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GRID DEVICES TO SELECT SHRIMP SIZE IN TRAWLS

by

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ABSTRACT

Discard of small shrimps and fish is a substantial problem in the fishery for deepwater shrimp in the Northwest Atlantic. In order to solve this problem, different grid devices are under development to sort out discard sized shrimp and fish in the trawl. Successive experiments with three different grid devices were carried out at West Greenland in 1991 and 1992. The ability to sort out small shrimps increased during the trials. However, the most efficient device tested in 1992 also sorted out a great amount of the larger shrimp, making it unsuitable for the commercial fishery at this developmental stage. Small fish with a regular shape such as redfish were well separated by the grids, while flatfish as Greenland halibut were inefficiently sorted and gave rise to blocking of the grid. A future improvement of the grid is discussed in relation to operation and selection abilities.

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1. Introduction

Target species in most shrimp fisheries is commercial sized shrimp. Small sized shrimp and fish are considered as bycatch and are therefore often discarded. Worldwide discard of juvenile fish of commercial important species as well as undersized shrimp is known as a major management problem.

In the fishery for deepwater shrimp (*Pandalus borealis*) in the North Atlantic, 10-20% of the shrimp catch is probably discarded, and up to 30% in the Greenland shrimp fishery. Major bycatch fish species are cod, haddock, redfish, Greenland halibut, herring, capelin and polar cod, of which all but polar cod are of major management concern as juveniles are caught and discarded.

Since the early 70's, an extensive research effort has been made to solve the bycatch problem experienced in the fishery for deepwater shrimp. In 1989 a selective device consisting of a rigid grid in the aft belly was developed in Norway. This grid proved to be very efficient at releasing fish without reducing the shrimp catch, and was made compulsory in the northern Norwegian coastal shrimp fishery from 1 May 1989 and in the northern part of Norwegian EEZ from 1 October 1992. From 1 January 1993 the grid device was also made mandatory in the Russian EEZ.

Encouraged by the convincing results from the fish bycatch excluder grid in the Norwegian shrimp fishery, several countries have copied the technique to solve their own bycatch problems. Nordic countries catching shrimp started in 1991 a joint project on grid technology to reduce catch of small sized shrimp and improve the fish separation based on a grid technology.

This report describes design and sorting principles of two different grid devices and selectivity experiments carried out on two cruises off West Greenland in 1991 and 1992. One device was a combined fish bycatch excluder and shrimp size selector (FASS), and the other was designed to reduce catch of small sized shrimp and small sized fish (3S). The development of the grid devices also included fullscale testing in a flume-tank at the Danish Institute of Fisheries Technology and Agriculture (DIFTA) and observations with a remote controlled underwater TV-vehicle in an Islandic Fjord.

2. Materials and methods

2.1 Surveys

Experiments with the FASS and 3S device were carried out in 1991 and 1992, both years in the period from 1. July to 14. July, on shrimp fishing grounds at West Greenland as shown in Fig. 1. The vessel was M/T "Paamiut", a 722 GRT 2000 hp stern trawler, equipped with doors of the type "Perfect Greenland" size 370*250 cm, weight 2420 kg, and a trawl, "Arctic Skjervoy", with bobbin footrope and a mouth circumference equivalent to 3000 meshes in 20 mm half mesh.

Trawling speed was about 2.5 knots and fishing depth was approximately 300-400 m. Hauls were of a duration between 25 minutes and three hours.

2.2 Design and rigging of grid devices

The FASS device consisted of two hinged grids; a front grid with 25 mm bar spacing, aimed at getting rid of fish (fish grid) and a rear grid with 11-13 mm bar spacing to size select shrimp (shrimp grid), a guiding funnel in front of the grids and guiding panels behind the rear grid (Fig. 2). The various components were installed in a cylindrical net section in front of the codend. The grid device was used in two modes, one as shown in Fig. 2 and the other turned 90° to a plough mode as illustrated in Fig. 3. The tests in 1991 with this device included several modifications, especially of the funnel part.

