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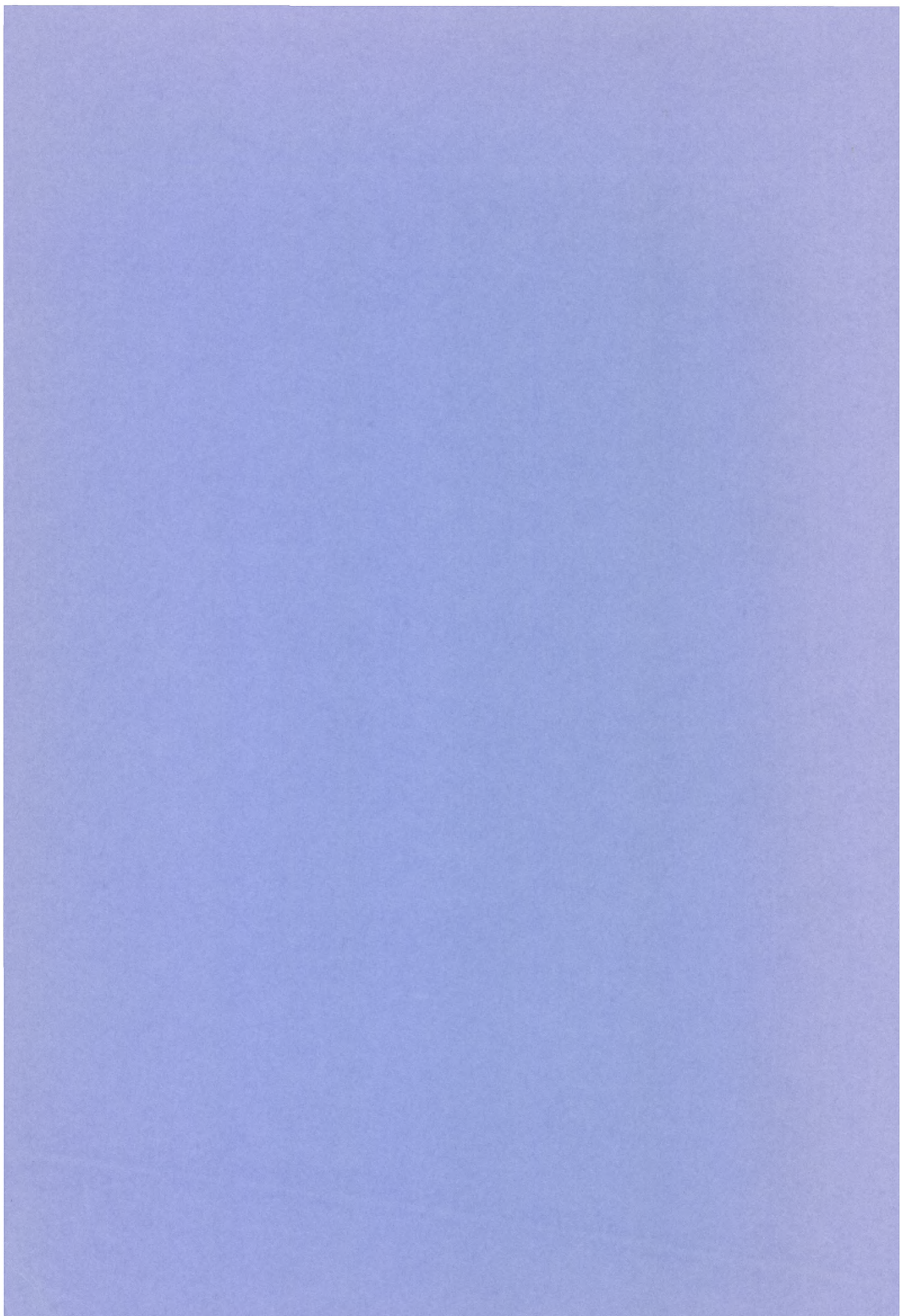
**INFORMATION**  
från  
**HAVSFISKELABORATORIET**  
**Lysekil**

**Bycatches of cod in Swedish  
trawl fishery for pelagic species  
in the Baltic Sea**

Yvonne Walther 1995

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## ABSTRACT

Catches were sampled in two fishing methods; industrial fishing for sprat (*Sprattus sprattus*) using a pelagic trawl, and fishing for herring (*Clupea harengus*) using a bottom trawl, to investigate bycatches of cod (*Gadus morhua*) and other species. Sampling took place in 1993 and 1994 in the Baltic Sea. The industrial fishing was sampled in SD 25-28, and the herring fishing was sampled in SD 25. Bycatches in industrial fishing comprised; herring (17.8%), cod <33 cm (0.06%), and cod >33 cm (0.15%). The only discernible bycatches of cod in industrial fishing were in SD 25. Other bycatches in industrial fishing were lumpsucker (*Cyclopterus lumpus*), three-spined stickleback (*Gasterosteus aculeatus*), flounder (*Platichthys flesus*) and salmon (*Salmo salar*). Catches in herring fishing comprised bycatches of cod <33 cm (0.6%), and cod >33 cm (2.7%). Other species occurring as a bycatch in herring fishing were sprat, whiting (*Merlangius merlangus*), trout (*Salmo trutta*), and jellyfish (*Aurelia aurita*).

## I. INTRODUCTION

Since 1985 the recruitment of the eastern cod (*Gadus morhua*) stock in the Baltic Sea has been very poor. This, combined with a high fishing mortality, has led to a rapid decrease in the Baltic cod population (Anon., 1992a).

The cod stock east of Bornholm has, since 1992, been below the minimum biologically acceptable level (Anon, 1992b). Where fishing for herring (*Clupea harengus*) and sprat (*Sprattus sprattus*) are concerned unavoidable bycatches of cod may be landed. The catch must not contain more than five percent undersized cod (<33 cm). Special regulations were drawn up in 1993 and 1994, during periods when Swedish cod fishing was completely prohibited. Landing of cod as a bycatch has been prohibited during such periods in 1993; and in 1994 only 600 tonnes of cod could be landed as a bycatch in compliance with the Constitution of the National Board of Fisheries nos. 1993:31 and 1994:19.

Bycatches in this report is defined as incidental catches of species other than the target species. It is difficult to make an estimation of bycatches using logbooks since the reports are often incorrect or underestimated (Modin, 1994). Instead, samples must be taken from catches either at sea or at the landing site.

