SEA FISH INDUSTRY AUTHORITY
Seafish Technology

SELECTIVITY IN TRAWLS
SELECTION DEVICES AIMED AT THE RELEASE OF JUVENILE COD
MFV CONGENER (SN86)

Internal Report No. 1420
MAFF R&D Commission 1990/91
Project Code IBA 16

July 1991
K Arkley

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SUMMARY

Seafish have a continuing programme to improve selectivity in towed gear and considerable advances have been made in reducing discards of haddock and whiting from trawls through the use of square mesh panels inserted into the upper part of the extension. There has not so far been any similar reduction in cod discards.

The purpose of this trial was to test various simple devices designed to reduce the numbers of undersized cod retained in the codend. The trial was carried out aboard the North Shields seiner/trawler CONGENER, skipper Alan Morse, during May 1991 on the Dogger Bank area of the North Sea using underwater television equipment on loan from the Marine Laboratory, Aberdeen. Laboratory staff were also on board to operate the equipment.

The principal ideas tested were simple square mesh panels with diverting and deflector strips inside the extension intended to direct the fish to the escape panels. The square mesh escape panels were 90mm mesh. Panels made of glow netting (luminious) from Japan were also tested to determine if they either attracted or frightened the fish. The weather conditions and underwater visibility during the trials were excellent, however fish catches were pitifully small, particularly cod. This was despite being knowledgably advised that a cod fishery could always be expected at this time of year. The consequence of this meant that too few observations of cod were made in order to draw any meaningful conclusions.

There was over 23 hours of film taken during the trip and some interesting aspects of fish behaviour were noted. It was shown that fish could be directed by diverting panels to specific areas in the net, however the square mesh panel was not successful in releasing undersized codling.

A follow-up voyage on the Scottish Office Agriculture and Fisheries Department research vessel CLUPEA was subsequently carried out but the problem of low fish catches was again encountered with little further knowledge being gained.

This work was funded under the MAFF R&D Commission 1990/91, Project Code IBA 16.

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1 BACKGROUND

During 1990 and 1991 Seafish's Gear Technology Group have been involved in a programme of work aimed at improving the selectivity of fishing gears.

One of the main areas of interest has been the investigation of ways and means of improving the selectivity of codends in towed fishing gears.

The development of square mesh selector panels or "windows", by Seafish and Marine Laboratory, has achieved very encouraging results with respect to the release of juvenile white fish species such as haddock and whiting.

However, as yet all selection devices so far evaluated have proved relatively ineffectual at releasing undersized cod.

It is to this problem that Seafish have now turned their attention. Efforts have been concentrated on the development of a selection device that would remain simple but effective at releasing undersize cod while maintaining catch levels of marketable cod and other species.

One of the most effective ways of evaluating any piece of fishing gear is by direct underwater observation under normal working conditions.

One of the best systems and operating teams carrying out this work is centred on the remote controlled television vehicle (RCTV) operated by the Scottish Office, Agriculture and Fisheries Department (SOAFD) and based at the Marine Laboratory in Aberdeen.

In co-operation with the Marine Laboratory team, Seafish set-up trials to evaluate a number of experimental selection devices using a RCTV camera system. Grateful acknowledgement is given to this team for their co-operation in this trial.

2 INTRODUCTION

Following the success of previous work with square mesh 'windows' for haddock and whiting, it was thought that the use of such simple devices should be further investigated in order to establish whether they could be modified and adapted to be effective at releasing undersize cod.

It is generally accepted that cod have a tendancy to remain very close to the seabed at most times and that this 'bottom hugging' tendancy is noticeable once the fish is caught in demersal trawl gear.

Based on this behavioural response it was decided to investigate a number of experimental designs of selection devices based on the use of square mesh selector panels situated in the lower sheet of the net. The underwater cameras were to be used to study the reaction of cod and other species to the devices and then optimise their design and position in the trawl.

In order to try and obtain the best evaluation of the experimental gear it was decided to select a fishing operation and fishery that would provide representative commercial fishing conditions and at the same time provide the best light conditions possible as required by the RCTV system. It was also important to carry out the trials at a time and in an area where reasonable concentrations of small codlings could be expected.

For the fishing operation, a suitable vessel of a size and power capable of working well offshore and also providing a large and relatively stable working platform for the RCTV system was required.

The vessel selected for this exercise was the North Shields based multi-purpose fishing vessel CONGENER (SN86) skippered by Alan Morse.

The fishing ground selected on advice from industry representatives, was the 'Dogger Bank'. This area, during the Spring and early Summer, provided the relatively clear, shoal water required for the TV operation. It was also grounds very familiar to the skipper Alan Morse and was expected to yield sufficient quantities of small codlings necessary to the trial.

3 EXPERIMENTAL SELECTION DEVICES

As previously mentioned, the selection devices under test were all based on the use of a square mesh panel fitted into the lower sheet of the net situated in the area of the parallel extension ahead of the codend.

Considering the current minimum landing size (MLS) for cod at 35cms, the mesh size selected for the square mesh panels was 95mm.

Detailed specifications of the selection devices are included at the end of this report but will be described briefly in the following text.

Despite general natural tendancy of cod to stay close to the lower areas of a net, it was felt that any selection devices should incorporate some means of directing and holding the fish in the areas of the escape panels in order to improve the opportunities for release.

All panel sections were between 4 and 5m in length and constructed as complete units for insertion into the existing net configuration.

A relatively new material (new to the U.K.) known as 'glow netting' was used in the construction of some of the selection devices. This material produced by Nichimo Co. Ltd. of Japan is a polyethylene (PE) netting incorporating a luminous material thus making it more visible to fish in low light conditions.

Two selector panels were constructed:-

- the first used 110mm diamond mesh glow netting in the top sheet with 95mm square mesh standard netting in the lower sheet (Fig 1).

- the second used 90mm diamond mesh netting in the top sheet with 110mm square mesh glow netting in the lower sheet (Fig 2).

The aim was to determine the fish response to the luminous material. Would the fish be attracted or scared away by the luminescence.

The luminous 'glow netting' was also used for the construction of some of the 'deflector' strips described later.

In order to present the fish with a greater area of release in the lower half of the net, a panel section was constructed incorporating additional side panels constructed in square mesh netting (Fig 3).

This arrangement thus consisted of a square mesh lower sheet and side panels with standard diamond mesh above it.

As well as providing a greater area of release the additional netting in this section was expected to produce an area of modified water flow. The idea was that an area of reduced water flow would allow fish to swim more easily in this area and so have more time to react to the square mesh panels.

In an attempt to slow down the passage of fish through the extension on the way back to the codend and hold fish longer in the 'release areas', a number of arrangements were tried whereby strips of netting were attached to the top sheet in such a way as to hang down taking up an angled attitude to the direction of tow. The strips were weighted at the free edge by forming a row of meshes using leadline. To further enhance the effect the 'deflector strips' were constructed in 'glow netting' (Fig 4).

These 'deflector strips' were positioned so as to hang down above the square mesh panel and so help 'push' the fish closer to the release area.

Another device used to direct fish towards the release areas of these panels was a panel of netting, once again attached to the top sheet and sited above the square mesh panel in such a way as to effectively direct fish into the lower half of the net (Fig 5).

This triangular section of netting (termed a 'diverting panel') was attached with the apex attached to the centre of the top sheet (forward) and laced down on a bar to finish with the base edge meeting at the selvedge and so effectively splitting the net into two halves at that point, of which only the lower half of the net was accessible to fish over the length of the 'diverting panel'. In this way fish in this area of the extension would be pushed closer the square mesh panel.

As a further means of trying to direct fish towards the escape area and also hold them in this area for longer periods, the base edge of the 'diverting panel' was also rigged with a 'deflector strip' as previously described.

A similar 'diverting panel' arrangement as just described was constructed to be used in conjunction with all the other panel arrangements in a position just ahead of each of the other devices. It was hoped that this would serve to concentrate fish into the lower half of the extension just prior to them encountering the selector panels (Fig 6).

Another configuration to be examined was a full square mesh extension with a standard diamond mesh codend. This arrangement has been evaluated on other trials with varying degrees of success. It was decided to carry out further observations and evaluations of it's suitability in this context (Fig 7).

4 TRIALS NARRATIVE AND OBSERVATIONS

All gear and equipment was transported to North Shields on the weekend of 4th-5th May 1991.

The RCTV and camera equipment were set-up ready for the commencement of trials on Monday 6th July.

CONGENER sailed from North Shields for local grounds in order to test the equipment and familiarise the crew with the hauling and shooting routine for the RCTV.

After deploying the vehicle and establishing a safe working routine the vessel returned to North Shields to iron out some minor 'teething' problems.

7th May

Trials commenced on Tuesday 7th May. It was decided to spend some time on local inshore grounds prior to moving off to the more distant Dogger Bank areas.

The fishing gear used for these trials was a hard ground hopper/bobbin trawl supplied by Jim Robertson Nets, North Shields. The net was rigged with 30 fathom split bridles and spread by 8ft 6in 'V' doors.

For the first shot a square mesh panel rigged with a 'diverting panel' was tested. This was positioned between the tapered extension and the codend (Fig 8).

