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The Lowestoft Frame Trawl

P. WALKER and I. L. DAVIES

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## 1. Introduction

In 1976, staff of the MAFF Fisheries Laboratory Lowestoft planned a number of new investigations into the distribution of young fishes in mid-water. Prior to this, three main samplers had been used to capture small pelagic fishes: the International Young Gadoid Pelagic Trawl, the Isaacs Kidd Trawl and the Boothbay Net. All three were found to be unwieldy and their operation close to the bottom proved to be impractical due to the high risk of loss or damage. Futhermore, use of the International Young Gadoid Pelagic Trawl required a large deck crew which prevented it from being used around the clock on the Ministry's research vessels.

To overcome these problems, a specification was drawn up for a new sampler embodying the following features:

(1) small size for ease of handling;
(2) fixed mouth opening permitting quantitative sampling;
(3) the ability to fish on or close to the sea bed;
(4) high-speed operation to reduce avoidance;
(5) known operating depth.

The main use for the new sampler was to be the determination of the distribution of pelagic and demersal 0-group and demersal 1-group gadoids. It was envisaged that all post-larval stages could be captured using the same basic sampler fitted with nets of varying mesh sizes. In addition, the sampler would be used in studies of pelagic fishes in inshore nursery areas.

In producing the final design for the new sampler, which became known as the Lowestoft Frame Trawl, requirements of several groups of investigators were taken into account. Two versions of the sampler were built to the basic design, having mouth openings of 1 $m^2$ for small boat use and 2 $m^2$ for use with vessels over 20 m.

The 2 $m^2$ trawl is described fully in this report. Appendix 1 gives details of the smaller version.

## 2. Design principles

The trawl was designed to encompass the following requirements:

1. the ability to sample during descent and ascent;
2. the capacity to use a single warp and twin bridles;
3. the mouth to be a rigid square frame;
4. the capability of fishing with mouth frame vertical;
5. the bottom of frame and lower edge of net to be rigged for safe bottom contact;
6. the net to be a four-panel design of small mesh material with a large mesh protective cover;
7. the capability of using a conductor cable and slip ring winch for the purpose of carrying a transducer and other instrumentation.

## 3. Construction

*The frame:* The trawl frame (Figure 1) is fabricated from welded steel tubing and plate, finished by hot dip galvanising. Tube of 32 mm outside diameter is used throughout. The shoes and lower towing points are 6.5 mm thick steel plate. Figure 2a is a scaled down, working drawing of the frame.

The shoes are welded to the leading edge and underside of the frame so that if it hits the sea bed they will take the impact.

