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International Council for the
Exploration of the Sea

CM 1976/H:17
Pelagic Fish (Northern) Committee

REPORT OF THE WORKING GROUP ON NORTH SEA HERRING LARVAL SURVEYS

1. At the 63rd Statutory Meeting of the Council the following resolution was passed (C. Res. 1975/2:19): "The Working Group on North Sea Herring Larval Surveys should meet 3-6 May 1976 in Lysekil to plan for more complete integration of larval surveys currently being conducted in that area; to reassess the methodology and sampling intensity required for surveys of herring larvae with particular emphasis on immediate pre-metamorphosis larvae. To achieve these objectives, it was strongly hoped that representatives of the German Democratic Republic, Poland and USSR would be in a position to attend this meeting".

The following members participated in the meeting:

H Bjørke	Norway
A Corten	Netherlands
O Hagström	Sweden
A Hansen	Denmark
G Lough	USA
E Ojaveer	USSR
T Pommeranz	Federal Republic of Germany
A Saville	Scotland (Chairman)
K W Siudzinski	Poland
R J Wood	England

It was noted with regret that the German Democratic Republic was not represented.

The Working Group on Surveys of Fish Eggs and Larvae in the Baltic met in Lysekil over the same period (C. Res. 1975/2:10). The first two days of the meeting were spent in joint session with that working group, discussing

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questions of methodology which were of interest to both working groups. On the following two days the working groups met separately on matters more specific to their own interests. The Working Group on North Sea Herring Larval Surveys would wish to place on record their gratitude to the Institute of Marine Research, Lysekil, for the high standard of accommodation and facilities placed at their disposal during this meeting.

2. Methodology

2.1 Sampling of Small Herring Larvae.

A review was made of the samplers in current use by the various countries for sampling of small herring larvae. All countries were using modifications of the Gulf III sampler but it appeared that there was considerable diversity in the detailed design. It was considered that these differences were unlikely to appreciably effect the estimates of larval abundance, with the possible exception of those countries which continued to use 'monel metal' filtering cones. It was strongly recommended that all participating countries should use filtering cones in the Gulf III made of 60 mesh per inch nylon (275 u aperture) material. In using the Gulf III all countries carried out double oblique hauls at a towing speed of 5 knots. There were however considerable differences between countries in measuring the depth at which the sampler was fishing. These ranged from using depth to warp ratios, obtained from experiments using some method of retrospectively measuring the depths attained with different amounts of warp, to direct, real time, depth readings on deck from acoustic or pressure transducers. Systems developed at the Lowestoft, Aberdeen and Kiel laboratories for obtaining real time measures of depth and flow during a haul were described. It was felt that it was of utmost importance that the sampler should be fished in a true oblique haul, with constant volumes of water filtered in each depth stratum, and from as close to the bottom as possible, if reliable and consistent estimates are to be obtained of the

abundance; particularly of the smallest size category of herring larvae. It was therefore strongly recommended that all countries should fit to their Gulf III sampler either a pressure transducer or an acoustic transducer, to ensure that they are fishing from a depth of not more than 5 metres from the bottom and in a true oblique haul. The continuation of the work currently under-way in some laboratories on more refined systems for ensuring that the volume filtered per unit depth is maintained at a constant value throughout a haul should be encouraged.

Mr Wood described the method used by the Lowestoft Laboratory of staining their samples with Borax Carmine to aid sorting of the fish larvae from the other constituents of the sample. A full description of the method has recently been published (Anon 1976b). The value of using polarised light, in conjunction with this staining technique, to increase the accuracy of myotome counting was also stressed.

The use of the Bongo net for catching small larvae was discussed. It was felt that there was no sound evidence that this sampler had any advantages over the Gulf III for obtaining quantitative estimates of early larval abundance, and that it had the very considerable disadvantage that changing the sampler would result in a break in the data series which has now been built up in the North Sea.