The first fish encountered were cod and codlings but only in small quantities. Nearly all the fish were above MLS of 35cm. Observations were made difficult by poor visibility. The water was "thick" due to a prolonged spell of northerly winds and the resultant swell just prior to the trials commencing. The larger cod were observed swimming effortlessly in the area of the square mesh panel and often seen lying stationary "hitching a ride" by passing a pectoral fin through the meshes of the lower sheet.

Towing speeds were varied to observe effect on the fish within the extension. The larger fish appeared to be able to cope easily with any increase in towing speed with little or no effort. No escape attempts were observed by any of the large cod but some small fish were observed passing out through the lower square panel. These were difficult to identify due to the poor visibility. Fishing took place in 30-33 fathoms.

After hauling the vessel steamed for grounds on the Dogger Bank in the area of the Southernmost Rough.

8th May

On Wednesday 8th May fishing commenced in 17 fathoms in moderate to good water visibility.

Problems were encountered with the buoyancy of the towed vehicle which took one or two hauls to correct.

Using the same panel arrangement as the previous day, observation and filming commenced on tow 3. The improved water clarity and visibility meant that filming could take place without camera lights.

Very few fish were encountered apart from quantities of sandeels which passed down through the gear and out through the codend. Very few were observed escaping through the lower square mesh panel despite the large mesh openings. Some were observed passing out through the relatively tightly closed top sheet meshes in the extension.

The few cod or codlings that were seen in the net showed very limited responses to the square mesh panels. However the 'diverting panel' did appear to be achieving the desired effect of directing fish to the lower sheet.

For the next tow the diverting panel was moved to a position just forward of the lifting becket, i.e. closer to the codend (Fig 9). The panel change was carried out as the vessel steamed a short distance to the west to try a new area of ground in an attempt to find greater concentrations of codlings.

Once again very few fish were encountered. Most areas appeared to be holding concentrations of sandeels but no white fish. Another change of ground was made this time to an area of the Dogger Bank known at the 'South West Patch'.

Problems arose early in this third tow. A twist in the codend at the area of the square mesh panel meant that the panel could not work effectively. The turn in the net meant that the square mesh section was lying for most part at the side of the net and at the aft end was actually on the topside of the net.

An increase in towing speed forced the twist further aft towards the codend and clear of the panel section.

Since a true picture of the panels performance could not be seen in this position, the opportunity was taken to use the camera vehicle to check the geometry of the gear.

The vehicle was hauled to the forward end of the gear and passed around the mouth and forward sections of the net to check the nets performance. The net was seen to be spread well with good bottom contact of ground gear. All appeared satisfactory.

By the time the vehicle had passed back to the area of the square mesh panel, quantities of pouting and whiting and a few codlings had entered the net.

With the half turn still in the net, pouting and whiting were observed passing out of the square mesh at the point where the twist had caused the square mesh panel to lie on the side and topside. No fish were observed passing out of the square mesh section in the position on the underside of the net. Similarly very few fish were seen to escape through the diamond meshes on the top sheet.

Some 'panic reactions' were observed from whiting and pouting as they came up against the constriction in the net caused by the half turn. However, the few cod/codling in amongst the other fish appeared to be undisturbed and unaffected by everything going on around them. None of the codlings showed signs of distress or any attempts at getting out through the panels and on a number of occasions cod were observed actively feeding on sandeels and other small fish as they swam steadily within the extension in the area of the square mesh panel.

A steady flow of sandeels were passing through the net for the duration of the tow. These were observed escaping through the top sheet of the net in most areas. At all stages the fish appeared to be nosing to the top sheet and showing a similar nosing action as observed with whitings and haddocks when passing down through the closed meshes of the extension.

Insufficient quantities of codlings were taken to justify continuing fishing in the area and so another change of ground was tried.

The next area to be fished was another patch of shoal water (17 fathoms) at the east edge of the 'North West Rough'.

9th May

Fishing commenced on this ground on Thursday 9th May. Once again water visibility was good.

Further adjustments to the buoyancy of the vehicle had to be made and also to the TV cable. On previous hauls some minor damage to the cable was sustained due to chafing on the seabed.

A shortage of fish prompted yet another move. During the change to a new area the panel configurations were changed.

The diverting panel arrangement was removed and replaced by a luminous square mesh panel situated in the top sheet attached directly to the arrangement incorporating a square mesh bottom panel and square mesh side panels (see Fig 10 for relative positioning).

The next tow took place on an area of ground at the south end of the 'Middle Rough'. The vehicle had to be hauled back and re-shot due to the cable fouling the net.

The camera vehicle was re-shot and passed down the length of the gear where it picked out the luminous section very easily. The glow netting showed up very clearly even in the clear water which was light due to fairly bright sunlight from above.

The only fish observed were whitings which were seen to pass out of the large luminous square meshes quite easily.

A telemetry failure caused by cable damage cut the tow short. A short steam to another tow in the same area allowed time for repairs to be carried out.

Using the same panel arrangements as the previous tow, the gear was shot again and the RCTV deployed only to be hauled straight back due to a foul TV cable. Once cleared it was re-shot and filming re-started.

There were still no signs of any numbers of codlings on the ground. The only fish encountered were small quantities of haddocks, whitings and pouting.

Despite the large open square meshes in the luminous square mesh panel (110mm) fewer whiting and haddock escapes were taking place than had been anticipated. This suggested that the 'glow' netting may be in fact scaring fish away.

The only cod encountered were all above the MLS. The shortage of suitable fish warranted yet another move. The vessel steamed to the west edge of the Rough in preparation for the following days work (Friday 10th May).

10th May

This ground was in deeper water from 30 fathoms shoaling to 22 fathoms. The very clear water meant that filming could take place without the use of camera lights.

Using the same panel arrangements some good film was taken of the side panel section showing the widening effect caused by the additional netting in the side panel although they were not opening to their full extent.

A few codlings were observed swimming in the area of the square mesh sections. The fish showed a tendency to try and stay within the area of the square mesh material. The fish appeared to be swimming easily and maintaining station with little or no effort. This was perhaps due to the easier flow conditions in this area.

One or two smaller codlings were seen lying against both the square mesh lower sheet and side panels but showed no signs of attempts at escape.

There were still insufficient numbers of codlings to observe reactions/response of groups of fish rather than those of one or two individuals.

For the next tow a square mesh panel lower sheet with 'diverting panel' above it was inserted into the net.

This arrangement appeared to have the desired effect of directing fish towards the lower sheet containing the square mesh panel. The 'deflector strip' showed up the passage of fish through this area of the extension and pushed fish towards the square mesh panel. However, the only fish encountered were haddock and whiting with some pouting occasionally entering the net. These fish showed little interest in passing out of the lower sheet of the net. The deflector strip with its weighted rear edge took up a position lying at an angle to the water flow and intermittently touched the lower sheet.

Although often seen in actual contact with fish in this area of the extension, the 'deflector strip' did not appear to invoke any additional 'panic' type reactions from the fish.

Another variation of the 'diverting panel/deflector strip' arrangement was used for the third tow of the day. This arrangement consisted of a diamond mesh extension section containing a 'diverting panel' situated forward of a section containing a square mesh lower sheet with two deflector strips hanging from the top diamond mesh sheet (Fig 12). The gear was shot in the same general area as the previous tow.

Some interesting observations were made of fish, mainly haddocks reacting to the 'deflector strips'. Their presence in the extension slowed up their journey back into the codend holding them in the 'escape area' for longer periods. Despite this response no further attempts at escape were noted.

Some codling and larger cod were also observed in the area of the 'deflector strips'. The fish were clearly aware of the strips but did not appear to be unduly worried by their presence. Although difficult to judge, it did appear that these strips were 'holding' the fish in this section of the net for longer than normal. On a number of occasions cod, ling and catfish were observed lying almost stationary against the square mesh panel directly under the 'deflector strips'.

The gear was hauled and some minor modifications were made to the panel arrangements in preparation for the next days filming.

11th May

Additional weight was added to the trailing edges of the 'deflector strips' in order to provide a better contact with the lower sheet in an attempt to hold fish in the area of the square mesh panel for longer. This would hopefully present them with a greater opportunity to pass out of the net.

Once again, no fish were encountered towing on the west edge of the rough (approximately 100 miles east by north of the Tyne) in 30 fathoms shoaling to 22 fathoms and excellent visibility.

Reports from other vessels in the area told the same story. There were very few fish anywhere.

Persevering with the same arrangement as the previous day, the additional weight added to the 'deflector strips' provided a better contact with the bottom sheet and the strips maintained a better attitude in the water flow. One or two larger cod were observed behind the second 'strip' but had showed little response to it.

The use of the 'diverting panels' and 'deflector strips' did demonstrate that fish could be manoeuvred and held with areas of the net by using these devices. Very few positive escape responses were observed by individual cod when presented with the square mesh in the lower half of the net. It must be emphasised, however, the cod were not observed in any large quantities and none were below MLS.

It may be that the fish recognise limitations with regard to the size of opening through which they can pass and consequently do not make any effort unless the opening is clearly sufficient.

Very small codlings may react in a different manner to the adult fish particularly if present in large groups or shoals.