The 3S device consisted of two grids arranged as illustrated in Fig. 4. The main components were a front grid with 12.5 mm bar mm spacing, rising 30° from the bottom panel, and a second grid with double length, 12.5 mm bar spacing, falling 30-35° from the top panel. Behind each grid there was a guiding net panel for shrimp that had passed through the grids. As an extension of the front grid, a guiding net panel to lift shrimps to a higher level was rigged in order to make maximum use of the second sorting grid. Another important component of this device was the lastridge chain mounted 7% shorter than the netting, thus taking the load from the codend and any catch when towing and hauling.

2.3 Experimental procedure

Prior to sea trials with the FASS device, the selectivity section was attached to a circular frame and its performance observed in the flume-tank at DIFTA. In an early phase of the sea trials off the coast of West-Greenland in 1991, the performance of the device installed in the 3000 Skjervøy shrimp trawl was studied with RCTV Focus 300 in depths from 120 to 170 m. Because of a damaged cable, the various modifications of the grid device made during the experiments, as well as behavior of fish and shrimp, were not fully studied.

The effect on shrimp size selectivity and fish escapement of the various designs was evaluated using small meshed (20 mm) bags behind the rear grid and small meshed (20 mm) inside blinders in the main codends. When the grid device was used in the horizontal mode, a collecting bag covered the fish outlets in front of the first fish escapement grid.

The 3S device was constructed on the basis of experience from a similar design used to select fish size as well as nephrops in trawls. The device was observed in the flume-tank at DIFTA prior to the sea trials off West Greenland. During the fullscale tests, various components were added, starting with one rear grid, ending up with two grids and an extra guiding net panel as extension of the front grid. To evaluate the selectivity of the two grids, collecting bags were mounted behind each of them. The grid device which proved to be best was later observed with a RCTV during a cruise in Iceland with the research vessel R/V "Drøfn" the same year. In the last part of the trial, alternate hauls with and without grid devices were carried out. The mesh size in the codend was 45 mm in these trials, as used in the commercial fishery.

2.4 Sampling

A representative sample (3-5 kg) of the shrimp catch in the collecting bags and the main codend was taken from different parts of the catch, and carapace length was measured with caliper to nearest 0.1 mm and grouped into 0.5 mm intervals. Representative samples of fish were taken in the same way and subsamples were measured (total length) to the centimeter below.

CPUE for shrimp was approx. between 100 kg/h and 1200 kg/h. For redfish and Greenland halibut CPUE ranged between 30 and 300 kg/h and 0 and 70 kg/h, respectively.

3. Results

3.1 Selectivity of shrimp

Length distributions of shrimp sorted out by grids and from the catch in the small mesh sized codend are shown for the two FASS devices and the 3S device in Fig.5.

In the experiment with the FASS plough mode device, shrimp from 17 mm to 29 mm carapace length dominated the catch. The catch rate in this experiment were very high. For smaller shrimp, less than about 20 mm, approximately half of the numbers entering the trawl was sorted out by the grid. The number sorted out of larger shrimps, above 22 mm, declined steeply by increasing length. Calculating the proportion of shrimps in the codend and using this data to estimate selection parameters gave a 50% retention length (L50) of 18.3 mm and a selection range (S.R.) of 7.9 mm. (Table 1).

The experiments with the FASS horizontal V-shaped mode device were carried out on fishing grounds where smaller catch rates were obtained and where smaller shrimps were relatively more numerous. Given these conditions this device seemed more effective in sorting out smaller shrimp (less than 20 mm) than the plough mode device. However, it also seemed to sort out a greater proportion of the shrimp in the range of 20 mm to 25 mm. L50 were found to be 19.5 mm and S.R. to be 7.7 mm.

The 3S device experiments were carried out on grounds where larger shrimps were relativly more numerous than on the grounds of the two other experiments. In the 3S device both grids sort out shrimp, and length distributions of shrimps passing through the two grids were very alike, with shrimp between 22 mm and 25 mm carapace length dominating. The second grid is approximately twice as effective as the front grid in sorting out shrimps. L50 were estimated to 21.8 mm and S.R. to 8.8.