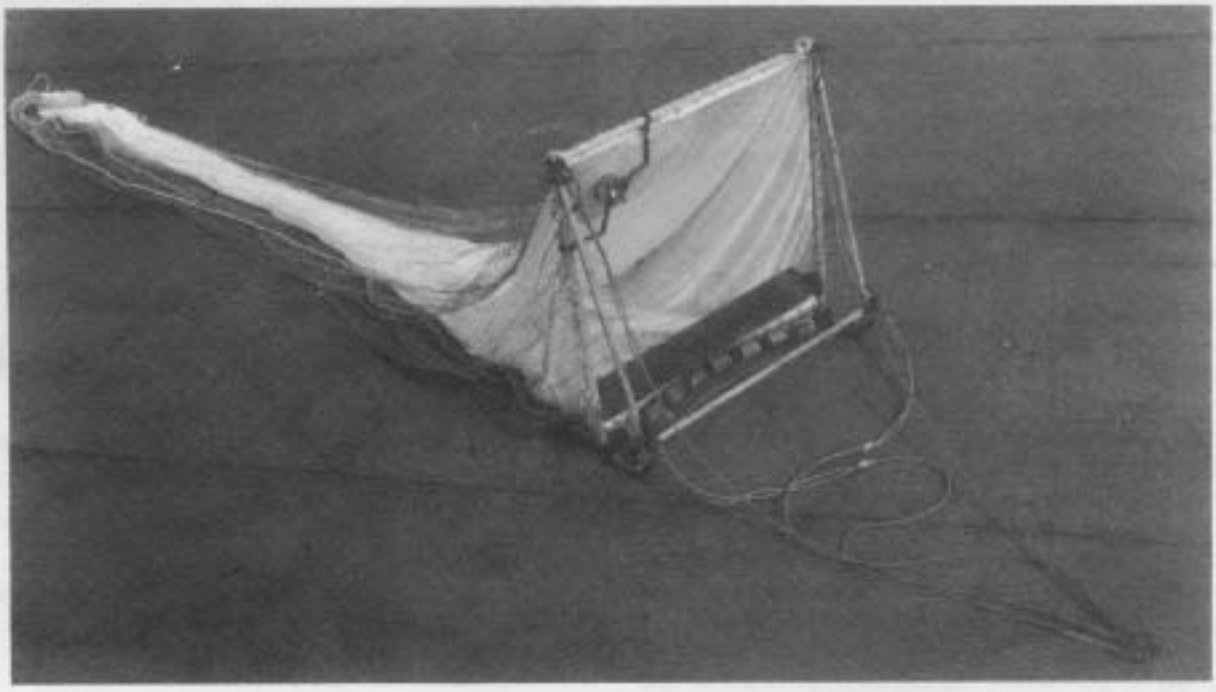

**Figure 1** The 2 $m^2$ frame trawl.

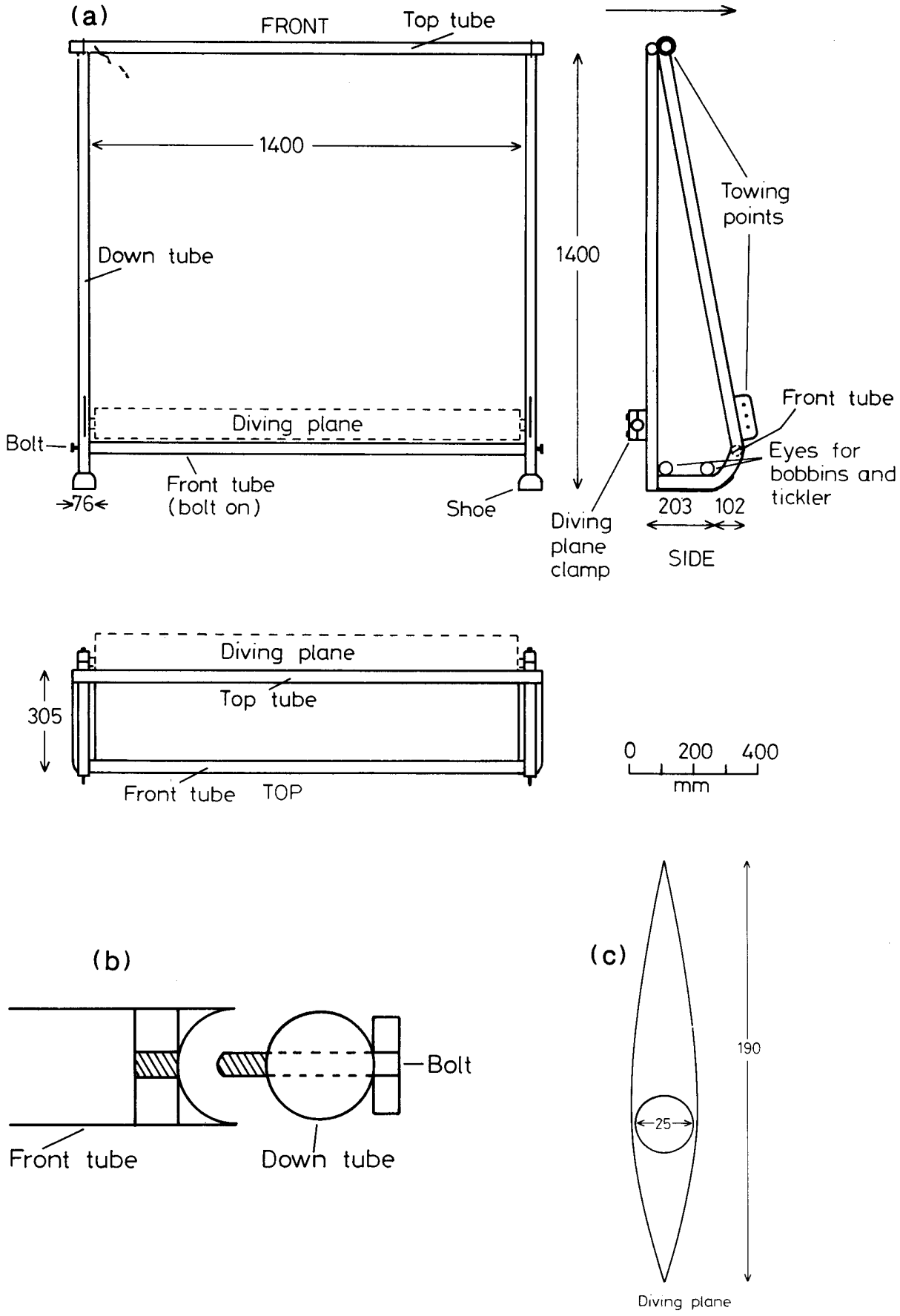


**Figure 2** Constructional details of the frame of the 2 $m^2$ frame trawl: (a) the frame; (b) attachment of the front tube; (c) end view of the diving plane (dimensions in mm).

They also act as runners when towing along the sea bed. The top horizontal tube is welded to the vertical side tubes, unlike the bottom horizontal, front tube, which is bolted to the main part of the frame (Figure 2b) and is raised above ground level to reduce the chance of accidental damage. If damage should occur it is easily replaced.

The diving plane is formed from sheet steel, 2 mm thick, bent over and welded to a 25 mm diameter, steel axle bar. The ends of the plane are sealed by a shaped piece of plate (Figure 2c) and the axle bar is held by a clamp on each of the rear vertical tubes.

