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Preliminary Results on Studies of the Effect of different Fishing Gear on the Catchability of Young Flatfish and its Effect on Abundance Indices

by

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Abstract

According to the economic importance of demersal species, fishery research and monitoring of fish stocks in the Wadden Sea is mostly based on data collected by beam trawls. Correspondingly there is lack of information on pelagic species. For the first time a synchronous sampling with a stow net cutter and a 3-m beam trawl such as employed by the Demersal Young Fish Survey was carried out in the Wadden Sea. The efficiency of the two gears for ecological monitoring purposes was tested and quantitative data on fish occurring in the pelagic were collected.

During a 3-day cruise in a restricted area of the Wadden Sea of Schleswig-Holstein 30 species were caught by the stow net cutter. Only 19 species were obtained by the 3-m beam trawl. An exemplary calculation of total numbers in the area showed, that herring was the most abundant species. Also ratios of demersal and pelagial specimen could be given respectively.

A comparison of night and day stow net catches showed changes in the distribution of species. The yields of shrimp, gobius, eel and flatfish increased at night, while the numbers of herring and sprat were slightly decreasing.

Stow net cutters appeared to be a useful tool to fill the gaps left by the current projects in the Wadden Sea. Their potential for ecological monitoring purposes is discussed.

Introduction

At present two programs are carried out in the German Wadden Sea by the Bundesforschungsanstalt für Fischerei (BFA) in Hamburg to collect data on the fish and crustacean fauna. The DEMERSAL YOUNG FISH SURVEY (DYFS) aims on the estimation of year class strengths of juvenile North Sea plaice and sole as early as possible for their use in the preparation of annual fishery management advice (VAN BEEK et al. 1989). A second program is based on the investigation of the bycatch from the commercial shrimp fishery and provides trends of long term changes of species in the German Wadden Sea (TIEWS 1990, TIEWS & WIENBECK 1990). In both research programs beam trawl catches are used for data collection, giving only poor information on pelagic species.
In the scope of the ecosystem research project in the Wadden Sea of Schleswig-Holstein (LEUSCHNER & SCHERER 1989) several fishing methods and gears are tested to gain information on their applicability and potential for ecological long-term observations. The main purposes of these investigations are records of all present species including the pelagic ones. Furthermore it is intended to improve the estimates of total fish and crustaceans biomass as well as total numbers in the Wadden Sea. This will give information on the role of the species in the ecosystem and their present status. Also the knowledge of specific ecological topics can be widened. First changes in the species composition which may be caused by global change effects are also included.
In addition to beach seine and push-net (BRECKLING & BEERMANN-SCHLEIFF in press) several stow nets are employed. In this paper the results of the first use of a stow net cutter in the Wadden Sea are reported. A synchronous sampling with a 3-m DYFS beam trawl was carried out, showing the potential of large stow nets for monitoring purposes in comparison to a well established program.

Material and methods

Investigations were carried out in Meldorf Bight in the southern part of the National Park Schleswig-Holstein Wadden Sea (Fig. 1). This area is characterised by tidal flats with sandy and mixed sediments, which are separated by tidal creeks with water depths up to 15 m. Mud flats and pile works cover the southern parts near the coast. The mean tidal range varies between 3.1 and 3.3 m, salinity ranged from 25 to 29 p.s.u. during the period of investigation. Sampling was carried out from 22. to 24. of August 1991 at three stations (Fig. 1) with both a stow net cutter and a beam trawl vessel.

Stow net catches

Large stow nets are used by the commercial fishery for different fishing purposes in large rivers and estuaries (see STERNER 1916, 1919, MOHR 1927, SCHNAKENBEK 1953, v. BRANDT 1959, KÜHL 1976). In the large rivers of Northern Germany mostly smelt, sturgeon, eel, salmon and ruffe were caught with such gears. In the outer parts of the estuaries also herring and sprat were important yields. In former times fishing cruises were made to the island Helgoland in the German Bight, where a strong current between the island and the associated Dune allowed to handle stow nets as well with excellent results (pers. comm. RÜBCKE).