It is difficult to compare the abilities for the three devices to sort out shrimps because the experiments were carried out on grounds with different catch rates and different length compositions of the shrimps. However, in order to give an idea of the amount of shrimps sorted out by the three devices, the catch in numbers has been converted to catch in weight by length group using a length-weight relationship. Table 2 shows the percentage of shrimp in three size groups sorted out by the three devices. The 3S device sorted out 57% of small shrimps, which is the highest percentage of the three devices, but this device also sorted out a great amount of the larger shrimps. The amount of small shrimps sorted out by the FASS plough device is significantly smaller than the amount sorted out by the FASS horizontal device. This could be due to the higher catch rates during the experiments with the FASS plough device.

The alternate hauls experiment with the 3S device gives an idea of the consequences for the commercial fishery if this device were introduced. Fig. 6 shows length distributions of shrimp from hauls with and without grid devices. In hauls without grids the catch by length group increased sharply at about 19 mm and remained high to about 26 mm where it dropped steeply. In hauls with grids the catch increased gradually to about 26 mm. For shrimp below 22 mm carapace length the hauls with grids caught in terms of weight only 29% of the catch by the hauls without grids. However, of the larger shrimp (above 25 mm carapace length) the hauls with grids caught only 68% of that of hauls without grids.

3.2 Selectivity of fish

Figure 7 shows length distribution of redfish from the grid and the codend, respectively for the three devices. For the FASS plough and FASS horizontal V-shape devices approximately half of the smallest redfish (7 cm, representing the youngest yearclass) entering the trawl was sorted out. Both devices indicated a lesser proportion of the larger individuals of the youngest yearclass (8 cm) to be sorted out. The proportion of small redfish sorted out in the 3S device was much higher than for the two other devices. Especially the rear grid was very effective in sorting out the small redfish. Only an insignificant part of redfish greater than about 9 cm was sorted out by the grids.

Greenland halibut is also taken as bycatch in great amount in the commercial fishery for shrimp. However, only the alternate hauls with the 3S device data allowed an evaluation of the ability to sort out this species. Figure 8 shows the length distribution of the catch by hauls with and without grid devices. The grids seemed to be inefficient to sort out bycatch of Greenland halibut to some significant extent.

4. Discussion

The handling of three different grid devices onboard M/T 'Paamiut' caused minor problems. It was important to be careful when shooting, so that twist in front of the grid was avoided. Underwater observations of the devices confirmed the expected performance, basically as indicated on the illustrations in Figs. 2-4.

In an attempt to avoid bycatch of small sized shrimp and fish by the introduction of grid devices, the fishing operation must not be hampered, and manpower costs must be maintained or reduced. If a grid design is to be introduced in the fishery, it should be as simple as possible, and it may be necessary to compromise between the complexity of the grid device and its selective abilities. In this respect the 3S device used in 1992 is a more simple concept than the FASS devices used in 1991.

The sorting capacity of the grid device should be evaluated against other alternatives such as increasing mesh size in the codend. A selectivity study carried out in West Greenland waters with 60 mm mesh size in teh codend found L50 between 17.8 mm and 21.2 mm and S.R. between 6.2 mm and 7.6 mm (Lehmann et al., 1993). This is about the same L50 but a lesser S.R. than found in this study. The reduction in catch in the 60 mm mesh codends of small shrimp (below 22 mm carapace length) were in the order of 40-50% compared to the normally used 45 mm mesh codends. The alternate fishing experiments with the 3S device showed a reduction of 71%, but a greater reduction of larger shrimp was also seen, however.

The proportions of small shrimp sorted out by the FASS devices were unsatisfactorily small. However this could be changed by increasing the bar spacing. In the 3S device, the bar spacing was changed to 12.5 mm, and the proportion of small shrimp sorted out was remarkably higher compared to that of the FASS devices. The major problem with the FASS devices is the relative high selection range. It was felt that a selection range smaller than found by a mesh size of 60 mm in the codend could be obtained. This was the main reason for fixing the bar spacing in the 3S device instead of operating with the variable bar spacing as used in the FASS devices.

Based on these figures there is no reason to prefer grid devices for 60 mm mesh codends, except if the selective capacity of the grid can be improved. L50 could be changed by using another bar spacing which would change the figures in the wanted direction. However, the main problem is the relatively "flat" selection ogive with a selection range around 8 mm. Several elements are obviously related to the high SR. Shrimps with soft shell are probably not so 'selectable' by this grid device, and as soft shelled shrimps are most numerous in the season at which the experiment were carried out, a high SR is expected. Secondly, the bar spacing varied during the survey because of the handling of the gear. The grid were made of aluminum, and another material such as plastic may retain a constant bar spacing which would result in a lesser SR. Thirdly, a reduced selectivity in hauls with high catch rates is observed. However, examining each haul with the 3S device, there does not seem to be a clear relationship between the selection capacity and the catch rate.

