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SIZE-SELECTION OF MACKEREL AND SAITHE IN PURSE SEINE

by

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Abstract

In purse seine fisheries, there may exist potentials for size selection because some of the fish in the catch are less than the legal size, and because different size groups are paid differently. Both potentials are present in the purse seine fishery for saithe along the Norwegian Coast, and at present the latter is of great interest in the mackerel fishery in the North Sea.

We have developed a technology for size selection of fish in purse seine based on rigid sorting grids of polyester composite or aluminium mounted to the bunt. The size selection process takes place when the catch is concentrated in the bag along the side of the vessel. The grids give sharp size selection both for mackerel and saithe, and they have a substantial capacity for sorting out small fish.

Introduction

Opposite to trawl, longline, and gill net, purse seine is traditionally categorized as a non-selective fishing method, aimed to catch all sizes of fish in the catches. Most of the countries in the world therefore have no mesh-size regulation for purse seine in their fishing regulations.

In Norway, the demand for size-selective purse seines has been increasing during recent years, especially in the mackerel and saithe fisheries. Most of the mackerel caught by the Norwegian purse seine fleet are frozen and exported to Japan. The Japanese market favours large mackerel (above 600 gram, so called G6) and pay twice as much for this large fish. The mackerel schools in the North Sea consist of different year classes and therefore different size groups. It has been claimed that fishermen sort the fish onboard and discard the smallest mackerel. If such discard is of any magnitude, this is bad exploitation of the mackerel stock. If the smallest mackerel could be sorted out of the purse seine alive and thereby increase the proportion of mackerel above 600 grams in the catches, this would increase the value of the catches and thereby the income for the fishermen. An 10% increase in the proportion of mackerel above G6 will expand the income for the fishermen by approximately NOK 500.000,- per vessel per year. If most of the mackerel that escape through the sorting device survive, this would also be good exploitation of the stock.

In the purse seine fisheries for saithe, fishing grounds have to be closed due to large amount of undersized fish in the catches. Closing of fishing grounds reduces the income for the fishermen since they have to leave the ground and search for new ones with larger fish. There is also a similar price differentiation with regard to fish size in the saithe fishery as in the mackerel fishery.

Sorting grids of metal have been developed and introduced with success as selection device in shrimp- and bottom fish trawls (Isaksen et al. 1992; Larsen and Isaksen 1992), Danish seine, and as a size-sorting device in salmon farming. In 1992, the Fish Capture Division at the Institute of Marine Research, Bergen, Norway, started to develop a technology for size selection of saithe and mackerel in purse seine based on rigid sorting grids of aluminium, stainless steel or/and polyester composite, mounted to the breast of the bunt. The first preliminary trials were conducted on saithe in net pens (Misund and Skeide 1992).

Mackerel experiments

To test if net could be used for size selection in mackerel purse seines, two panels of relatively large meshed, stiff, impregnated net were mounted in the bag of a traditional mackerel purse seine. One panel was made of 4 mm braided knotted net with a mesh size of 84 mm. The other was made of 9 mm knottless ultra cross net produced by Nichimo with a mesh size of 90 mm. Both net panels were mounted in a section of the bunt directly under the selvage and about 25 m from the breast of the purse seine. The panels were 9.5 m long and 3.5 m deep.

A sorting grid in metal was designed for use in conventional mackerel purse seines used in the North Sea. The mackerel grid consisted of an aluminium frame with bars made of stainless steel of 25 mm (Fig. 1). The size of the grid was 3 x 3.5 m, which gave a selection area of about 10 m^2. The distance between the bars was originally 40 mm. During the experiments, the bar distance was adjusted to 44 mm and then to 42 mm. The weight of the grid was about 220 kg.

The mackerel grid was mounted in the purse seine by the following procedure: When the pursing of the seine was finished, the breast of the purse seine was brought in on deck by the crane. To prevent the breast from being pulled out to sea again, the net was locked to the rail by a rope. The breast rope was then released from the crane, and the breast stretched out around the grid. The breast was then laced to the grid by an 8 mm twisted line. When stretched, the breasts of the two purse seines used in the selection experiments measured 15 m and 12 m, respectively, and the surface of the three sides of the grid to be fixed to the gear measured about 10 m. The length of the breast was therefore adjusted by folding the breast during mounting along the lower convex side of the grid. The grid was then mounted to the crane, the net released from the rail, and the grid with the bunt attached hoisted overboard. The grid was lowered carefully in the sea until most of it was submerged. When the purse seine was nearly hauled in, and the "drying" of the catch up along the side of the vessel started, the grid formed a "wall" in the bunt (Fig. 2). During "drying" of the catch, the fish were forced against the grid. The grid was continuously controlled by the crane. When the catch was pumped onboard, the grid were brought up along the rail and the purse seine released.