In scientific programs the stow net is mostly applied for bait fishery to supply eelbaskets with small fish. In this case the upper beam is placed near the surface, while the lower beam is located 1-2 m above the bottom. The lower beam can also be placed on the bottom, in case there are no or few macroalgae or sand-megaripples drifting. The opening of the net is 90 m^2 (9 x 10 m), and it has two tunnels. Mesh size in the cod end is 5,5 mm. Two current velocity meters placed in the opening of the net provide data on the water volume fished.

Stow nets catch all fish and crustaceans migrating with the tidal current. In research programs they have been employed with different objectives for instance by PETERS et al. (1986), MÖLLER (1988a, 1990) or NELLEN & WEIGELT (1991).

In the Wadden Sea suitable fishing grounds can be found in tidal creeks with water depths from 6 to 10 m at places with high tidal currents e. g. in front of steep slopes or narrow passages between tidal flats or islands.

The stow net is exposed one or two hours following tidal change. Fishing time may last 3 to 4 hours during which a volume of 450.000 to 1.000.000 m^3 can be fished. While the cutter is at anchor, it is possible to work for 24 hours with fishing periods of 3 to 4 hours every half tide.

The standard catches are related to 1.000.000 m^3.

Beam trawl catches

The beam trawl catches were conducted with a 3-m beam trawl in the manner of the DYFS (VAN BEEK et al. 1989) during daytime. A total of 22 hauls was carried out near the stow net cutter. The duration of hauls was 15 minutes each. Water depths ranged from 3 to 12 metres.

Analysis of catches

- Total number of species

A comparison of the number of species recorded by the different fishing methods shows the efficiency of the gears in describing accurately the species composition. This is needed for the detection of changes in species composition, for instance the invasion and settlement of lusitanic species.

- Quantitative analysis

Catches of the stow net provide data on the number of fish and crustaceans migrating in and out of an area with the tidal current. They can be related to the volume of water flowing through the net. To compare these data with results of beam trawl catches, which are given as ind./1000 m^2, we chose a method applicable to the specific conditions of the area investigated.

For some regions of the German Wadden Sea the volume of water flowing in and out through the tidal creeks is well known. In some cases it is also possible to estimate the catchment area of a tidal creek. Then the total number of fish migrating in and out can be estimated from stow net catches. The residual volume of water in the tidal creek at low tide can be calculated from special maps of the Wadden Sea. When the number of fish per residual volume is supposed to be equal to the number caught per volume with the stow net, it becomes possible to calculate the total number of fish in the catchment area in a first approximation.
The beam trawl catches include migrating and stationary individuals as well. These data may also be projected on the catchment area, but it has to be taken into account whether or not the species concerned perform migrations to the tidal flats during daytime.

The diurnal differences of stow net catches give additional information on the diurnal change of distribution patterns of the species living in the Wadden Sea area.

Results

Record of species

In total, the stow net cutter caught 30 species, while the beam trawl of the DYFS caught 19 species (Tab. 1). The stow net catches during daytime are listed separately because the beam trawl catches were carried out only during daytime. The most abundant species in the stow net catches were pelagic ones such as

herring and sprat. But also demersal species such as plaice, sole, hook-nose, eelpout or bull-rout were sometimes caught in high numbers.
Lumpsucker, mackerel, scad and garfish mainly appeared in catches at station I (Fig. 1) which is located towards the open North Sea, while close to the shore at stations II and III smelt, sole, plaice and whiting were caught in abundance.