Another change of tow was made, this time to a position on the north west edge of the Rough approximately 86 miles east by north of the Tyne in an attempt to locate codlings. The previous panel arrangement was replaced by a simple square mesh panel section (lower sheet) this time constructed from the luminous 'glow netting' (Fig 2).

This tow provided some good film demonstrating the highly visible nature of the luminous material in contrast with the standard PE netting. Unfortunately, apart from a few whitings, no fish were seen passing through the gear to assess any reactions to the panels.

A short move to the south allowed time to change the panel arrangement, this time replacing the luminous square mesh with a standard material square mesh with a luminous 'glow netting' top sheet above it.

The move did not improve the fishing situation and all that was gleaned from the filming of this tow was a further demonstration of the highly visible nature of the 'glow netting' material. This tow was in slightly deeper water - 34 fathoms - and was nearing the limit of operation for the TV system.

The geometry of the gear was checked once more prior to hauling. All appeared satisfactory.

In a further attempt to locate fish the vessel steamed to North East Bank for operations to continue there on Sunday 12th May.

12th May

Using the standard square mesh panel with luminous top sheet, some interesting film was made of whiting escapes through the lower square mesh panel. Due to tidal influences in this area, the codend was rolling more than usual, causing the square mesh panel to be 'canted' to one side. When the square mesh was rolled to lie on the side or topside of the gear, numerous whiting escapes were recorded. When the panel was in its lower side position there were no whiting escapes indicating that whiting will not escape from the lower sheet towards the seabed.

In a final attempt to locate quantities of codlings the vessel steamed to a position off Whitley Bay in the area around St. Mary Lighthouse. This is an area of harder ground.

For this exercise the panel arrangements were changed and replaced by the full square mesh extension with a small diamond mesh codend (Fig 7).

Fishing in approximately 25 fathoms of water, the visibility was not as good and some camera lighting was required.

Some relatively large quantities of whitings were encountered and showed typical nosing behaviour as they passed down the extension and out through the square mesh.

A few fish were observed but once again very little response or reaction was noted. Most of the fish were fairly large and swam effortlessly just ahead of the codend in the area of the square mesh extension.

When the gear was hauled, substantial damage had been caused to the net. The belly was 'out' and one of the lower wings was badly damaged. The codend was also damaged.

13th May

Both the net and the panel arrangements were changed.

The Rockhopper net was changed for a Stuart and Jackson seine/trawl and the panel configuration was changed back to that used on Saturday 11th May, i.e. the extension containing the diverting panel, attached to the lower square mesh panel with 'deflector strips' from the top sheet (Fig 12). For this tow the 'deflector strips' were loosely tied down to hold the angled attitude of the panel in order to push fish onto the bottom square mesh panel. This arrangement did not appear to improve the situation. Cod were observed swimming and maintaining station between the 'deflector strips' but there were still no further reactions to the square mesh panel. A few more cod were present on this ground but mainly too large for the requirements of the exercise. However, best advantage was taken of their presence.

As an experiment to demonstrate whether cod could be guided or diverted within the net, as required, a panel arrangment was rigged to direct the fish towards a square mesh panel fitted to the top sheet of the extension. This was achieved by reversing the square mesh panel and removing the 'deflector strip' that was attached to the free edge (Fig 13).

During the second tow in this same area a number of cod were observed being directed into the upper half of the extension by the 'diverting panel' where they remained and were observed nosing the top sheet square mesh panel: an interesting reaction and one which had not been seen on any other occasions during this exercise. The fish were seen trying to maintain their position near the top panel. These reactions would seem to warrant further investigation.

The gear was hauled for panel alterations in freshening weather conditions. Just prior to hauling, the geometry of the new net was checked using the RCTV. Once again, the gear appeared to be performing satisfactorily.

As the RCTV was being hauled the trawl became fast on the seabed. The RCTV was recovered but unfortunately the net was lost.

At this stage in the exercise, with one net severely damaged and the other lost and with freshening weather conditions, it was decided to terminate the trials.

After a number of unsuccessful attempts to retrieve the net the vessel returned to North Shields on 14th May where all gear and equipment was stripped down and off-loaded.

5 DISCUSSION

As a result of the CONGENER voyage, over 23 hours of video film was taken showing the full range of selection devices used in the trials.

Despite the ideal weather and water visibility conditions, the main aim of the exercise was not achieved. This was to establish the reactions and responses of codlings to the selection devices under examination in order to develop a suitable arrangement for release of undersize fish.

Some very interesting observations were made of cod/codling as individuals or in very small groups. Most of the fish ignored the opportunity or could not be deflected into making an escape through the square mesh panels.

The exercise did further demonstrate the effectiveness of the square mesh panel for other species like haddock and whiting and did serve to add further to the ideas behind the effectiveness of these panels. There was further evidence to suggest that the panel's effectiveness relies greatly on two factors, namely a light contrast effect and a modified water flow produced by the panel(s).

The panel arrangements used in the latter stages of the trials (with the square mesh 'window' in the top half of the net), showed that fish can be directed and moved within the extension area. The problem arises in actually inducing fish such as cod to pass out through the meshes.

The observations of cod and other species on numerous occasions continuing to feed within the extension, suggest that they are not under any high degree of stress or other pressure to escape. They appear to swim quite leisurely in the extension and codend showing little or no inclination to pass out through the meshes.

However, it would be unreasonable to suggest that any of the devices or configurations examined in this exercise should be completely discounted. The reactions/responses of individual and/or small groups of cod cannot be taken as completely representative of this species behaviour. It may be that very small cod at which these devices are aimed would react differently, particularly if encountered in large numbers or shoals. Until these devices can be evaluated and observed in the presence of large numbers of small codlings no conclusions should be drawn in that respect.

The underwater observations of the panel arrangements showed up a number of design faults and enabled minor alterations to be performed on the spot. This also allowed for any follow-up designs to be improved.

6 SUPPLEMENTARY TRIALS - FRV CLUPEA - MAY 1991

A second chance to observe some modified designs of the panel arrangements used in the CONGENER exercise arose when Seafish were invited to participate in a SOAFD, Marine Laboratory, exercise onboard their research vessel CLUPEA.

A ten day cruise was arranged at the end of May 1991. One of three main objectives of the exercise was again to observe square mesh 'windows' in diamond mesh codends designed to aid the escape of juvenile cod and other species and to measure the changes in water flow in codends due to the insertion of 'windows'.

As a result of the CONGENER observations it was thought worthwhile to further evaluate the use of two combined square mesh window arrangements fitted with 'diverting panels'. The aim was to try and demonstrate that by using a combination of square mesh panels in the topside and lower sheet, juvenile fish in a mixed species fishery could be released. It was hoped that species such as haddock and whiting could be selected through a topside panel while codlings could be released through the lower square mesh panel.

The flow pattern of water through an extension fitted with square mesh panels varies from that of a standard diamond mesh codend/extension. It was hoped that by using flow meters, this variation in water flow could be established and measured.

The modified panel design/configuration examined in the CLUPEA trial is shown in Fig 14.

It consisted of a forward section with a square mesh window in the topside rigged with a triangular shaped 'diverting panel' directing fish towards the top sheet square mesh. This was joined directly to another section with the same arrangement in reverse, i.e. the 'diverting panel' directs the fish towards the square mesh in the lower sheet. The free edge of the lower 'diverting panel' could also be rigged with a 'deflector strip' to enhance its performance.

Unfortunately, as in the CONGENER trials, very few fish were encountered and insufficient to satisfactorily evaluate the performance of the panel. However, initial observations with small haddocks and whitings looked promising. No codlings were encountered.

7 FURTHER ACTION

Considering that neither the CONGENER nor the CLUPEA trials provided any conclusive evidence as to the effectiveness of any of the panel or diverting arrangements in achieving the objective of releasing juvenile codlings, and that on neither occasion did any of the panels receive a full evaluation in the presence of juvenile cod, it is recommended that a similar exercise to the one carried out on the CONGENER be repeated. This new exercise must be assured good concentrations of small codlings in order that significant results can be gained. Only under these circumstances can it be established whether any of the panel configurations will be effective or not.