Fishing for sprat for industrial purposes using a pelagic trawl (mesh size 16-22 mm) and fishing for herring using a bottom trawl (mesh size 32-40 mm) in the Baltic Sea is, according to some fishermen, responsible for substantial bycatches of undersized cod. The Advisory Committee on Fishery Management (ACFM) states that the bycatches of cod with sprat and herring trawl fishing were rather high in the late 1970s and early 1980s due to the high level of cod stock. An evaluation of bycatches in recent years is, however, not possible (Anon., 1993a). Since it is impossible to prove or disprove these statements, the National Board of Fisheries has found it necessary to start sampling the catches to make an evaluation of current bycatches. It is also interesting to survey the length distribution of sprat and herring caught.

No research has been made on this subject in Sweden prior to the present project. However, the Institute of Marine Research in Lysekil has, as part of the present project, now started to sample landings at the only fishmeal plant in Sweden, Ängholmen. In Norway and Denmark, landings from fishing with small meshed trawls are regularly sampled to gain information on age, length and species composition (Anon., 1993b). A German investigation on bottom trawl fishing for herring in the southern and western part of the Baltic Sea found a large percentage of undersized cod taken as a bycatch (Schulz and Berner, 1981). In Poland, recent observations have been made in the southern Baltic Sea of bycatches of cod aboard boats fishing for herring with bottom trawl. The results of these observations have not as yet been published.

The purpose of this investigation is to investigate bycatches in trawl fishing for sprat using a pelagic trawl (mesh size 16-22 mm) where the catch is used for industrial purposes i.e fishmeal and fish oil, and fishing for herring using a bottom trawl (mesh size 32-40 mm) where the catch is used for consumption. The investigation is focused on bycatches of cod, mainly below legal size (<33 cm), though other species are also considered. The project started in February 1993.



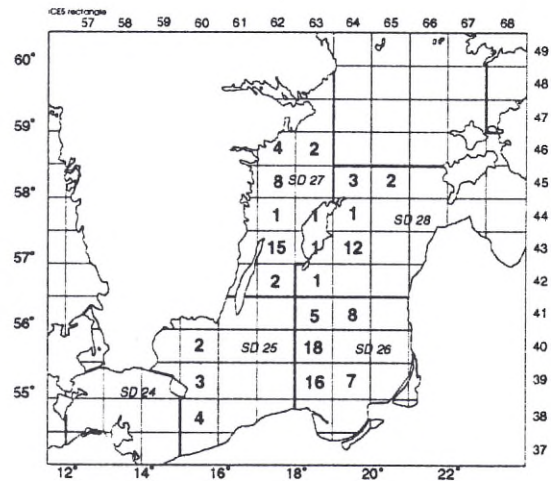
## II. MATERIAL AND METHODS

Samples from the catch were taken aboard commercial fishing vessels. The sample taken in each haul comprised three subsamples (about 30 kg each) taken with a basket. When the catch was taken onboard in a codend the basket was placed where the catch was to be dumped. If the catch was pumped onboard, the basket was placed under the flow of fish. In both cases the three subsamples were taken in order to sample the first, middle and last part of the catch to avoid sampling error due to stratification of the fish in the trawl cod-end (Gunderson, 1993). The fish in each sample were sorted according to species, and weighed. The cod were divided into two groups, above and below legal size, and weighed separately. The length of all fish caught as a bycatch was measured, as well as a minimum of 100 herring and sprat respectively. All calculations on the percentage of bycatches in the catch were based on weight.

Characteristics such as position, depth, trawl depth, duration of haul and weather conditions were noted for each haul.

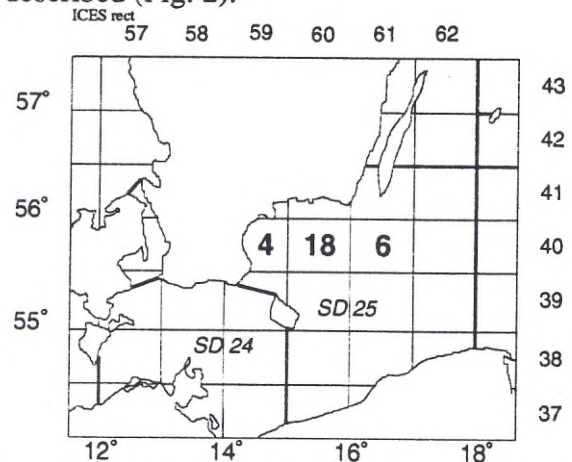
In two cases, samples were taken in harbour from containers in which the catch was landed without previous sorting. The samples were taken with a bucket (5 kg) up to approximately 100 kg, and treated according to the procedure described.

Fishing for sprat for industrial purposes is carried out from October until May in the area between east of 14 E and south of 59 N. Sampling took place in two periods during March-April 1993, and October 1993-May 1994, by which time sixteen journeys with ten different fishing vessels had been completed and two samples from catches had been taken at the landing site. The fishing trips lasted for approximately one week and the number of samples from each trip were between 4 and 12. A total of 116 samples were taken (Fig.1).



**Figure 1.** Number of samples per ICES rectangle from sprat fishing for industrial purposes using pelagic trawl (16-22 mm mesh size),  $n=116$ .

Sampling in fishing for herring using a bottomtrawl was carried out between May and October 1993 on ten different ships and 18 journeys. The fishing trips lasted one day each and 1-2 samples were taken on each trip. All of the samples were taken in SD 25 in the Hanö Bight. The Hanö Bight has according to fishery surveys with the research vessel Argos the highest abundance of young cod in the Baltic Sea (Larsson, 1993). A total of 28 samples were taken and treated according to the procedure described (Fig. 2).



**Figure 2.** Number of samples per ICES rectangle from herring fishing using bottom trawl (32-40 mm mesh size),  $n=28$ .

In order to facilitate a comparison of the sampling area with fishing during 1992 and 1993, a study of log books was made. This comparison was made to evaluate if the samples were taken in an area representative for the fishing.