2.2 Sampling of Pre-metamorphosis Herring Larvae

In assessment of the North Sea herring stock, because a major part of the catch is taken as 0-group and 1-group fish, and because it is necessary to estimate the TAC two years in advance of the fishery, it is of major importance to be able to estimate the strength of a year-class earlier than is currently done by the North Sea Young Herring Surveys. Recent work by Swedish and Dutch workers, although done in rather restricted areas, suggests that it might be possible to get estimates of year-class strength by measuring the abundance of pre-metamorphosis larvae.

Swedish sampling in the Skaggerak in March-April gave the estimates of late larval abundance shown below.

Year-class	Late Larval Abundance
1971	49.8
1972	19.2
1973	361.4
1974	2.2
1975	0.5

These estimates of year-class strength, although based on a very restricted area surveyed, are in reasonable agreement with the estimates of the strength of these year-classes produced by the Herring Assessment Working Group for the Area South of 62°N (CM 1976H:2).

Dutch sampling of late larvae, in the entrance to the Wadden Sea in February-April, showed that in this area there were two distinct size groups of larvae; one of these was thought to be derived from spawning in the Central North Sea, the other from Channel spawning. The estimates of abundance of these two size groups, and the estimates of year-class strength in these two spawning groups from Dutch catch per unit effort are shown below.

Year class	Abundance larvae > 33mm (15/3-15/4)	Year class strength Central North Sea	Abundance Larvae <41 mm (15/4-15/5)	Year class strength Channel
1966	32	7.9	275	59.6
1967	120	14.1	83	15.8
1968	463	11.4	40	9.2
1969	31	2.2	1025	50.3
1970	101	33.4	148	12.5
1971	81	11.0	169	6.2
1972	0	?	86	
1973	11	?	247	
1974	48	?	118	

Againthere is a rough correspondence between the larval estimates and those from fisheries data.

It was felt that these data were sufficiently encouraging to justify mounting a larger scale international programme for sampling these larger larvae. It was considered that this could most economically be done by combining the requisite survey with the current North Sea Young Herring Surveys which are carried out in the right area and at the right time. As the trawl

hauls for sampling 1-group herring are done only during the day, and the large larvae can be sampled most effectively in darkness, the two objectives could be combined with only a small additional requirement for research vessel time.

Accordingly the most suitable gear for sampling this size group of larvae, and the methods of fishing it, were discussed. In 1975 and 1976 limited sampling of this size group of larvae had been done by some countries, in conjunction with the Young Herring Survey. This had been done on too limited a scale to give any estimate of abundance but had given some useful experience in using nets of different types. Experience in using two rather different designs of Isaac-Kidd net, and of a Booth Bay net were discussed. It was decided that the standard gear to be used by all countries on these surveys should be the Swedish modification of the Isaac-Kidd net, of which a detailed specification is given as Appendix 1. This gear has proved to be easy to handle, even in fairly heavy weather, and to give adequate samples at relatively low levels of abundance. Departures from the specification given in Appendix 1 should be avoided to ensure the highest practicable level of inter-ship comparability.

This net should be used, by all countries participating in the International Young Herring Surveys in the North Sea, by fishing a double oblique tow from surface to 100 metres or to 5 metres from the bottom where the depth is less than 100 metres and back to surface. The vertical profile of the tow, and particularly the distance from the bottom at the greatest depth reached, should be monitored by an acoustic transducer fitted to the headline, and directed downwards. The warp should be paid out at 25 metres per minute and retrieved at 12.5 metres per minute. The ships speed during the tow should be 3 knots. Hauls with this gear should be done only during darkness (defined, as in the Young Herring Surveys, as the period between 15 minutes past sunset to 15 minutes before sunrise).

The distance over which the gear is towed should be accurately measured, either by fitting a calibrated flow-meter attached outside the net, by an accurate ships log, or by measuring accurately the distance between the Decca coordinates of position of shooting and hauling. In the North Sea at least two tows should be done in each ICES statistical square in the area south of 57°30'N and east of 4°E, and at least one tow per statistical square in the area south of 57°30'N and west of 4°E. The squares to be sampled by the various participating countries will be allocated at the same time as squares are allocated for young herring trawl sampling.

