13 - 20	41	9	78
29-08-90	620	whiting	13 - 16	90	24	73
29-08-90	510	whiting	13 - 16	98	19	81
29-08-90	580	whiting	13 - 16	300*	54	82
29-08-90	490	whiting	13 - 16	311*	75	76

ed by agriculture. Refuse dumps are of minor importance in that area during the season in question. Numbers and species composition behind the fishing vessel vary considerably in different parts of the area (Rösner, unpubl. data). Since these variables have not been investigated, it is presently not possible to give a reliable estimate on the dependence of Wadden Sea birds on discards from the shrimp fishery (*cf.* BLABER & WASSENBERG, 1989). According to the numbers using discard as a food source, it might be important for herring gull, black-headed gull and common gull in terms of having a positive effect on their population size. However, at present there is too little known about the population dynamics of these species to answer this question.

Nevertheless, the re-catch method can potentially close the gap in estimating the removal of discard by various seabird species in the Wadden Sea. Therefore, reliable data can be obtained at this point for gaining more insight into the following high priority questions of ecosystem research:

—1 How important is the discard from shrimpers for the energetics of seabirds, and in particular for breeding success (FURNESS, 1978).

—2 What is the influence of (increased) access to intermediate hosts of parasites in seabirds on the epidemiological situation. There are a number of parasites, in particular trematodes and nematodes, which invade the birds via predation on fish (LAUCKNER, 1990).

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