

**Selectivity Trials of
Seine Net Codends.
MFV Kestrel (INS 253)
April 1990**

Seafish Report No. 379

June 1990

SEA FISH INDUSTRY AUTHORITY
Seafish Technology

SELECTIVITY TRIALS OF SEINE NET CODENDS
MFV KESTREL (INS 253) - APRIL 1990

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SUMMARY

The KESTREL trials are one of a series to attempt to improve the design of codends to reduce the level of discards whilst retaining acceptable proportions of marketable fish.

The KESTREL is a seiner owned by Mr Ian Sutherland and registered in Inverness. The trials were conducted from Fraserburgh in an area some 40 to 50 miles NNE from Buchan Ness.

Recent U.K. legislation has introduced a minimum codend mesh size of 110mm as an alternative to restricted fishing time with 90mm mesh. The trials set out to collect data on three codends:-

- A) 90mm nominal mesh x 120 meshes round. This was typical of the vessels own gear.
- B) 90mm nominal mesh x 100 meshes round (a so called narrow codend).
- C) 110mm nominal mesh x 100 meshes round (representing the new regulatory standard).

The trials were carried out with a small mesh cover to retain those fish passing through the codend and thus permitting the measurement of discards. This data is then used to produce selectivity characteristics including Ogive curves. As well as the trials with the cover, codends B and C were tested in the open mode to assess their commercial performance and a small trial was carried out using the square mesh window in the extension - a device which had proved successful on previous trials.

The results have shown that where the fish populations are significantly below the MLS all three codends will release satisfactory quantities of what would become discards. Where the fish population size is close to or straddling the MLS the discard rate will be high and the differences between the codends are not sufficiently significant to favour any one or the other.

The trials have demonstrated the complexity of the relationships between population size and net design. Significant information exists about the three codends but more work needs to be done to find the best solution.

This work was funded by the 1990/91 MAFF Research Commission, Project Code IBG16.

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Contents

	Page No.
SUMMARY	
1 INTRODUCTION	1
2 FISHING GEAR	2
3 TRIALS PROGRAMME	3
4 TRIALS NARRATIVE	4
5 DATA COLLECTION AND ANALYSIS	15
6 RESULTS	16
6.1 Nature of the Problem	16
6.2 Whiting	18
6.3 Haddock	18
7 SELECTIVITY DATA	19
8 CONCLUSIONS	21
9 ACKNOWLEDGEMENTS	23
10 FURTHER ACTION	23

Contd....

Contents

FIGURES AND TABLES

APPENDIX I - Results and Data Analysis as prepared by Marine Laboratory.

APPENDIX II - Management of North Sea White Fisheries in 1990 - Gear Restriction Option.

PHOTOGRAPHS SHOWING GEAR USED DURING SELECTIVITY TRIALS - MFV KESTREL

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1 **INTRODUCTION**

A joint exercise between Seafish and DAFS Marine Laboratory, Aberdeen was conducted in April 1990. The objective of the exercise was to collect selectivity data on three codend types fitted to a demersal seine net. The data was collected using a totally enclosing 30mm square mesh cover fitted to the codends. The three codend types tested were also evaluated under normal commercial fishing conditions in which discard data were collected. The trials were part of a continuing programme to find the best design of codend which minimises discard rates.

The vessel chartered for this exercise was MFV KESTREL (INS 253) skippered by Mr Ian Sutherland. This vessel had previously been used for other selectivity trials conducted by Seafish (S.R. 378 refers).

The trials took place between 1st and 10th April 1990 with the vessel operating out of the port of Aberdeen on the North East coast of Scotland.

Staffing for this work was provided jointly from Seafish Technology, Hull and the Marine Laboratory, Aberdeen. The trials were conducted under the supervision of one Seafish Fisheries Development Officer and two Laboratory staff conducted the data collection and later analysis.

This work was funded by the 1990/91 MAFF Research Commission, Project Code IBG16.

2 FISHING GEAR

A 'Harvester' trawls rockhopper seine net with a 178ft headline and 'cut-away' wing arrangement was used throughout the trials. The net incorporated an extension of 100 meshes x 90mm giving a nominal length of 9m. The three codends under examination were as follows:-

- A) standard codend as used by the vessel under normal operations, i.e. nominally 90mm x 120 meshes including selvages of 20 meshes total.
- B) 90mm x 100 meshes including selvages of 20 meshes total.
- C) 110mm x 100 meshes including selvages of 20 meshes total.

The number of meshes round each codend is quoted as the number including those in the selvedge. The number of open meshes between selvages will therefore be smaller by 20 meshes (10 per side). In the case of the 110mm codend the meshes were limited to 80 between selvages. This was an example of a codend configuration that conformed with the recently introduced gear restriction option (see Appendix II).

A 30mm x 460 bar square mesh totally enclosing cover was used for the selectivity data collection. Details of the cover arrangement are shown in Figure 1. The overall cover length was 17.1m.

Codend mesh sizes were measured using an ICES gauge (setting 4kg) and averages of 100 measurements were taken.

Codend (A) - 86.74 x 120 meshes round

Codend (B) - 89.90 x 100 meshes round

Codend (C) - 103.78 x 100 meshes round

A 3m long square mesh selector panel/"window" was evaluated for a short period during the trial. A total of four hauls were carried out with and without the use of the small square mesh cover. Very limited selection and catch data were obtained and no conclusions could be drawn from such a brief evaluation. Details of the square mesh panel arrangements are shown in Figure 2.

3 TRIALS PROGRAMME

The trials programme was intended to take the following format:-

DAY 1 - Vessel's standard net fitted with standard codend, i.e. 90mm mesh x 120 meshes in circumference (total) fitted with the small mesh cover, to give baseline data for the experimental codends.

DAY 2 - Standard net fitted with a narrow codend, i.e. 90mm mesh x 100 meshes in circumference, once again fitted with the small mesh cover.

DAY 3 - Standard net fitted with narrow codend, i.e. 90mm mesh x 100
4 & 5 meshes round, fished in a normal commercial mode, no cover fitted.

DAY 6 - Standard net fitted with a narrow codend of larger mesh size, i.e. 100mm x 100 meshes in circumference (80 meshes maximum between selvages), fitted with small mesh cover.

DAY 7 - Standard net fitted with narrow, large mesh codend, fished in
8 & 9 normal commercial mode, no cover fitted.

However, this trials programme was re-arranged during the trials due to handling difficulties associated with the use of such a large small mesh cover, particularly in adverse weather conditions. Wherever possible, the use of the cover was restricted to fine weather days.

The actual format of trials that were carried out is described in the trials narrative and is summarised in Table 1. The fishing times for each tow are also summarised in Table 2.

4 TRIALS NARRATIVE

Prior to sailing, the small-mesh cover to be used during the exercise and provided by Marine Laboratory, was stretched out on the quayside at Peterhead for examination and also to familiarise the skipper and crew of the MFV KESTREL with the gear. Discussions between Marine Laboratory staff, Seafish staff and the skipper and crew took place in order to try and determine the best mode of operation for the use of the small-mesh cover arrangement.

A system was worked out and the cover was rigged on the quayside in preparation for the first day's work. The crew were able to familiarise themselves with the handling and problems associated with the large bulk of netting in the shelter of the harbour prior to sailing. The cover was substantially larger than had been expected and this later gave some problems at sea.

The intention was to try and concentrate fishing effort on areas of ground known to yield quantities of small fish in order to try and optimise results. Once a suitable 'sample' of fish had been located it was hoped to be able to fish all three codend types for the trials duration in order to obtain comparable results.

The vessel sailed on Sunday evening 1st April 1990 and headed for an area of ground approximately 40 miles NNE of Fraserburgh. The depth of water is 40-60 fathoms.

For the first day's operations the vessel's own standard codend (120 meshes round x 90mm) was used fitted with the small mesh cover. As on most days, four tows were carried out, fishing commencing at first light.

The duration of the actual fishing operation varies depending on the type of ground, weather and sea conditions etc. Typically, once the dahn has been shot it takes between 7 and 10 minutes to shoot one side of ropes (14 coils). The net is then shot which takes less than 5 minutes (assuming no problems). The second side of ropes is shot, once again taking between 7 and 10 minutes.

Once the shot is complete the dahn is picked up and the two ropes connected to the hydraulic rope reels by way of the winch. The gear is then towed and hauled back slowly until the ropes come together. The towing time varies between $1\frac{1}{2}$ and 2 hours.

The first shot on Day 1 (2nd April) produced a bulk of 24 boxes (approx. 8 stones/box) from the codend with only $2\frac{1}{2}$ boxes from the cover - the catch consisting of very small haddocks and whiting. Considering the size of the fish caught, the very small quantity of fish in the cover seemed to suggest that there may have been a problem with the cover during the tow, it may have twisted and become tightly wrapped around the codend.

When using the codend cover, the catch from the codend and the cover had to be kept completely separate for obvious reasons. The method used for handling the covered codend arrangement was as follows:-

The small mesh cover was attached to the extension of the net at a point 3 or 4 meshes above the codend/extension join. By attaching small rings around the circumference of the top edge of the cover and at the appropriate point on the net extension, the cover was attached to the net by reeving a rope through the two sets of rings, thus lacing the cover onto the extension (see Figure 1).

The lacing rope was then secured at the selvedge ensuring enough length so as not to obstruct the codend or extension. For additional safety, i.e. as a precaution against losing the cover, should the lacing rope have parted, two strops were attached, one at each selvedge securing the cover to the extension of the net.

The idea of this lacing arrangement was to enable the cover to be quickly and easily separated from the codend as the net was hauled. In this way, the codend could be hauled clear of the cover and emptied separately. Once the codend had been emptied and the fish pound clear of fish, the cover could then be emptied as a separate bag.

Once emptied, the codend could be replaced inside the cover and the cover re-laced onto the codend with very little trouble. This procedure worked well. However, any use of the small mesh cover had to be restricted to fine weather conditions due to the massive bulk of netting involved.

The small mesh cover was checked for damage or holes at the end of each tow prior to shooting back. Any holes in the cover, particularly near the codend could mean an invalidation of the results from the tow.

Because of the bulk of the material in the small mesh cover, it is difficult to ensure that the codline completely seals off the bag. In order to try and ensure no escapes through the codline, the codend on the cover was double tied using a second codline reeved through the cover approximately 2ft up from the normal codline. This second codline was secured using a 'Dutch Clip'. As a further precaution the hole was sealed using two floats connected by a short piece of rope, one on the inside and one on the outside of the codline.

Once the catch had been emptied into the fish pound it was assessed for composition by species and size before deciding on the size of sample to be taken.

For predominantly single species catches with relatively small size range as little as two or three boxes were selected for measurement (in order to obtain a sample of 200-300 fish). If the catch consisted of larger size ranges, a bigger sample was normally taken for measurement. With mixed species catches a greater sample size was taken in order to obtain enough data.

In all situations an estimate of the total catch size was made by boxing up all fish from the catch - this applied to fish from both the codend and the cover. In this way data on selectivity and discard levels could be obtained.

The second haul on Day 1 consisted mainly of whiting - 30 boxes were retained in the codend and 29 boxes of bulk in the cover and it was assumed the cover was working correctly.

Similar quantities were taken during the third tow, the catch composed of a mixture of small whittings and haddocks - 27 boxes of bulk from the codend and 34 from the cover.

Fishing took place in depths of between 40 and 44 fathoms, with relatively fine weather at the start of the day which deteriorated rapidly during later afternoon with a strong northerly breeze force 8-9.

The deterioration in the weather conditions made the hauling operation for the fourth tow of the day more difficult. The large quantity of fish in the cover meant that the bag had to be split to be hauled onboard. A considerable motion had built-up which made handling of the cover difficult. The rings holding the halving becket onto the cover parted on two occasions during the lifting operation. Once the fish were aboard the cover was repaired. A total of 66 boxes of bulk were retained in the cover and 20 boxes from the codend. The fish were of similar species mix and size composition to the previous haul, i.e. small whittings and haddocks.

With the prospect of continued bad weather for the following day (3rd April), it was decided to remove the small mesh cover and to evaluate the 90mm mesh x 100 meshes round codend in a commercial situation.

The vessel steamed approximately 14 miles to the NW during the night for the second day's operations. The forecast was northerly force 8 with heavy snow showers. The area of operation was approximately 30 miles due east of Duncansby Head with the first tow in a depth of about 61 fathoms.

The first haul on 3rd April produced a catch of 10 boxes of haddocks. For the second tow the vessel moved into slightly shoaler water to try and find a mix of haddocks and whittings. Once again the catch consisted of predominantly haddocks with 6 boxes in total. This pattern continued for the next two tows. No whiting were encountered, 6 boxes of bulk were taken for haul 3 which included approximately half a box of large cod. The last haul of the day produced only 2 boxes of small haddocks.

Because of the poor results from Day 2 (3rd April) the vessel moved ground approximately 32 miles to the NE to an area known as the "jungle" in an area of "skate hole".

The codend was changed to the 110mm mesh x 80 meshes between selvages with the intention to use the small mesh cover, weather permitting.

The third day (4th April) saw continued poor weather but with a more promising forecast. The decision was made to try the cover with the hope of an improvement in the conditions as the day went on.

A good mix of small whittings and haddocks were encountered for the first tow. A total of 74 boxes of bulk, 44 boxes from the cover and 30 from the codend were taken. Considering the small size run of fish, there was a surprisingly high number of small fish retained in the 110mm codend. It was suspected that the cover may have been "masking" the codend.

The second haul consisted mainly of haddocks. Once again there was a surprisingly high number of small fish retained in the 110mm codend - 22 boxes of bulk compared to 27 boxes from the cover.

The last two hauls of Day 3 (4th April) were composed predominantly of whittings. These were taken in a depth of between 66-70 fathoms. The third tow at the shallower end of the ground produced more whittings than the final tow in 70 fathoms. Tow 3 produced 42 boxes of bulk from the codend and only 25 from the cover.

Tow 4 produced 32 from the codend and 15 from the cover. Once again it appeared that a lot of small whittings were being retained in the codend.

The 110mm codend was changed for the 90mm x 100 mesh round codend for the following days operation. The use of cover was again weather dependant.

Fishing in the same area on Day 4 (5th April), the gear was shot without the cover due to a south westerly wind force 6-8 hampering operations. Only 3 boxes of bulk were taken from the first tow consisting of haddocks with a few small whiting in the mix. The gear sustained a small tear in the bunt end of the starboard wing.

A lull in the weather, together with an improved forecast allowed the use of the small mesh cover for the remainder of the day. Fishing in 71 fathoms the first haul with the cover produced 12 boxes of bulk from the codend consisting of an even mix of haddocks and whiting and 23 boxes of bulk from the cover consisting almost entirely of whiting. This suggested that the whiting were escaping more easily (size for size) from the codend compared to the haddock.

The next haul produced a similar result. By this time the vessel was working an area of soft ground (mud and sand) in about 75-100 fathoms approximately 40 miles due east of Copinsay. The catch consisted of 10 boxes of bulk in the codend (mixed haddocks and whiting) and 48 boxes (all whiting) in the cover. The final haul of the day produced 7 boxes of bulk from the codend and 10 from the cover. The cover contained large numbers of "feed", mainly very small poutings and herrings.

The same arrangement as for the previous day was tested for the first haul on Day 5 (6th April), i.e. 90mm x 100 round with cover, with the intention of removing the cover for a commercial assessment for the remainder of the day. The weather situation had improved by this time - the forecast being variable force 3-4. The cover produced 28 boxes of small whiting, the codend produced 14 boxes of mainly haddocks.

By the second tow the weather was fine (easterly force 3-4). This first tow without the cover produced 5 boxes of bulk, mainly haddocks with a mix of whittings and codlings.

Another two tows were carried out using this arrangement, very similar catches resulted namely 5 boxes and 4 boxes of bulk respectively for the third and fourth tows. Both consisted of a mix of small haddocks and whittings.

In order to optimise the fishing time for each gear type an extra haul was fitted in on Day 5 using the 110mm mesh codend. As expected, this produced a low catch rate. Only 2 boxes of bulk were retained out of which nothing was saved as marketable. At this point it is worth noting that on nearly all occasions, very few fish were actually retained from each haul as marketable. On average only 2-3 boxes of "rounded" haddocks and whittings were saved from each haul.

At the end of Day 5's operation the codend arrangement was changed. The 90mm x 100 mesh round codend was fitted to the gear along with a short 80mm square mesh panel fitted between the codend and the extension. The intention was to fit the net with the cover to evaluate the size, composition and quantity of fish passing through the codend and panel arrangement.

Some minor modifications had to be made to the position of attachment of the cover to the net to try and ensure that the square mesh panel was not being obstructed by the cover (see diagrams describing arrangement - Figure 2).

It was realised that the cover would retain fish passing through both the codend and the panel without being able to distinguish the amount attributable to each component. However, it was thought that it would be a worthwhile exercise to see if any significant differences in catch composition or quantity appeared when the net with the panel was compared to the net without.

The first haul on Day 6 (7th April) using the above mentioned arrangement fitted with the small mesh cover produced 23 boxes of bulk from the cover, made up of predominantly whittings, whereas the codend only produced 9 boxes which consisted of predominantly haddock. This suggested that the whittings were escaping more easily into the cover. Very few haddocks appeared to be escaping into the cover. It was expected to have seen some of the larger whittings meshed in the square mesh panel. None were evident. It was suspected that the panel may have been obstructing or at least reducing the effectiveness of the panel in some way.

It is thought that the effectiveness of the square mesh 'window' relies to a large extent on the visual aspect of the panel from the point of view of contrast. By using the small mesh cover over the panel this attribute would be lost. It was also suspected that the water flow through the gear at this point could also be adversely affecting the performance of the panel. The fact that the small mesh cover could be physically obstructing the panel could also not be entirely ruled out.

For the second tow the cover was removed for comparison. The second shot was a tight berth alongside the first to try and encounter the same run of fish. This haul produced 5 boxes of bulk, all haddocks, again no fish were meshed in the window panel.

In order to try and improve the effectiveness of the panel it was decided to move its position relative to the codend. It was moved closer to the position of the halving becket. This was achieved by changing to a short codend (this was the simplest and quickest way of achieving the desired arrangement). The codend was one of the vessels own standard 90mm mesh x 120 meshes round (see diagrams for details of the codend arrangements - Figure 2).

This arrangement was used for the next haul, without the cover, to be compared with a final haul with the cover.

The tow without the cover produced 8 boxes of bulk, predominantly haddock with approximately 1 basket of mixed flats among the catch. When the cover was fitted, a bulk of 10 boxes of mixed haddocks and whiting were retained in the codend and 28 boxes of mainly whiting in the cover.

The cover and the codend contained numbers of very small haddocks in the range 15-20cms, not encountered to the same extent to date particularly in the 90mm codend. Also large numbers of small herrings were retained in both the cover and the codend.

Having completed the brief look at the square mesh panel, the codend was changed to the 110mm mesh for the remainder of the trials. The codend was evaluated under normal commercial fishing conditions. Because of the relatively large mesh size and narrow width to the bag, only small quantities of fish were expected from the areas being fished.

Five hauls were carried out on Day 7 (8th April). The first produced 5 boxes of bulk including half a box of mixed flats. It should be noted that flats invariably lie across the meshes in the codend effectively blocking them as an escape route. Thus a quantity of flats can significantly distort the trial results.

During the second haul, small fish could be seen passing out of the codend as it lay alongside the ship just prior to lifting aboard. As the weight was off the gear the meshes were more open allowing small fish to fall out. However, it was apparent that these escapees had little chance of survival. Most were struggling to swim away, and once clear of the net were almost instantly "picked off" by gulls, gannets etc. Once onboard the catch measured out at only 1 box of mixed haddocks, whittings and a few flats. This loss of fish too can distort the result in so far as the discard rate may appear to be less than it is.

Three more tows were carried out in freshening weather conditions. Each produced 3 boxes of bulk consisting of a slightly bigger size range of haddocks (mixed with whittings on the first and the last of the tows).

Day 8 (9th April) saw deteriorating weather conditions (south westerly force 7-8). Once again 4 hauls were fitted into the day to try and gain as much data on the 110mm x 80 mesh codend.

Five boxes of bulk was the best catch for the day taken on the last haul. The days catch consisted mainly of haddocks mixed with some flats (namely lemon soles). The first two tows produced 1½ to 2 boxes of bulk respectively.