Quantitative comparison of stow net and beam trawl catches:

The following estimates of the catchment area of the Kronenloch (station II, Fig. 1), shall serve as an example as the catchment areas and tidal volumes of stations II and III were not possible to determine ad present state.
The volume of water flowing in and out through the tidal creek at station II is 34 mio. m^3 (ALW Heide, Department for Aquatic Sciences, pers. comm.) at each tide. The catchment area is estimated to be 11,4 km^2 including 2,3 km^2 sublitoral habitat. The residual water volume at low tide is assessed at 7 mio. m^3.
The mean number of demersal fish specimen in the catchment area of station II is calculated from beam trawl catches and the quantity of pelagic fish is raised from stow net catches (Tab. 2). The results show, that herring was the most abundant fish species in the catchment area of Kronenloch. Furthermore the ratio of specimens staying close to the bottom and within the water column, respectively, is derived. Despite of the small number of hauls the distribution pattern of several species can be shown.
During night-time the distribution of fish and crustaceans changes. Species known to be demersal such as shrimps, gobies, eels and flatfishes use to rise into the pelagic and appear in higher numbers in the stow net catches, while the numbers of pelagic species such as herring and sprat decreased slightly (Tab. III). Due to the small number of hauls the data cannot be tested statistically.

Discussion

Large stow nets have not been used in fishery research in the Wadden Sea before. The record of 30 fish species during a 3-day cruise at 3 stations in a relatively small area, where a synchronously employed 3-m beam trawl caught 19 species, shows the great efficiency of the stow net for faunistic approaches. This can be underlined by a comparison with other studies carried out over longer periods in the Wadden Sea. HINZ (1989) caught 33 species, PIEPENBURG

(1984) 28 species, LILLELUND & BERGHAHN (1981) 33 species and BRECKLING & BEERMANN-SCHLEIFF (in press) 35 species. Their investigations lasted from 7 months to 2 years and several fishing methods such as commercial beam trawls for shrimps, fyke nets, beach seines or push nets have been used. Studying the bycatch of commercial beam-trawlers from shrimp fishing grounds off Büsum (Fig. 1) in 1991, ACHENBACH & OPITZ (pers. comm.) found 27 species, while from the DYFS in the course of 18 years of investigation 41 species were reported in total, with some gobiid species missing as they were reported by family only (NEUDECKER, T.; RAUCK, G. and WIENBECK, H. 1990).
The presented results of the 3-day cruise also demonstrate, that a research program with a special, clearly defined goal such as the DYFS does not go far enough towards answering all fundamental questions of ecological concern. Fishing with stow nets is less harmful for the benthic fauna and can be conducted with a minimum of acoustic disturbances caused by running engines, because the cutter is at anchor while fishing. These are important aspects for monitoring approaches in environmental protection areas such as national parks. More over the fish is in better condition compared to fish caught by trawl nets.

Besides biological aspects it may be stated that the working conditions on deck all around the clock are much better than on commercial shrimp trawlers. Therefore the stow net cutter can be a useful tool for different research approaches of ecological interest as outlined by RUTH & BERGHAHN (1989). During this first preliminary survey the number of stow net hauls was too small to perform statistical analysis. But each haul fished about 2% of the total water volume flowing in and out of the catchment area at station II (Kronenloch). Giving an example of the potential of the stow net fishery in the Wadden Sea, the presented data should already be taken into account, and further methodological work will improve the quality of the estimates of total numbers of fish and crustaceans per area.
The most considerable step forward is the improvement of the estimates of pelagic species stock sizes in the Wadden Sea by stow nets and the possibility to count demersal species migrating in the pelagic. Despite of being a basic tool for other fish stock assessment programs such as the SFB Tide-Elbe (NELLEN & WEIGELT 1991) the determination of fish stock size from stow net catches is not without problems. The projection of the catches on a fished water volume requires a passive drift of fish with the tidal current. But it can be expected, that the fish compensate the effects of the current by swimming against it, especially in larger rivers. This may cause an underestimate of stock sizes. Furthermore the projection of catch data on a catchment area is a source of

errors, which are estimated though to be in the same order of magnitude as for beam trawl catches.

In principle the catches of active and passive gear are different and hard to compare for quantifying analysis. But the way it is suggested and performed in this paper gives a first imagination of the underestimation of pelagic fish stocks in the Wadden Sea when calculations are based on beam trawl catches as shown in Table 2.