The grid devices seemed to sort out small redfish (7 cm) very well, especially the 3S device, but were inefficient concerning small Greenland halibut. This could probably be due to the asymmetrical shape of Greenland halibut (and other flatfish). On grounds where Greenland halibut were very numerous, the sorting ability of the grid were reduced because the fish block the grid. Other fish species which occasionally occur in great numbers, such as polar cod and lanternfishes, were sorted out well by the grids.

5. References

Lehmann, K., Valdemarsen, J.W., and Riget, F. 1993. Selectivity in shrimp trawl codends tested in a fishery in Greenland. *ICES mar. Sci. Symp.*, 196: 80-85.

Table 1. Selection parameters for shrimp in the three grid devices.

	1991 FASS plough device	1991 FASS horizontal V-shaped device	1992 3S device
L25	14.4	15.7	17.4
L50	18.3	19.5	21.8
L75	22.3	23.4	26.2
S-factor	0.66	0.62	0.57
S.R.	7.9	7.7	8.8

Table 2. Percentages (by weight) of shrimp in three size groups sorted out by the three devices.

size groups carapace length	1991 FASS plough device	1991 FASS horizontal V-shaped device	1992 3S device
< 22 mm	35	53	57
22 - 25 mm	18	29	38
> 25 mm	3	4	20