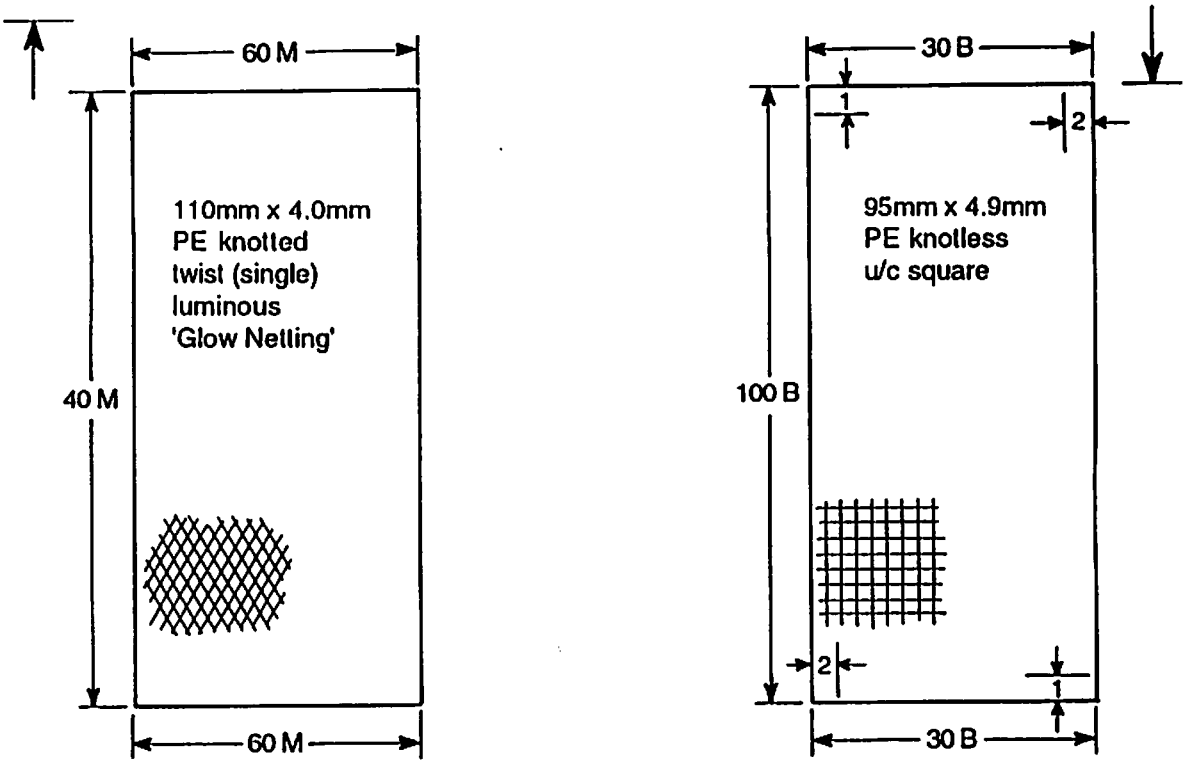
8 ACKNOWLEDGEMENTS

Seafish would like to thank Skipper Alan Morse and the crew of the fishing vessel CONGENER for the assistance and cooperation in carrying out this exercise. Thanks are also due to the skipper and crew of the SOAFD's FRV CLUPEA for their part in this work.

Seafish would also wish to acknowledge the cooperation of SOAFD Marine Laboratory, Aberdeen for the use of the RCTV. Special thanks to Messrs Jack Robertson, Peter Barkel and Bob Kynoch from the Marine Laboratory for their operation of the RCTV and TV camera equipment and their overall cooperation in both exercises.

Figs. 1-7
CONSTRUCTION
of PANELS

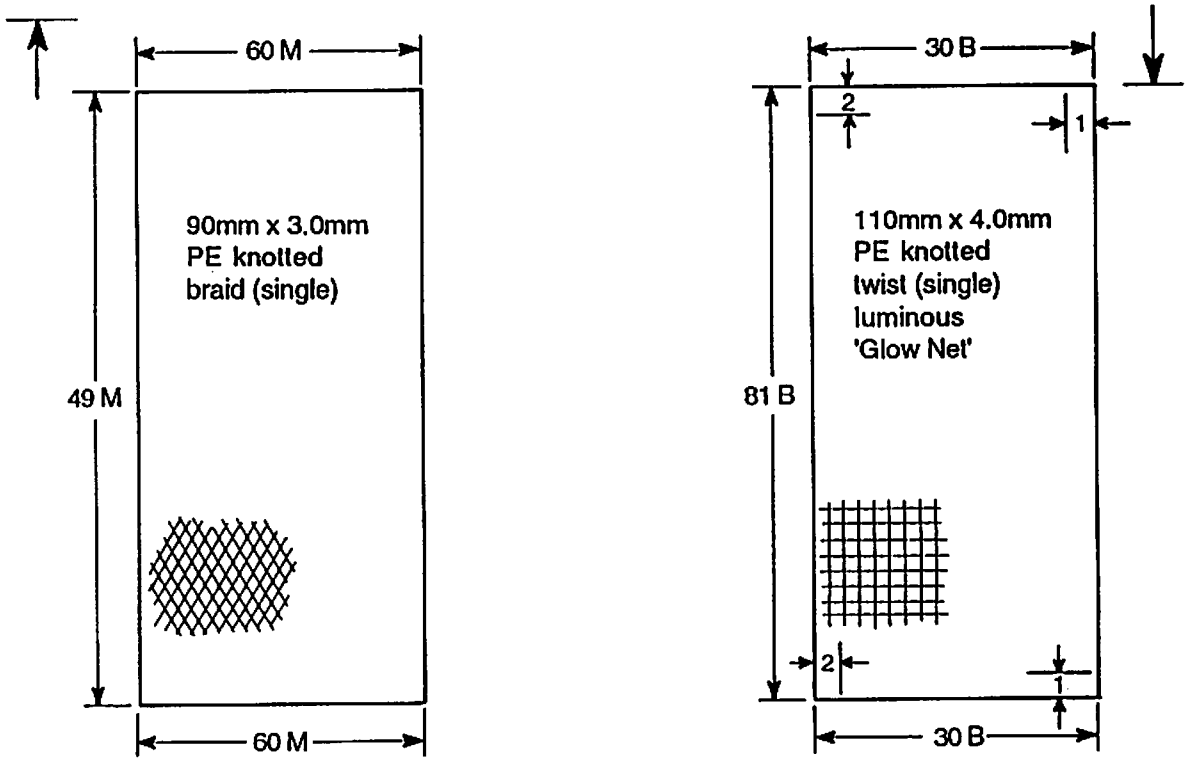
95mm square mesh panel *(lower sheet)*
with luminous 'Glow Netting' top sheet.



Notes: Luminous 'Glow Netting' used for construction of top sheet in square mesh panel arrangement.

Fig.1

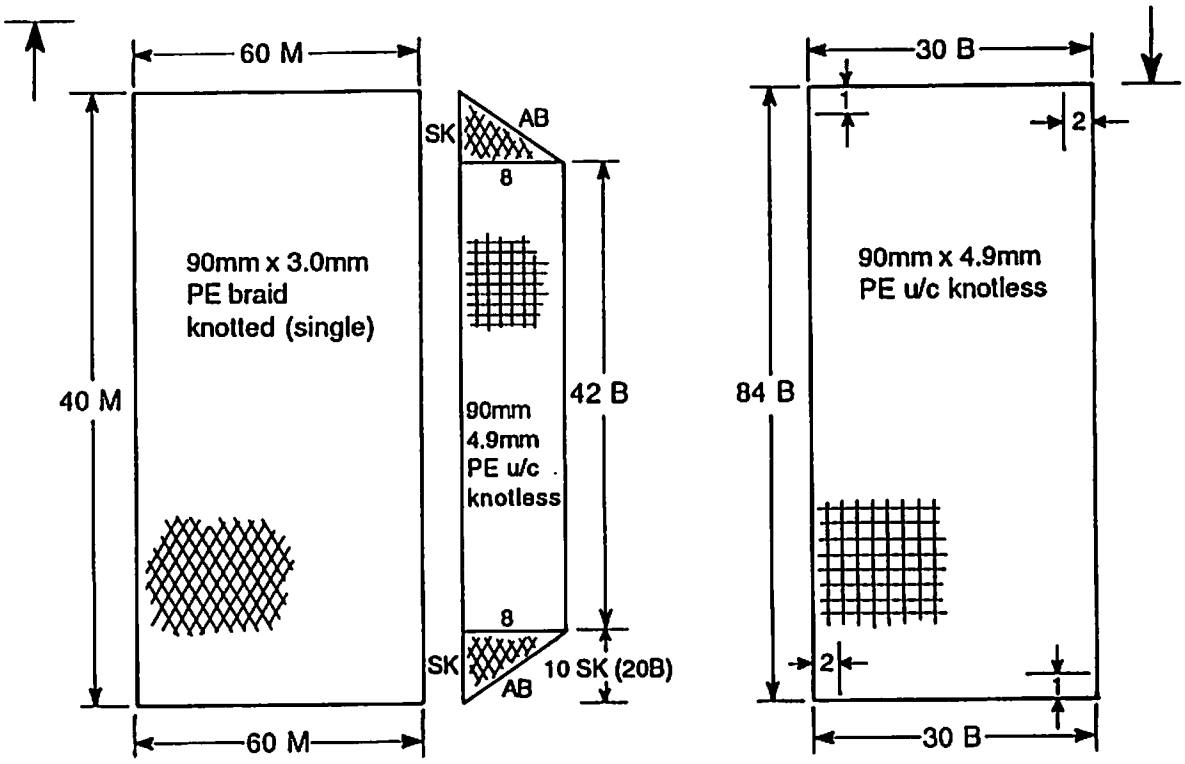
110mm luminous square mesh panel *(lower sheet)*.



Notes: Standard square mesh panel arrangement but constructed in luminous 'Glow Netting' - Lower Square mesh panel. Top sheet of standard PE braid.