*The net:* The net is made from four identical panels of 'Fryma' fabric L4238 (Figure 3), sewn together along the selvedges with a canvas collar forming the mouth. (L4238, a polypropylene, knotless netting with 5 mm stretched mesh, may be obtained from Fryma Fabrics Ltd., Fryma House, Denison Street, Nottingham NE7 3PJ, UK.). Figure 4 gives the dimensions of the panels with no allowance for the seams.

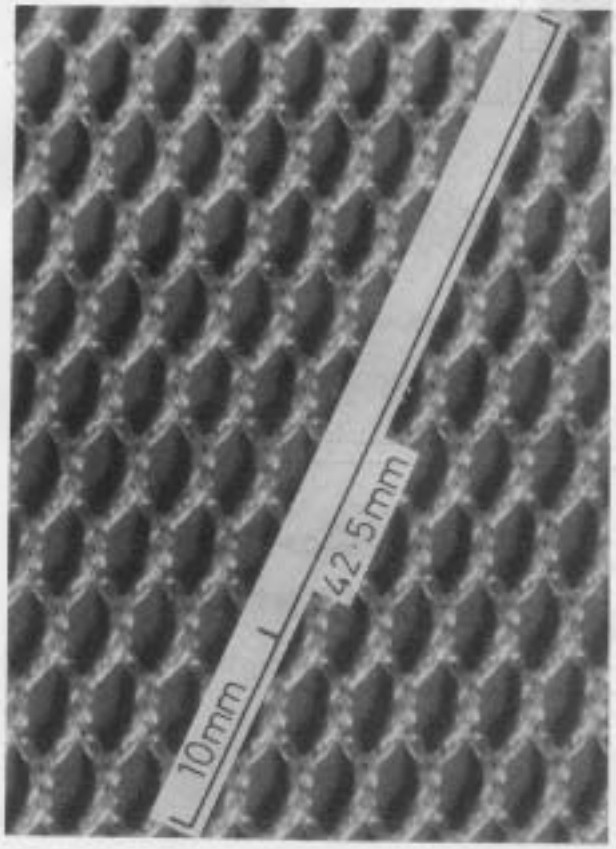


**Figure 3** A sample of 'Fryma' fabric L4238.

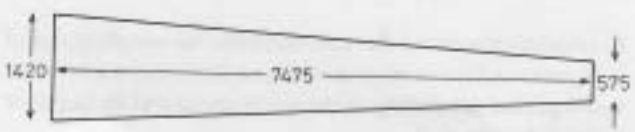


**Figure 4** Cutting diagram for the 'Fryma' net of the 2 m² frame trawl (dimensions in mm). (Note: no allowance is made for seams).

A 100 mm wide strip of No 2 Duck canvas is folded in two to form the collar. Fifty-six No 2 brass eyelets with 100 mm between centres are inserted into the collar. Through these the top and sides of the collar are laced directly onto the frame and a ground chain (38 mm link) is laced to the bottom of the collar. The cod end is closed by bunching it together and tying it round with a nylon line.

The 'Fryma' net is supported and protected by an outer, four-panel net of 70 mm mesh polypropylene netting roped with 'Spunstron' rope. This outer net is cut to such dimensions as will support the cod end of the 'Fryma' net. Its cod end is closed by a cod end line.

*The bobbins and tickler chain:* To enable the trawl to be fished on the sea bed it is fitted with a tickler chain attached to the forward eyes at the foot of the frame. A wire footrope with wooden bobbins and rubber discs is shackled to the rear eyes at the foot of the frame and seized to the ground chain at the bottom of the collar (Figure 5). The trawl may be used on sandy bottoms to take bottom living species and may also be operated very close to the bottom on rough ground. Figure 6 shows the spacings of the tickler chain and footrope behind the front tube of the trawl frame.

*The bridles:* 32 mm circumference wire is used for the towing bridles. The lengths of the top and bottom pairs are 6100 mm and 5950 mm respectively. Each bridle has a soft eye at one end and a loop secured by two 'Bulldog' grips at the other. These grips enable the bridle lengths to be adjusted to suit the towing position of the vessel.

*The flowmeter:* A 'TSK' flowmeter (Catalogue No 501) is mounted on flat, steel brackets in the top left-hand corner of the frame (Figure 1). The analogue revolutions indicator supplied with the instrument has been removed and replaced by a digital counter unit. Two stops on the instrument prevent the blades turning in the wind.

*Overall weight:* The total weight of the frame, net, bridles, bobbins and tickler chain is 66 kg.