A short steam to the SW to clear some poor ground gave the crew time to overhaul some of the seine ropes. The change of ground did not improve the results - only 2½ boxes of bulk resulted from the third haul. Almost 1 box of that total was made up of flats (of which half were lemon soles) the rest was made up of mainly haddocks.

Due to the deteriorating weather conditions and the poor forecast for the following 12 hours the vessel steamed into Fraserburgh for the night with the intention of resuming operations just off Fraserburgh the following morning.

Day 11 (10th April) was the final day of the trials. Two tows with the 110mm codend without cover were fitted in before the vessel steamed for Peterhead.

During the first tow the net 'came fast' but was cleared without damage. Two boxes of haddocks and lemon soles resulted. The haddocks were of a slightly larger size run than had previously been encountered. No whittings were encountered.

The final haul of the trials produced fish of a similar size range as the previous tow in a bulk of 4 boxes which included approximately half a basket of flats (mainly small lemon soles).

The vessel steamed into Peterhead in deteriorating weather conditions with the wind freshening steadily from the SW.

All gear was off-loaded at Peterhead harbour.

The vessel landed 82 boxes of marketable fish over 90% of which were "rounded" haddocks and whittings. A total of approximately 750 boxes of all species and sizes had been taken aboard during the hauls with and without the cover.

5 DATA COLLECTION AND ANALYSIS

The procedure for data collection is mentioned in the trials narrative. To summarise, the total bulk of fish caught in the codend and also the cover when it was used was measured by boxing separately. The lengths of fish from samples taken from the catches were measured. The total numbers at each length were then obtained by raising the measured numbers by the sample ratio.

As the same number of coils of rope were used on each set it is assumed that the swept area and the potential catch for each haul is constant. No allowance is made in the analysis for the variations in fishing time. Catch data are compared haul by haul.

Included in this report are data and the subsequent analysis of that data as produced by the two involved parties, namely Seafish and the Marine Laboratory. The data and analysis produced by the Marine Laboratory is included as an Appendix to the report.

6 RESULTS

During the course of the trials the main species of fish that were sampled were - haddock, whiting and cod. Haddock and whiting were the only two species encountered in any significant numbers to justify data collection. The results must be interpreted with care and much of what follows relates to overall mean values and there are quite widely diverging results from separate hauls, mainly as a result of the varying populations on the ground.

6.1 Nature of the Problem

Before discussing the results it is important to note some of the more general points relating to the fish populations, fish sizes and discards.

- During the 36 hauls, approximately 750 boxes of fish of all sizes were taken aboard of which only 82 boxes were marketable. Of the 750 boxes, a large amount were captured in the codend cover and comprised of very small fish including juvenile herring, which would not normally be found in a 90mm or greater mesh codend.
- There were two size classes of haddock on the grounds with mean lengths of 18 and 28cm, both under the MLS of 30cm. The range was 15-40cm.
- There was one class of whiting with a mean length of 22cm. The MLS for whiting is 27cm. The range was 19-35cm.
- Discards are defined scientifically as all fish below the MLS. However, they will normally be found in the range from 10cms to the MLS and it is this size group which are the target of increased selectivity in the seine or trawl and the codends. Fish below these size limits would be expected to escape from some part of the net either before reaching the codend or in the codend itself.

With any catch comparison exercise, the main assumption is that the fish encountered at any point in the trial are representative of those encountered over the whole trial period, i.e. the population sampled does not change. This is very difficult to guarantee. In an exercise of this type it is the skippers experience and knowledge of the fishing grounds that is relied upon to a great extent to try and reduce these limitations of this type of catch comparison exercise. Any variations in the population of fish being sampled complicates the analysis of the catch comparison data.

In a seine net operation which covers large areas of seabed in a set, it is necessary to change grounds in order to try and encounter fish every time. This means that in an exercise of this type, if fishing on the same piece of ground twice in a short time period is to be avoided, relatively large distances can be covered.

With the selectivity exercises involving the use of the small mesh covers there was some concern as to the effects the cover would have on the inside codend with respect to "masking" the meshes and preventing fish from escaping.

It is apparent from the data that masking did occur. Catches retained in the codend when a cover was fitted were much larger than those without a cover (see Tables 3*, 4* and 5#). Even taking into account variations in the concentrations of fish encountered on different days in different areas, the effect seems to be consistently due to the cover rather than any other factor.

The actual means by which the cover reduces escapes from the codend is not definitely known. It may be a direct physical blocking of the meshes or it may influence fish reactions and behaviour within the codend in such a way that prevents escape attempts.

* From Marine Laboratory analysis.

From Seafish analysis.

6.2 Whiting

- When using the cover substantial quantities of whiting under the MLS of 27cm were released by all three codends in a ratio of about 4:1. This is to be expected in view of the small size of the whiting population on the grounds (mean length 22cm).
- Although there were few whiting above the MLS, in all three codends the numbers of fish retained was about equal to the numbers released.
- In the commercial fishing trials, the catches of whiting were very low in all three codends. This is consistent with the above observations.

6.3 Haddock

- When using the cover almost all the marketable haddock above the MLS of 30cm were retained by each of the three codends. In the case of the 90mm mesh codends A and B the ratio was about 20:1 and for the 110mm mesh codend it was about 5:1.
- When using the cover all three codends retained approximately the same proportion of discards under the MLS of 30cm to those released. This is understandable since one of the two populations of haddock had a mean size of 28cm and was just under the MLS of 30cm. It is likely this population contributed to a greater extent to the discards than the 18cm population.
- When not using the cover on comparative commercial trials the total catch was reduced by 46% and the haddock catch by 60% with the 110mm x 100 mesh compared to the 90mm x 100 mesh. This is inconsistent with the covered results. Two explanations are offered:-
 - i) The commercial trials with the 110mm codend coincided with a period of deteriorating weather conditions during the last three days of the trials. This together with the population variation could have had greater effect than the variation in mesh size.

- ii) All codends tended to open the meshes once it was hauled alongside as a result of the strain being taken off. At this time much undersized fish and some marketable fish floated away and the loss would have been greater with the 110mm than with the 90mm. However this would only have a minor effect.

7 SELECTIVITY DATA

The data collected was analysed and used to produce selection curves for each codend under examination. These are shown in Figure 4 for haddock and Figure 5 for whiting.

The selectivity characteristics show a small but progressive improvement for both haddock and whiting from codend A to B to C, but it is the Seafish view that the discard rates for those fish at or near the MLS, are too high to justify favouring any one of the three codends over another.

To release all fish just under the MLS would necessitate a further increase in mesh openings either by increasing mesh size or further reductions in the number of meshes round. These observations are borne out by the selectivity data analysed by Marine Laboratory.

Length/frequency distributions were also produced for fish (haddock and whiting) retained in both the cover and the codend for all three codend configurations under examination. These are shown in Figures 6 to 11.

The selectivity data collected using the cover arrangement is summarised in Figures 12 and 13. The data is presented in the form of bar charts showing the relative catches of fish as percentages of the total catch (Figure 12) for both haddocks and whiting above and below the MLS and also as actual numbers of fish (Figure 13) for four hauls carried out for each of the three codend arrangements under examination.

Within the Marine Laboratory analysis of the data, the mean numbers of haddocks caught per haul were calculated for both the 90mm x 100 mesh and 110mm x 100 mesh codends. These were divided into two groups - those above and those below the minimum landing size (MLS) of 30cms (see Table 6). The results show a reduction of 60% in the total numbers of fish caught and a reduction of 66% in the numbers of discarded fish (below 30cms) when the 110mm x 100 mesh codend was used compared to the 90mm x 100 mesh codend. The numbers of marketable fish caught in the 110mm x 100 mesh codend dropped by 54% compared to the 90mm x 100 mesh. However, it must be remembered that the run of fish sampled during the exercise was generally very small. Large reductions in the total number of fish caught and the number of discards caught would be expected. Larger quantities of fish over a larger size range would be required to establish if there were any significant differences.

Also shown in Table 6 is the difference in bulk catch experienced between these two codend types. The difference of 46% is considered a significant reduction.

8 CONCLUSIONS

The use of the totally enclosing small mesh cover significantly increased the retention of whiting and haddocks when used with the 90mm x 100 mesh and 110mm x 100 mesh codends. This factor must be taken into consideration when examining the selectivity data produced from these trials and no firm conclusions should be drawn.

Catch data from the 90mm and 110mm codends showed a 60% reduction in the total numbers of haddock caught in the 110mm codend compared to the 90mm. A reduction of 66% in the numbers of discarded fish was also obtained with the larger mesh codend. When considering these statements, factors such as the considerable numbers of undersized fish encountered on the grounds during the trials should be borne in mind.

The increases in the 50% retention length from one codend to the next for those under examination were not as large as expected. This may be attributable to the increased retention of fish. It is also too small to be confident that there is a marked improvement from codends A to B to C.

With respect to the Marine Laboratory analysis, when considering both haddock and whiting, the 90mm x 120 mesh and the 90mm x 100 mesh codends were found to have larger 50% retention lengths during those trials than those predicted by the selection model of Armstrong et al (1989) developed from earlier seine net trials data.

The number of marketable haddocks taken in the larger mesh codend showed a reduction of 54% but the figure was not considered to be as significant as those for the total numbers of haddocks and those for discards because of the small numbers of fish above the MLS that were caught.

None of the codend configurations under examination in this trial achieved any significant success at reaching the desired result, i.e. release of maximum numbers of juvenile fish with minimum loss of marketable catch.

The trials have given some reference points but firm conclusions cannot be drawn from this particular series. Each codend retained substantial quantities of haddock above the MLS, but there was a loss of some whiting above MLS. Conversely each codend permitted the escape of juveniles well below the MLS of both species. None of the codends were able to give a satisfactory result for fish close the MLS.

9 ACKNOWLEDGEMENTS

Credit must be given to the skipper and crew of MFV KESTREL for their patience and skill shown during the conducting of this exercise and for their practical advice.

Seafish would also like to thank all those members of the Marine Laboratory staff at Aberdeen that were involved with these trials.

10 FURTHER ACTION

It is the Seafish view that the increase in diamond mesh is not giving the expected results in reducing discards. Although the comparative trials showed an apparent difference, there are a number of factors that may have influenced this result. There are reasonable grounds for doubt that the solution lies in the diamond mesh variations in the codend.

Seafish have a strong preference for the square mesh window which:-

- i) provides open meshes throughout the duration of a tow.
- ii) provides a logical escape route for all undersized fish before they are trapped in the codend from where the chances of escape are reduced.

The square mesh window has shown much promise, it is therefore the Seafish view that the square mesh window approach should be developed to minimise discards and that much more emphasis be placed on the different characteristics of fish behaviour to achieve the best solution for all the main demersal species.

Further trials are required to obtain the necessary selectivity data and commercial evaluation to reach an early conclusion.

FIGURES AND TABLES

DIAGRAM SHOWING ARRANGEMENT OF CODLINE FITTED WITH SMALL MESH COVER.

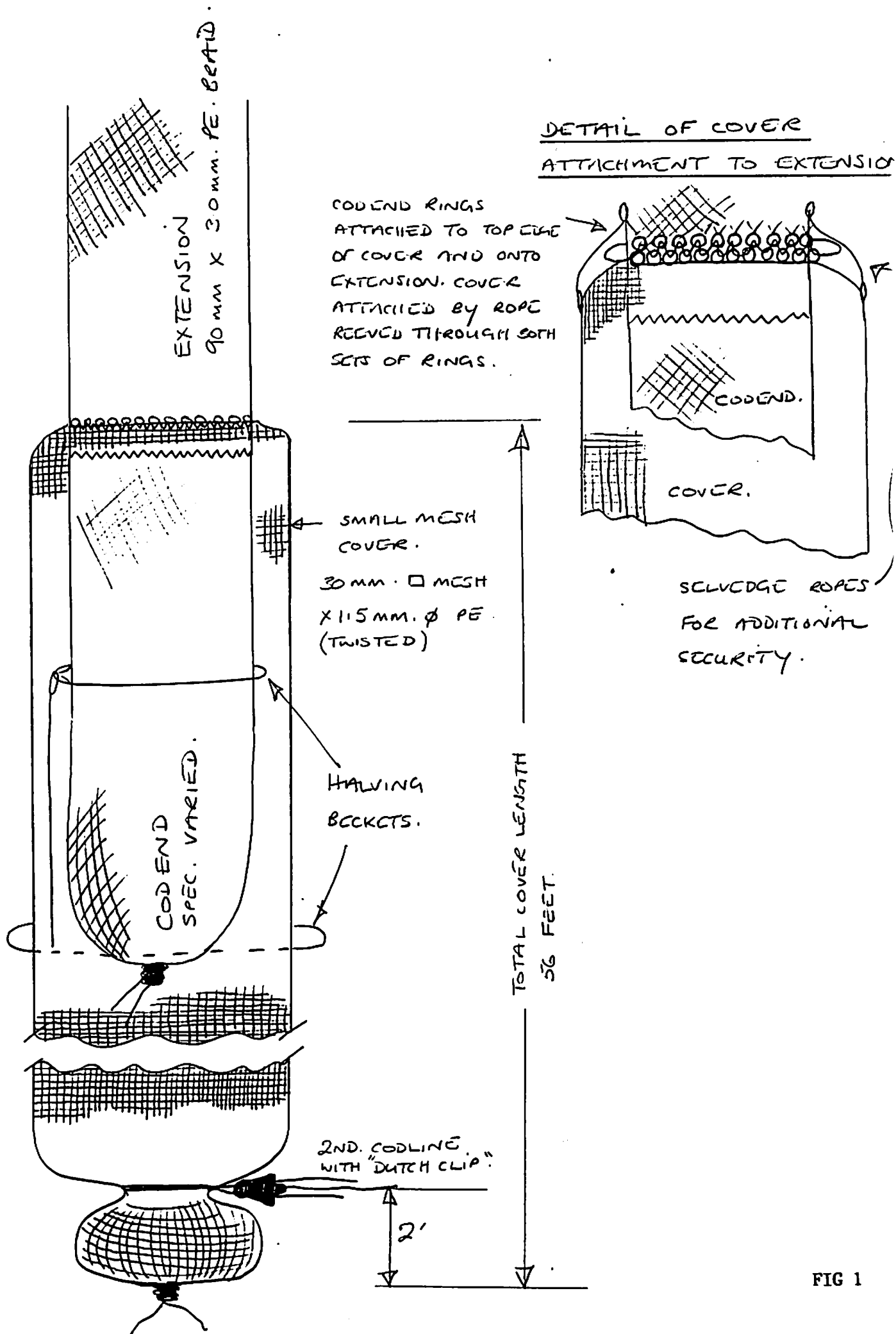


FIG 1

DIAGRAM SHOWING ARRANGEMENT OF SQUARE-MESH
SELECTOR PANEL FITTED WITH SMALL MESH COVER.

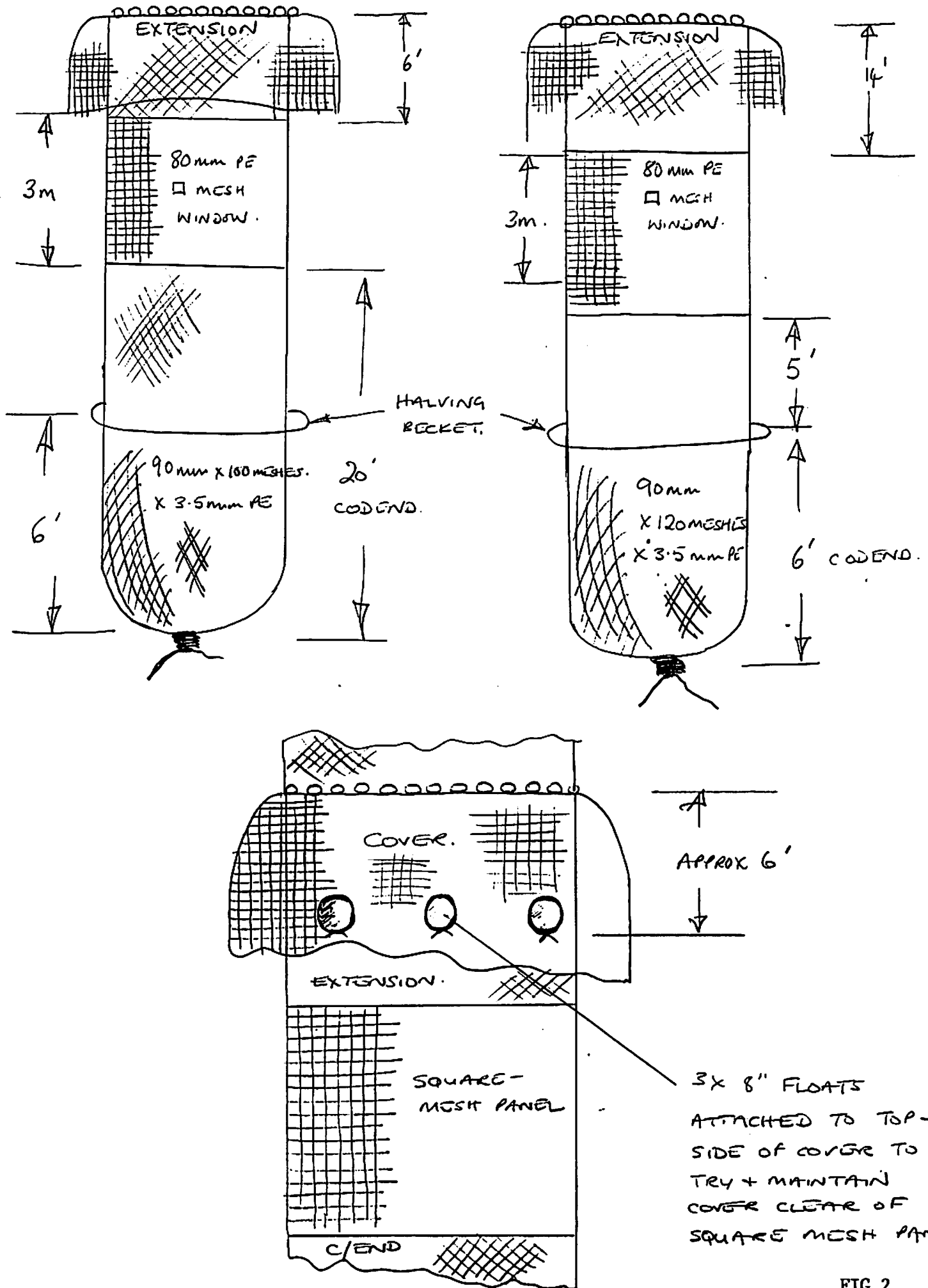
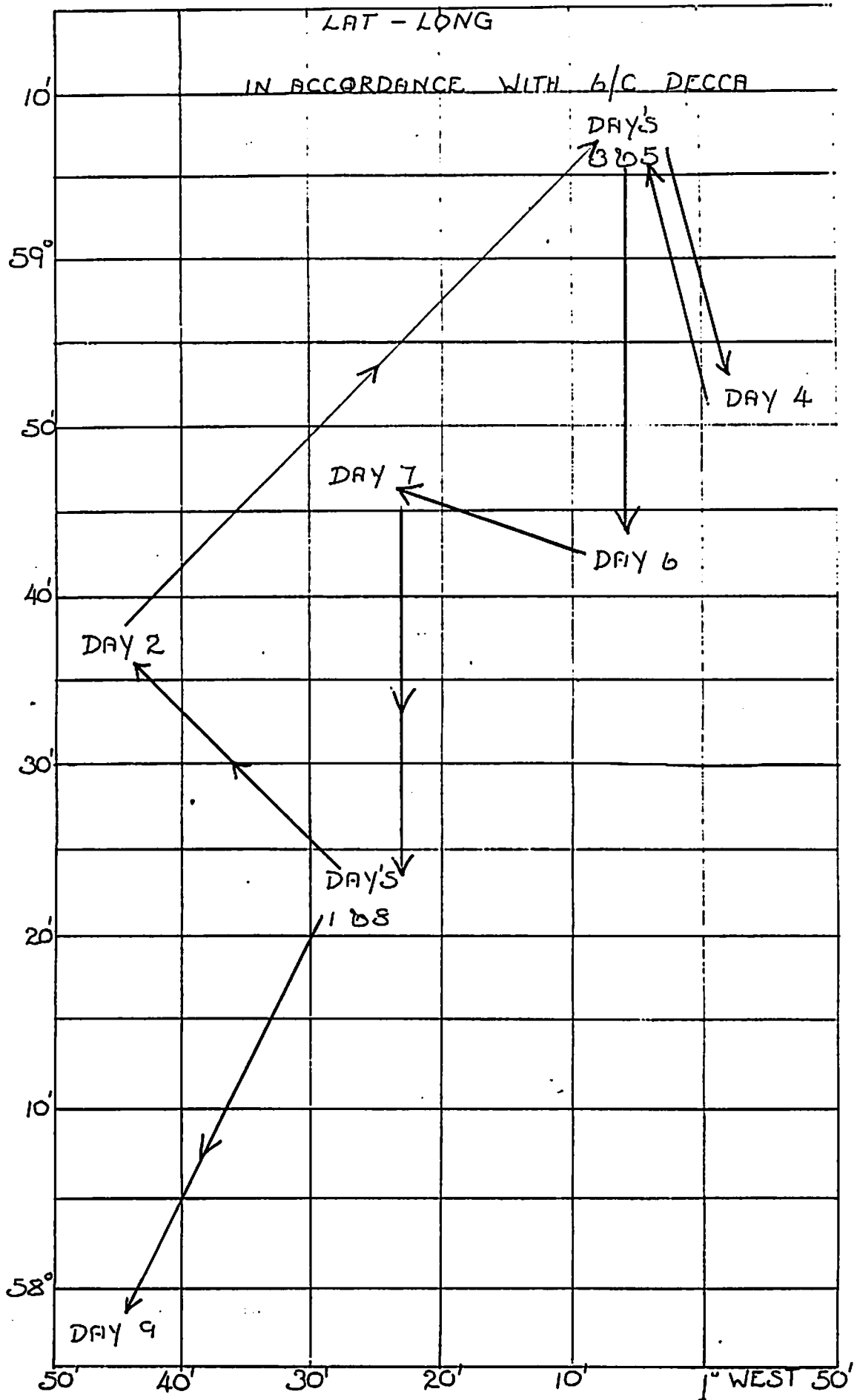