Fig.2

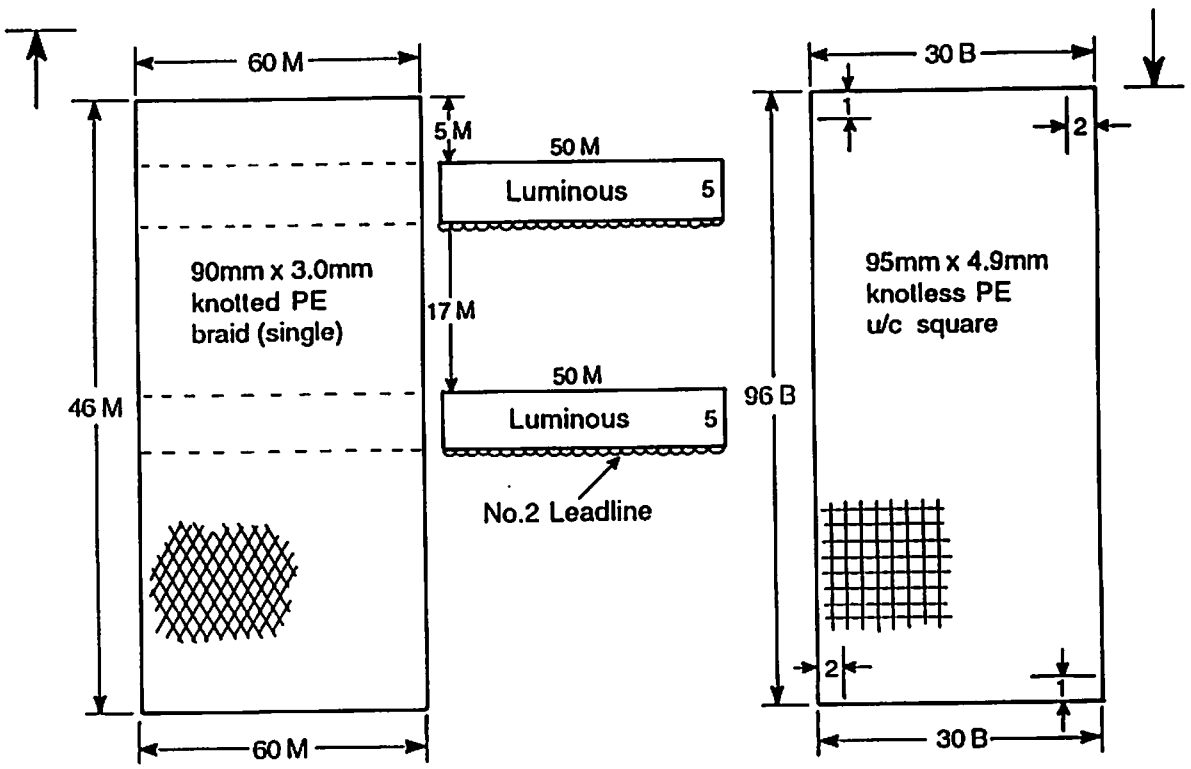
90mm square mesh panel arrangement
incorporating square mesh side panels.



Notes: Side panels rigged for adjustment from 8 bars deep to 10 bars deep by cutting away 2nd selvedge (white).

Fig.3

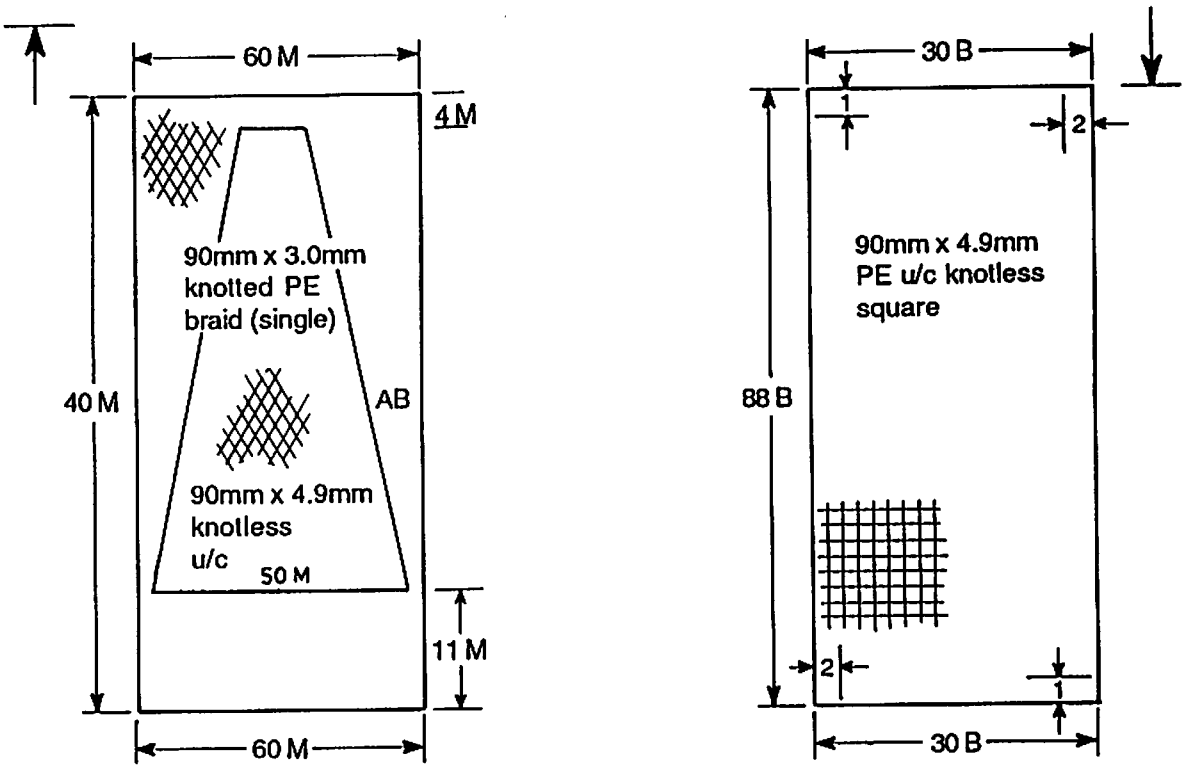
95mm square mesh panel *(lower sheet)*
fitted with "diverters".



Notes: Two 5 mesh deep 'Diverting' strips of luminous netting have been fitted to the top sheet above the square mesh panel. A row of leadline meshes in the lower edge will hopefully help the strip maintain the correct attitude with the intention of 'Pushing' fish towards the lower sheet and escape panel.

Fig.4

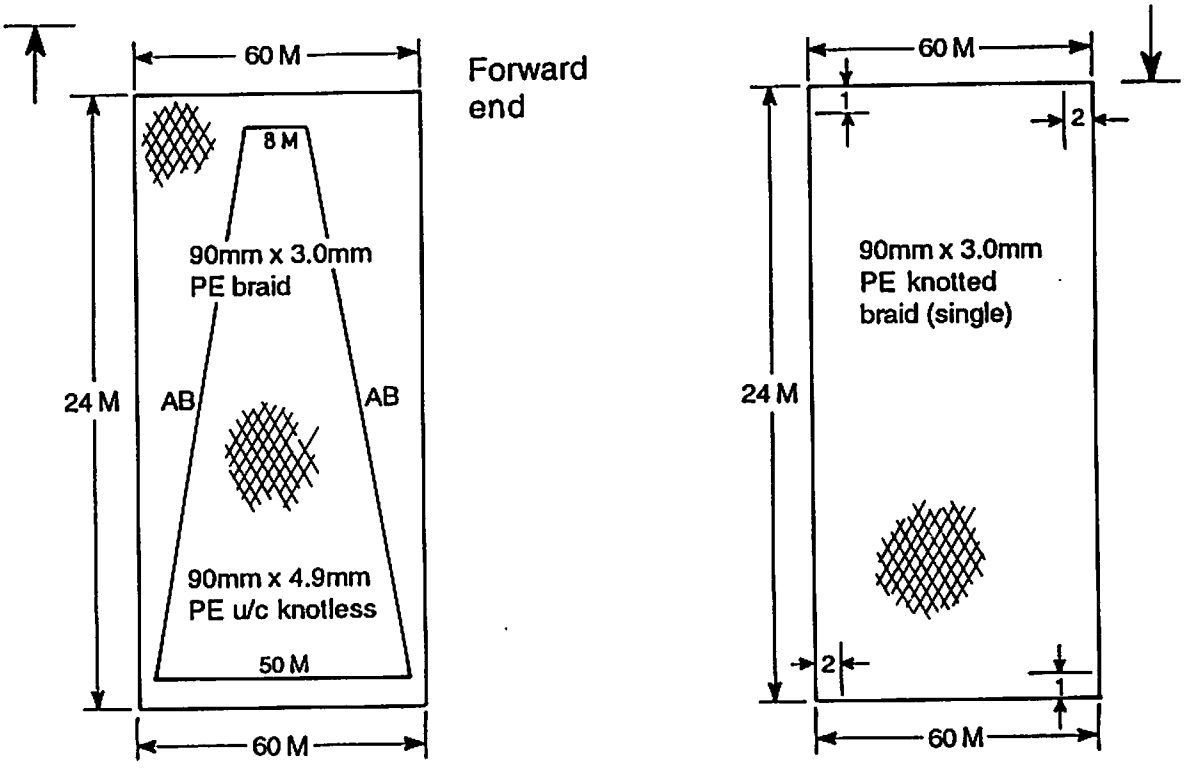
90mm square mesh panel *(lower sheet)*
with diverting panel fitted into top sheet.