## 4. Operation

The frame trawl is normally towed from a boom on the stern of vessels equipped with a slip-ring winch and armoured conducting towing cable. Power from the vessel's electrical supply passes down the cable to a depth/temperature sensor attached to the front of the rear vertical side tube of the trawl frame. Data from the sensors passes up the cable to a conning position where it is displayed on a chart recorder (Figure 7). Three men are required to operate the frame trawl: two members of the vessel's crew control the winch and handle the trawl in and out over the stern while a scientist observes the depth record and an echo-sounder. The trawl is shot by raising the frame off the deck with the winch and the cod end is thrown into the sea. Drag on the cod end pulls out the net and this in turn pulls the frame away from the vessel. The tow is made by slowly paying out the cable with power on the winch so that the trawl fishes an oblique path down through the water column.

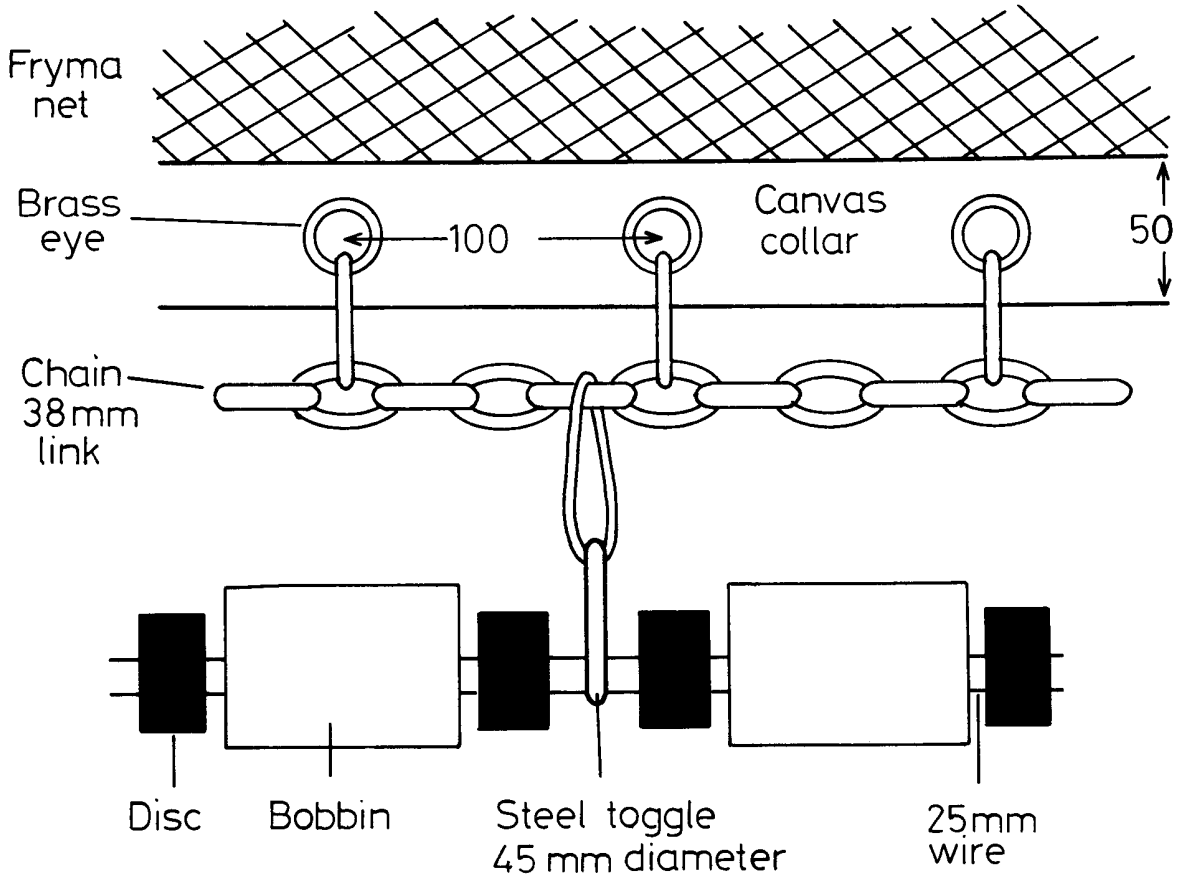


**Figure 5** Method of rigging the ground chain and bobbin rig to the Fryma' net (dimensions in mm).

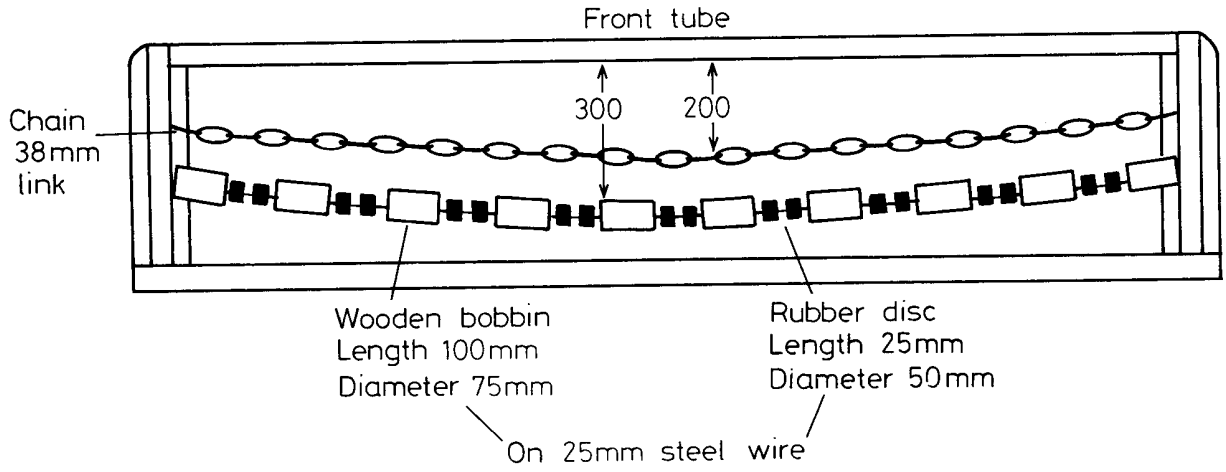


**Figure 6** Separation of the tickler chain and bobbin rig (dimensions in mm).

The position of the trawl in the water is monitored by comparing the readings of the depth gauge and echo-sounder. Hauling commences immediately the trawl has reached the bottom or the desired maximum operating depth. During the hauling phase, the trawl fishes a further oblique path up through the water column.

Experience has shown that a minimum useful sampling period is 20 minutes. One or more descents and ascents may be made in this period depending on the winch speed and the depth of water to be sampled.

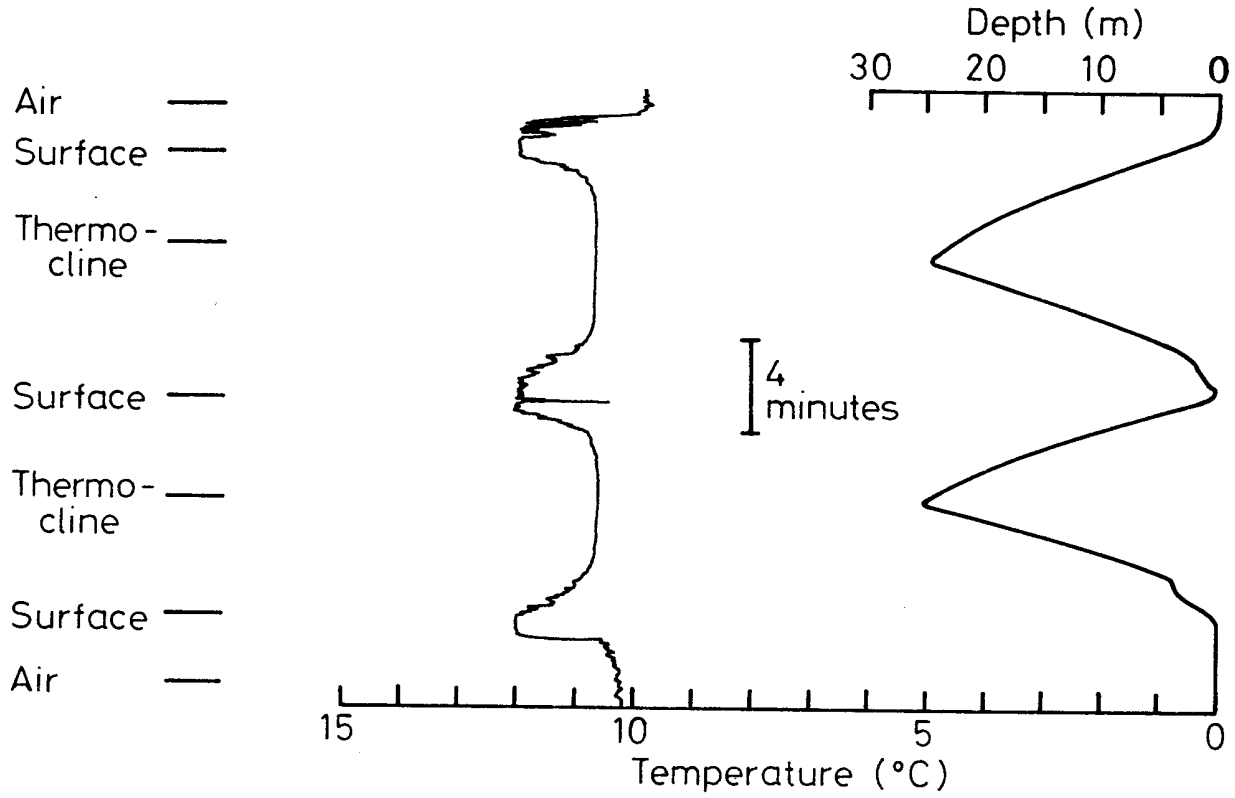


**Figure 7** A portion of the recorder chart showing temperature and dive profiles obtained with the 2 $m^2$ frame trawl at station 68, RV CLIONE Cruise 8, 18 June 1981.