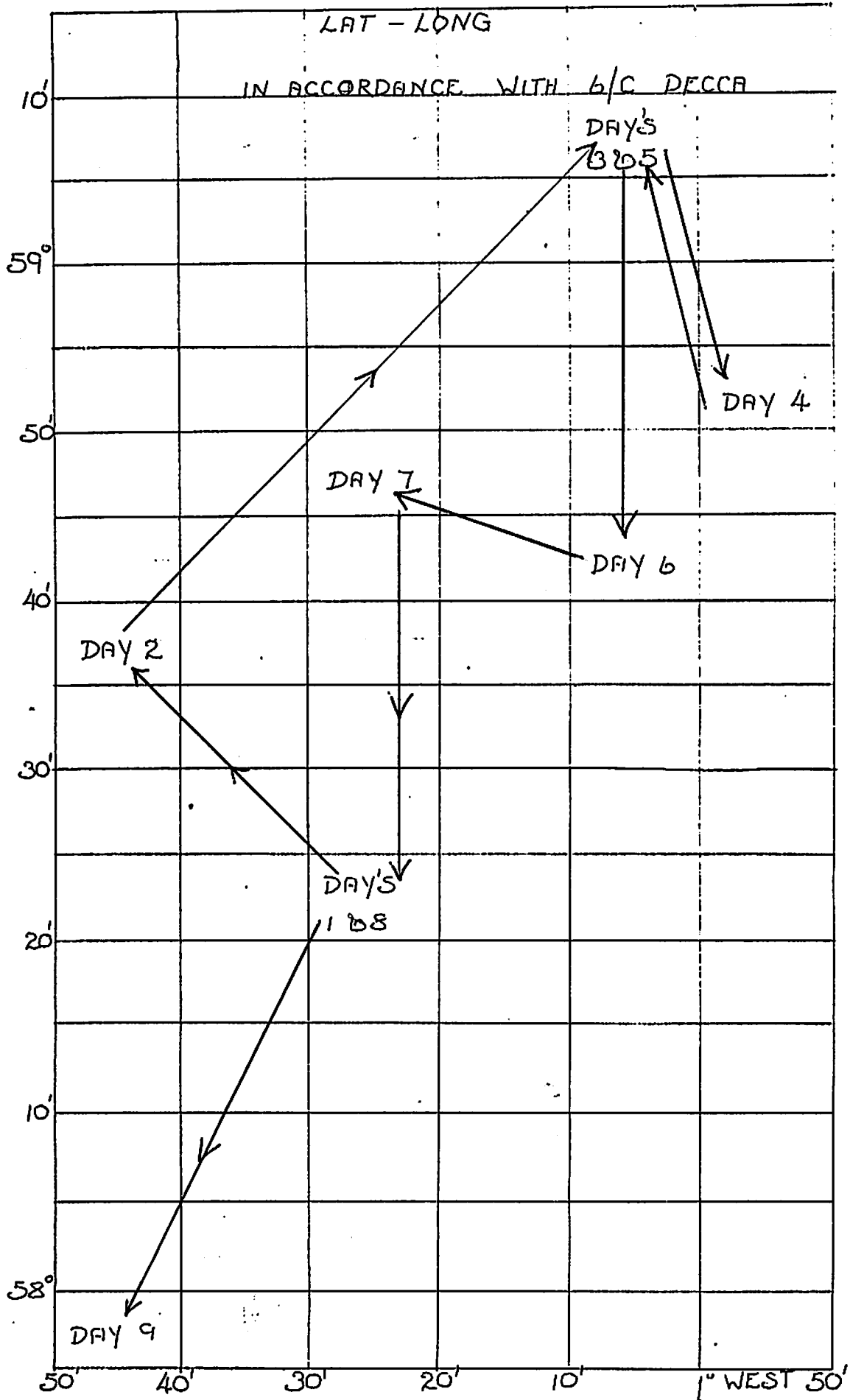
FIG 2



AREAS OF OPERATION FOR THE NINE DAYS
OF SEA TRIALS - M.F.V. "KESTREL"
2/4/90 - 10/4/90 INCLUSIVE.

DATE (DAY)	CODEND TYPE	BULK CATCH (BOXES)			SPECIES MIX HADDOCK (H) WHITING (W) FLATS (F)		COMMENTS
		HAUL	CODEND	COVER	CODERID	COVER	
2/4/90 (1)	90 mm x 120 MESH WITH COVER	1	24	2-5	H+W	H+W	FISHING TIME - DHAN AWAY TO BRIDLES IN POWER BLOCK - APPROX. 2.00 HRS.
		2	30	29	W	W	
		3	27	34	SMALL W+H	W+H	
		4	20	66			
3/4/90 (2)	90 mm x 100 MESH NO COVER	1	10	/	H	/	SHORT STEAM - CHANGE OF GROUND. POOR WX. HALF BOX OF LARIC COI FOR TOW 3.
		2	6	/	H	/	
		3	6	/	H	/	
		4	2	/	SMALL H	/	
4/4/90 (3)	110 mm x 80 MESH WITH COVER	1	30	44	SMALL H+W	SMALL H+W	CHANGE OF GROUND TO TRY AND ENCOURAGE SPECIES MIX.
		2	22	27	H	H	
		3	42	25	W	W	
		4	32	15			
5/4/90 (4)	90 mm x 100 MESH NO COVER	1	3	/	H	/	POOR WX. SLIGHT DAMAGE TO STEEL BUT 1ST. TOW. HADDOCKS BEING RETAINED.
	WITH COVER	2	12	23	H+W	W	
		3	10	48	H+W	W	
		4	7	10	H+W	W	
6/4/90 (5)	90 mm x 100 MESH WITH COVER	1	14	28	H	W	FINE WX
	NO COVER	2	5	/	H+W	/	
		3	5	/	H+W	/	
		4	4	/	H+W	/	
	110 mm x 80 MESH	5	2	/	W	/	
7/4/90 (6)	90 mm x 100 MESH + □ MESH WITH COVER	1	9	23	H	W	WHITINGS APPEAR TO BE ESCAPING MORE EASILY - PANEL POSITIONING ALICE.
	PANEL - NO COVER	2	5	/	H	/	
	NO COVER	3	8	/	H+F	/	
	WITH COVER	4	10	28	H+W	W	
8/4/90 (7)	110 mm x 80 MESH NO COVER	1	5	/	H+W+F	/	WX FRESHENING.
		2	1	/	H+W	/	
		3	3	/	H+W	/	
		4	3	/	H	/	
		5	3	/	H+W	/	
9/4/90 (8)		1	1.5	/	H+F		POOR WX.
		2	2	/			
		3	2.5	/			
		4	5	/			
10/4/90 (9)		1	2	/			NET 'FAST' NO DAMAGE.
		2	4	/	H+W+F		

TABLE 1



AREAS OF OPERATION FOR THE NINE DAYS
 OF SEA TRIALS - M.F.V. "KESTREL"
 2/4/90 - 10/4/90 INCLUSIVE.

TABLE 2

SELECTIVITY TRIALS - MFV KESTREL (INS253)FISHING TIMES

<u>Day 1</u>	Tow		
	1)	
	2) -	average time
	3)	2 hrs
	4)	
<u>Day 2</u>	Tow		
	1	-	1 hr 50 mins
	2	-	2 hrs 10 mins
	3	-	1 hr 55 mins
	4	-	2 hrs 15 mins
<u>Day 3</u>	Tow		
	1	-	2 hrs 10 mins
	2	-	2 hrs
	3	-	2 hrs 5 mins
	4	-	1 hr 55 mins
<u>Day 4</u>	Tow		
	1	-	2 hrs
	2	-	1 hr 55 mins
	3	-	1 hr 55 mins
	4	-	1 hr 30 mins
<u>Day 5</u>	Tow		
	1	-	2 hrs 5 mins
	2	-	1 hr 20 mins
	3	-	1 hr 45 mins
	4	-	1 hr 55 mins
	5	-	1 hr 50 mins
<u>Day 6</u>	Tow		
	1	-	1 hr 20 mins
	2	-	1 hr 50 mins
	3	-	1 hr 45 mins
	4	-	1 hr 45 mins
<u>Day 7</u>	Tow		
	1	-	1 hr 50 mins
	2	-	1 hr 55 mins
	3	-	1 hr 50 mins
	4	-	1 hr 45 mins
	5	-	1 hr 55 mins

TABLE 2 (Contd.)

<u>Day 8</u>	Tow		
	1	-	1 hr 45 mins
	2	-	2 hrs 5 mins
	3	-	1 hr 40 mins
	4	-	2 hrs 35 mins*

<u>Day 9</u>	Tow		
	1	-	1 hr 50 mins
	2	-	1 hr 45 mins

* Net came 'fast' during hauling.

NOTE:-

These fishing times are given as the time from "dhan away" to "net-up", i.e. sweeps into the power block head.

Typically each set of 14 coils per side takes between 7 and 10 minutes to shoot. The net takes between 5 and 10 minutes to shoot (depending on conditions). The remainder of the time is taken up actually setting and towing the net and hauling the seine ropes back. This time varies with conditions etc.

Table (3) Values for the mean number of fish caught in the codend per haul for two codend mesh sizes with and without the cover.

Codend B - 89.9mm mesh

	With cover	Without cover	Significance
Haddock	816	568	Not sig.
Whiting	1480	290	P<0.01

Codend C - 103.8mm mesh

	With cover	Without cover	Significance
Haddock	2758	225	P<0.001
Whiting	3096	284	P<0.05

Significance levels :

'Not sig' means significance does not reach the 95% confidence level, which is the usual criterion for a statistically significant result.

P<0.05 means significant at the 95% confidence level.

P<0.01 means significant at the 99% confidence level.

P<0.001 means significant at the 99.9% confidence level.

Table (4) Effect of cover on catch in codend.

Day	Cover?	Total number of whiting	Haul
4	No	125	13
4	Yes	1902	14
4	Yes	1765	15
4	Yes	1332	16
5	Yes	921	17
5	No	207	18
5	No	114	19
5	No	204	20

Table (5)

MFV KESTREL INS 253 APRIL 1990 [SEAFISH 1990]

MFV KESTREL INS 253 APRIL 1990

Numbers of fish above/below minimum landing
size for each type of gear used:
(RAISED VALUES)

90mm x 120M C/E

HADDOCK	UNDER 30cm	OVER 30cm
CODEND:	8841	1879
COVER:	12528	106

90mm x 120M C/E

WHITING	UNDER 27cm	OVER 27cm
CODEND:	7611	4044
COVER:	31155	3162

90mm x 100M C/E

HADDOCK	UNDER 30cm	OVER 30cm
CODEND:	1715	909
COVER:	1982	40

90mm x 100M C/E

WHITING	UNDER 27cm	OVER 27cm
CODEND:	3000	3061
COVER:	24084	3658

110mm x 80M C/E

HADDOCK	UNDER 30cm	OVER 30cm
CODEND:	6717	4644
COVER:	6614	883

110mm x 80M C/E

WHITING	UNDER 27cm	OVER 27cm
CODEND:	7921	4680
COVER:	19947	5778

Table (6) Catch comparison results for the 89.9mm and 103.8mm codends.

1. Mean number of haddock per haul

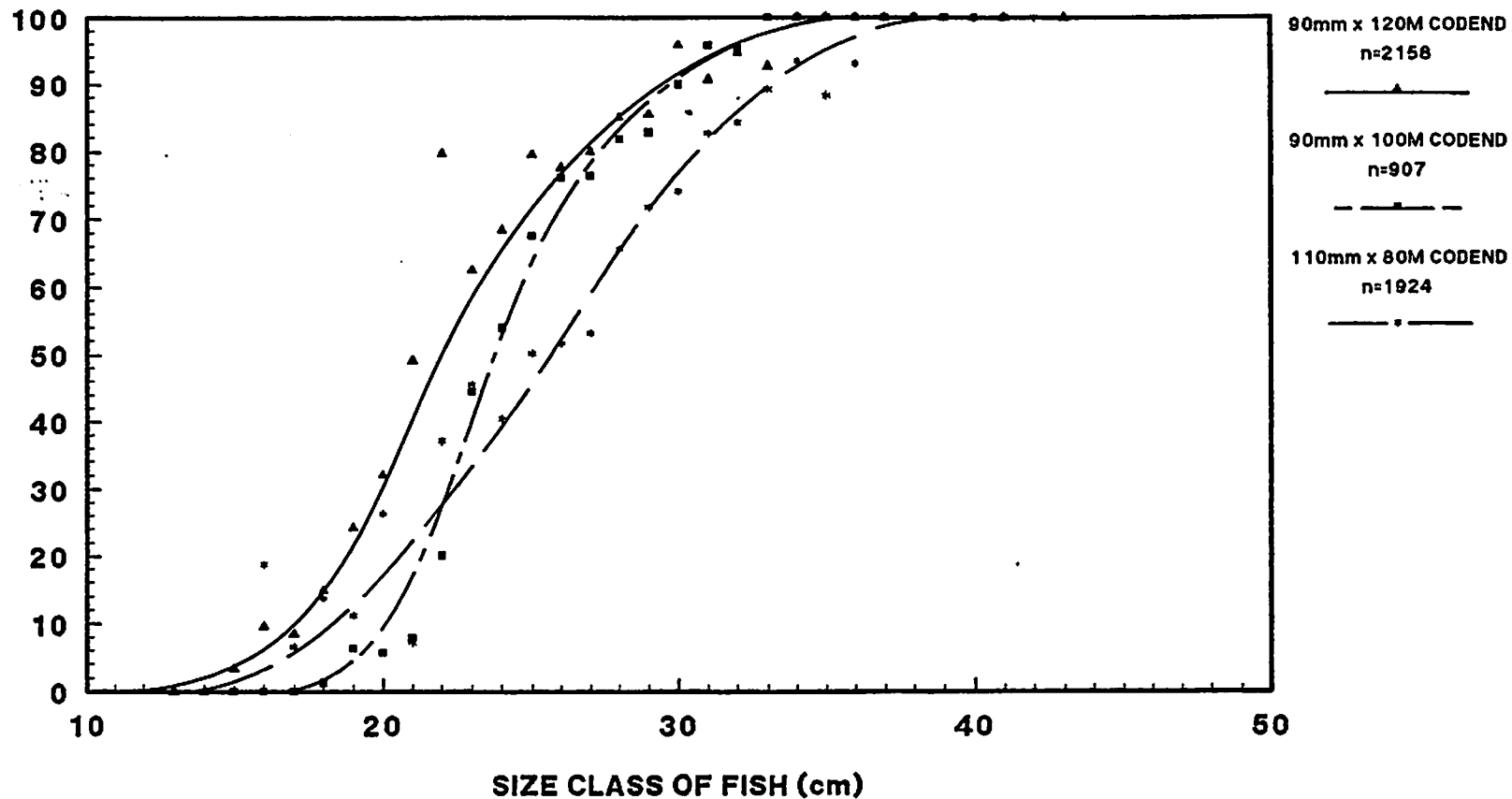
	89.9mm	103.8mm	% Reduction	Significance
Number of hauls	8	10		
Total number of fish	567	225	60	P<0.05
Discarded fish less than 30cm	315	108	66	P<0.05
Marketable fish of 30cm or more	252	117	-	Not sig

2. Mean number of boxes per haul

	89.9mm	103.8mm	% Reduction	Significance
Number of hauls	8	12		
Number of boxes	5.13	2.75	46	P<0.05

**COVERED CODEND: A COMPARISON OF HADDOCK SIZE
DISTRIBUTIONS OF RETAINED/ESCAPEE FISH USING A
30mm SMALL MESH COVER & THREE TYPES OF CODEND**

PROPORTION RETAINED (%)

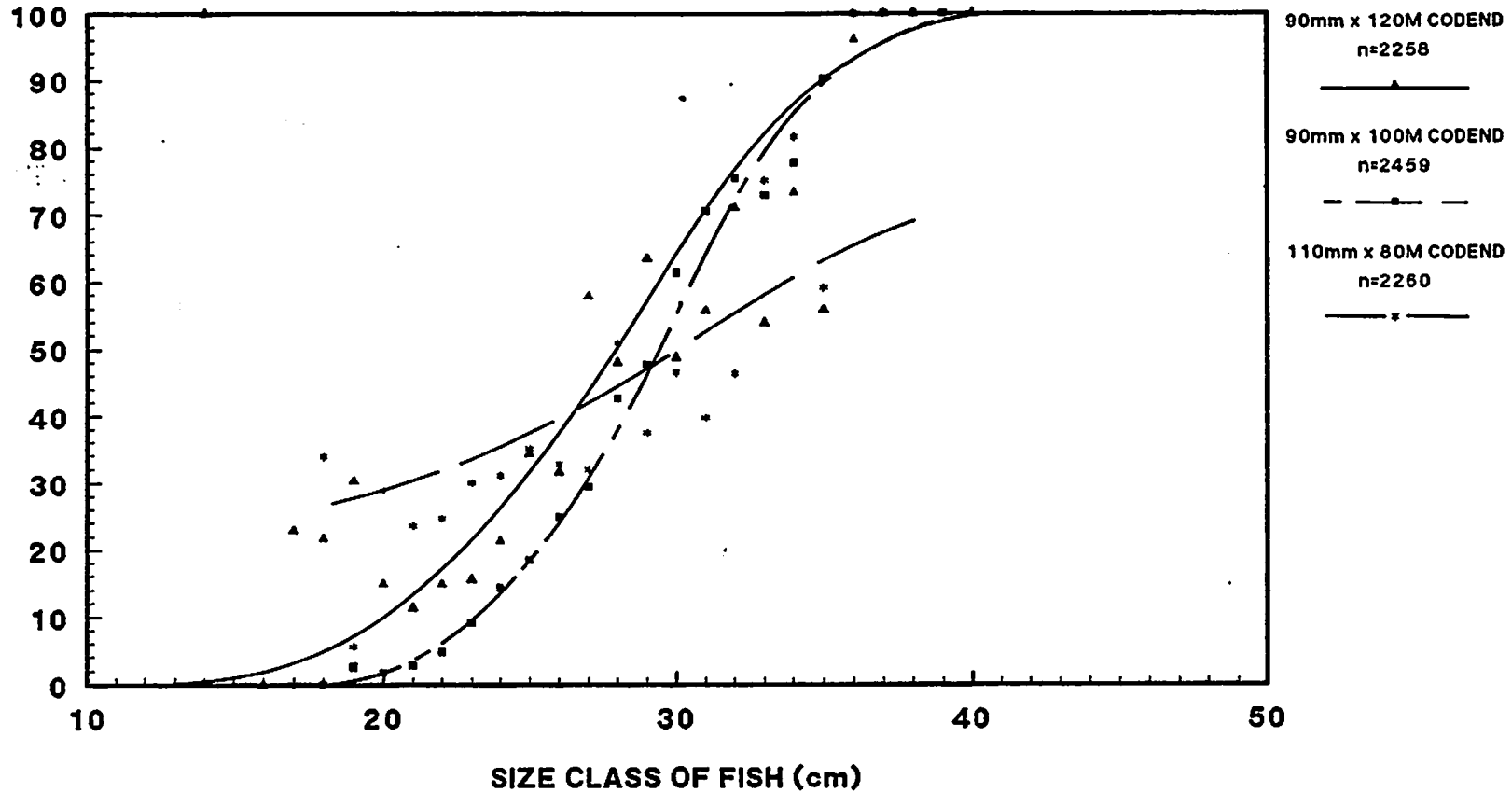


MINIMUM LANDING SIZE = 30cm
12 OF 36 TOWS
RELATIVE PROPORTIONS RETAINED FOR EACH CLASS

2nd APRIL TO 10th APRIL
MFV KESTREL INS 253
SEAFISH 1990

**COVERED CODEND: A COMPARISON OF WHITING SIZE
DISTRIBUTIONS OF RETAINED/ESCAPEE FISH USING A
30mm SMALL MESH COVER & THREE TYPES OF CODEND**