Sampling pre-metamorphosis herring larvae in the Skaggerak and Kattegat will continue to be done by Sweden. In that area the procedure will be as defined above for the North Sea, with the exception that the maximum depth of tow will be 50 metres.

3. Integration and Coordination of Small Herring Larval Surveys

3.1 A major objective of the Working Group meeting was to try to achieve a higher degree of coordination of the North Sea Larval Surveys and, in particular, to try to integrate the surveys which have in the past been conducted independently by the German Democratic Republic, Poland and the USSR into the survey scheme operated by other member countries. It was agreed that the principle aim of these surveys should be to obtain quantitative estimates of the abundance of the earliest larval stages, from which a measure could be obtained of the relative changes from year to year in the sizes of the spawning stocks. It was stressed that if NEAFC were to adopt the advice of the Herring Assessment Working Group for the Area South of 62°N, which was endorsed by the Liaison Committee, that fishing on North Sea herring should be prohibited until the spawning stocks in that area had been rebuilt to a more viable level, then the only method available to monitor the progress in rebuilding the stocks was likely to be from young larval surveys. It was also agreed that, because the major spawning grounds were largely distributed within the zones of national fisheries jurisdiction, surveys conducted outwith the

ICES framework were at a considerable disadvantage in sampling the earliest larval stages.

The representative of Poland stated that his country was prepared to participate in the ICES coordinated surveys and that he had been given authority to announce that the German Democratic Republic were also prepared to do so. The representative from the USSR said that his country had been conducting independent herring larval surveys for several years in the North Sea but that these were the responsibility of another institute in the USSR and that he had no authority to make any firm statement on their willingness to join the ICES system. He suggested that this matter should be discussed with his countries representatives at the forthcoming statutory meeting.

Dr Ojaveer also presented a paper, in Russian, prepared by the Kaliningrad Institute on the results of the North Sea larval surveys conducted by that institute. The Working Group expressed its interest in these results but suggested it would be appropriate if an English version of this paper was prepared for presentation at the 64th Statutory Meeting, where it could be discussed more fully, and by a wider audience.

3.2 The results of surveys carried out in the period 1970-74 were reviewed, in relation to the sampling scheme for these surveys drawn up at the previous meeting of the Working Group in 1971 (Anon 1971). This suggested that the previous recommendations regarding both area coverage and the timing of surveys required some revision.

It was agreed that to obtain an adequate estimate of annual variations in production of small larvae, a minimum of one survey must be carried out in the time periods given below in the spawning areas listed:

Orkney-Shetland	Buchan	Central N. Sea	Southern North Sea and Channel
1 - 15 September	1-15 September	1-15 September	December
16-30 September	16-30 September	16-30 September	January
1-15 October	1-15 October	1-15 October	
		15-31 October	

However in the light of the very low production of larvae in the Channel area in the last decade it was decided that until there is some evidence of a recoveryof that spawning stock one survey in the first half of January in that area would be adequate to monitor any change in the situation. The statistical squares, which in the past have yielded catches of larvae less than 10 mm long, in each of the time periods given above, are shown in Figures 1-3 for the Orkney-Shetland and Buchan areas, in Figures 4-7 for the Central North Sea, and in Figures 8-9 for the Southern North Sea and Channel. Each of these squares should be sampled, as described in paragraph 2.1, by stations at 10 mile intervals. When time does not permit of a full coverage of all statistical squares shown, greater priority should be given to those fully shaded than to those marked with a circle.