Samples are collected with the vessel steaming at 3 knots. The rates of descent or ascent themselves may differ, although to obtain uniform sampling throughout the water column the rate of descent or ascent during any one phase of sampling must be constant. On the Ministry's research vessels, cable is paid out from the winch at speeds in the range of 10—40 m $min^{-1}$ and hauled in the range of 10—20 m $min^{-1}$. At these rates, as long as the winch pays out and hauls at constant speeds, a symmetrical sampling profile is obtained (Figure 7). At the end of the sampling period, the trawl is hauled from the water and into the air above deck level. The frame swings in towards the vessel's stern and the net is hauled in by hand. Finally, the frame is lowered to the deck.

To permit operation from vessels without slip-ring winches, a battery-powered depth sensor has been developed. This system employs an electric cable in addition to the non-conducting towing warp, so a fourth man is required to control the winch for the electric cable.

## 5. Diving characteristics

The trials described below were conducted in calm weather, but changes in performance have been found to occur in less favourable conditions.

### 5.1 Warp/depth ratio

Trials were made from the Research Vessel CLIONE (LOA 42.7 m, 960 bhp) steaming at 4 knots and with the diving plane set at an angle of 30°. The towing cable was released slowly from the winch until the depth sensor indicated that the trawl was steady at a depth of 10 m. The amount of cable paid out was noted from the winch warp meter. More cable was released until a steady reading was obtained at 20 m. The procedure was repeated at 10 m intervals until a depth of 80 m was reached. A similar procedure was followed as the net was hauled back to the surface. Figure 8 shows that the ratio of cable released to depth attained at 4 knots was about 6:1.

### 5.2 Diving plane angle

Tests were conducted to determine the optimum diving plane angle, using the Research Vessel CORELLA (LOA 40.5 m, 1060 bhp) steaming at 3 knots. The diving plane was set at an angle of 30° below the horizonal and cable released from the winch until the trawl had descended to an indicated depth of 25 m. The winch warp meter reading was noted and the trawl hauled. Using the same amount of warp as on the first descent, the trial was repeated with the diving plane set at 10° increments from 10° to 60°. The results obtained are shown in Figure 9. As a result of this trial the setting of the diving plane angle for surveys was standardised at 30°.

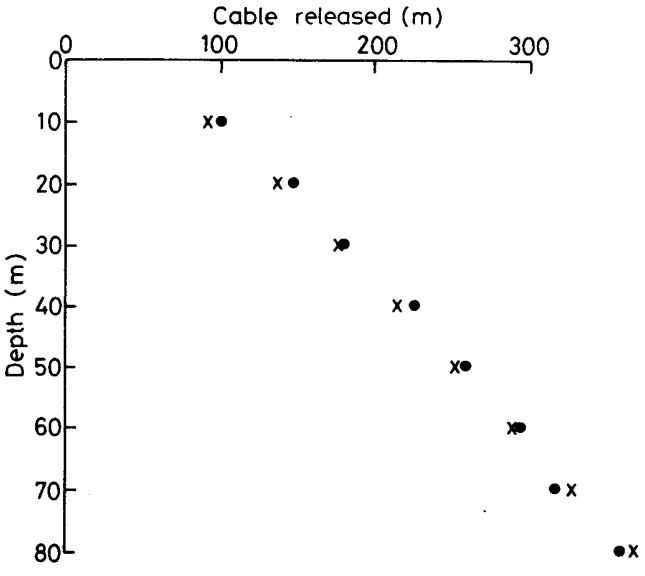


**Figure 8** Relation of the cable released to the depth attained at 4 knots with the 2 $m^2$ frame trawl.

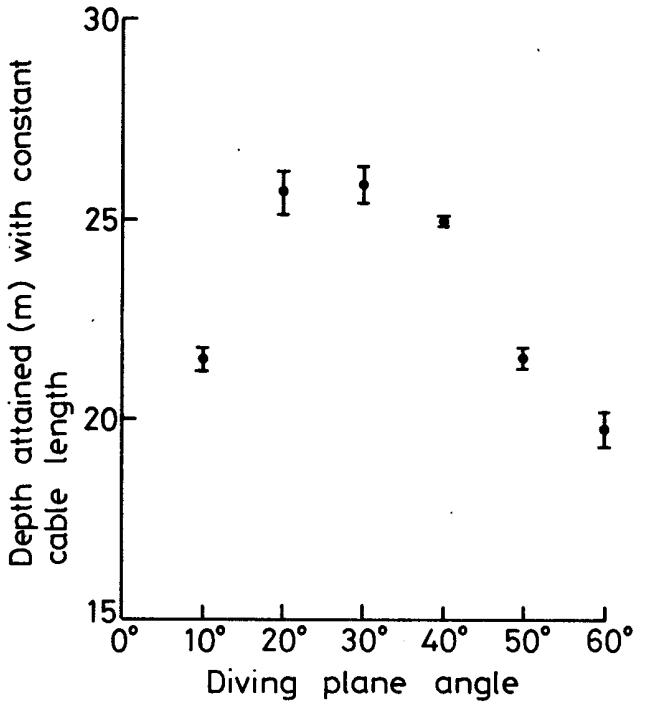


**Figure 9** Effect of varying the diving plane angle at a constant cable length and with a constant speed of 3 knots.

### 6. The frame trawl in use

The 2 $m^2$ frame trawl has been used successfully from RVs CLIONE and CORELLA. In early trials a towing speed of 4 knots was used but this was reduced to 3 knots following winch damage.