PROPORTION RETAINED (%)

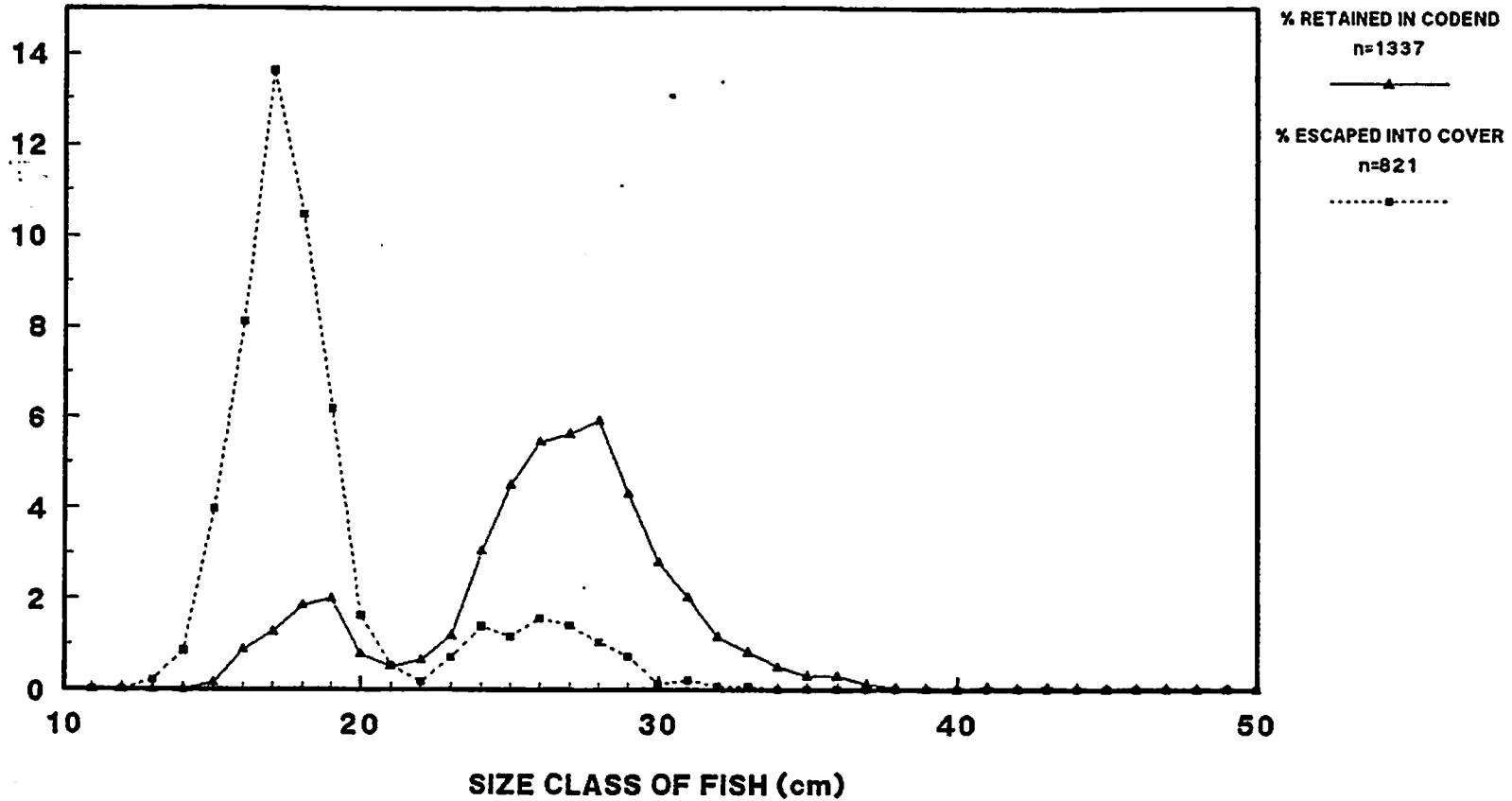


MINIMUM LANDING SIZE = 27cm
12 OF 36 TOWS
RELATIVE PROPORTIONS RETAINED FOR EACH CLASS

2nd APRIL TO 10th APRIL
MFV KESTREL INS 253
SEAFISH 1990

**COVERED CODEND: A COMPARISON OF HADDOCK SIZE
DISTRIBUTIONS OF RETAINED/ESCAPEE FISH USING A
30mm SMALL MESH COVER & 90mm x 120M CODEND**

FREQUENCY (percent)

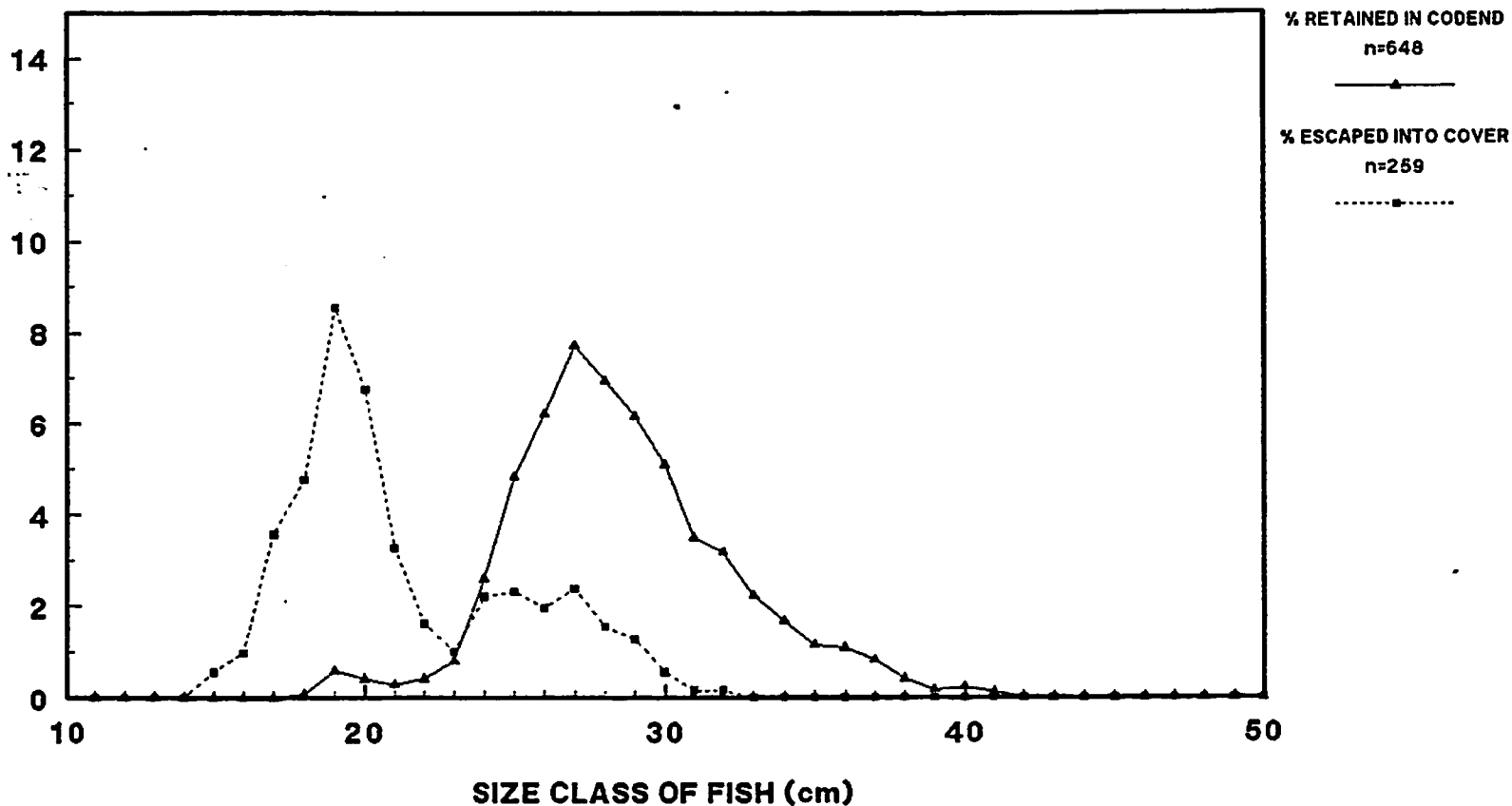


MINIMUM LANDING SIZE = 30cm
4 OF 36 TOWS
ALL PERCENT EXPRESSIONS ARE OF THE TOTAL CATCH

2nd APRIL TO 10th APRIL
MFV KESTREL INS 253
SEAFISH 1990

COVERED CODEND: A COMPARISON OF HADDOCK SIZE DISTRIBUTIONS OF RETAINED/ESCAPEE FISH USING A 30mm SMALL MESH COVER & 90mm x 100M CODEND

FREQUENCY (percent)

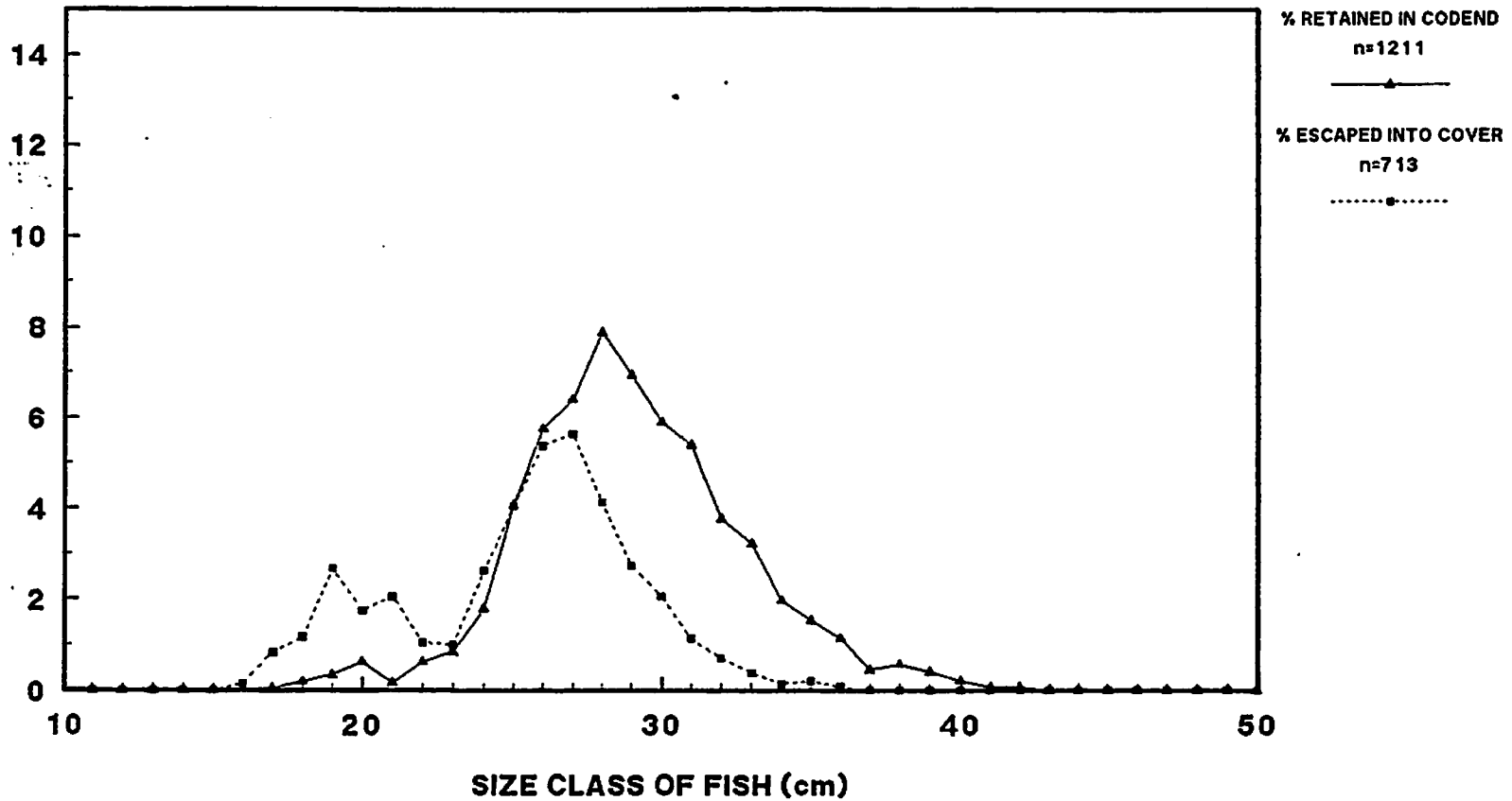


MINIMUM LANDING SIZE = 30cm
 4 OF 36 TOWS
 ALL PERCENT EXPRESSIONS ARE OF THE TOTAL CATCH

2nd APRIL TO 10th APRIL
 MFV KESTREL INS 253
SEAFISH 1990

COVERED CODEND: A COMPARISON OF HADDOCK SIZE DISTRIBUTIONS OF RETAINED/ESCAPEE FISH USING A 30mm SMALL MESH COVER & 110mm x 80M CODEND

FREQUENCY (percent)



MINIMUM LANDING SIZE = 30cm

4 OF 36 TOWS

ALL PERCENT EXPRESSIONS ARE OF THE TOTAL CATCH

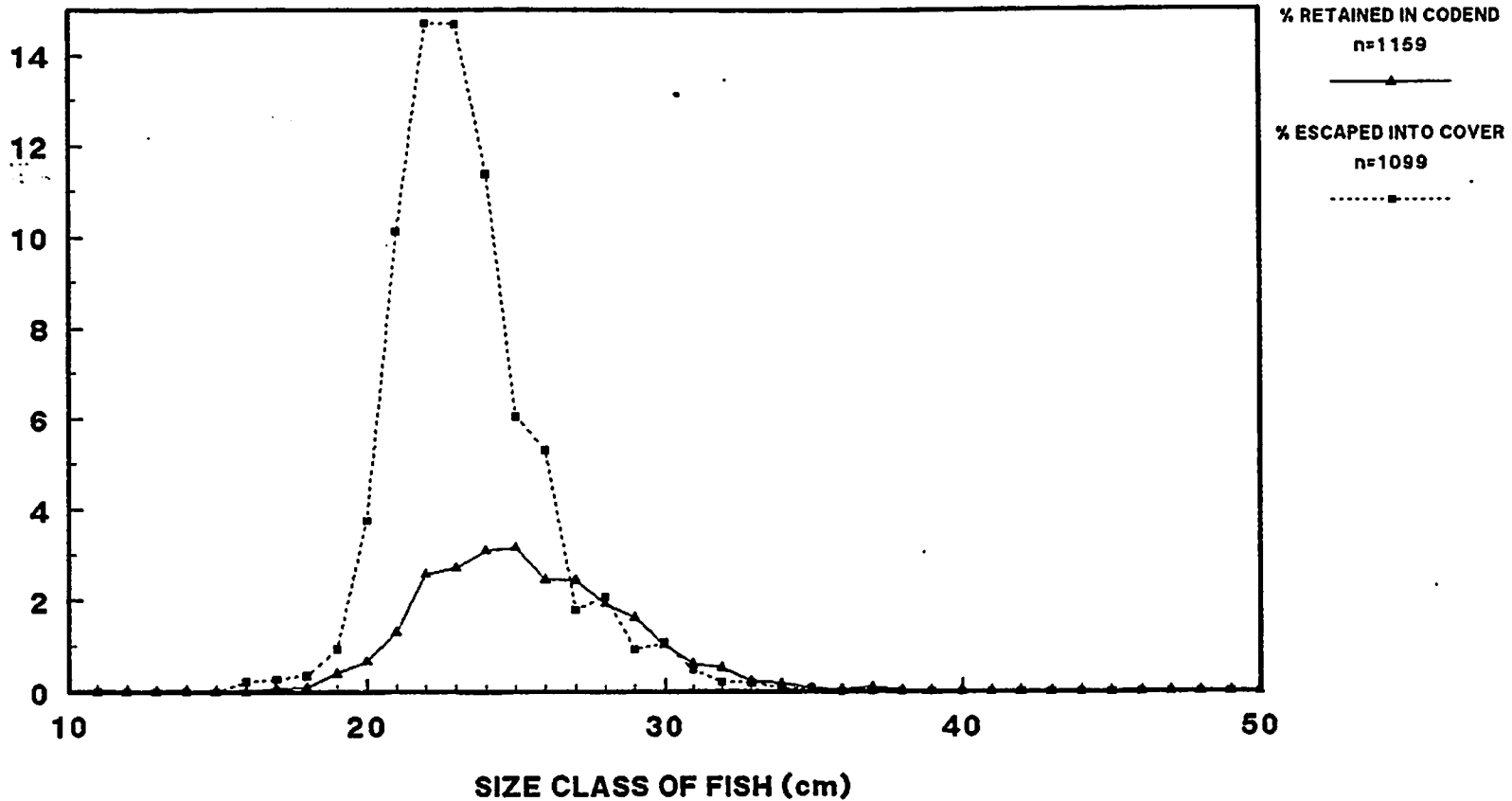
2nd APRIL TO 10th APRIL

MFV KESTREL INS 253

SEAFISH 1990

**COVERED CODEND: A COMPARISON OF WHITING SIZE
DISTRIBUTIONS OF RETAINED/ESCAPEE FISH USING A
30mm SMALL MESH COVER & 90mm x 120M CODEND**

FREQUENCY (percent)