### III. RESULTS

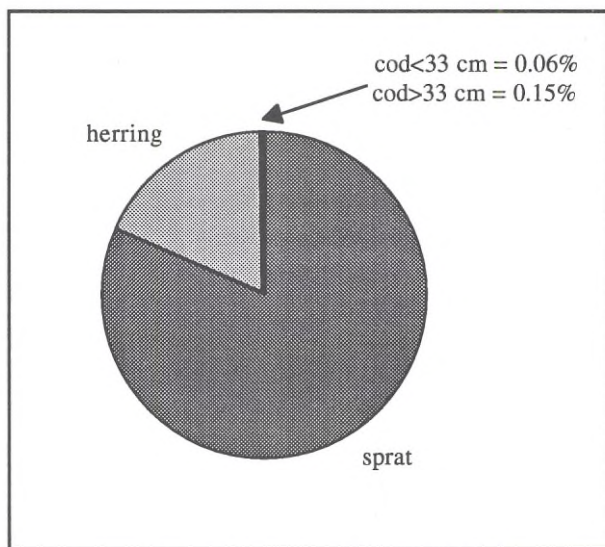
#### Sprat fishing for industrial purposes

The weight composition of the samples showed that bycatches of cod occurred in six samples. In four samples from SD 25, cod <33 cm comprised 0.2-4.0% of the catch, and cod >33 cm comprised 0.4-5.5%. The samples in SD 26-27 contained small amounts of cod, and in most cases there was little or no cod in either the sample or in the catch. Cod was found in two samples from SD 27. In these two samples, cod >33 cm comprised 1.0% and 4.98 % respectively of the catch.

Herring occurred in all of the samples, and comprised 0.1-97.4% of the catch. The highest amount of herring found in the samples was in SD 27 and 28.

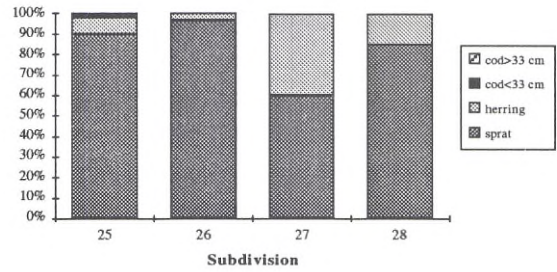
Other species occurring as a bycatch are lumpsucker (*Cyclopterus lumpus*), three-spined stickleback (*Gasterosteus aculeatus*) and flounder (*Platichthys flesus*), altogether these species comprised 0.016% of the catch.

The composition of all samples shows that bycatches of herring were 17.8%, cod <33 cm were 0.06% and cod >33 cm were 0.15% of the sample (Fig. 3).



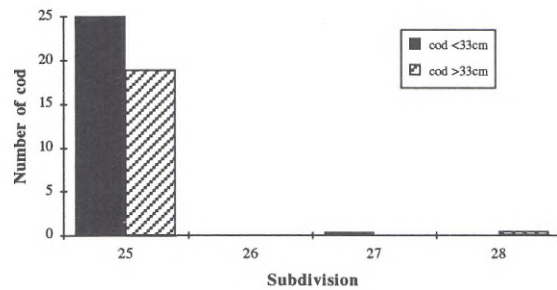
**Figure 3.** The weight-composition of all samples (n=116) from fishing for sprat for industrial purposes using pelagic trawl (16-22 mm mesh size).

The composition of all samples per subdivision shows that discernible bycatches of cod are only to be found in SD 25 (Fig. 4).



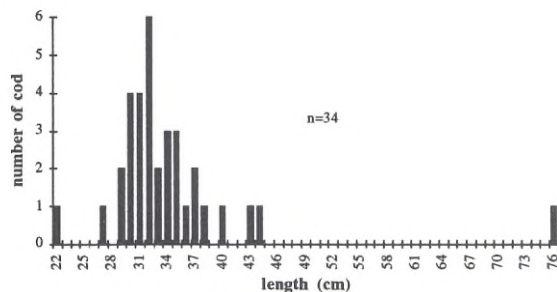
**Figure 4.** The weight-composition of all samples (n=116) from fishing for sprat for industrial purposes using pelagic trawl (16-22 mm mesh size), divided into subdivisions, in SD 25 cod >33 cm =1.2% and cod <33 cm =0.8 %.

The average number of cod per metric ton catch was greatest in subdivision 25. In subdivision 26, the number of cod per tonne catch was zero; and in subdivision 27-28, it was below one (Fig. 5)



**Figure 5.** Fishing for sprat for industrial purposes using pelagic trawl (16-22 mm mesh size). The average number of cod per metric ton catch in all samples, n=116.

The length distribution of cod caught as a bycatch in sprat fishing for industrial purposes shows that the cod were between 22-76 cm long (Fig. 6).



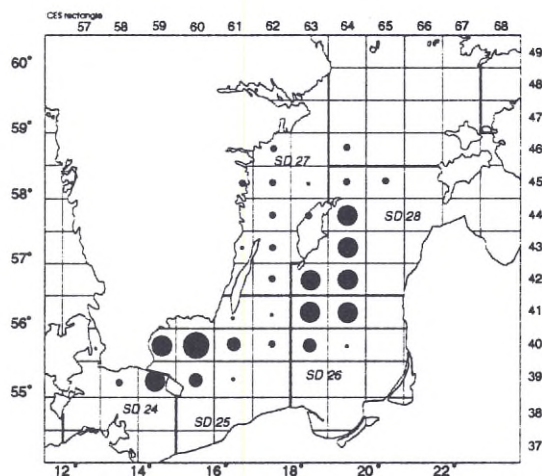
**Figure 6.** Length distribution of cod caught as a bycatch in fishing for sprat for industrial purposes using a pelagic trawl (16-22 mm mesh size). Total number of cod=34.



Length measurements of herring in the samples from industrial fishing show that most herring caught were 14-18 cm long (App. 1). Herring below 11 cm were found only in the samples from SD 27.

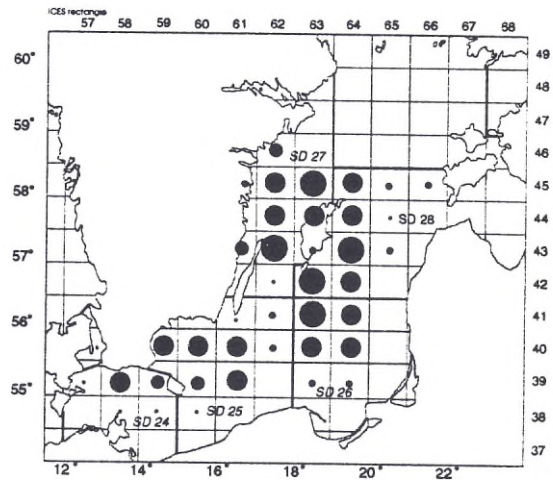
The length distribution of sprat indicates that sprat in SD 25 were longer than in SD 26-28. Sprats below 10 cm were found in only one sample from SD 28 (App. 2).

The log-book study shows that in 1992 fishing for sprat for industrial purposes using pelagic trawl was located mainly in SD 26 and 28, east and south of Gotland, and in SD 25 in the Hanö Bight (Fig. 7).