Notes: Inside diverting panel arrangement laced on top sheet down AB edges to selvedges with aft edge open. Panel directs fish to lower half of net and escape panel.

Fig.5

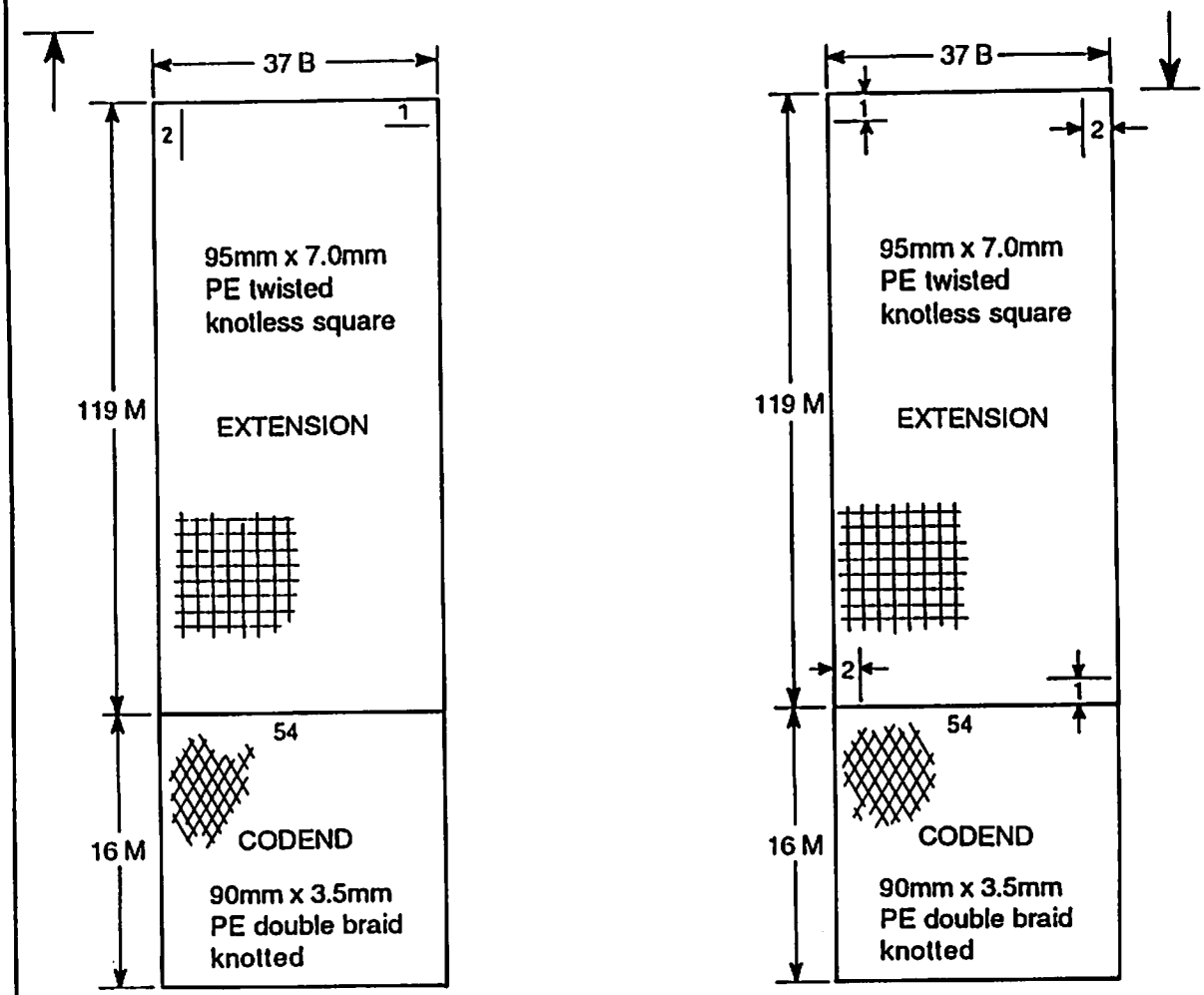
Extension fitted with diverting panel to be used in conjunction with other selection devices.



Notes: Diverting panel in knotless material laced to top sheet at leading edge and down all bar edges leaving aft end 'Flying'. This effictively splits the extentsion horizontally reducing the opening by half and so pushing fish into the lower half of the net.
Used in conjunction with other selector panels the aim is to direct fish towards escape areas.

Fig.6

95mm full square mesh extension
with 90mm diamond mesh codend.

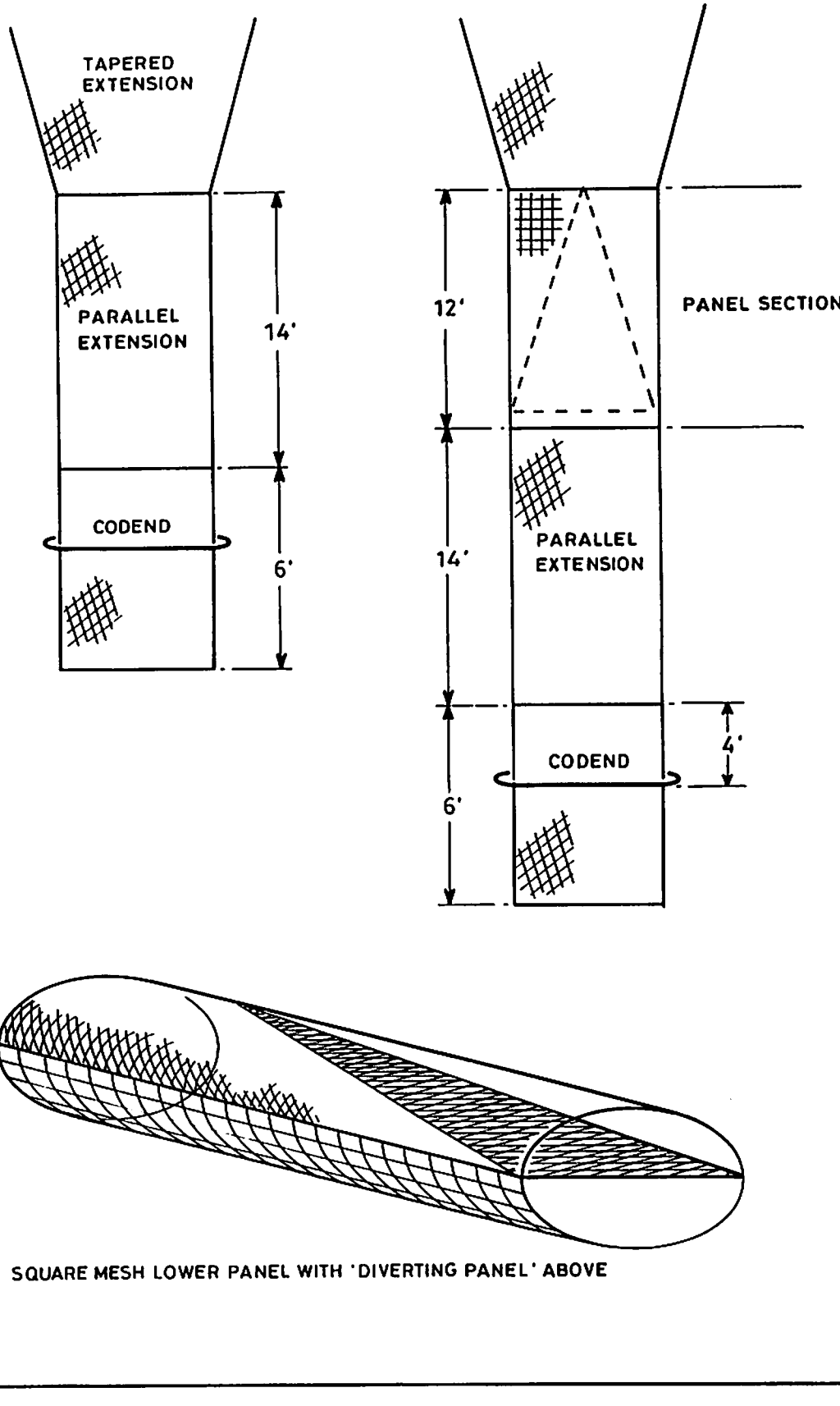


Notes: Extension / cod end arrangement as used on trials from Seahouses, Northumberland. MFV's 'Providence IV' and 'Radiant Way' (August 1989).