The first experiments on size selection of mackerel in purse seine were made on a cruise by the charted Norwegian purse seiner M/V "Selvaag Senior" (67.5 m Loa.) in the North Sea in November 1992. The vessel was equipped with a conventional polyamid North Sea purse seine of 650 x 170 m with a mesh size of 31 mm (stretched). The net panels were tested on the first five catches and the mackerel grid on three succeeding catches. The bar distance in the first two trials was 40 mm, and before the last trial the bar distance was adjusted to 44 mm. In September 1993 the grid (42 mm bar distance) was tested on four catches during a cruise along the coast of Western Norway by the charted Norwegian purse seiner M/V "Ligrunn" (47 m Loa.). The vessel was equipped with a polyester purse seine of 850 x 170 m with a mesh size of 35 mm stretched in the body and double 50 mm stretched in the bunt (Beltestad 1990).

To collect fish escaping through the grid, a shrimp trawl bag was mounted to the mid-section on the outer side of the grid. This collection bag was about 10 m long, had a mesh size of 35 mm, and covered about 1/9 of the grid area. For length and weight measurements, subsamples of about 100 individuals were taken from the collection bag and from the catch that was pumped onboard after the selection grid had been functioning for about 15 min.

Saithe experiments

For size selection of saithe in purse seine, grids in aluminium and polyester composite have been constructed. The grids were designed for a small experimental purse seine of 320 m length and 45 m depth (Misund et. al. 1992). The aluminium grid was made of 20 mm aluminium bars with a bar distance of 35 mm, and measured 2 x 2 m which gave a weight of about 40 kg. The polyester composite grid was made of 15.5 mm bars with a bar distance of 30 mm and measured 1 x 2 m, which gave a weight of only 10 kg.

The saithe grids were tested during a cruise by R/V "Fjordfangst" (14 m Loa.) in April 1994 to Finnåsvika at the island Bømlo, Western Norway. The vessel was rigged as a coastal purse seiner and equipped with a 150 kHz Furuno CH-12 sonar to localize schools and guide shooting of the purse seine. In case of catches, a grid was laced to the breast of the purse seine and hung up in a boom along the side of the vessel. As with the mackerel grid, the saithe grid acted as a "wall"

in the bag of the purse seine. The catches were forced towards the grid when hauling the purse seine. During the cruise, six catches from about 40 kg up to about 10 000 kg saithe were taken. The saithe were schooling at about 30 m depth, and four trials gave no catch because the schools escaped under the seine during pursing. To collect subsamples for length measurements, a small net pen (3 x 3 x 3 m) was laced to the outer side of the grid. Subsamples of about 100 individuals were taken both from fish passing through the grid and into the collecting pen and of the catch that remained in the purse seine bag.

Results

During the five trials by the selection net panels in the mackerel purse seine of M/V "Selvaag Senior" in 1992, most of the meshes both in the knotted net and in the knottless ultra cross net were rapidly clogged by gilled mackerel. The size selection through these net panels therefore stopped rather quickly. The gilled fish also reduced the friction in the net hauling system (Triplex) and made the hauling of the net more difficult, especially when handling the largest catches (up to 220 tons).

In the trials with the mackerel grid, the selection process started when the schools "exploded" during the last part of the "drying" of the purse seine. Substantial amounts of small fish were observed to escape through the grid, and the fish that was too large to pass through, rapidly swam away from the grid and back into the bunt. Just a few fish became gilled between the bars, mostly above the horizontal strengthenings of the grid. The selection process took place as long as the mackerel were active in the bag, and the duration of the selection process was up to about 20 min. for catches up to about 400 tons. The selection process stopped gradually as the fish died, probably due to oxygen depletion and exhaustion, and sank to the bottom of the bunt.

The selection curves for 40 mm and 44 mm bar distance of the mackerel grid were rather sharp, both with regard to the length and the weight of the mackerel (Fig. 3a, Fig. 3b). However, the selection curves do not approach zero retention for the smallest fish sizes. This is because not all of the small fish in the catch came in contact with the grid and were selected out. It should be noted that a change in bar distance from 40 mm to 44 mm increased the 50% retention length

by about one cm (from 36 cm to 37 cm), and the 50% retention weight by about 80 g (from about 420 g to about 500 g). Substantial amounts of small mackerel were sorted out during the tests with 42 mm bar distance, but the selection curves for these trials is not presented because inaccuracies in the bar spacing of the grid seemed to have influenced the selection properties substantially.