**Figure 7.** Fishing for sprat for industrial purposes using pelagic trawl (16-22 mm mesh size). Distribution of catches during 1992. The largest catch in one ICES rectangle (4060) was 8,333 metric tonnes. Total catch was 39,833 metric tonnes.

In 1993, the catches increased, and the fishing area was extended. Fishing was still concentrated around Gotland, with increased fishing west and north of the island. Catches in the Hanö Bight were still of importance (Fig. 8).



**Figure 8.** Fishing for sprat for industrial purposes using pelagic trawl (16-22 mm mesh size). Distribution of catches during 1993. The largest catch in one ICES rectangle (4163) was 6,389 metric tonnes. Total catch 66,731 metric tonnes.

A comparison between the maps made over fishing in 1992 and 1993 (Fig. 7 and 8) and the sampling (Fig. 1) shows that the sampling was representative for the fishing area with an exception for SD 25 where few samples were taken.

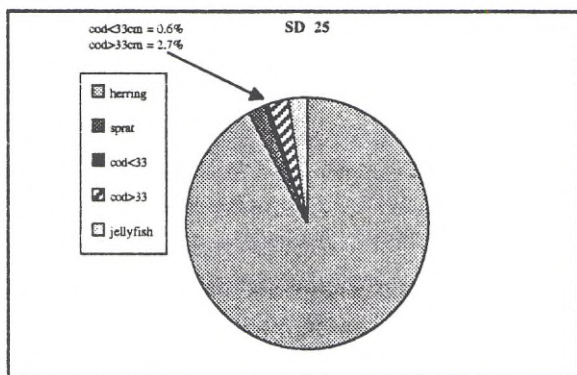
### Herring fishing

In fishing for herring using a bottom trawl, bycatches of cod <33 cm comprised 0.0-3.4% of the catch, and cod >33 cm comprised 0.0-15.0%. Cod as a bycatch was more frequent during the latter part of the sampling period. Other species occurring as a bycatch were sprat (2.25%), whiting (*Merlangius merlangus*) (0.03%), trout (*Salmo trutta*) (0.03%) and jellyfish (*Aurelia aurita*) (2.25%).

Bycatches of sprat were 0.0-16.3%. Trout and whiting were only found in one sample each; and then, comprised a mere 0.8% respectively 0.9% of the sample. Jellyfish were found in the samples from August onwards, and comprised 0.0-24.9% of the catch.

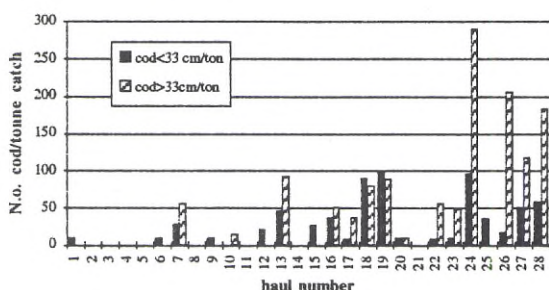
The composition of all samples shows that the discernible bycatches in herring fishing comprised both cod and jellyfish (Fig. 9).





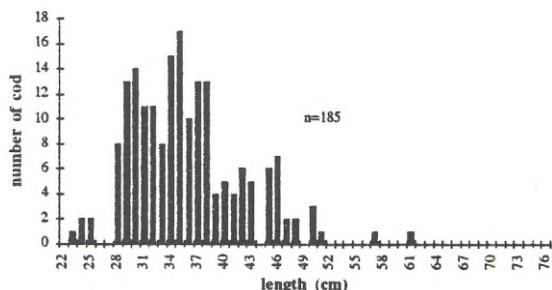
**Figure 9.** The weight-composition of all samples (n=28) from herring fishing using bottom trawl (32-40 mm mesh size).

The number of cod per metric ton of catch was low in the first thirteen hauls, during which time it was prohibited to land cod. In the following hauls, the number of cod per metric ton catch increased (Fig. 10).



**Figure 10.** Number of cod per metric ton catch in the samples (n=28) from herring fishing using bottom trawl. The average number of cod<33cm = 24 and cod>33 cm = 48.

The length distribution of cod caught as a bycatch in herring fishing using a bottom trawl shows that the cod were between 22-61 cm long (Fig. 11).



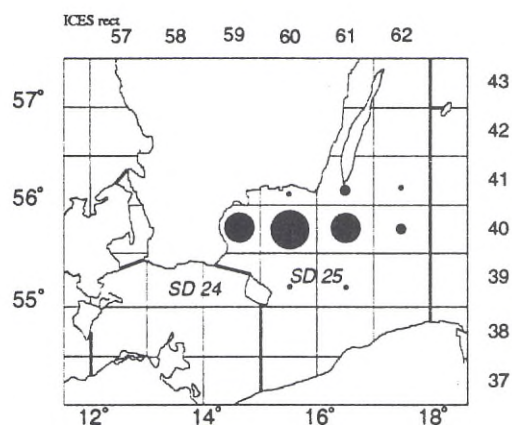
**Figure 11.** Length distribution of cod caught as a bycatch in fishing for herring using a bottom trawl (32-40 mm mesh size). Total number of cod=185.

Herring caught using bottom trawl were mainly between 18 and 24 cm long. In SD 25, the herring showed a tendency to be longer. Due to an error

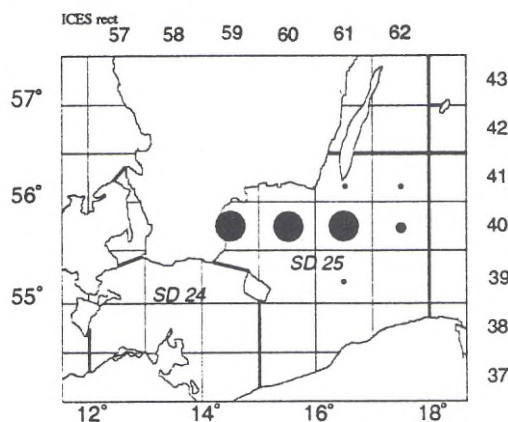
in measurement, the herring in bottom trawl fishing were compiled in centimeter groups (App. 4).

Sprat caught using bottom trawl were mainly between 13-15 cm long (App. 5).

The log-book study made over the sampling area, the Hanö Bight, showed that fishing was concentrated within the same area in 1992 and 1993. During 1993, the total catch was slightly smaller than in 1992 (Fig.12 and 13).



**Figure 12.** Fishing for herring using bottom trawl (32-40 mm mesh size). Distribution of catches during 1992 according to logbooks. The largest catch in one ICES rectangle (4060) was 4,141 metric tonnes. Total catch was 8,588 metric tonnes.