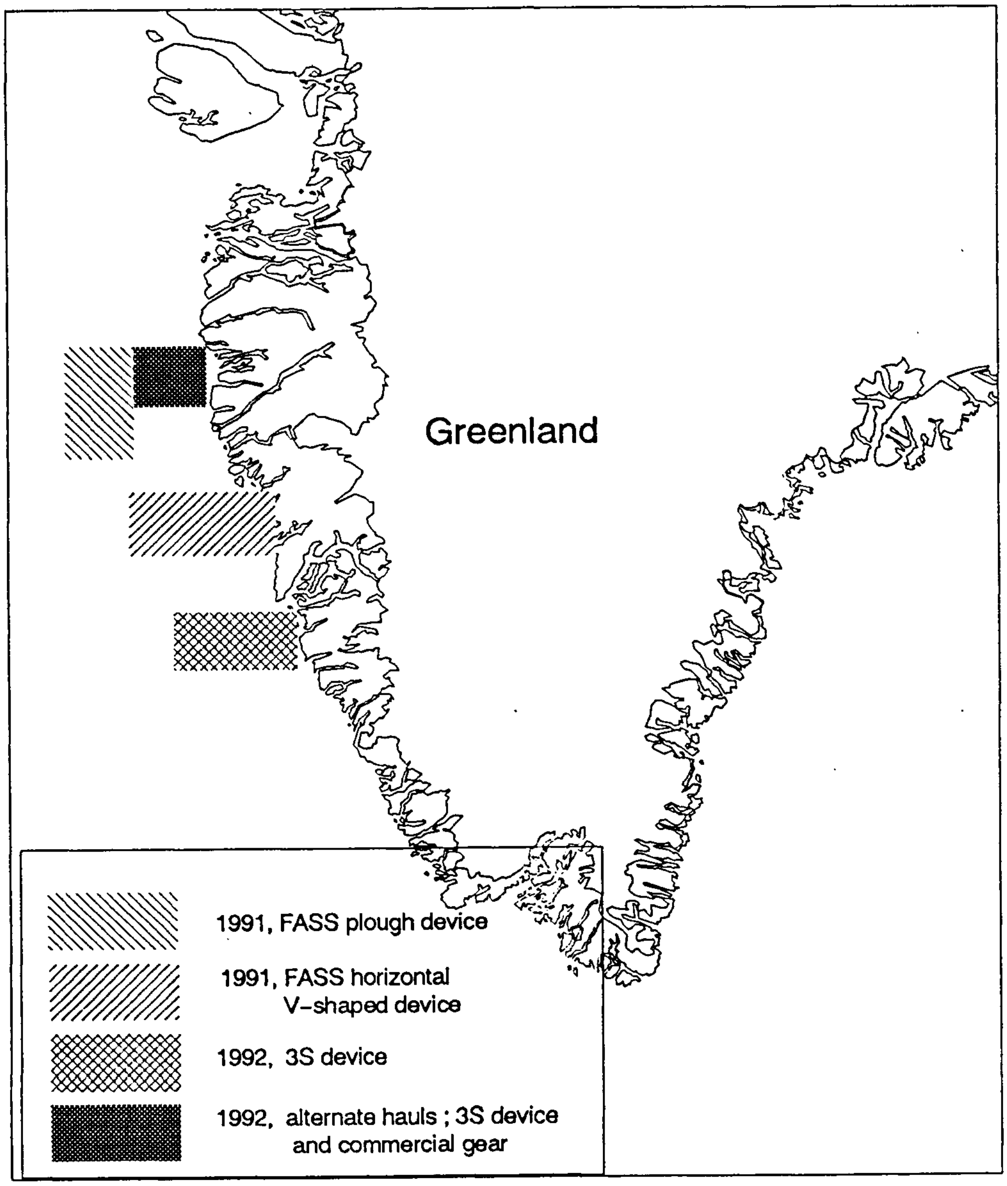

Figure 1. Map of the areas surveyed.

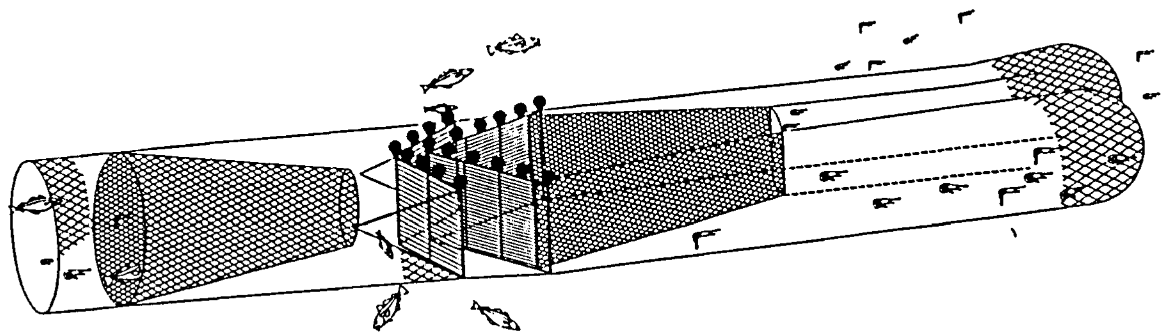

Figure 2. Fish and shrimp size selector in front of the codends (FASS). Plough mode.

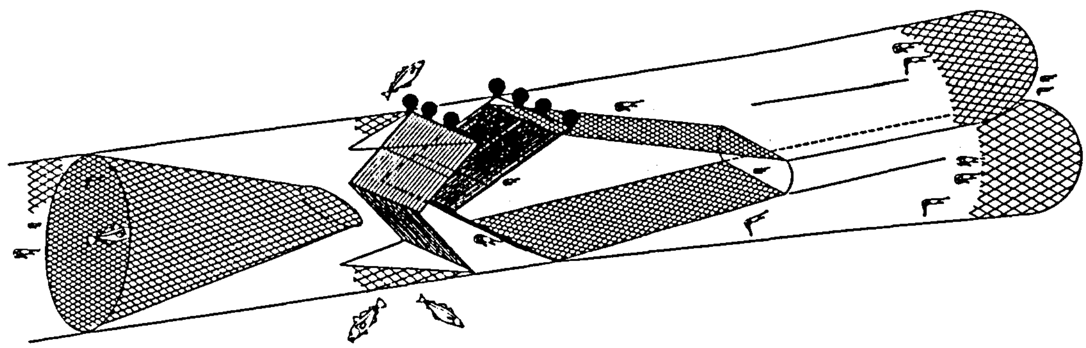

Figure 3. Fish and shrimp size selector in front of the codends (FASS). Horizontal V-shaped mode.