The 35 mm aluminium saithe grid was first tested on a catch of about 3000 kg saithe from 26 cm up to 41 cm. Most of the catch escaped through the grid during a few minutes, and only about 40 individuals remained in the bag. Comparison of the length distributions of the escaping and remaining fish indicate a rather sharp selection, even if the numbers remaining was too few for the construction of a proper selection curve. The 35 mm aluminium grid was also tested on another catch of about 200 kg saithe, and again nearly all fish escaped through the grid. The 30 mm grid was tested on four catches from about 40 kg up to about 10 000 kg saithe. In all cases most of the catch escaped through the grid, and the selection process of the largest catch was carried out within about 15 min. The 30 mm grid gave a very sharp selection curve (Fig. 4), with a selection interval of only about 5 cm.

Discussion

The selection experiments with rigid grids in mackerel and saithe purse seines showed that it is possible to use such devices for size selection of fish in purse seines. Large amounts of fish were sorted out through the metal grids used in the mackerel and saithe purse seines, and also through the plastic grid in the saithe purse seine. The experiments with net panels for size selection in the mackerel purse seine showed that clogging of the meshes by gilled fish prevented effective selection through such panels in the bunt of purse seines. Also gilled fish in meshes in the bunt created difficulties during hauling, through reduced friction in the net hauling system.

The mounting and handling of the rigid grids functioned without great difficulties both for the mackerel and the saithe purse seine. However, the metal mackerel grid was large and heavy, and handling by hydraulic crane was nesessary. Also, the grid occupied substantial space on deck, and mounting and handling of the grid may be a dangerous operation for the crew if not

conducted carefully. The saithe grids were so small and light that they could be handled manually. Obviously, it is possible to further develop the design, construction, and handling of rigid size selection grids for purse seines. In small purse seines, it is possible to use light constructions made of synthetic materials. For larger purse seines, rigid grids must be strong enough to withstand substantial forces when handling catches of several hundred tons. Therefore, such grids probably must be constructed of a metal frame. To reduce the weight, it may be possible to use bars of composite polyester. Another advantage with bars of such a material is that they will have a certain flexibility and take up the original shape if slighly bent during handling.The bars of metal grids were easily bent during handling, and the selection properties of the grids changed accordingly.

The selection curves of the rigid grids were rather sharp, and the selection occured within a narrow size interval. For the mackerel grid, which was tested on large catches up to about 400 tons, the left part of the curve did not approach zero retention. This is because large amounts of small mackerel did not hit the grid and became sorted out, but were instead pumped onboard. To obtain a high quality of the catch, the pumping onboard had to start immediately after the catch was concentrated in the bunt and the selection through the grid started. Also the mackerel died quite rapidly in bunt, and few fish escaped through the grid after 20-30 min. of concentration in the bunt. The selection experiments with saithe were counducted with much smaller quantities of fish, and all fish in the catches eventually came in contact with the grid. Therefore the left part of the selection curve for the 30 mm saithe grid approached zero retention. It is possible that all the fish may eventually come in contact with the grid even for larger catches of saithe. The saithe did not seem to "panic" when concentrated in the bunt even when occuring in quantities of up to about 10 tons. Trials with an adjustable sorting grid in net pens with up to 5 tons of saithe, showed that all the fish survived after having been concentrated in a bunt for up to half an hour (Misund and Skeide 1992). Therefore, all small fish in saithe catches by purse seines may possibly be sorted out through rigid grids.

However, a fundamental issue regarding use of rigid sorting grids for size selection in purse seines is the survival of the escaped fish. When using the mackerel and saithe grids, the fish actively swam out between the bars and escaped. It is possible that the selection process exposes the escaping fish to physical stress or injuries that lead to long term mortality. Lockwood et al.