**Figure 13.** Fishing for herring using bottom trawl (32-40 mm mesh size). Distribution of catches during 1993 according to logbooks. The largest catch in one ICES rectangle (4060) was 2,973 metric tonnes. Total catch was 6,353 metric tonnes.

A comparison between the maps made over fishing in 1992 and 1993 (Fig. 12 and 13) and the sampling (Fig. 2) shows that the sampling area was representative for the fishing.



#### IV. DISCUSSION

The representativeness of sampling in this kind of project can be discussed. The fishermen can avoid bycatches in a number of different ways e.g. fishing areas known to have a high abundance of cod can be avoided; the trawl can be set in such a way as to reduce bycatches; and it is also possible for the fishermen to refuse to have personnel from the laboratory aboard.

Taking part in commercial fishing trips on different boats means that the sampling is affected by different factors connected with e. g. the vessel, the trawl, and the fishermen's skill. The samples taken on different boats will therefore not be true replicates of each other. But choosing to take part on fishing trips on many boats will instead be more representative for the fishing.

The sampling in this project is estimated to be representative for the fishing. Observations during the fishing trips showed that the fishing vessels chose the same fishing grounds as their colleagues, and the active boats were usually gathered in the same area. There is no reason to believe that the trawl was set in any other way than to gain the maximum catch in order to achieve maximum financial gain. Since there has been no market for undersized cod during the sampling period, the project must be deemed to be unaffected in this respect. The biologists were never refused permission to take part in the fishing trips, and were indeed welcomed on each occasion.

The low bycatches of cod in sprat fishing for industrial purposes in SD 26-28 are probably caused by the lack of cod in this area. In SD 25, the limit of 5% of undersized cod was never exceeded. Sampling in SD 25 ought to be larger in order to evaluate the degree to which sprat fishing for industrial purposes using a pelagic trawl has an important impact on the cod stock in this area. During this project, SD 25 was not believed by the fishermen to be the most favourable area for sprat fishing, with the result that alternative areas were chosen.

The occasionally rather large bycatches of herring in sprat fishery show that it is impossible to know if a school of herring or sprat are going to be caught. At present this is not a problem since the herring stock is above average size. ACFM have suggested an increased Total Allowed Catch (TAC) for herring and sprat (Anon., 1994). Today the mortality of sprat and herring is low due to the low exploitation rate and small cod population.

Bycatches during sampling of other species in sprat fishing have been so scarce that they have no notable impact on the populations.

It is probable that the bycatches of cod in herring fishing using bottom trawl varied as the amount of bycatch can be controlled with this type of fishing gear. Raising the fishing line from the seabed can reduce cod catches in bottom trawling (van Marlen, 1993). Consequently, bycatches of cod were low during the period when it was prohibited to land cod. This indicates that the fishermen were trying not to catch fish that would otherwise have had to be discarded in an effort to avoid unnecessary work for the crew. During the period when it was permissible to land cod, the bycatches of cod increased. Fishing regulations for the Autumn 1994 permit a 10% cod bycatch when fishing for other species according to the Constitution of the National Board of Fisheries no. 1994:19. This should also be taken into account in forthcoming fishing quotas. Cod that are discarded are unlikely to survive, although this has not been confirmed scientifically. The indications are that the mortality rate of discarded cod is very high (Otterlind 1961).

The amount of other species caught as a bycatch during sampling in herring fishing with bottom trawl was so small that it can be reasonably assumed they had no impact on the population.

The fact that fishing for sprat for industrial purposes has increased in the last two years shows that this has become an important revenue for some fishermen. This investigation shows



that fishing for sprat in SD 26-28 during 1993 and 1994 had little impact on the cod stock. In SD 25, the sampling is too sparse for evaluation.

Fishermen have reported increased catches of cod in SD 25 during the Autumn 1994, which has probably lead to an increase in bycatches of cod in this area. The high bycatches of cod in the late 1970s and early 1980s were caused by the cod stock expanding its distribution to a much larger area than earlier (Anon., 1993a).

The sampling up to this date has given a valuable indication on how the cod stock is affected by the two investigated fishing methods. It is of great importance that this project continues, preferably with combined sampling aboard ships and at landing sites, to show how the situation varies in time and with different circumstances.

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## VI. APPENDICES

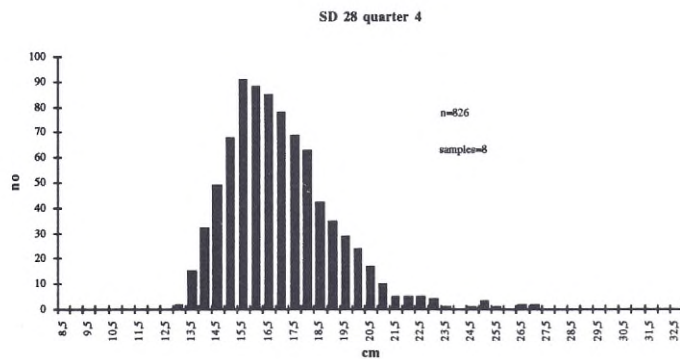
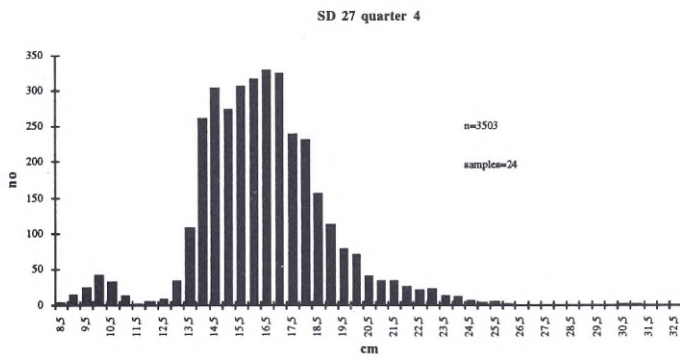
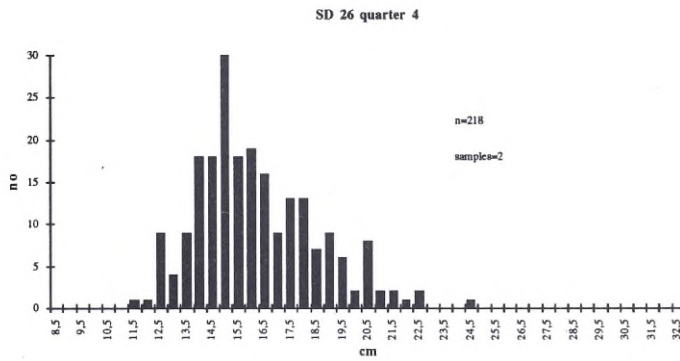
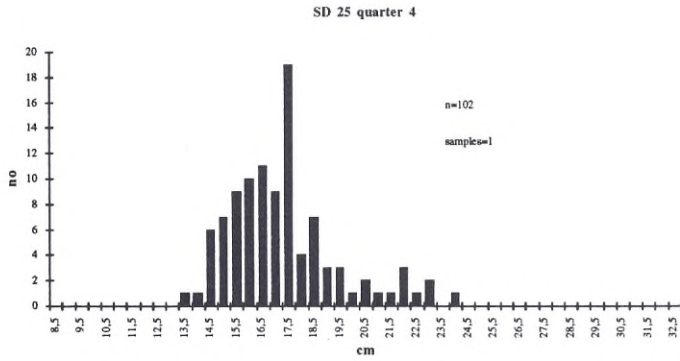
Appendix 1. Length distribution of herring caught as a bycatch in sprat fishing (pelagic trawl, 16-22 mm mesh size).