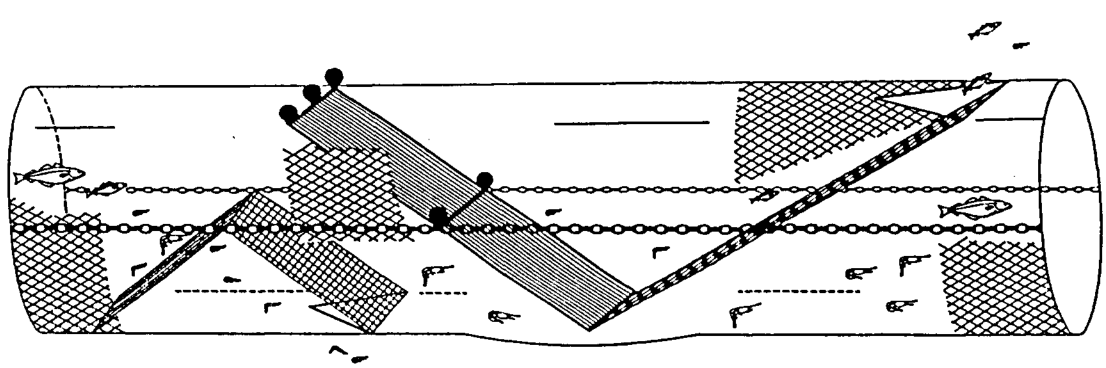

Figure 4. Shrimp and small sized fish selector.