Fig.7

Figs. 8 - 13
CODEND and EXTENSION
ARRANGEMENTS
USED on TRIALS

Fig. 14
CODEND ARRANGEMENT
'CLUPEA'



SQUARE MESH LOWER PANEL WITH 'DIVERTING PANEL' ABOVE

Fig. 8

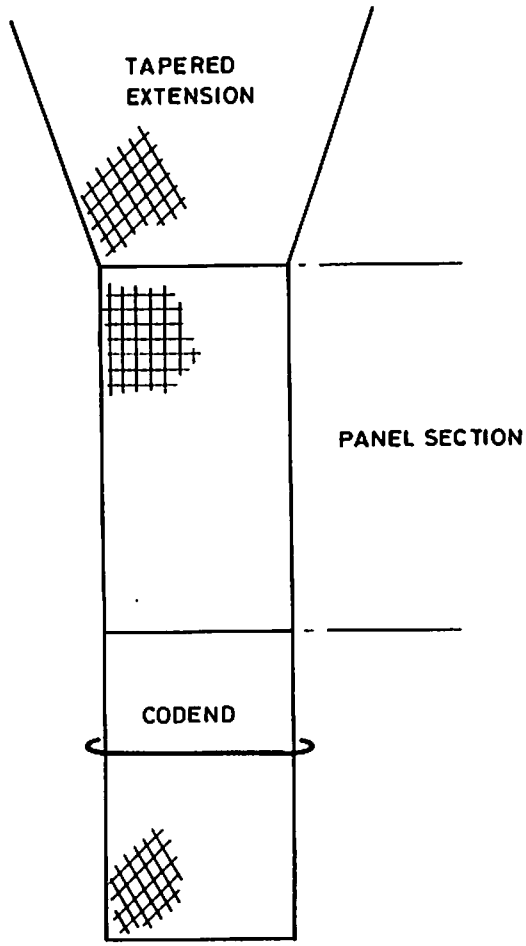


Fig.9

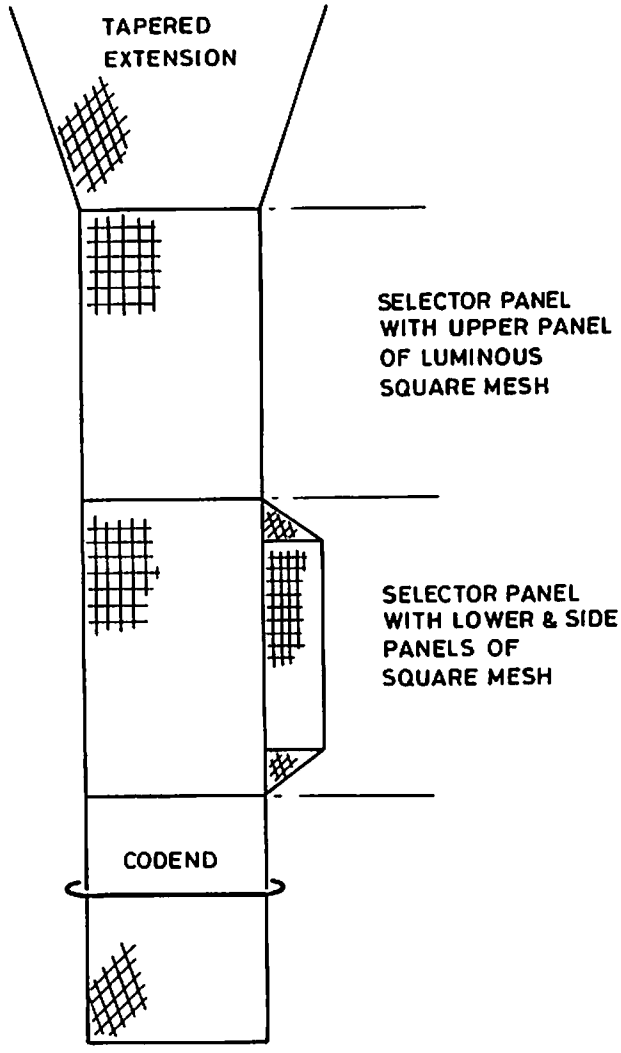
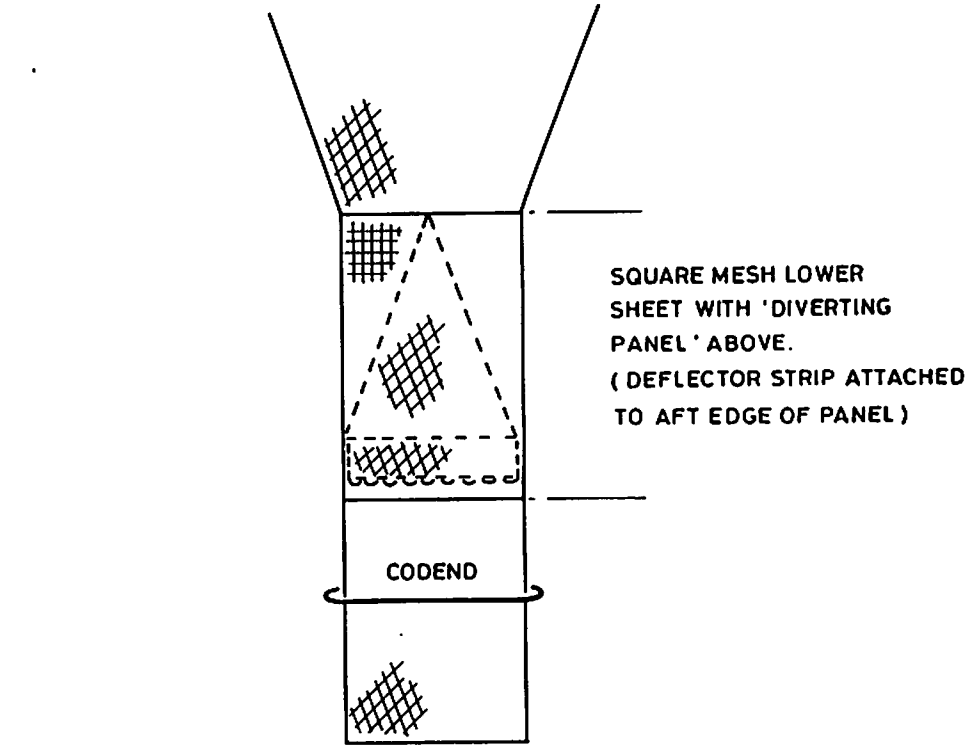

TAPERED
EXTENSION
SELECTOR PANEL
WITH UPPER PANEL
OF LUMINOUS
SQUARE MESH
SELECTOR PANEL
WITH LOWER & SIDE
PANELS OF
SQUARE MESH
CODEND

Fig.10


SQUARE MESH LOWER
SHEET WITH 'DIVERTING
PANEL' ABOVE.
(DEFLECTOR STRIP ATTACHED
TO AFT EDGE OF PANEL)
CODEND

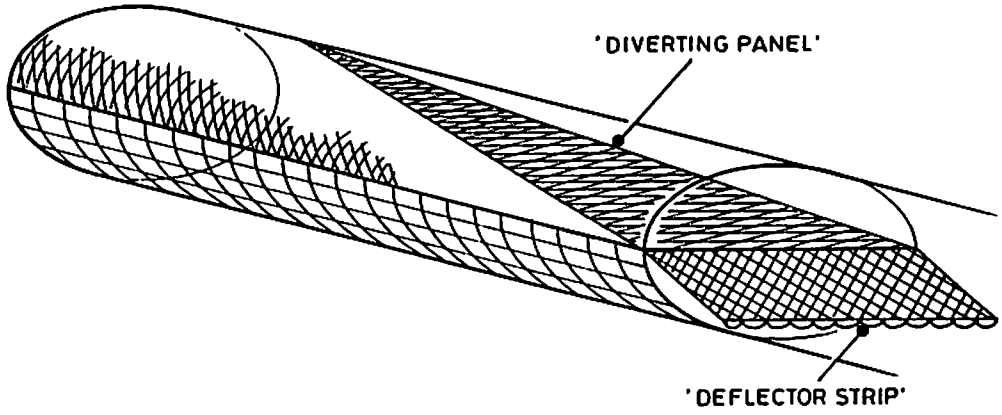

'DIVERTING PANEL'
'DEFLECTOR STRIP'