The frame trawl is calibrated to obtain a relationship between flowmeter revolutions and the volume of water filtered by the net. As the ratio of netting open area to mouth area is in excess of 6.5:1 it can be assumed that all water offered to the net is filtered (Tranter and Smith, 1968). With the vessel steaming at a known steady speed and at right angles to the wind, three replicate tows are made with the net in the free flow condition, having the cod end open.

On each calibration tow the flowmeter counter reading is noted and the frame trawl is then lowered into the water. As soon as the flowmeter blades begin to turn a timer is started. The trawl is lowered to a depth of 10 m and towed for 10 min. On hauling, the timer is stopped when the flowmeter blades stop turning. The flowmeter counter is then read again. The number of revolutions made during the tow (R) is the difference between the two counter readings.

The relationship of volume filtered to duration, speed and frontal area is $V = T \times S \times F$

where V = estimated volume filtered ($m^3$),
T = duration of haul (s),
S = speed of vessel (m/s),
and F = frontal area of frame trawl ($m^2$).

Dividing the number of flowmeter revolutions by the volume filtered gives the V/R ratio. The mean of the three calibration V/R ratios is then used to convert the flowmeter revolutions recorded during sampling tows to volumes sampled.

Fish catches during sampling tows may be expressed as either numbers per unit volume, or by taking into account the depth sampled, numbers under unit area of sea surface.

In a series of eleven daylight hauls, made by RV CORELLA, in June 1976, off the north-east coast of England, 0-group cod, haddock and whiting were taken. For each species the catches were summed to produce the percentage length frequency distributions shown in Figure 10. These show that the frame trawl catches very small gadoids, although the sampling efficiency for different size groups, and relative to other samplers, has not yet received rigorous examination.

A survey of 0-group gadoid distributions in the Irish Sea and Celtic Sea was carried out by RV CLIONE in June 1979. In nine days, seventy-four hauls were completed with the frame trawl, in addition to work with other types of gear. Figure 11 shows the distribution of 0-group cod as determined by that survey.

The capture of demersal stages of gadoids using the frame trawl has not yet been attempted. However, no difficulty is anticipated as cod and whiting have been taken in mid-water at sizes greater than that at which they first occur on the bottom.

The 1 $m^2$ frame trawl has been used successfully from RV TELLINA (LOA 15.5 m, 114 bhp) and RV NUCELLA (LOA 14.0 m, 80 bhp), vessels previously owned by the

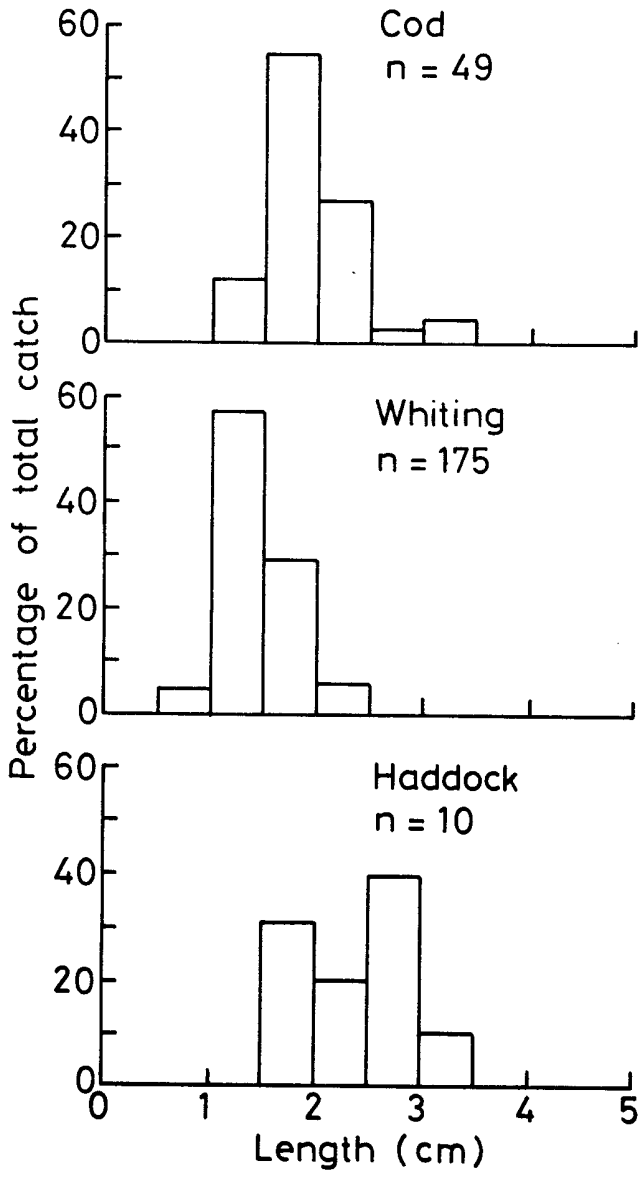


**Figure 10** Percentage length frequency distributions of three species of gadoid taken in the 2 $m^2$ frame trawl; n = number of fish.