Appendix 2. Length distribution of sprat (pelagic trawl, 16-22 mm mesh size).

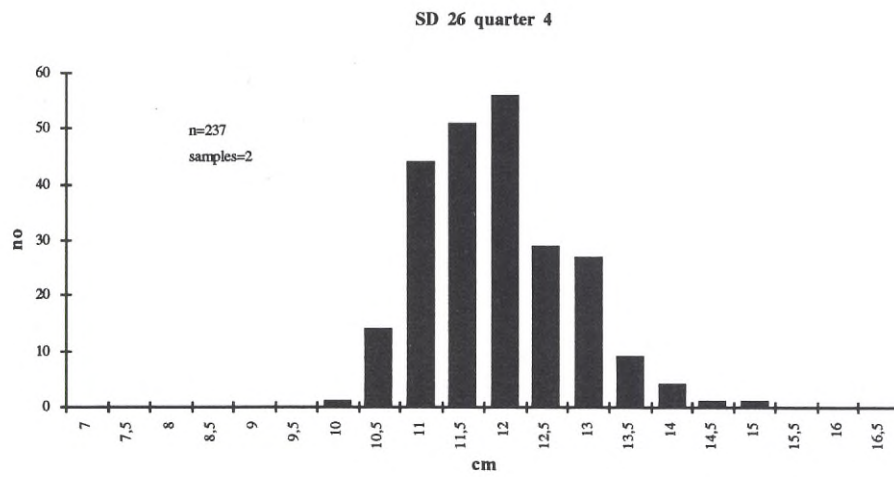
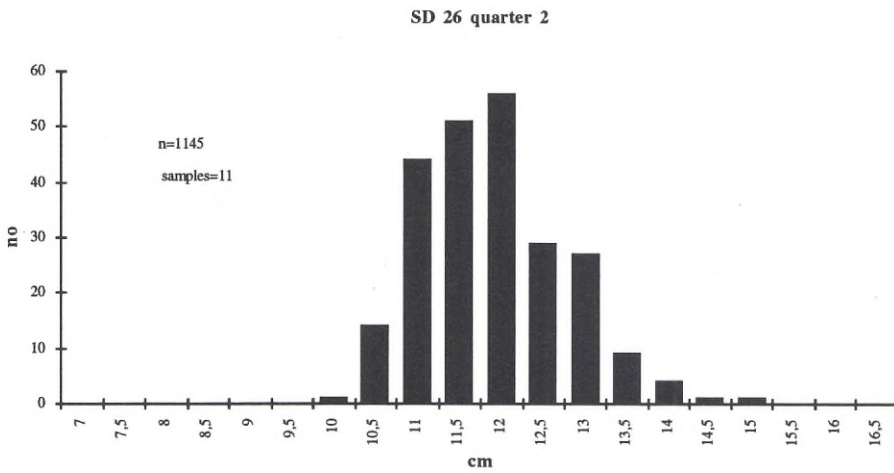
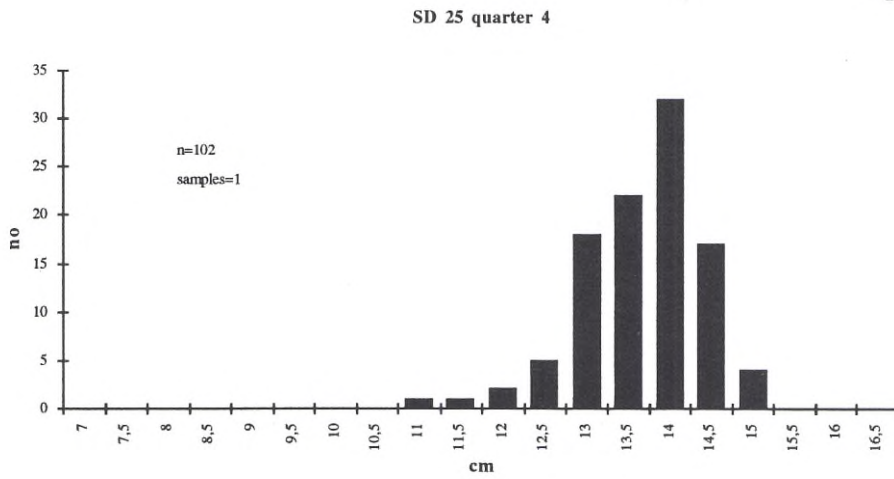
Appendix 3. Length distribution of herring (bottom-trawl 32-40 mm mesh size).

Appendix 4. Length distribution of sprat caught as a bycatch in herring fishing (bottom-trawl 32-40 mm mesh size).