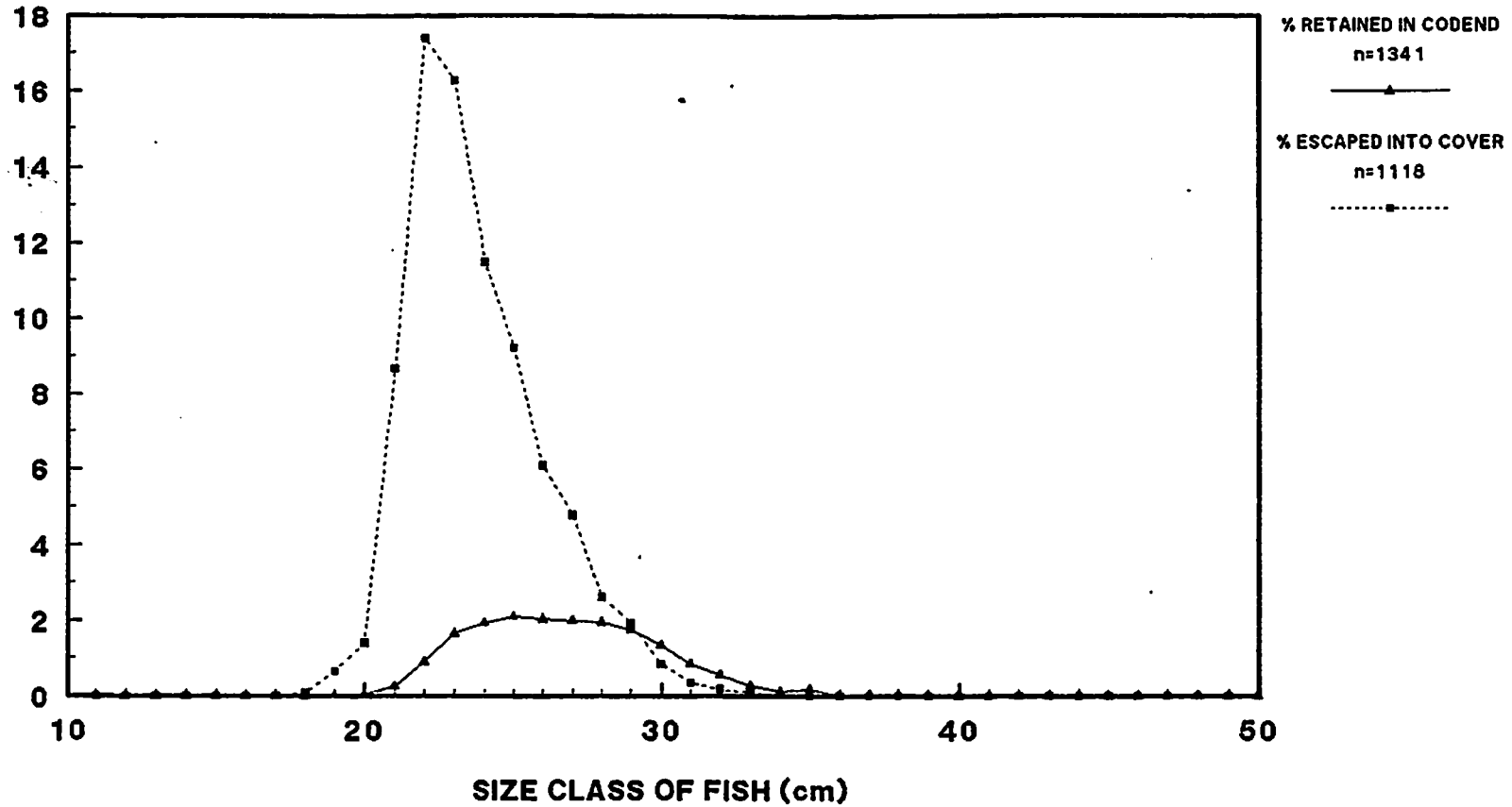


MINIMUM LANDING SIZE = 27cm
4 OF 36 TOWS
ALL PERCENT EXPRESSIONS ARE OF THE TOTAL CATCH

2nd APRIL TO 10th APRIL
MFV KESTREL INS 263
SEAFISH 1990

COVERED CODEND: A COMPARISON OF WHITING SIZE DISTRIBUTIONS OF RETAINED/ESCAPEE FISH USING A 30mm SMALL MESH COVER & 90mm x 100M CODEND

FREQUENCY (percent)



MINIMUM LANDING SIZE = 27cm

4 OF 36 TOWS

ALL PERCENT EXPRESSIONS ARE OF THE TOTAL CATCH

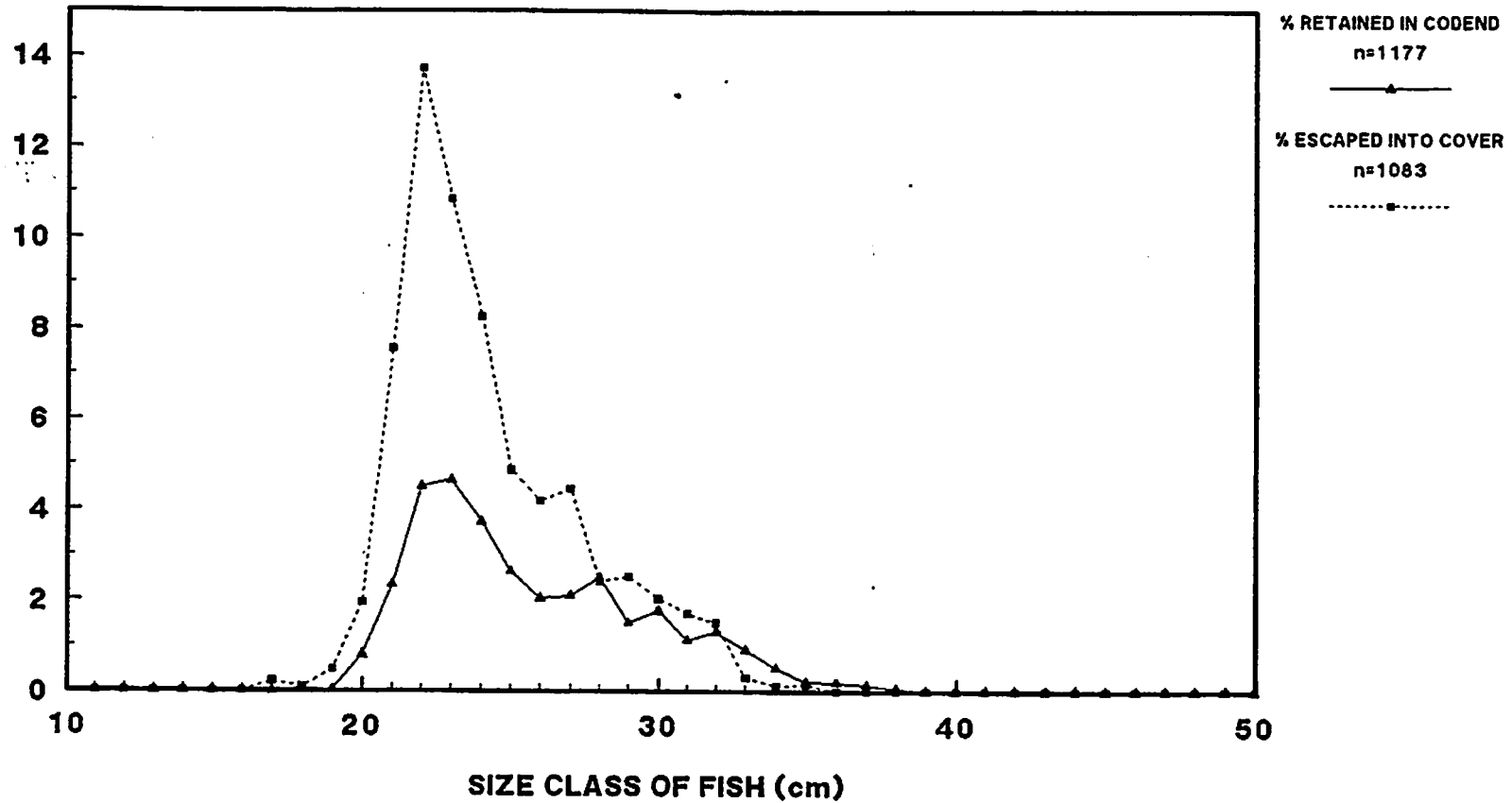
2nd APRIL TO 10th APRIL

MFV KESTREL INS 263

SEAFISH 1990

COVERED CODEND: A COMPARISON OF WHITING SIZE DISTRIBUTIONS OF RETAINED/ESCAPEE FISH USING A 30mm SMALL MESH COVER & 110mm x 80M CODEND

FREQUENCY (percent)



MINIMUM LANDING SIZE = 27cm

4 OF 36 TOWS

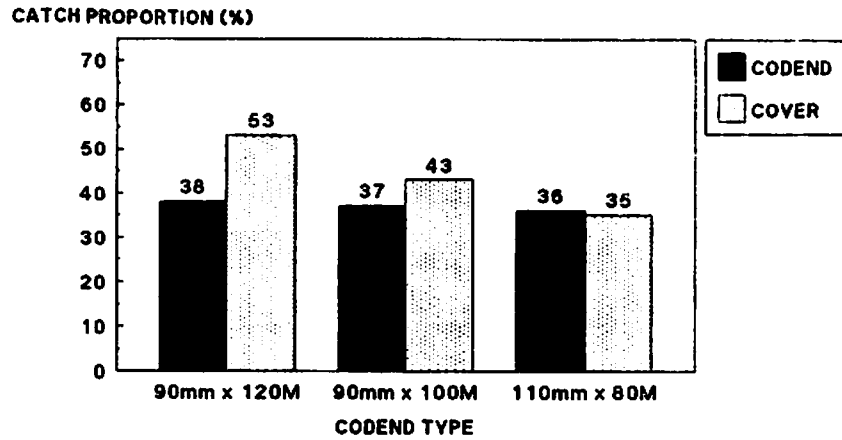
ALL PERCENT EXPRESSIONS ARE OF THE TOTAL CATCH

2nd APRIL TO 10th APRIL

MFV KESTREL INS 253

SEAFISH 1990

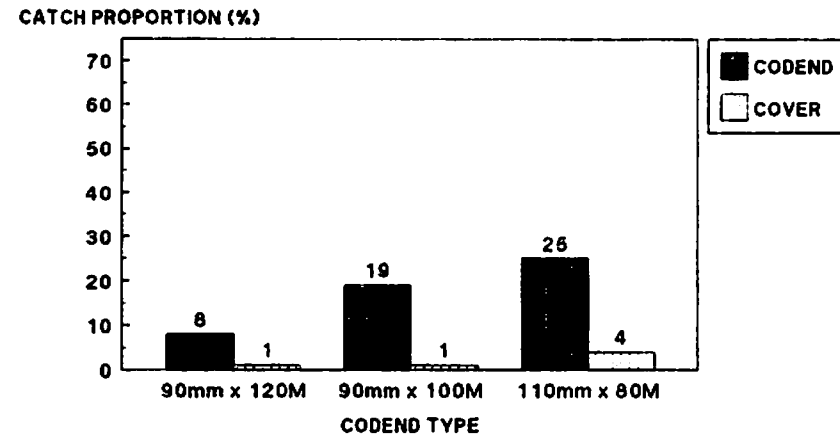
RELATIVE CATCHES OF HADDOCK BELOW 30cm OCCURRING
IN EACH CODEND AND IN THE 30mm SMALL MESH COVER



MFV KESTREL INS 253 APRIL 1990
4 HAULS

SEAFISH 1990

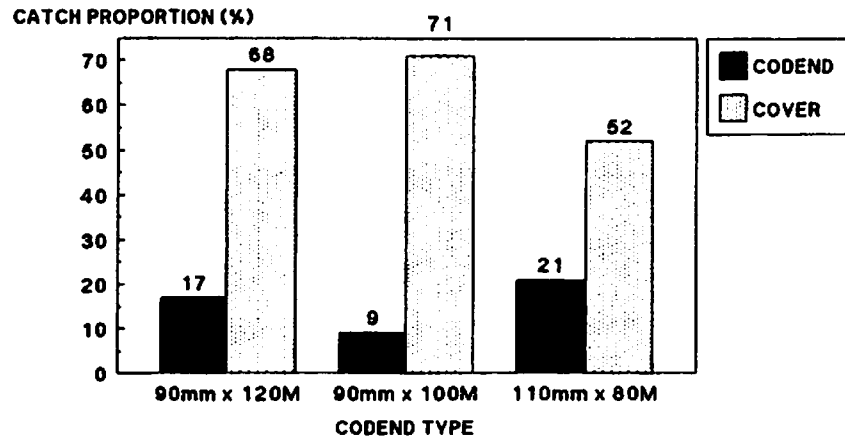
RELATIVE CATCHES OF HADDOCK ABOVE 30cm OCCURRING
IN EACH CODEND AND IN THE 30mm SMALL MESH COVER



MFV KESTREL INS 253 APRIL 1990
4 HAULS

SEAFISH 1990

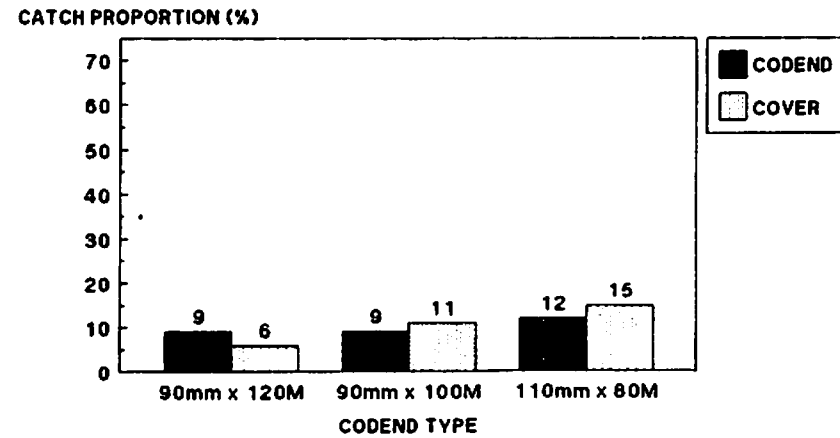
RELATIVE CATCHES OF WHITING BELOW 27cm OCCURRING
IN EACH CODEND AND IN THE 30mm SMALL MESH COVER



MFV KESTREL INS 253 APRIL 1990
4 HAULS

SEAFISH 1990

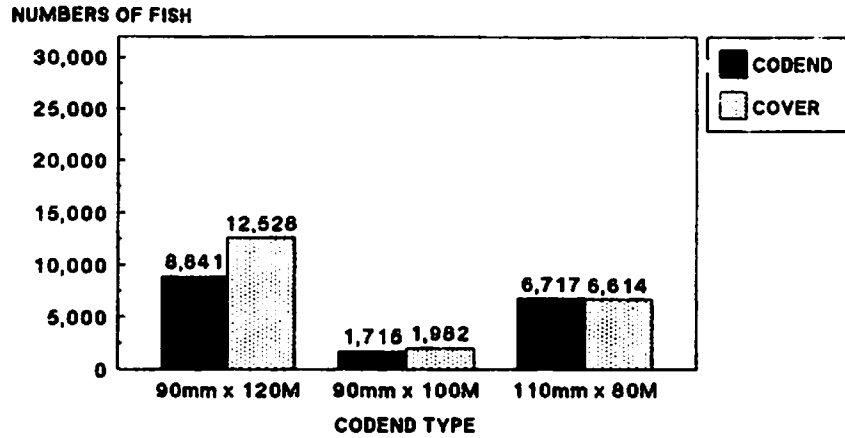
RELATIVE CATCHES OF WHITING ABOVE 27cm OCCURRING
IN EACH CODEND AND IN THE 30mm SMALL MESH COVER



MFV KESTREL INS 253 APRIL 1990
4 HAULS

SEAFISH 1990

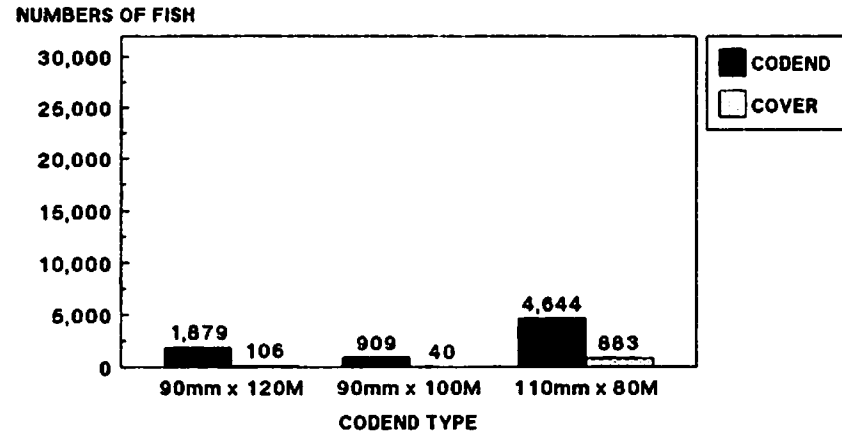
**CATCHES OF HADDOCK BELOW 30cm OCCURRING
IN EACH CODEND AND IN THE 30mm SMALL MESH COVER**



MFV KESTREL INS 253 APRIL 1990
4 HAULS

SEAFISH 1990

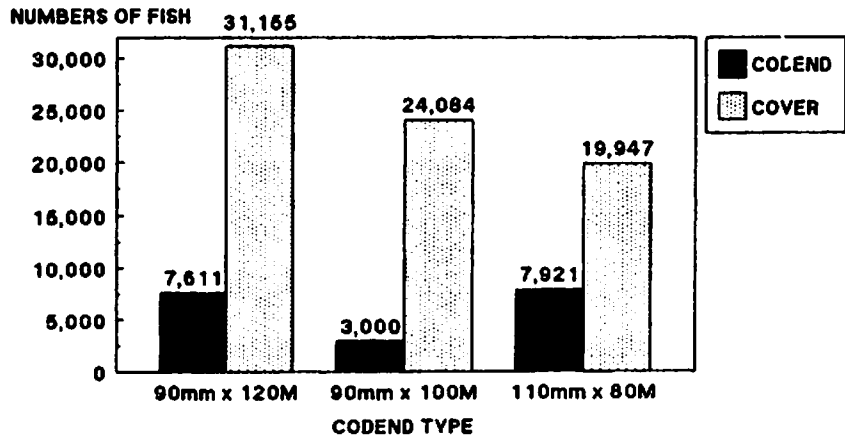
**CATCHES OF HADDOCK ABOVE 30cm OCCURRING
IN EACH CODEND AND IN THE 30mm SMALL MESH COVER**



MFV KESTREL INS 253 APRIL 1990
4 HAULS

SEAFISH 1990

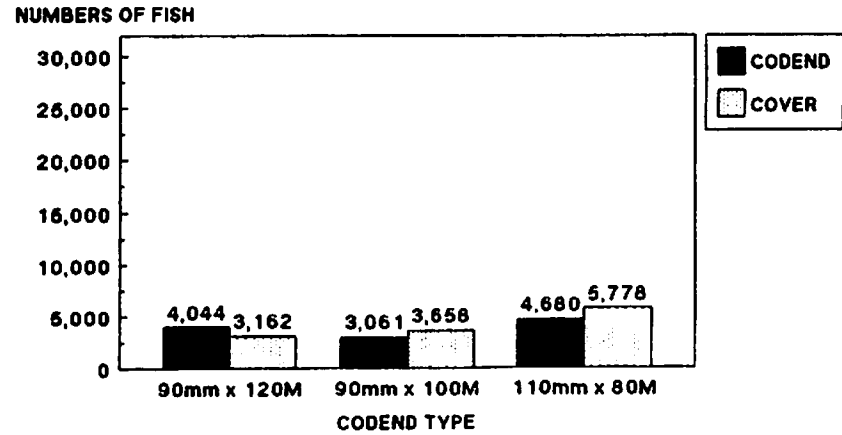
**CATCHES OF WHITING BELOW 27cm OCCURRING
IN EACH CODEND AND IN THE 30mm SMALL MESH COVER**



MFV KESTREL INS 253 APRIL 1990
4 HAULS

SEAFISH 1990

**CATCHES OF WHITING ABOVE 27cm OCCURRING
IN EACH CODEND AND IN THE 30mm SMALL MESH COVER**



MFV KESTREL INS 253 APRIL 1990
4 HAULS

SEAFISH 1990

APPENDIX I

RESULTS AND DATA ANALYSIS AS PREPARED BY MARINE LABORATORY

RESULTS

1. Fish size and species

Haddock and whiting, but no other species, were caught in significant numbers during most hauls. The size of haddock ranged from about 15 to 40cm with a bimodal distribution and the size of whiting from about 19 to 35cm with a unimodal distribution. The catch contained few whiting above the 50% retention length of the codends tested.

For more detailed analysis of the catch, the total number of fish was divided into number of discarded fish below the minimum landing size and marketable fish equal to or above that size. The minimum landing sizes for haddock and whiting are 30cm and 27cm respectively.

2. Selectivity hauls

(a) Cover Effect.

It is immediately apparent that the catches retained in the codend when a cover is being used are much larger than those without a cover. Comparisons can be made between codends B and C (table III).

Hauls with the cover have a very significantly higher catch in all cases except for haddock in codend B. The numbers of discarded and landed fish also show similar significant differences.

Because of the way the trials were conducted, with one codend being used usually for a whole day, this effect could be caused by differences in population if, for instance, there were few fish when the cover was not used. There is some evidence that this cannot be the explanation. On both days 4 and 5 in areas about 30 miles apart, codend B was fished with and without the cover. The whiting catches for the individual hauls (table IV) show that, with a cover, the number of whiting is always over 900 while, without a cover, the number retained is always less than 210, regardless of the area fished. The effect seems to be consistently due to the cover rather than the area fished.

The cover may reduce escape either by mechanical masking of the codend meshes or by changing the reaction of fish perhaps due to reduction of flow when the cover is in place.