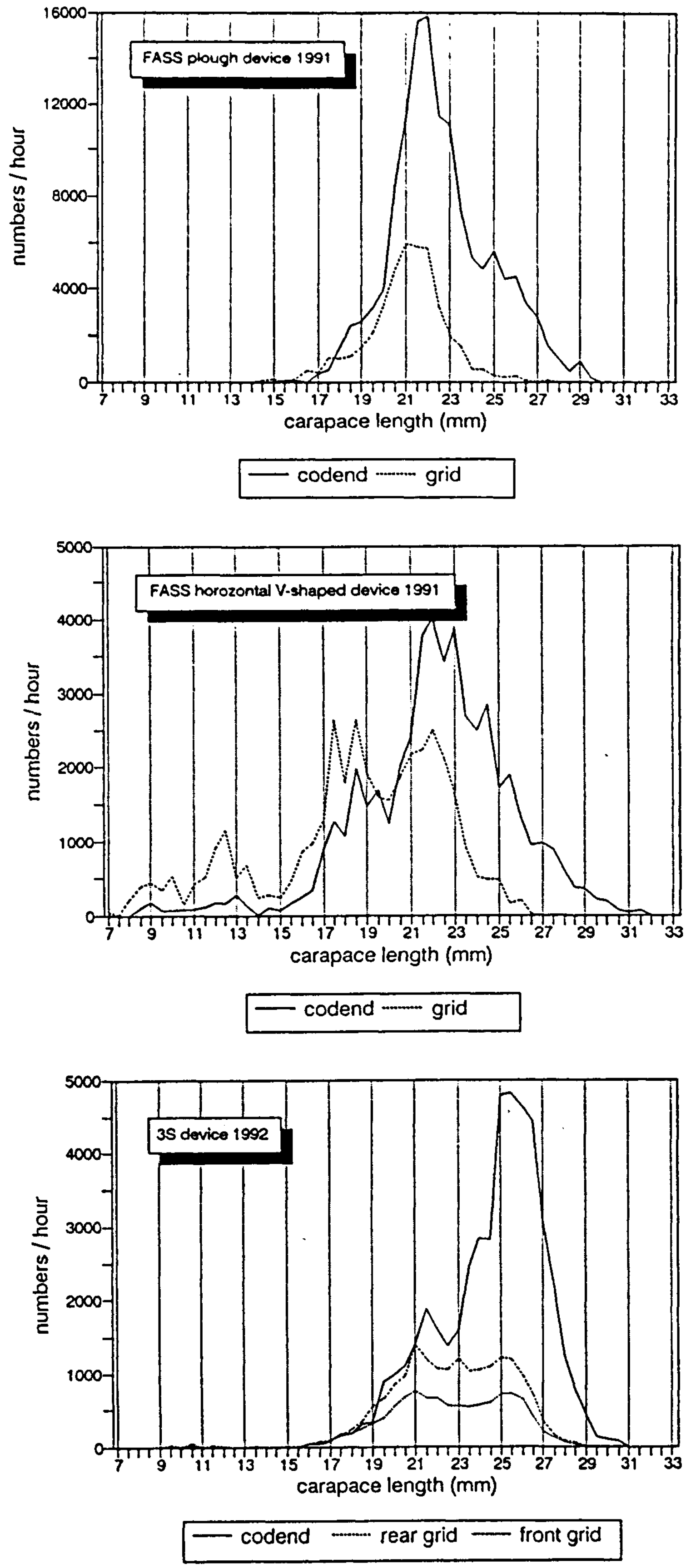

Figure 5. Length frequencies of shrimp from codends and collecting bags in the three devices.

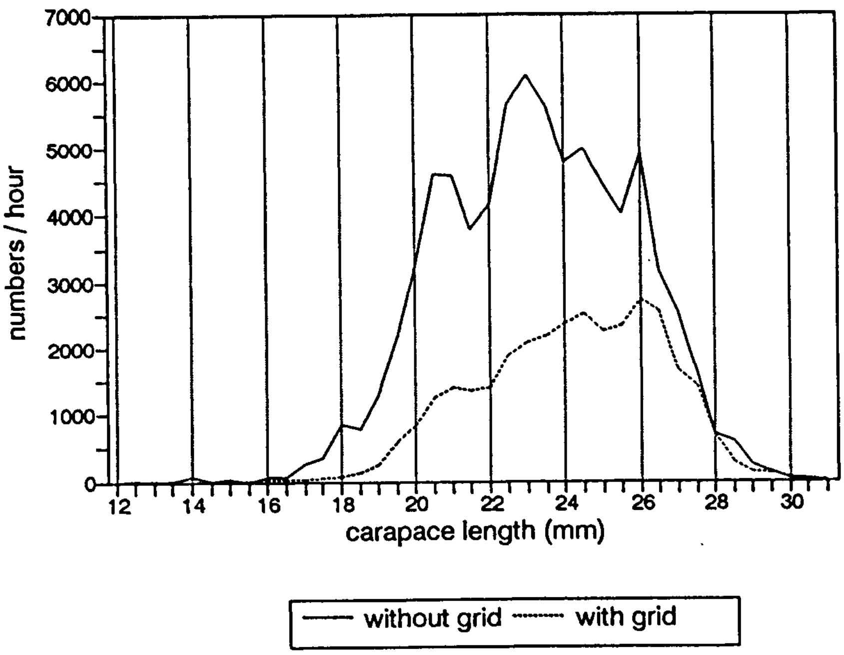

Figure 6. Length frequencies of shrimp from the alternate hauls experiment.