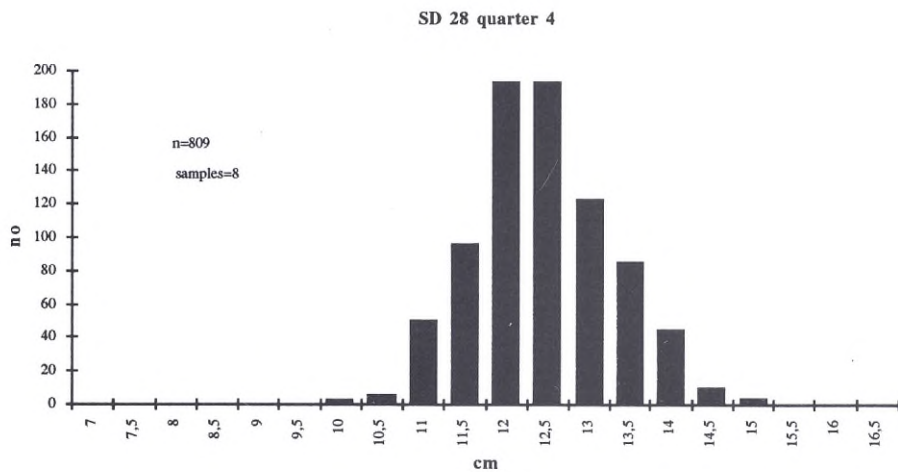
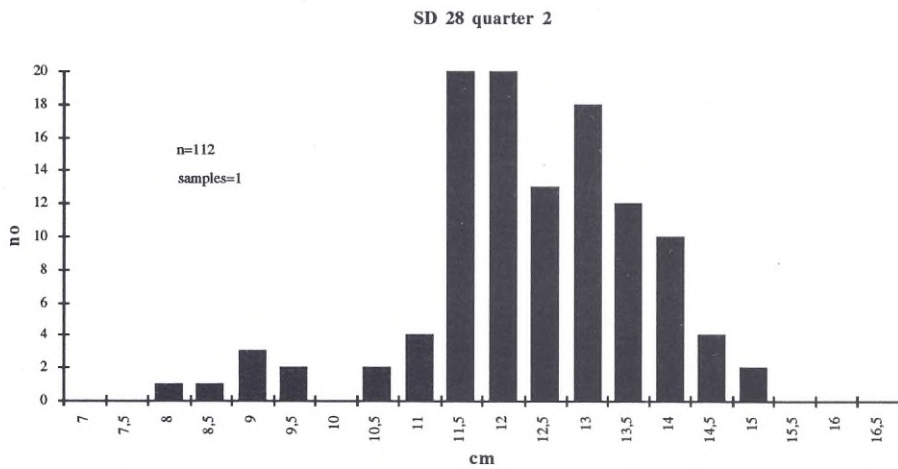
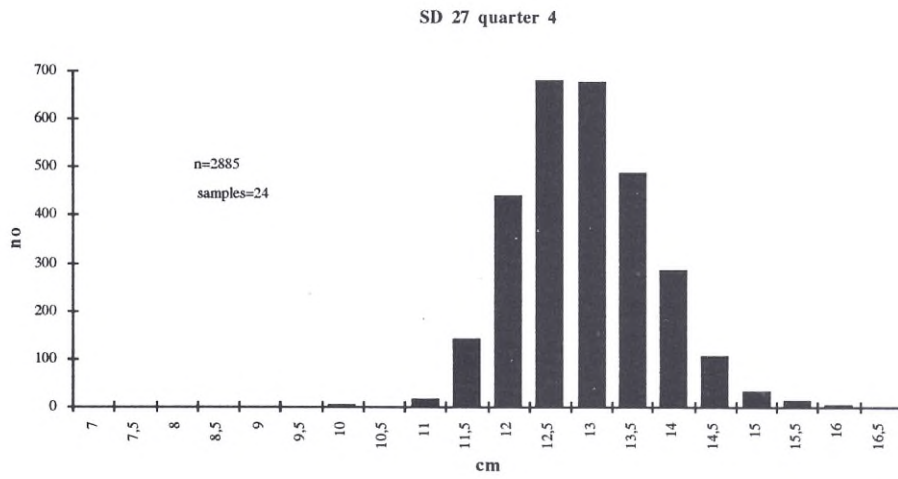


Charts showing length distribution of herring (*Clupea harengus*) caught with a pelagic trawl (mesh size 16-22 mm) in 1993.

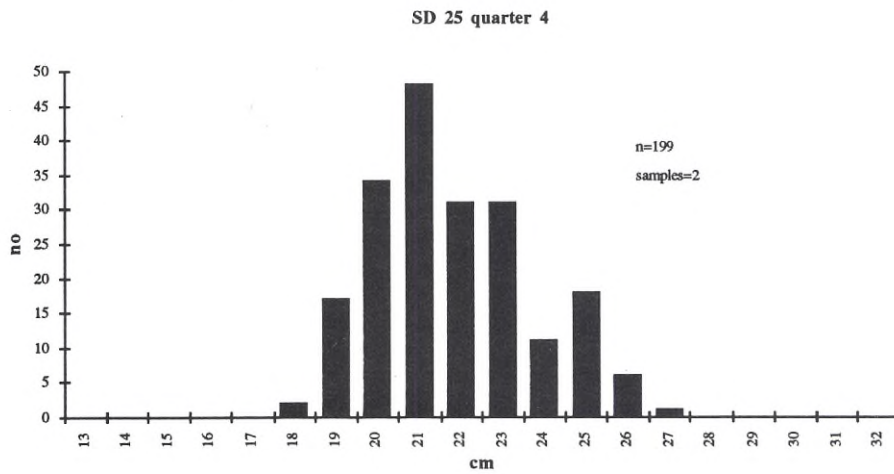
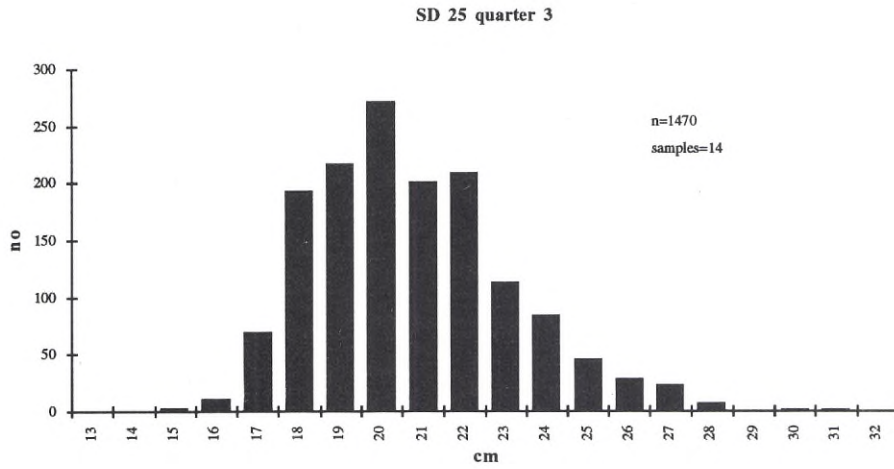
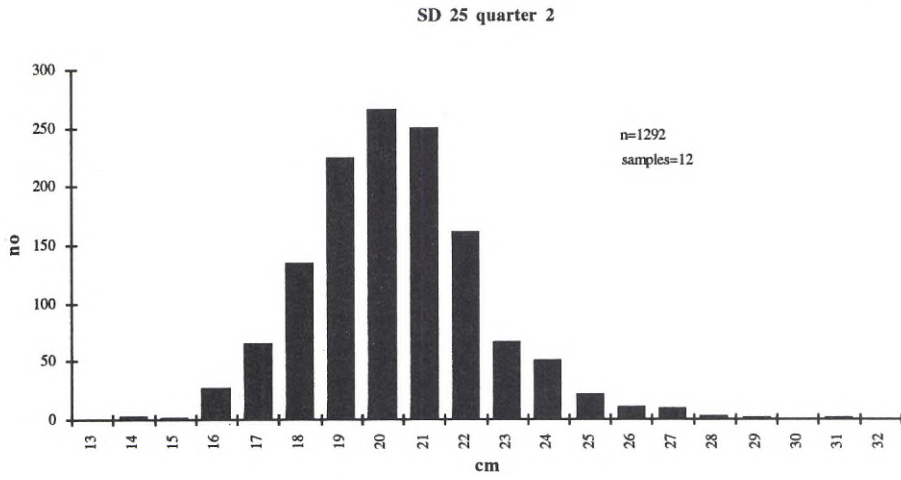