Another important aspect is the possibility to study diurnal behavior patterns. It is sometimes argued that day catches of passive gear are regularly smaller than night catches, because the fishes have a better chance to notice the gear in time and escape. The stow net fishery in the Wadden Sea however is carried out at localities with the highest current velocities, high turbidities and Secchi-depths being regularly less than 1 m. The fished water column extends for 9 m depth, giving reason for the assumption that escapes because of noticing the gear visually should be of minor importance. Furthermore the number of herring and sprat, the most abundant fish species in the pelagic, tended to be even higher in our day catches (Tab. 3). These species may perform migrations on to the inundated tidal flats during night-time.

For some species diurnal changes of the distribution patterns in the Wadden Sea, such as shown in this study, are already known in principle (HINZ 1989, KRUUK 1963, NELLEN et al. in press., RUTH pers. comm.), though only few (e.g. BERGHAHN 1986) quantitative analyses are found in literature.

In spite of the small numbers of hauls in this study, clear trends are already observable, and the importance of the pelagic, especially during night-time, requires more investigations of this habitat. This will also lead to a better understanding of relationships within the food web of the Wadden Sea.

In conclusion, stow net fishery could serve as an additional, useful tool for an ecological monitoring of the coastal fish fauna and help to fill a gap of ecological knowledge left by the long time-series of the DYFS and bycatch investigations. It may also be one mean to elaborate correction factors for the species abundance indices found in routine programs like the DYFS and used for stock assessment purposes.

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Table 1: Fish species caught in the "Meldorfer Bucht" in August August 1991 in the order of abundance in the total stow net catches

Species	Stow net (total)	Stow net (day)	3-m-beam trawl
Herring (Clupea harengus)	X	X	X
Sprat (Sprattus sprattus)	X	X	X
Smelt (Osmerus eperlanus)	X	X	X
Sand goby (Pomatoschistus minutus) [1]	X	X	X
L. pipe-fish (Syngnathus rostellatus)	X	X	X
Sole (Solea solea)	X	X	X
Plaice (Pleuronectes platessa)	X	X	X
Scad (Trachurus trachurus)	X	X	X
Dab (Limanda limanda)	X	X	X
Hook-nose (Agonus cataphractus)	X	X	X
Whiting (Merlangius merlangus)	X	X	X
Grey gurnard (Trigla gurnardus)	X	X	X
Stickleback (Gasterosteus aculeatus)	X	X	
Flounder (Platichthys flesus)	X	X	X
Common goby (Pomatoschistus microps) [1]	X	X	
Twaite shad (Alosa fallax)	X	X	
Sandeel (Ammodytes tobianus)	X	X	
Eel (Anguilla anguilla)	X	X	X
Cod (Gadus morhua)	X	X	X
Lumpsucker (Cyclopterus lumpus)	X	X	
Eelpout (Zoarces viviparus)	X	X	X
Bullrout (Myoxocephalus scorpius)	X	X	X
Mackerel (Scomber scombrus)	X	X	
Lampern (Lampetra fluviatilis)	X	X	
Gunnel (Pholis gunellus)	X		X
5-bearded rockling (Ciliata mustela)	X		X
Brill (Scophthalmus rhombus)	X	X	
Garfish (Belone belone)	X	X	
Dragonet (Callionymus lyra)	X		
Sea snail (Liparis liparis)	X		
Number of species	30	26	19