(1983) found that mackerel suffered high mortality when stressed in small net pens. We have conducted preliminary trials with one month storage of mackerel in large net pens. The fish was taken by purse seine by M/V "Ligrunn" about 10 nautical miles off Sotra, Western Norway. The trials gave 35% survival of the mackerel which escaped through the grid and was collected in a large net pen, and 55% survival for the control group which swam directly from the purse seine and into a large net pen. Another trial with one month storage of small mackerel that were concentrated in net pens and then allowed to escpace through the grid and into a larger net pen, gave about 98% survival. The saithe seemed to tolerate the selection process, and Misund and Skeide (1992) observed no mortality of saithe after size selection through a rigid sorting grid in net pens. Similarly, we observed no mortality in two small catches of saithe that escaped through a polyester composite grid and into net pens of 3 x 3 x 3 m, where the fish were held for about one month. However, it is possible that saithe caught at greater depths and in larger groups that take longer time to select suffer long term mortality when escaping through rigid sorting grids in purse seines.

Further trials to test the survival of mackerel and saithe escaping through sorting grids in purse seines need to be conducted before any definite conclusions about the survival of escaped fish can be drawn.

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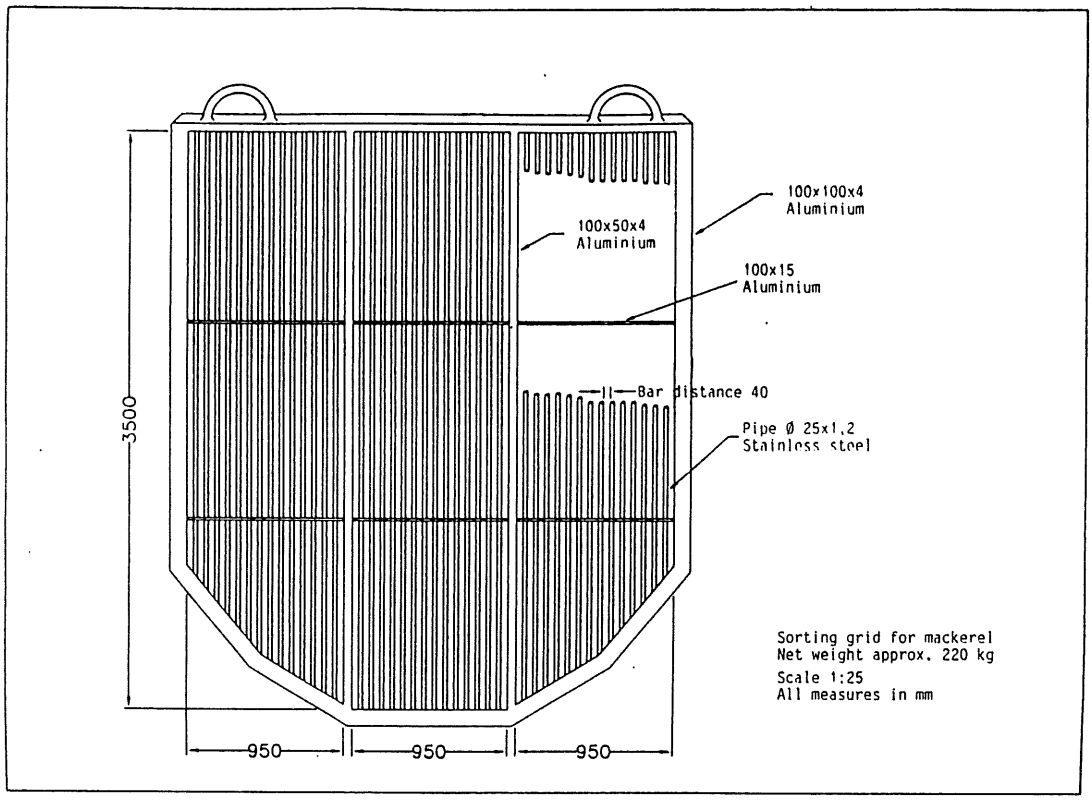

Figure 1. Sorting grid for mackerel purse seine.