The stretched width of the cover is 13.8m compared to the width of the largest codend of 10.4m. The cover was very long relative to the codends. In these circumstances masking is not likely unless the cover is folded. On the other hand, there may be reductions in flow towards the aft end of covered codends. However, without more evidence eg from TV it is impossible to be sure of the real reason for the increased retention of fish.

(b) Selection characteristics.

Selection curves have been drawn for each codend using grouped data for haddock (figure 1) and whiting (figure 2). Only two valid hauls were available for the 89.9mm x 100 mesh codend for haddock whereas four hauls were used in the other cases.

Despite the evidence that greater numbers of fish are retained in the codend when a cover is used, the selectivity parameters (table V) show consistency.

To check the populations from which these ogives were obtained, length-frequency plots of the fish in the cover and in the codend have been prepared (figures 3-5 for haddock and figures 6-8 for whiting). The populations caught in the 103.8mm x 100 mesh codend and cover are atypical: few small haddock below 24cm are present in either the codend or the cover (figure 5) and there is an unexpectedly high proportion of small whiting retained in the codend (figure 8), which is the cause of the high selection range of 19.6cm for that mesh size.

The 50% retention lengths for haddock and whiting for these codends with a 9m extension can be predicted by the model of Armstrong et al (1989). The values from the model (table V) are lower than those measured in this trial for the two smaller mesh sizes. The model values for the largest mesh size are nearer to the measured values confirming that the 103.8mm mesh codend may be atypical in some way in this series of trials.

3. Catch comparison hauls.

(a) Fish availability.

Any catch comparison exercise is based on the assumption that the fish population does not change during the trial. In this case the two test codends, 89.9mm x 100 meshes and 103.8mm x 100 meshes - were fished in different areas and on different days.

There is an opportunity to measure the variability of fish population by comparing the total populations fished on 2.4.90 and 4.4.90 (table II). Since covers were used, the combined catch in codend and cover should represent the total population. These same areas were also fished during the catch comparison experiments by codends B and C without covers on 6.4.90 and 9.4.90 respectively. Although the whiting populations (figure 10) look similar there is nevertheless a mean difference of 27% in numbers over the length range from 22 to 26cm. The haddock population (figure 9), on the other hand, shows marked differences at both ends of the range. A catch comparison could not be valid if two such different distributions were fished.

In practice these length-frequency plots apply to only two of the six areas fished during the catch comparison hauls and there is no means of knowing what the distributions were in the other areas. It will be assumed that overall the two codends fished similar populations but any conclusions should be qualified by these observations.

(b) Catch comparison.

The numbers of whiting caught in either codend during the commercial fishing phase of the trials were very low. Several hauls produced fewer than 20 whiting in total. Clearly if there were whiting on the grounds then both codends allowed large quantities to escape. No statistical comparison has been made for whiting.

The mean numbers of haddock caught per haul have been calculated for the 8 valid hauls using the 89.9mm x 100 mesh codend and the 10 valid hauls using the 103.8mm x 100 mesh codend. These have also been divided into two groups - those below the minimum landing size of 30cm and those of a legal landing size (table VI).

The numbers of haddock per haul are small but the reductions in total number of fish (60%) and discarded fish (66%) are statistically significant at the 95% confidence level. The numbers of marketable fish caught per haul vary too much for the difference to be significant at this level. More hauls and preferably larger quantities of fish would be required to show a significant difference.

Care must be exercised in interpreting these results. Clearly the percentage reductions found between the two codends will depend on the population fished. There were large numbers of small fish on the grounds during these trials so that large reductions in the total number of fish caught and the number of discards caught would be expected. Because there were small numbers of larger haddock it is not clear what the effect on the catch of marketable fish is.

In the lower half of table VI the difference in the bulk of fish of all species retained in the codend is shown. A significant 46% reduction in bulk is found.

4. Conclusions.

The retention of whiting in 89.9mm and 103.8mm mesh codends was increased significantly when a totally enclosing cover was used. There was also a significant increase in numbers of haddock retained in the 103.8mm codend when covered, but not in the 89.9mm codend.

The selection characteristics for these two codends having 100 meshes round their circumferences (including meshes in the selvedge) and for the vessel's 86.7mm by 120 mesh codend have been found. The increases in 50% retention length from one codend to the next are not as large as expected and may be due to the increased retention of fish.

For both haddock and whiting, the 86.7mm x 120 meshes and 89.9mm x 100 meshes codends were found to have larger 50% retention lengths during these trials than those predicted by the selection model of Armstrong et al. (1989) developed from earlier seine net trials data.

In some areas fished during the catch comparison phase there was evidence that there were major changes in the size distribution of fish and this may have affected the results.

Catch data comparing the 89.9mm and 103.8mm codends show that there is a 60% reduction in total numbers of haddock caught in the larger mesh codend compared to the smaller. Because there were considerable numbers of undersized fish (below 30cm) on the fishing grounds the large reduction is to be expected and welcomed. A different result will be obtained when fishing on a different population. There were fewer marketable haddock caught in these catch comparison hauls and, for the small number of hauls made, the difference in numbers for the two codends is not statistically significant. A larger number of hauls would improve the likelihood of significant results.

Very few whiting above the minimum landing size were available on the grounds. The 50% retention lengths for whiting (29 - 32cm) were higher than the minimum landing size (27cm) and hence few were retained by either codend. No meaningful comparisons can be made for the changes in catch levels of whiting.

REFERENCE.

Armstrong D.W., Fryer R.J., Reeves S.A. and Coull K.A. 1989. Cod-end selectivity of cod, haddock and whiting by Scottish trawlers and seiners. International Council for the Exploration of the Sea, CM1989/B:55.

Table III. Values for the mean number of fish caught in the codend per haul for two codend mesh sizes with and without the cover.

Codend B - 89.9mm mesh

	With cover	Without cover	Significance
Haddock	816	568	Not sig.
Whiting	1480	290	P<0.01

Codend C - 103.8mm mesh

	With cover	Without cover	Significance
Haddock	2758	225	P<0.001
Whiting	3096	284	P<0.05

Significance levels :

'Not sig' means significance does not reach the 95% confidence level, which is the usual criterion for a statistically significant result.

P<0.05 means significant at the 95% confidence level.

P<0.01 means significant at the 99% confidence level.

P<0.001 means significant at the 99.9% confidence level.

Table IV. Effect of cover on catch in codend.

Day	Cover?	Total number of whiting	Haul
4	No	125	13
4	Yes	1902	14
4	Yes	1765	15
4	Yes	1332	16
5	Yes	921	17
5	No	207	18
5	No	114	19
5	No	204	20

Table V. Selectivity characteristics for the three codends for haddock and whiting.

Haddock

	86.74mm 120mesh	89.9mm 100mesh	103.8mm 100mesh
50% retention length cm (L50)	23.0	25.4	26.2
Selection range cm	6.1	4.7	8.2
Selection factor	2.6	2.8	2.5

Predictions from selection model with 9m extension length :

L50 cm	18.4	21.9	27.9
Selection range cm	6.4	6.4	6.4

Whiting

	86.74mm 120mesh	89.9mm 100mesh	103.8mm 100mesh
50% retention length cm (L50)	29.2	30.3	32.0
Selection range cm	9.0	5.9	19.6
Selection factor	3.4	3.4	3.1

Predictions from selection model with 9m extension length :

L50 cm	23.2	26.0	30.9
Selection range cm	7.1	7.1	7.1

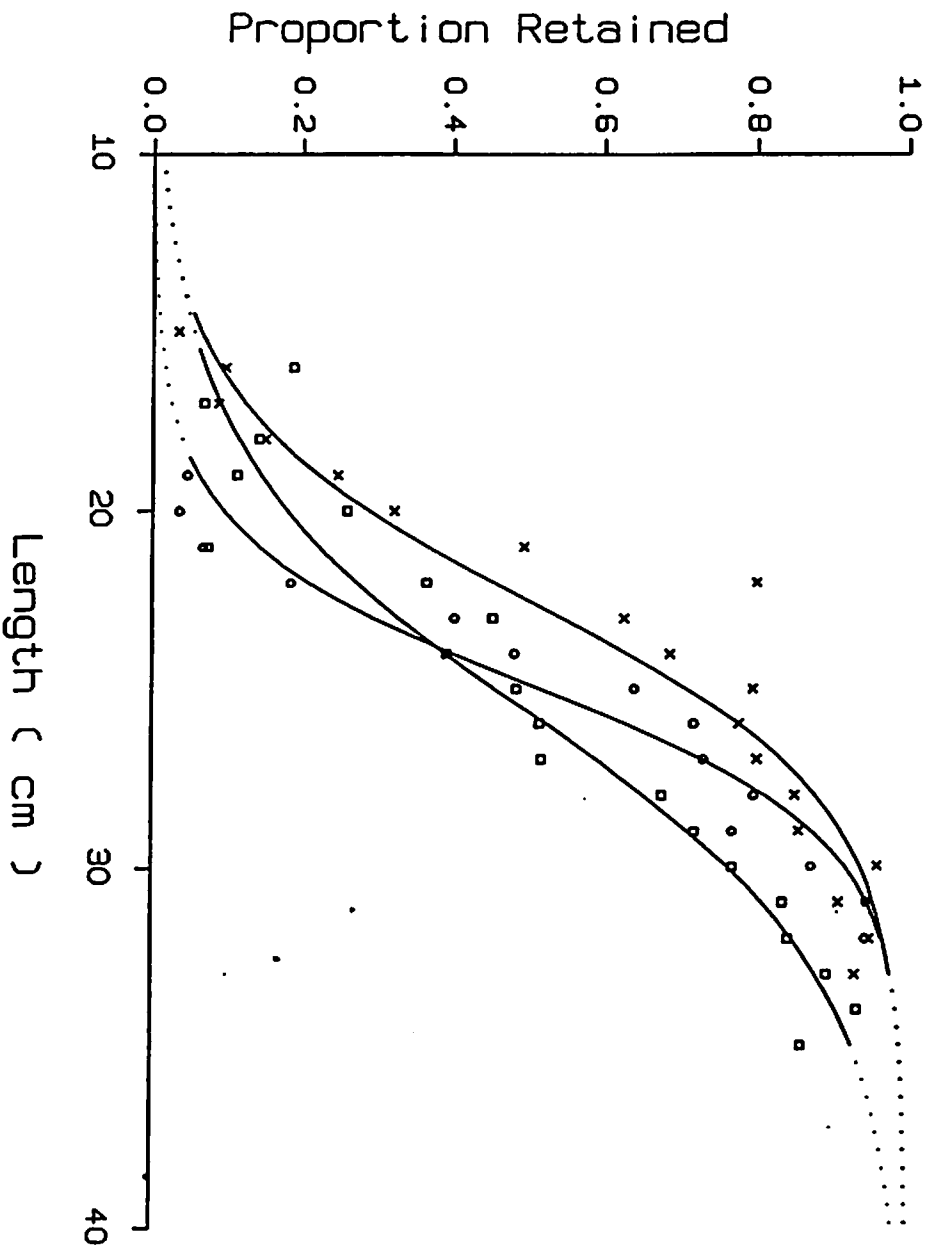
Table VI. Catch comparison results for the 89.9mm and 103.8mm codends.

1. Mean number of haddock per haul

	89.9mm	103.8mm	% Reduction	Significance
Number of hauls	8	10		
Total number of fish	567	225	60	P<0.05
Discarded fish less than 30cm	315	108	66	P<0.05
Marketable fish of 30cm or more	252	117	-	Not sig

2. Mean number of boxes per haul

	89.9mm	103.8mm	% Reduction	Significance
Number of hauls	8	12		
Number of boxes	5.13	2.75	46	P<0.05



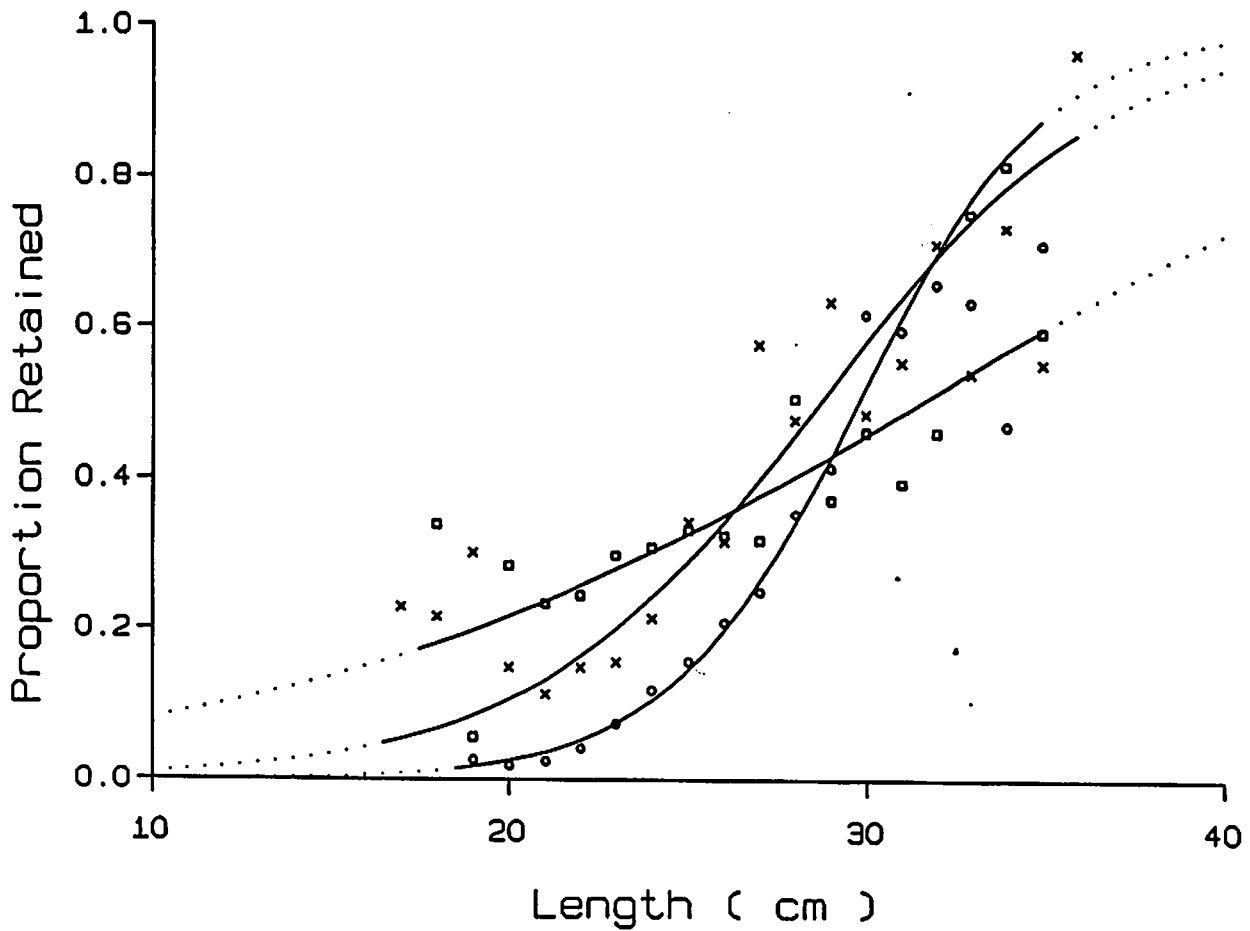
Haul	C.E. Mesh Size (mm)	50% Length (cm)	Selection		Total No.		No. in S.R.	
			Factor	Range cm	Cod End/Cover	Cod End/Cover	Cod End/Cover	Cover
x	86.74	23.0 ± 0.05	2.65	6.1	10630	12497	2294	1980
o	89.90	25.4 ± 0.10	2.82	4.7	1906	1896	551	362
□	103.78	26.2 ± 0.07	2.52	8.2	11033	7303	5961	4982

x Hauls 1+2+3+4

o Hauls 15+17

□ Hauls 9+10+11+12

FIGURE 1. Selectivity curves for haddock
 Kestrel - April 1990
 86.7mmx120, 89.9mmx100, 103.8mmx100 mesh



Haul	C.E.Mesh Size (mm)	50% Length (cm)	Selection		Total No.		No. in S.R.	
			Factor	Range cm	Cod End	Cover	Cod End	Cover
x	86.74	29.2 ± 0.08	3.36	9.0	11642	34317	7467	12523
o	89.90	30.3 ± 0.07	3.37	5.9	5920	32315	2932	5004
□	103.78	32.0 ± 0.21	3.08	19.6	12385	25713	11258	22711

x Hauls 1+2+3+4

o Hauls 14+15+16+17

□ Hauls 9+10+11+12

FIGURE 2. Selectivity curves for whiting Kestrel - April 1990
86.7mmx120, 89.9mmx100, 103.8mmx100 mesh

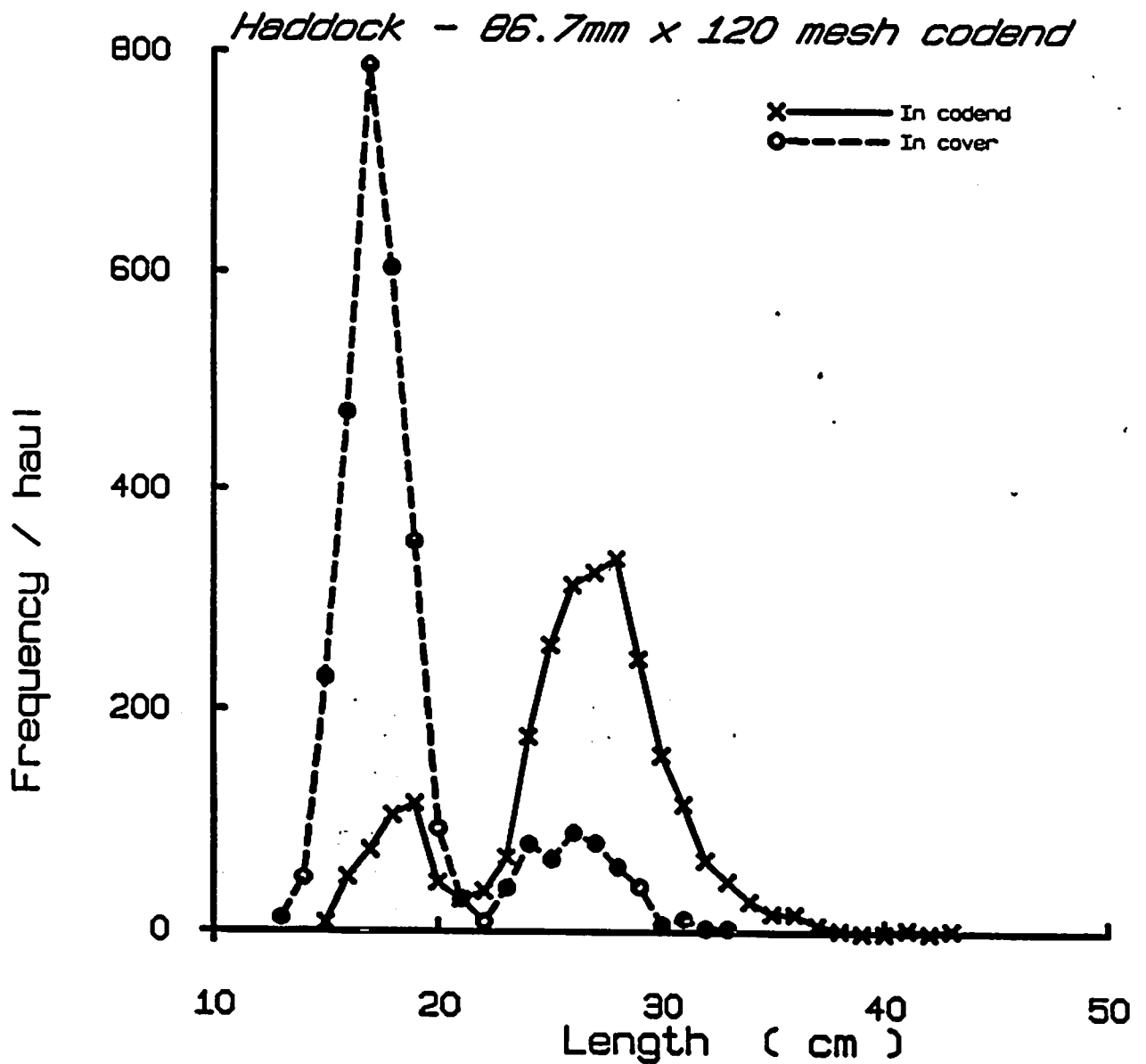


FIGURE 3. Size distribution of haddock in the 86.7mm codend and in the cover during selection hauls.