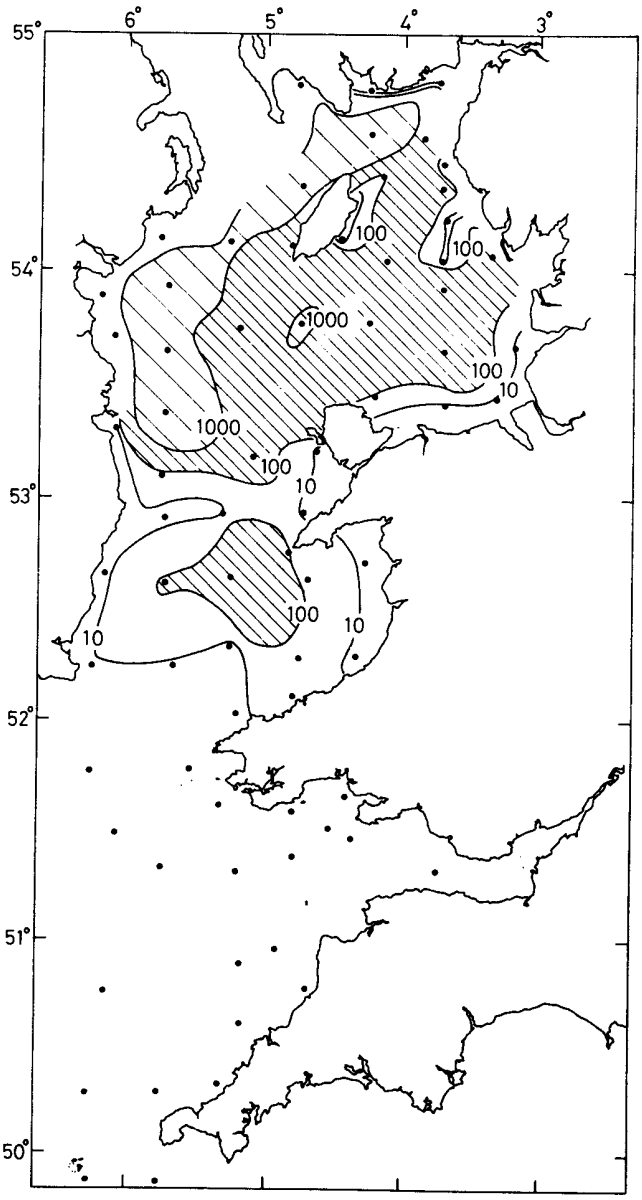


**Figure 11** Distribution of 0-group cod in the Irish Sea, from RV CLIONE Cruise 7, 1979: contour levels — 10, 100, 1000 fish taken under 10 000 $m^2$; • Sampling station.

Ministry but which have since been sold. However, attempts to use it from open motor boats have proved unsuccessful due to the strains imposed on the structures of the boats when towing at 3 knots.

## 7. Reference

TRANTER, D. J. and SMITH, P.E., 1968. Filtration performance. pp 27—56. In 'Zooplankton Sampling'. Monographs on Oceanographic Methodology, (2). UNESCO, Paris, 174 pp.

**Appendix 1.** The 1 $m^2$ frame trawl: specifications and use.

The 1 $m^2$ frame trawl is made from the same materials as the larger, 2 $m^2$ version. The physical dimensions which differ from the 2 $m^2$ version are as follows:

| | |
|---|---|
| Frame — internal height | 1000 mm |
| — internal width | 1000 mm |
| Diving plane — span | 920 mm |
| — chord | 150 mm |
| Height of centre of plane clamp above shoes | 160 mm |
| Height of lower towing point above shoes | 160 mm |
| Front tube to centre of tickler chain | 170 mm |
| Front tube to centre of bobbin rig | 260 mm |
| Length of 25 mm circ. wire bridle — top | 3600 mm |
| Length of 25 mm circ. wire bridle — bottom | 3350 mm |
| Number of bobbins | 5½ |
| Total weight of frame, net, bridles, bobbins and tickler chain. | 47 kg |

The 'Fryma' net panels are of the same shape as in the 2 $m^2$ trawl. These dimensions are: front width 1000 mm; rear width 250 mm; length 4750 mm.

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The reference to proprietary products in this report should not be construed as official endorsement of these products, nor is any criticism implied of similar products which have not been mentioned.