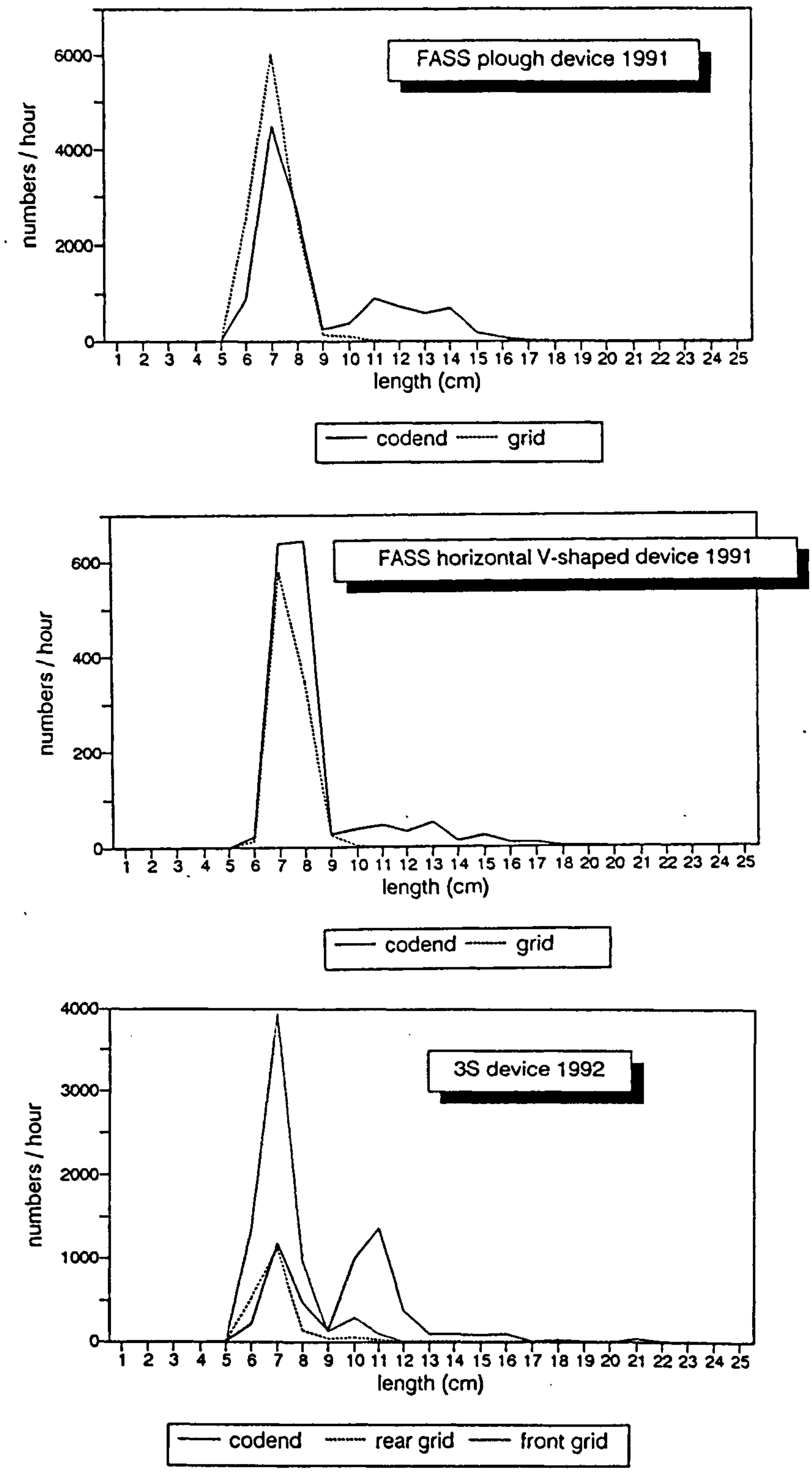

Figure 7. Length frequencies of redfish from codends and collecting bags in the three devices.

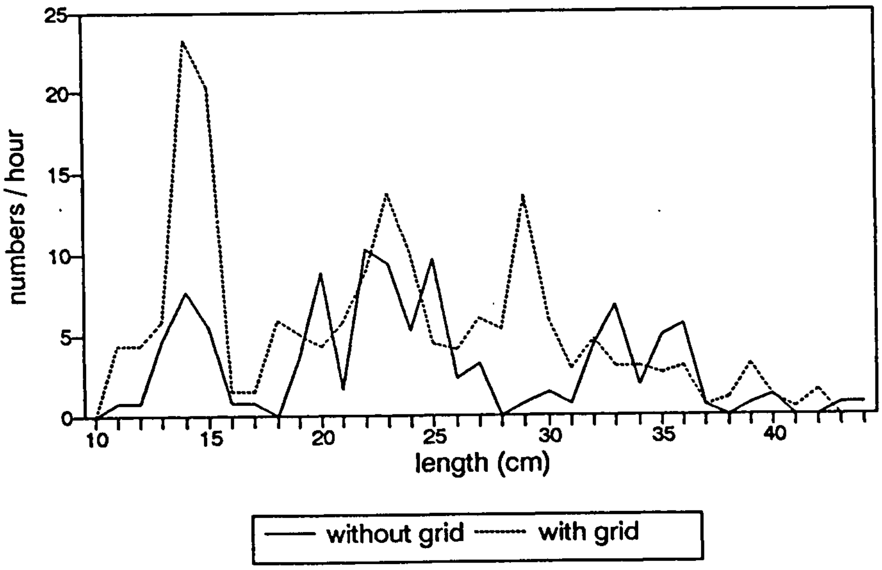

Figure 8. Length frequencies of Greeland halibut from the alternate hauls experiment.