Haddock - 89.9mm x 100 mesh codend

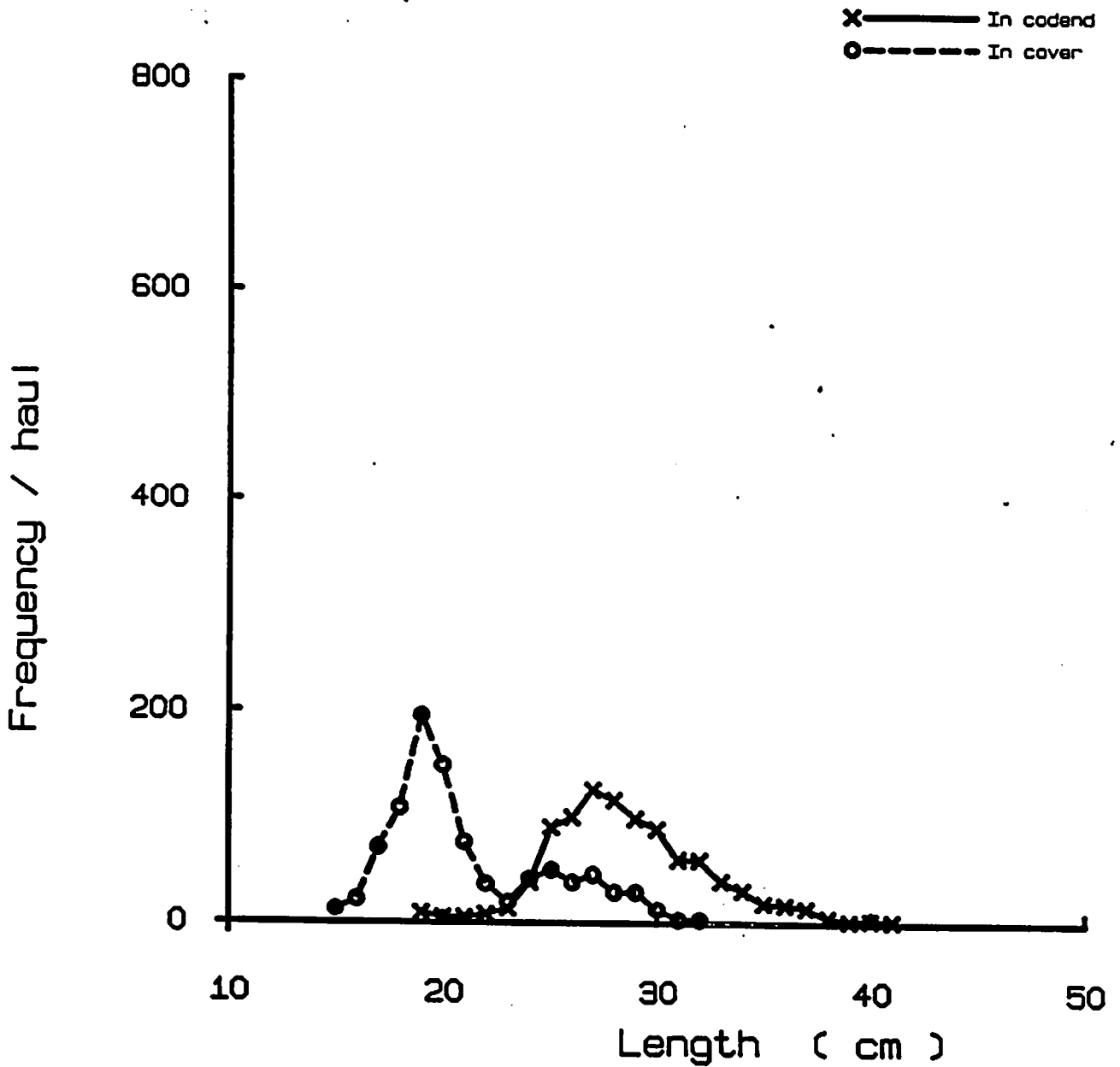


FIGURE 4. Size distribution of haddock in the 89.9mm codend and in the cover during selection hauls.

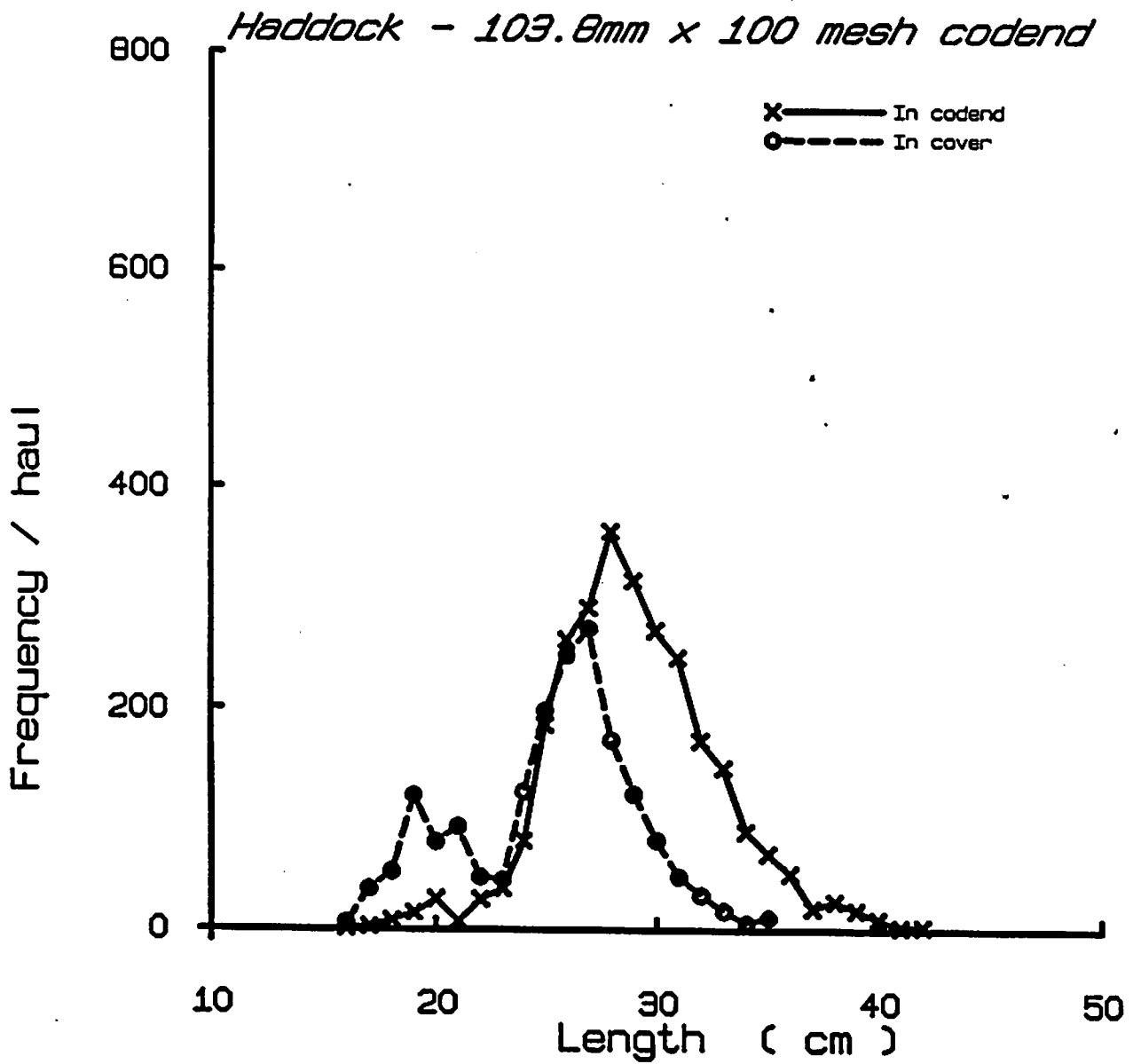


FIGURE 5. Size distribution of haddock in the 103.8mm codend and in the cover during selection hauls.

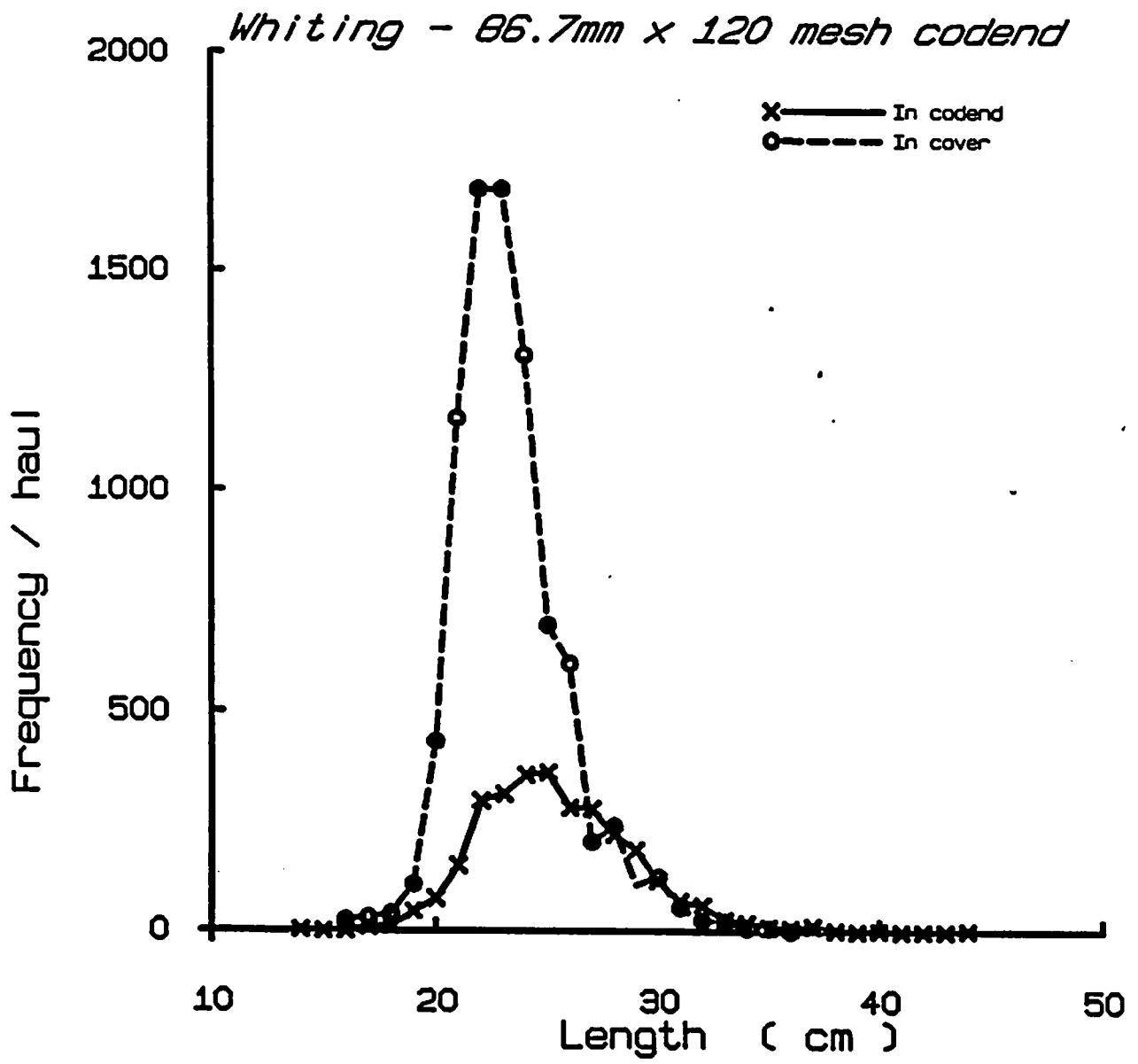


FIGURE 6. Size distribution of whiting in the 86.7mm codend and in the cover during selection hauls.

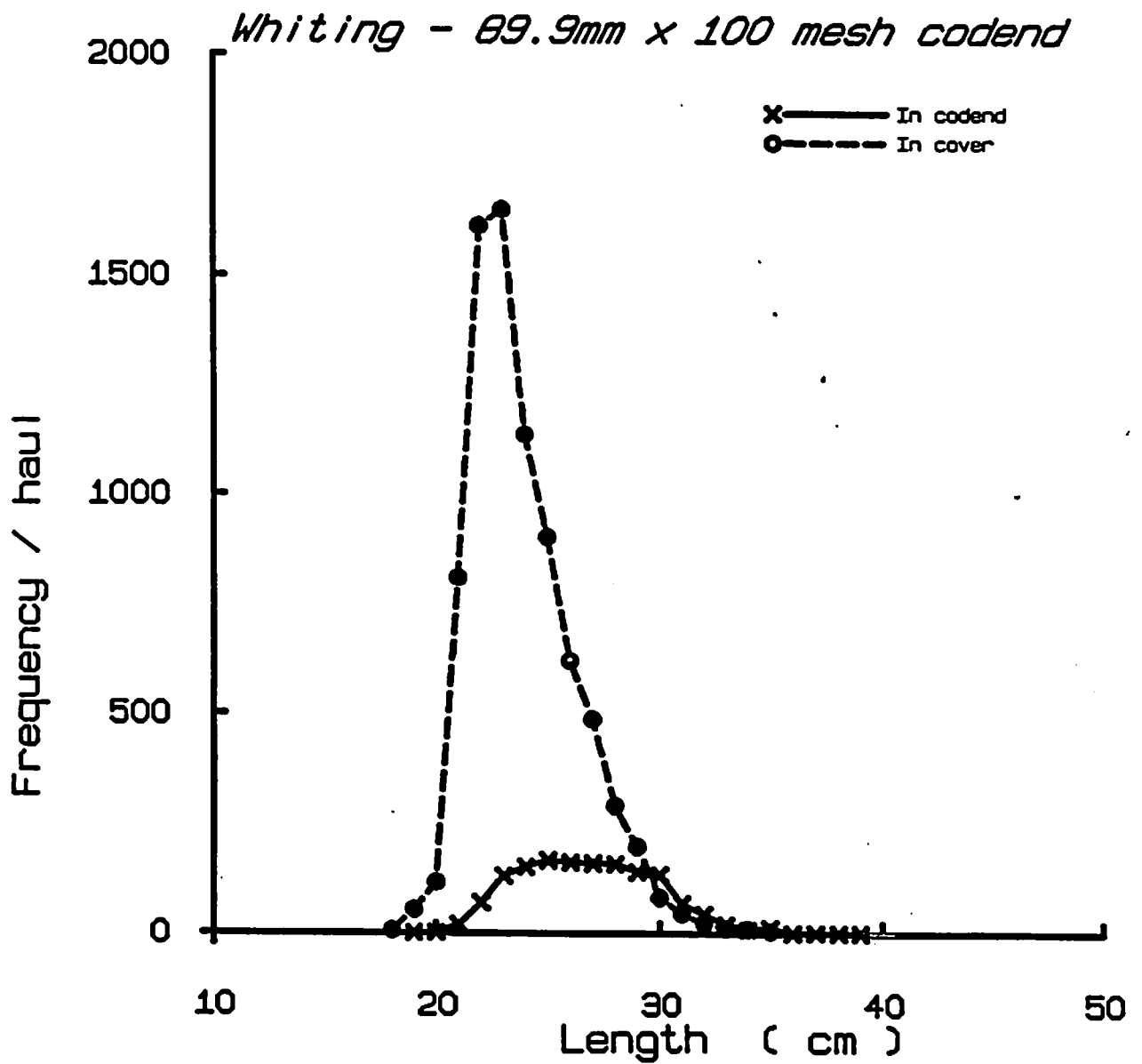


FIGURE 7. Size distribution of whiting in the 89.9mm codend and in the cover during selection hauls.

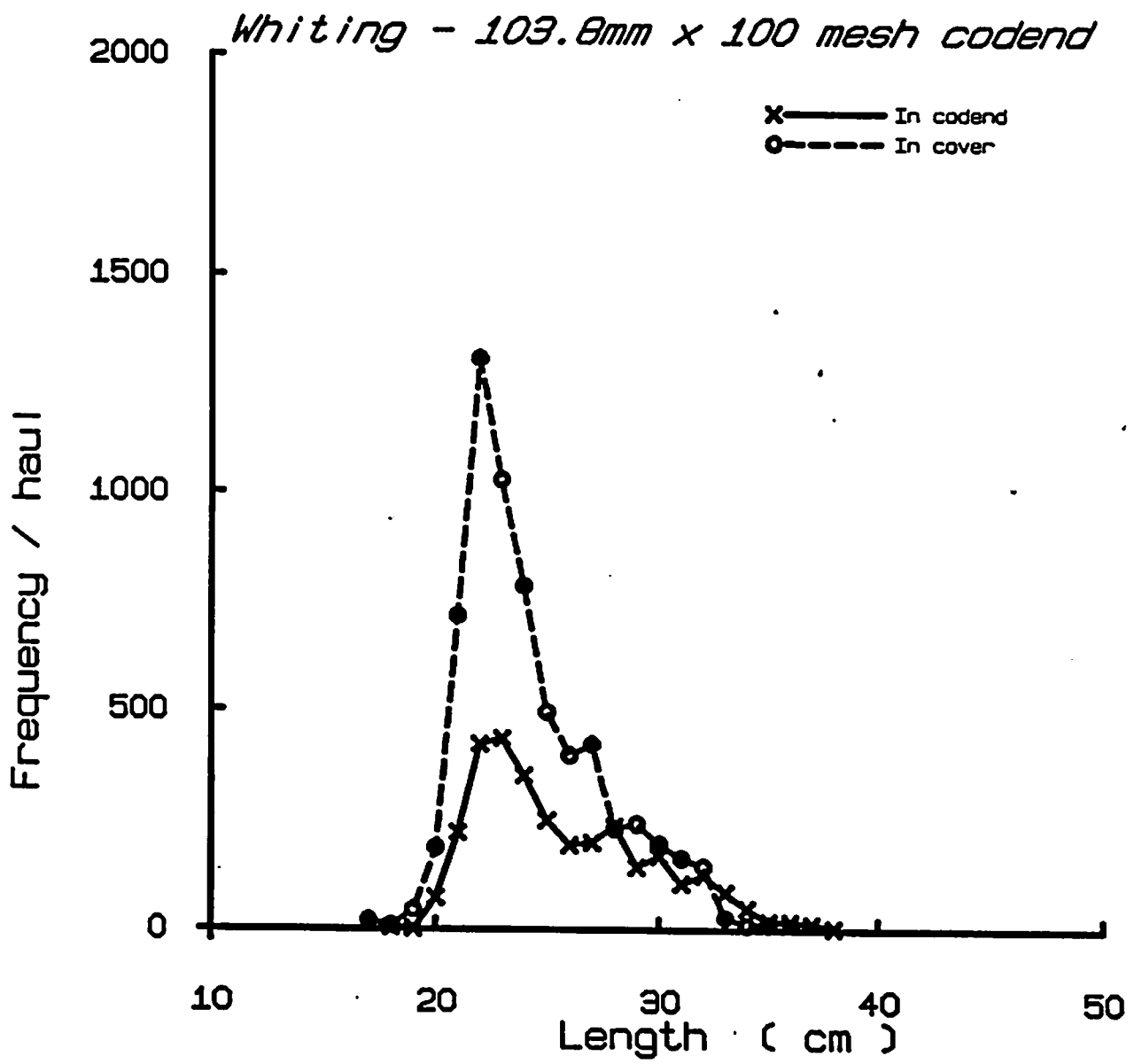


FIGURE 8. Size distribution of whiting in the 103.8mm codend and in the cover during selection hauls.