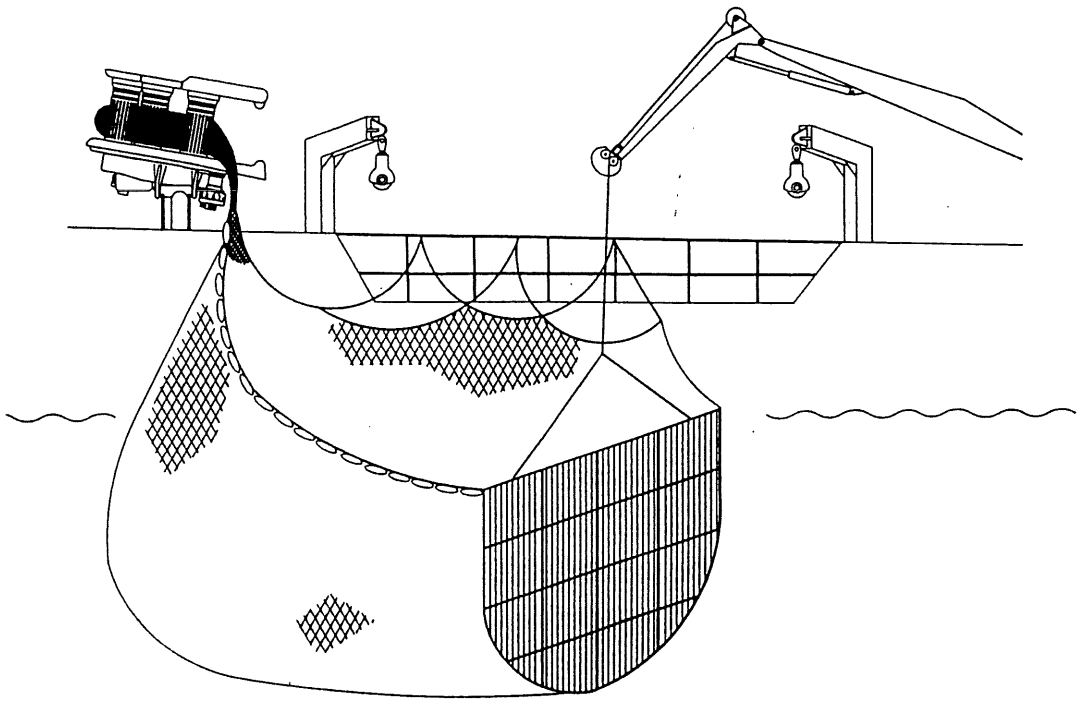

Figure 2. Sorting grid mounted in a mackerel purse seine.

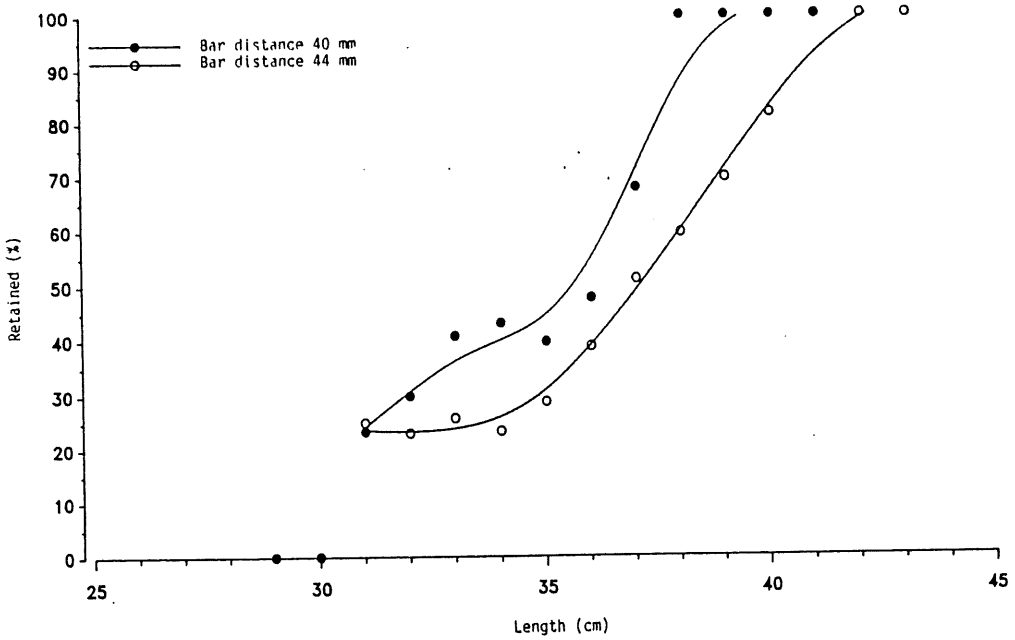

Figure 3a. Length selection curves for mackerel for 40 and 44 mm distance between bars in the sorting grid.