Fig.11

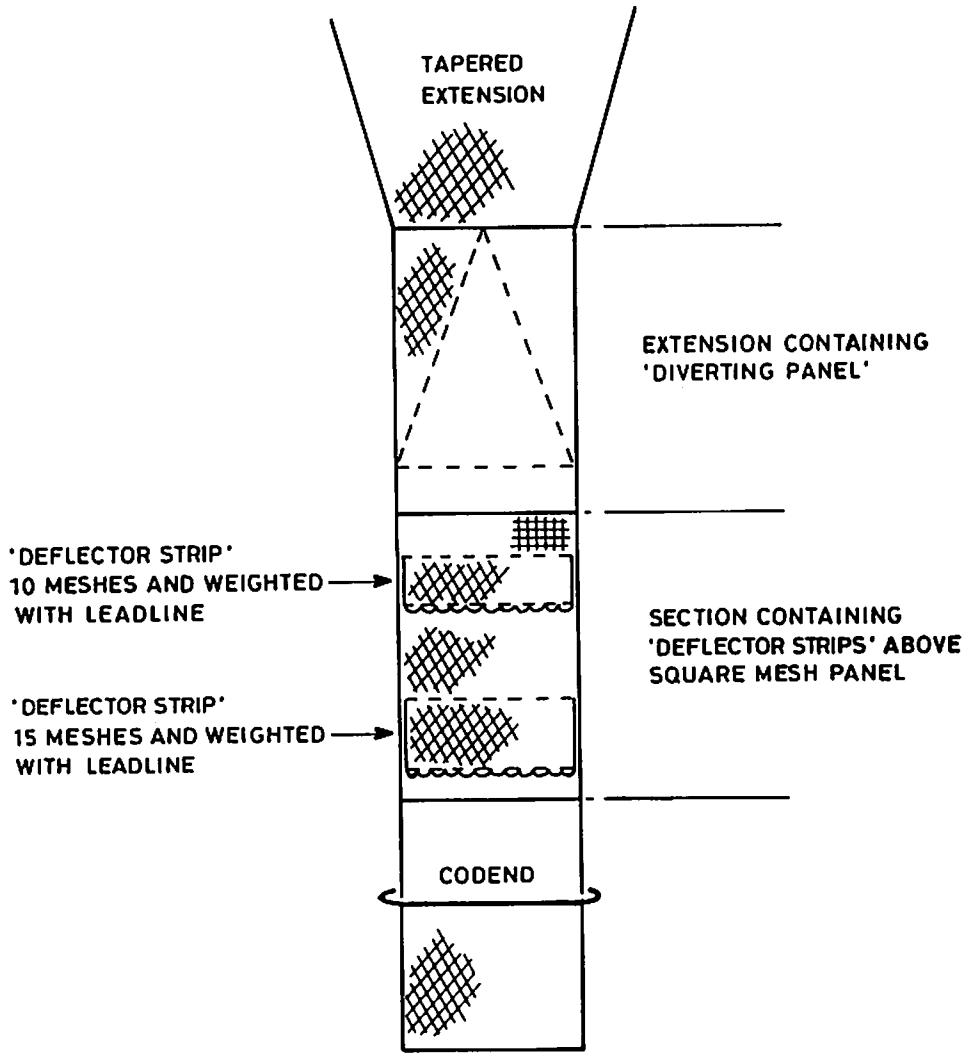

TAPERED
EXTENSION
EXTENSION CONTAINING
'DIVERTING PANEL'
'DEFLECTOR STRIP'
10 MESHES AND WEIGHTED
WITH LEADLINE
SECTION CONTAINING
'DEFLECTOR STRIPS' ABOVE
SQUARE MESH PANEL
'DEFLECTOR STRIP'
15 MESHES AND WEIGHTED
WITH LEADLINE
CODEND

Fig.12

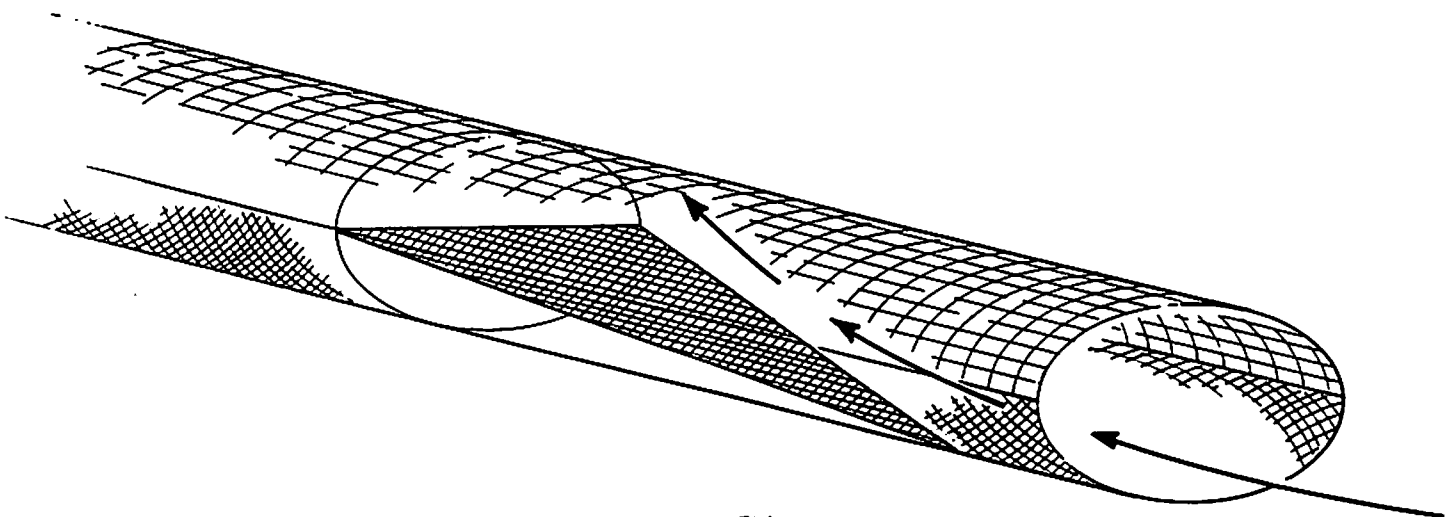
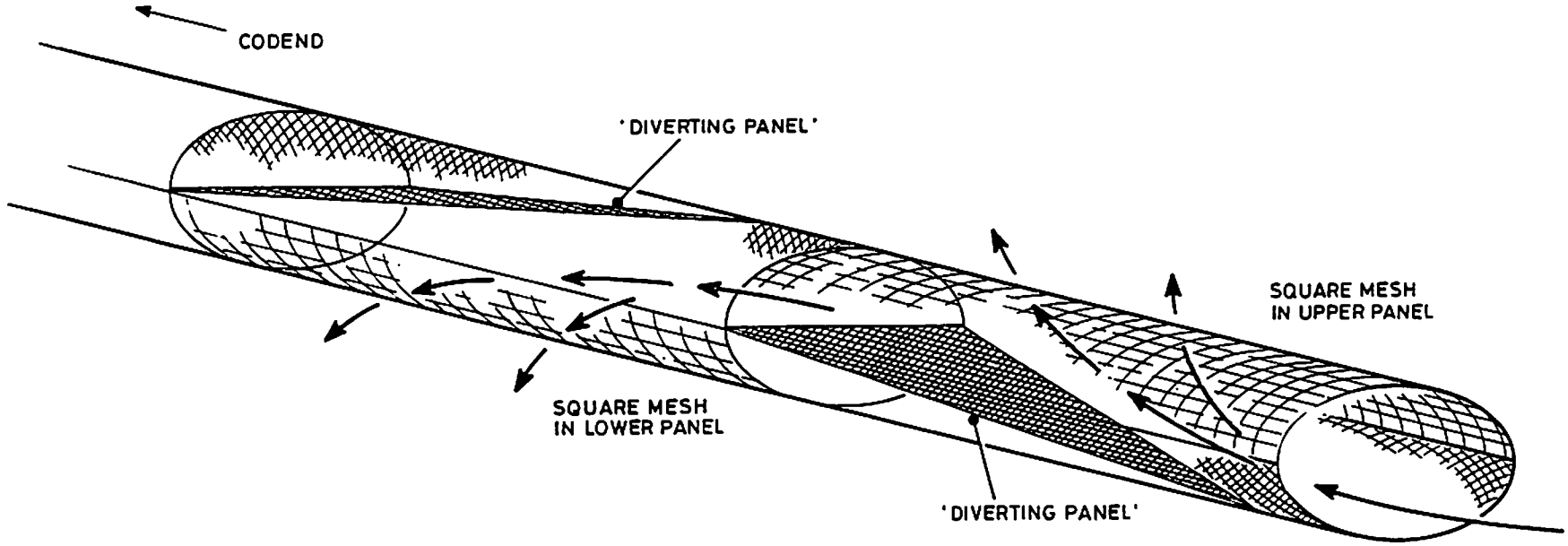

'DIVERTING PANEL'
REVERSED TO PUSH FISH
TOWARDS SQUARE MESH
IN TOP SHEET.

Fig.13



COMBINATION OF TWO SQUARE MESH 'WINDOWS'
WITH 'DIVERTING PANELS'

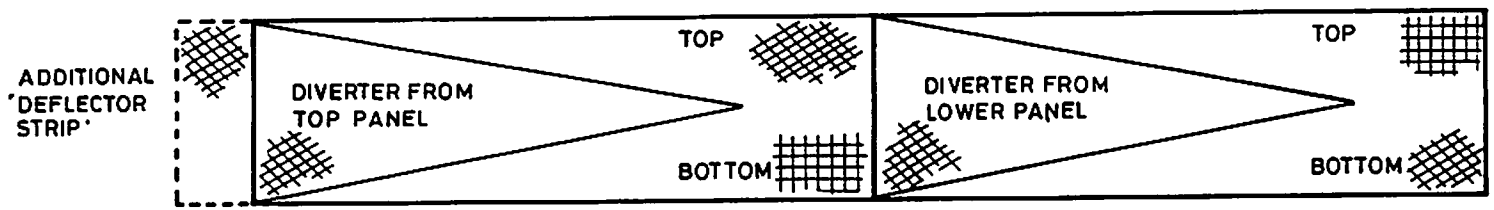


Fig.14