Charts showing length distribution of sprat (*Sprattus sprattus*) caught with a pelagic trawl (mesh size 16-22 mm) in 1993.



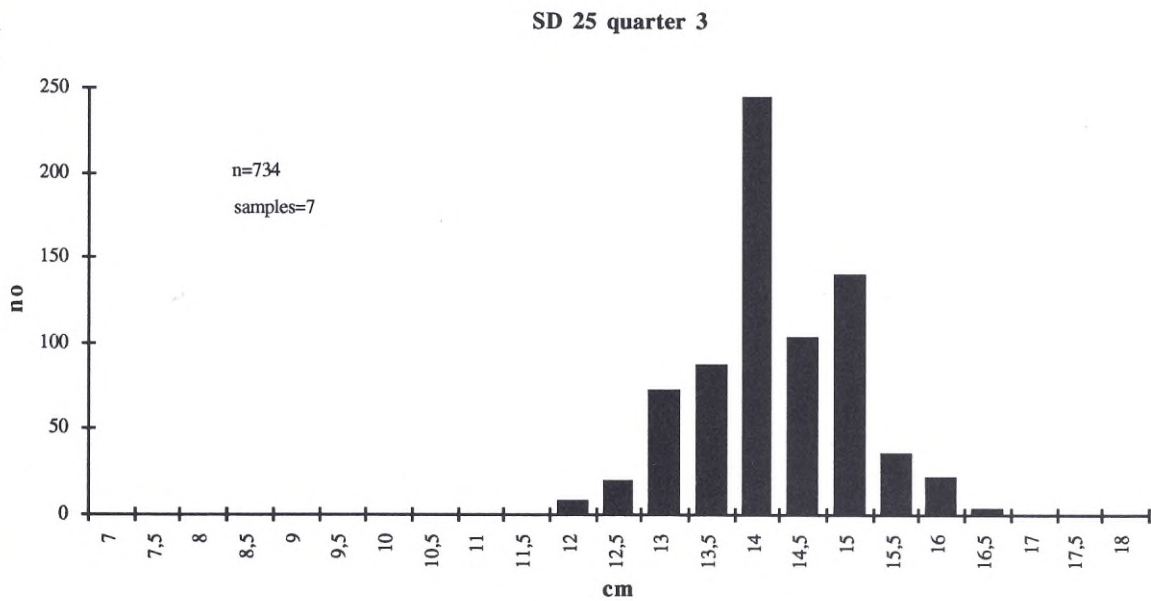
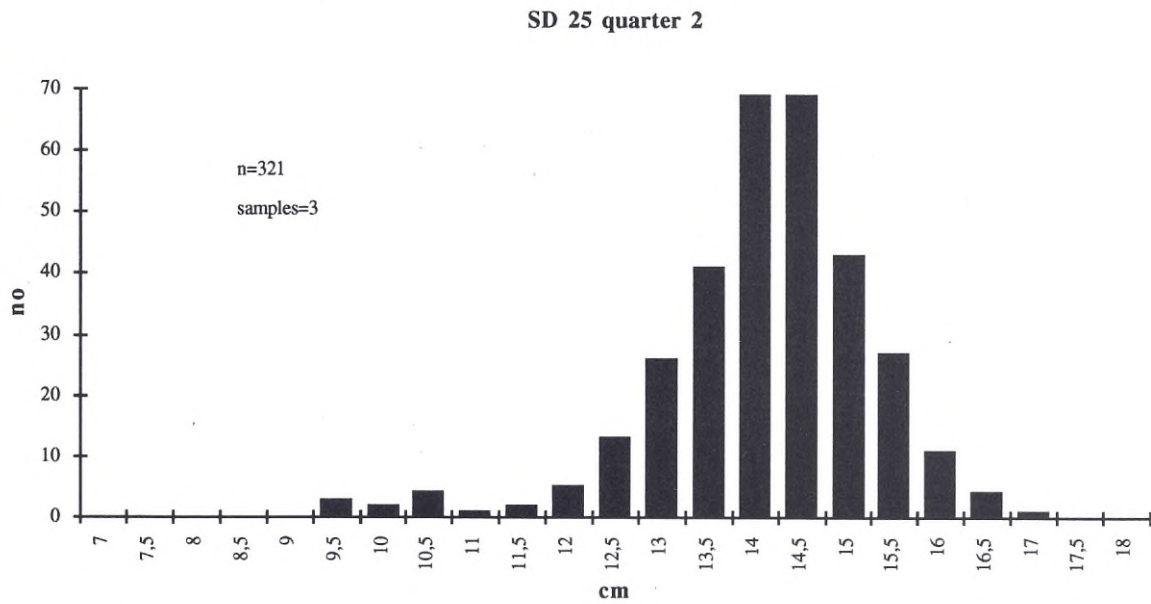


Charts showing length distribution of sprat (*Sprattus sprattus*) caught with a pelagic trawl (mesh size 16-22 mm) in 1993.



Charts showing length distribution of herring (*Clupea harengus*) caught with a bottom trawl (mesh size 32-40 mm) in 1993.





Charts showing length distribution of sprat (*Sprattus sprattus*) caught with a bottom trawl (mesh size 32-40 mm) in 1993.