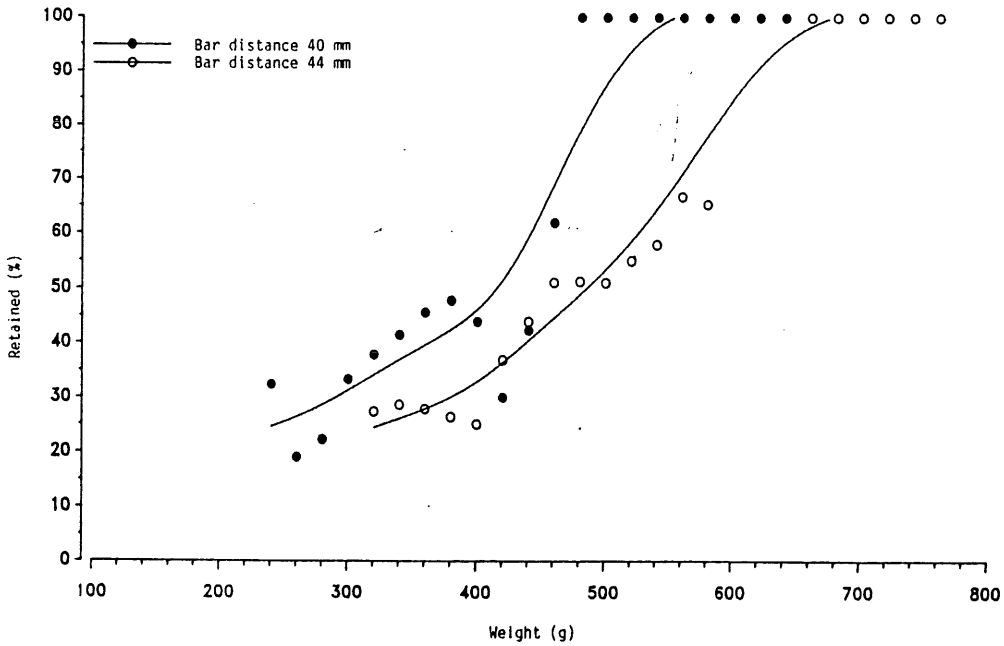

Figure 3b. Weight selection curves for mackerel for 40 and 44 mm distance between bars in the sorting grid.

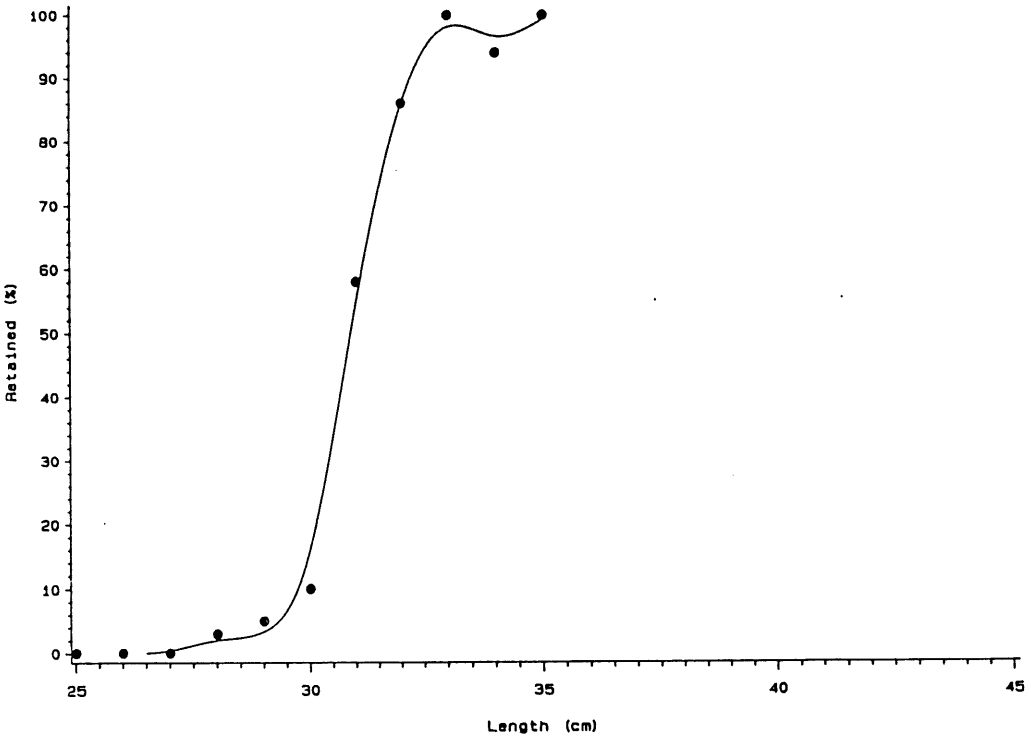

Figure 4. Lenght selection curve for saithe for 30 mm distance between bars in the polyester composite sorting grid for saithe.