[1] Gobiidae from 3-m-beam-trawl catches were not determined by species

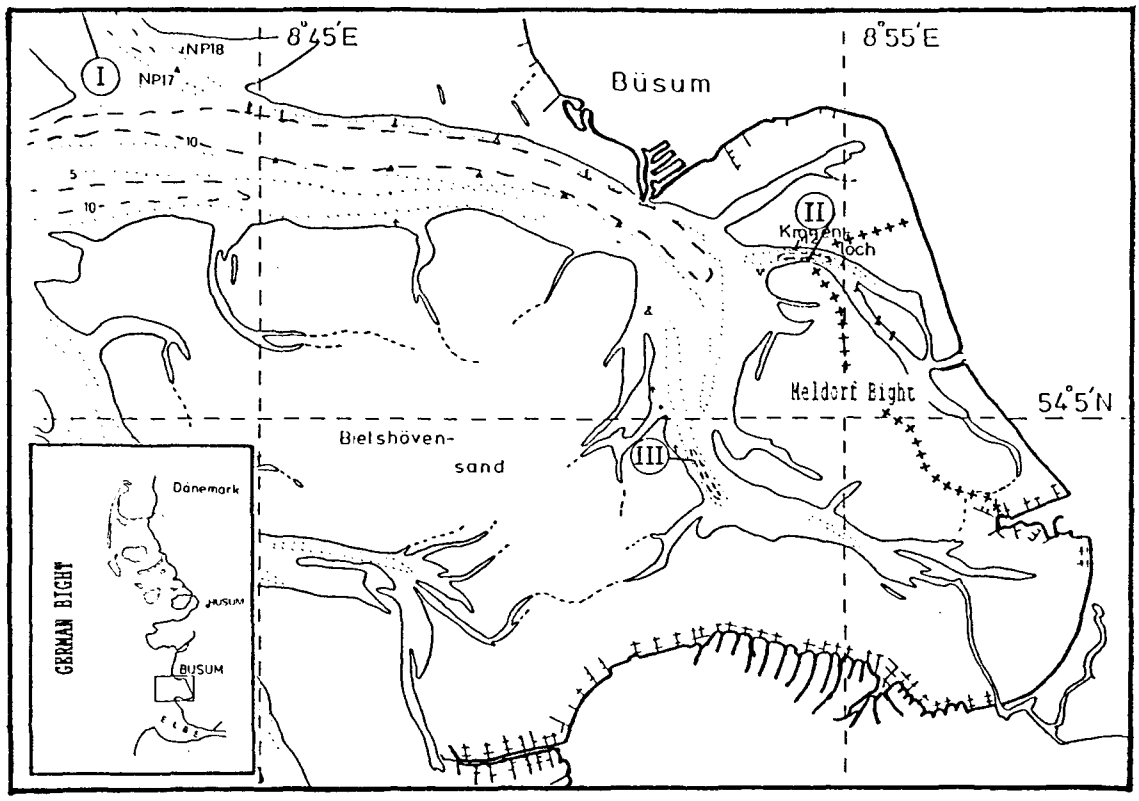

Fig. 1 : Sampling sites at the Meldorf Bight
(+++ = catchment area of Station II)

Table 2: Total numbers of fish and crustaceans of selected species in the catchment area of station II (Kronenloch) calculated from beam trawl catches and stow net catches

Species	Number in the catchment area of the Kronenloch		Ratio demers.:pelag. specimens
	3-m beam trawl (3-6 hauls)	Stow net (1-3 hauls)	
Herring	1 653	382 407	1 : 200
Swimming crab	116 330	575 640	1 : 5
Smelt	35 226	110 618	1 : 3
Whiting	1 445	492	3 : 1
Sand goby	51 756	2 378	20 : 1
Plaice	242 326	1 025	250 : 1

Table 3: Comparison of day (o) and night (●) stow net catches in the "Meldorfer Bucht" (Ind/mio m^3 and kg/mio m^3, 2-4 hauls)

<< = difference > factor 10
< = difference > factor 2 < factor 10
≈ = difference < factor 2

Species	Stow net day		Stow net night
Shrimp	22,1 kg	o << ●	263,4 kg
Sand goby	106	o << ●	1 185
Sole	212	o < ●	851
Plaice	307	o < ●	724
Flounder	45	o < ●	134
Eel	6	o < ●	23
Whiting	62	o < ●	370
Smelt	2 492	o ≈ ●	3 825
Herring	40 559	o ≈ ●	21 277
Sprat	21 162	o ≈ ●	13 111
Swimming crab	14 088	o ≈ ●	18 084