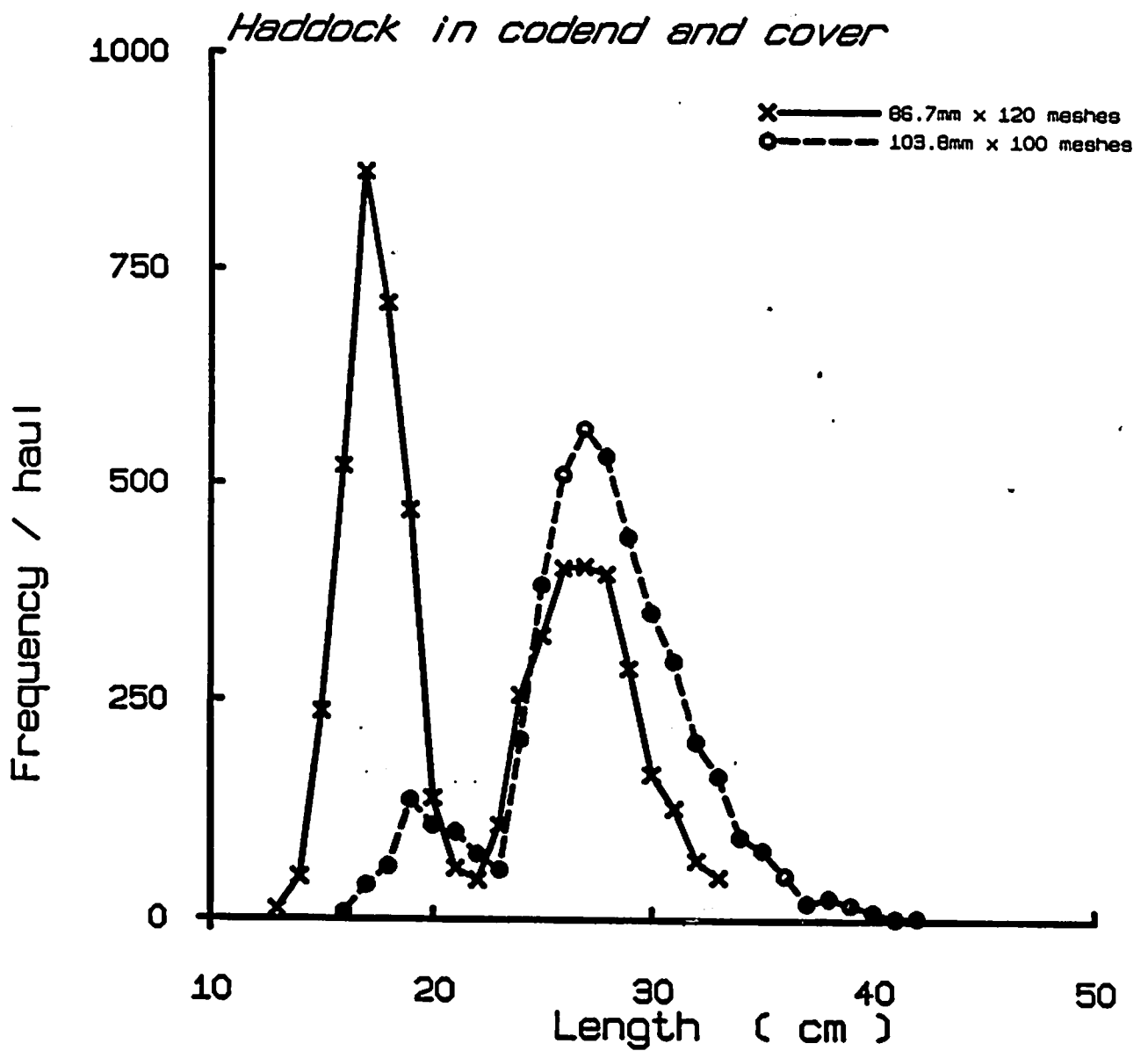


FIGURE 9. Comparison of total populations of haddock on two different days. The mean frequency/haul for codend & cover combined.

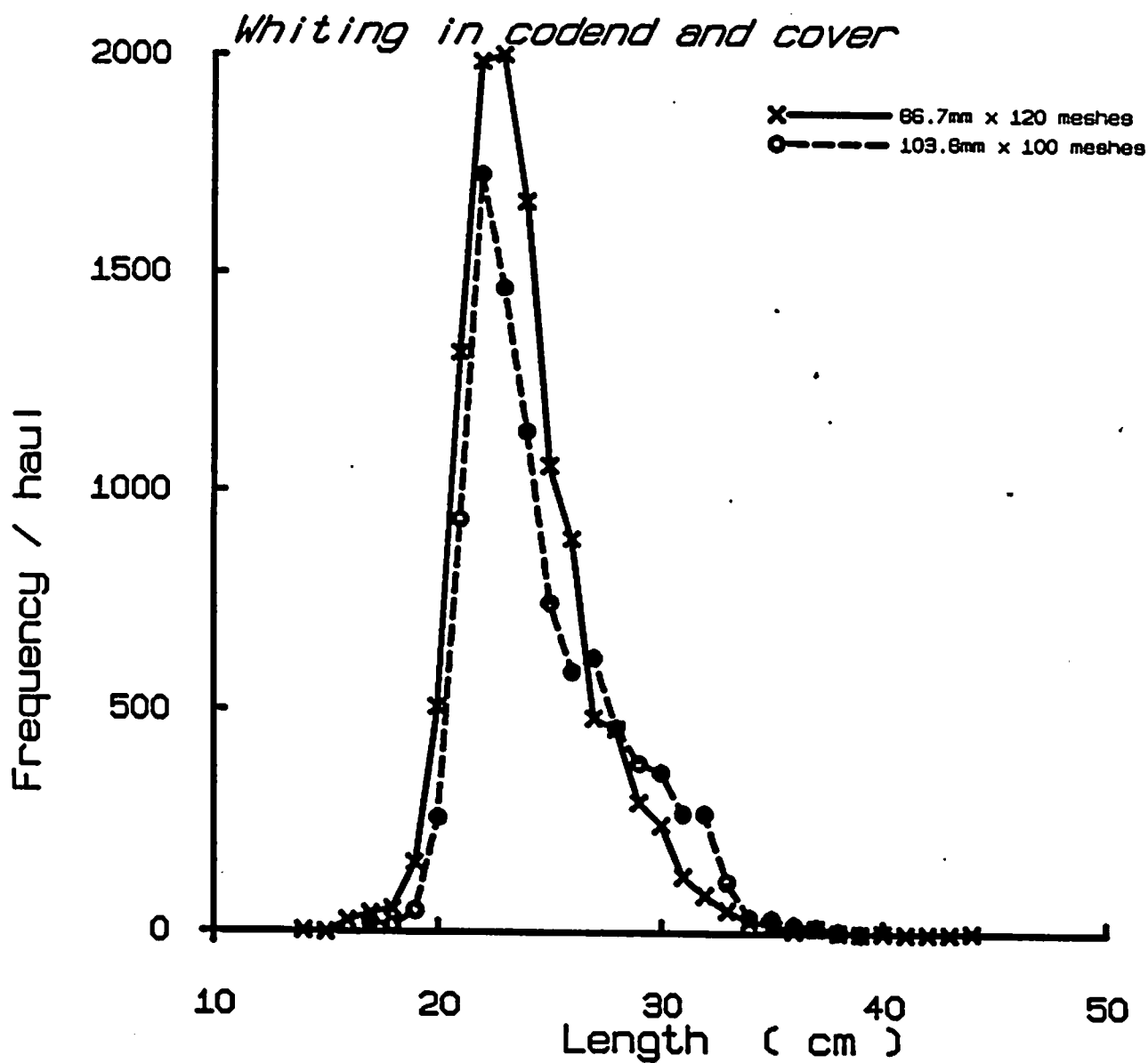


FIGURE 10. Comparison of total populations of whiting on two different days. The mean frequency/haul for codend & cover combined.

APPENDIX II

MANAGEMENT OF NORTH SEA WHITE FISHERIES IN 1990

GEAR RESTRICTION OPTION

Under the gear option a vessel will be prohibited when fishing in the North Sea for all species except sole, Norway lobster, herring, mackerel, shrimp (crangon), prawn (pandulus), sprat, molluscs, blue whiting, horse mackerel, argentines or sandeel to use or to have on board any trawl, Danish seine, or similar towed gear unless its mesh size in that part of the net having the smallest meshes is equal to or greater than 110 millimetres and it has a codend (including any lengthening piece) which complies with the following specification.

The codend, excluding lengthening piece, shall be constructed from one or more panels of netting with parallel sides and the general course of the netting yarn perpendicular to the long axis of the net (and the general direction of tow). The codend (excluding lengthening piece) shall have at least 30 and no more than 100 meshes along its length. Excluding meshes in the selvedges, there shall be no more than 80 meshes on the circumference at any point along the length of the codend (excluding lengthening piece). The number of meshes on the circumference shall be identical throughout the length of the codend (excluding lengthening piece). The number of meshes at any point on the circumference of any lengthening piece shall be not less than the number of meshes on the circumference of the codend. The use of strengthening bags or topside chafers shall be prohibited.

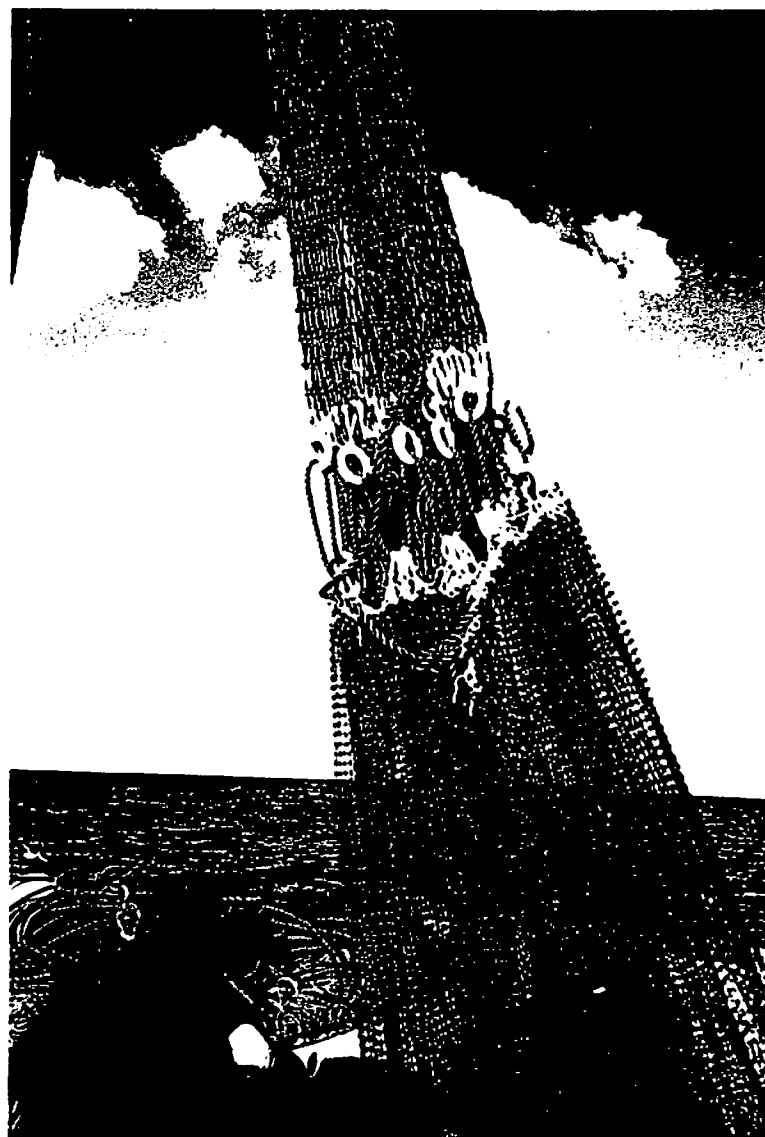
PHOTOGRAPHS SHOWING GEAR USED DURING SELECTIVITY TRIALS

MFV KESTREL

1. SMALL MESH COVER



2. METHOD OF ATTACHMENT OF SMALL-MESH COVER

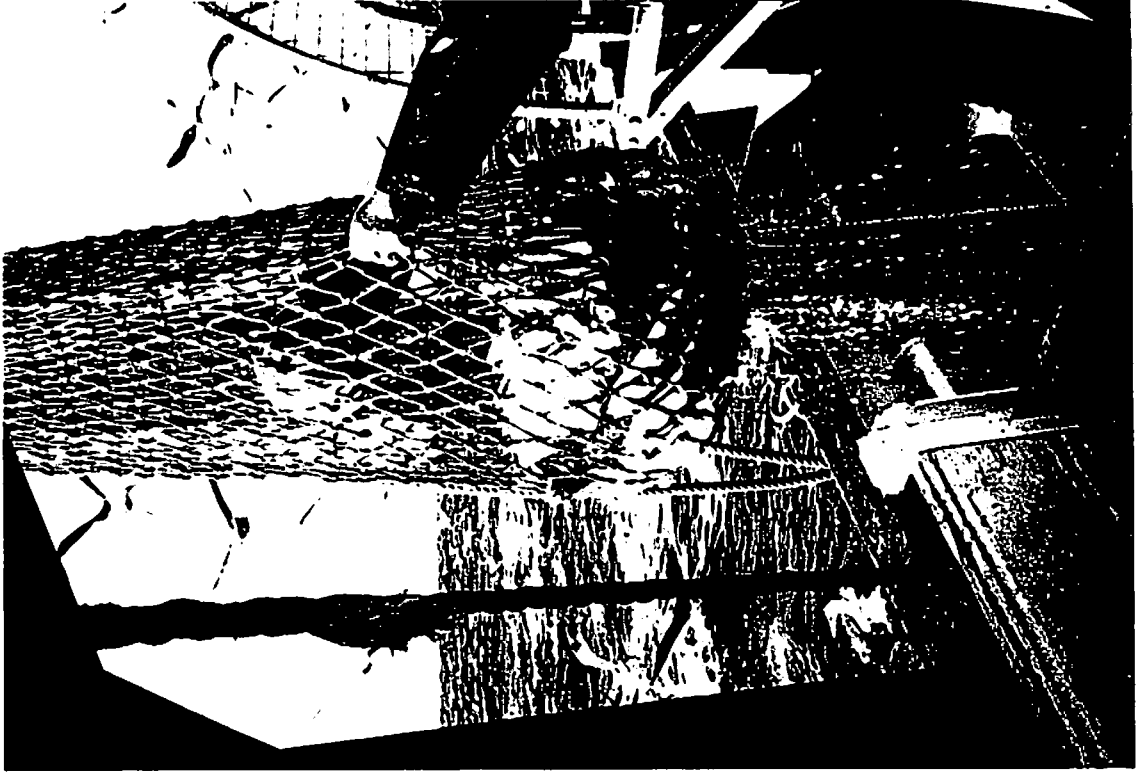


PHOTOGRAPHS SHOWING 110MM X 80 MESH ROUND CODEND AS USED IN SELECTIVITY TRIALS (MFV KESTREL)

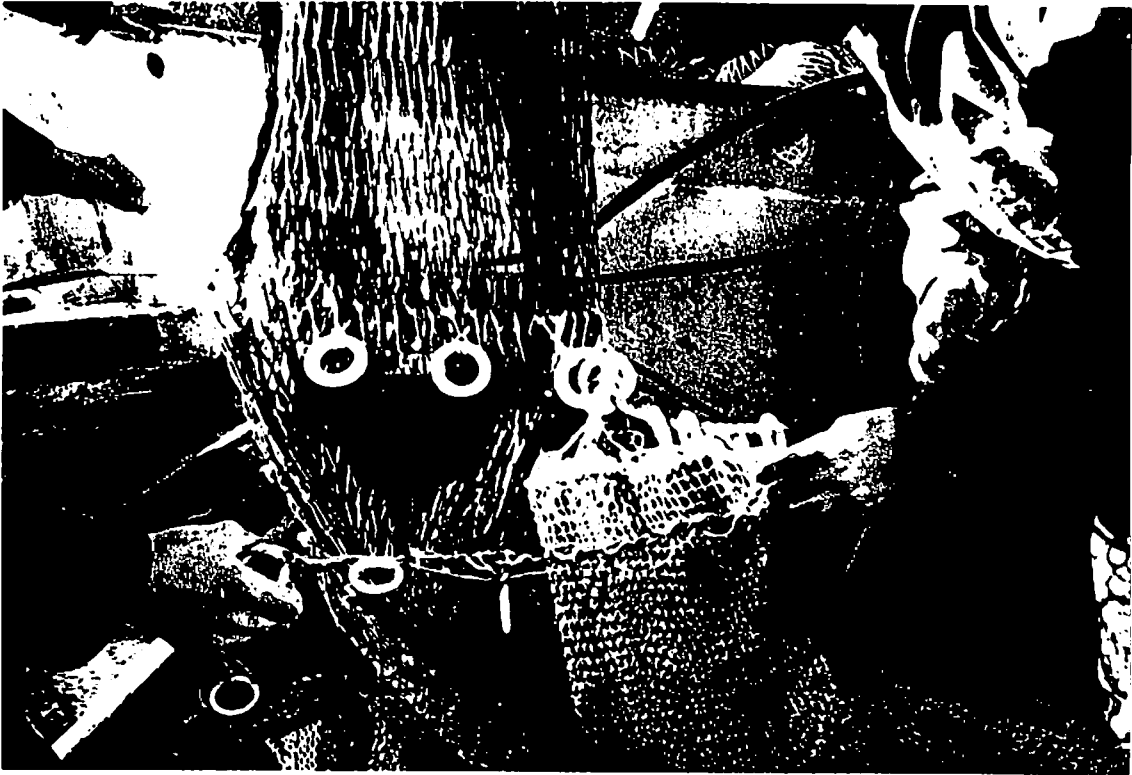
3.



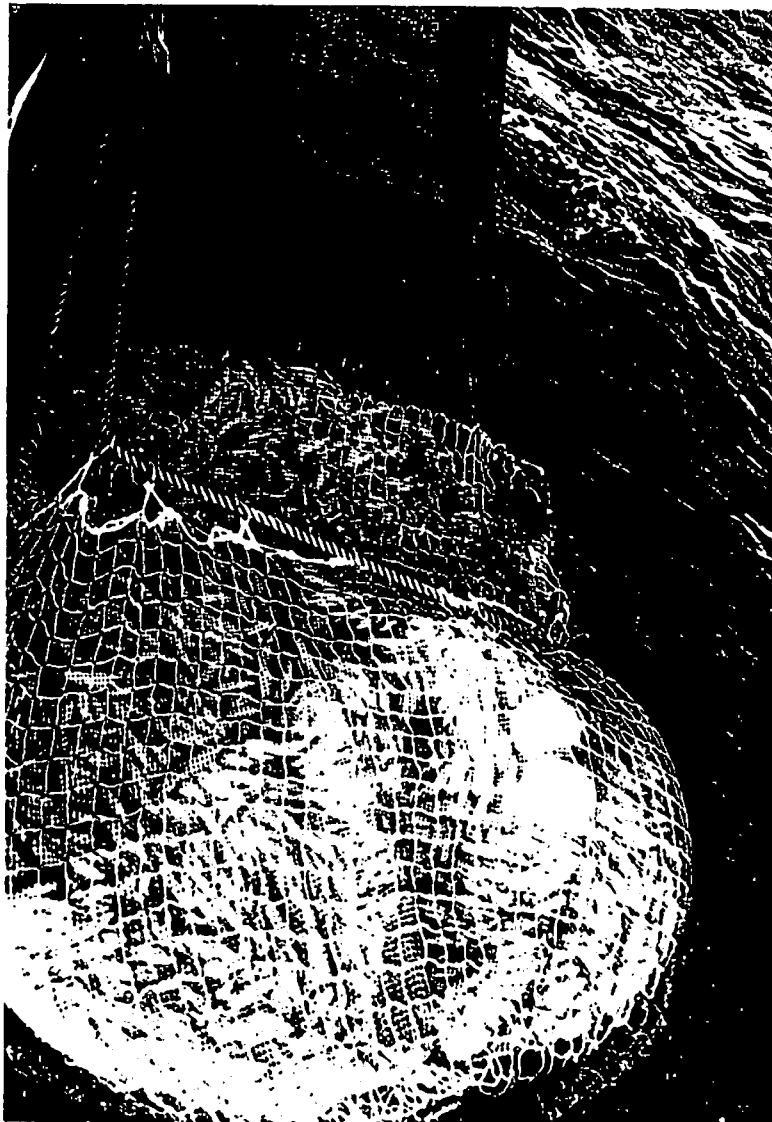
4.



5. ATTACHMENT OF SMALL-MESH COVER



6. FISH IN SMALL-MESH COVER PRIOR TO LIFTING ONBOARD



7.



PHOTOGRAPHS SHOWING FISH RETAINED IN SMALL-MESH COVER

8.