It was agreed that it will be necessary in future to allocate research vessels more rigidly to ensure that the sampling scheme described above is carried out. There are problems in doing this because countries allocate their research vessels to various projects at very different times of the year. It was decided however that it would be useful to all countries if an outline allocation scheme was drawn up, which gave the participants an indication of the areas and time periods they would be expected to survey. Adjustments could then be made from year to year in the light of research vessel availability. This provisional allocation is given below:

	Orkney-Shetland	Buchan	Central North Sea	Channel
1-15/9	Denmark Federal Republic of Germany	Scotland	England	
16-30/9	Scotland Federal Republic of Germany	Denmark German Democratic Republic	Netherlands Poland	
1-15/10	German Democratic Republic	Poland	England Netherlands	
15-31/10			Norway	
1-15/1				Netherlands

In future participants should notify the Chairman of the Working Group, as soon as the allocation of their research vessels to North Sea herring larval surveys are known, of the time periods and areas they can sample in the ensuing year, so that any necessary adjustments can be considered and arranged.

4. Evaluation of Results from Past Surveys

As stated in paragraph 3 the main aim of the International Herring Larval Surveys in the North Sea has been to provide quantitative estimates of the abundance of the earliest larval stages, which could be used as a relative index of changes in the size of the adult spawning stock. These surveys began in 1967, so that there are now estimates of larval abundance, derived from them, for nine years in each of the major North Sea spawning areas. It therefore now seemed opportune to attempt to evaluate these data as a means of providing an independent estimate of the size of the spawning stocks.

The major problem in evaluating the usefulness of the larval abundance data is that they refer to the individual spawning stocks, whilst the only reliable estimates of variations in spawning stock size from other sources are those for the North Sea herring populations as a whole, given in various reports of the Herring Assessment Working Group for the Area South of 62°N (Anon 1972-76). The estimates for the individual stocks from larval data are not necessarily additive to give a total estimate for the North Sea because of variations between stocks in the period over which hatching takes place, in larval growth rate, and in fecundity. The Report of the Herring Assessment Working Group for the Area South of 62°N used the relative decline in larval production between 1974 and 1975 to confirm their estimate from other data that the spawning stock had declined by about 50% during this period; but they were only able to do so because the decline in larval abundance for all three stocks had been of approximately the same magnitude.

In an attempt to overcome the problem of estimating the sizes of the individual spawning stocks from fisheries data a virtual population analysis was carried out, using the catch data for Division IVa as referring to the Shetland-Buchan spawning stock, the catch data for Division IVb as referring to the Whitby-Dogger spawning stock, and the catch data from Divisions IVc and VIId and e, as referring to the Downs stock. It is realised that these estimates of stock abundances will not be reliable if there is an appreciable proportion of any one of these stocks caught in the area of another stock. But it is thought that the error due to this is probably small, at the rather low stock sizes which have prevailed since 1967.

From the estimates of stock size in numbers per age group at 1 January in each year and the fishing mortality rates on each age group in each year estimated by VPA the residual stocks in number at 1 September in Division IVa, and in Division IVb; and at 1 December in IVc and VIId and e were estimated, and the corresponding spawning stock biomass calculated by multiplying by the mean weights at age and summing across age-groups. It was appreciated that the assumption made in calculating the residual spawning stock, that the annual fishing mortality rate of the adult stock was uniformly distributed throughout a year, might not be true, and that its distribution with time might vary from year to year. However it was considered more realistic to make this assumption to correct for mortality between 1 January and spawning than to take estimates applicable 8-12 months earlier as a measure of the spawning stock. The larval abundance estimates were obtained by taking the mean of the reliable cruise estimates for larvae less than 10 mm long in the Shetland and Buchan areas in September, in the Central North Sea in September and October, and in the Southern North Sea and Channel in December and January. The surveys which were used in estimating the larval abundances are given in Table 1. During the period 1967-75, covered by these international larval surveys, the range of variation in spawning stock size in the Southern North Sea and English Channel was too small to give any indication of the relationship between the estimates

of larval abundance and spawning stock size. The data of larval abundance are plotted against the corresponding estimates of spawning stock size for Division IVa in Figure 10 and for IVb in Figure 11.

The data for the Northern North Sea would suggest that the relationship between larval abundance and stock size in the years 1967-70 was quite different from that in the period 1971-75 (Fig 10). The reasons for this are not clear; a possible explanation may be that in these early years of the international surveys the sampling of small larvae was much less efficieint than subsequent to 1970, due to failure to fish sufficiently close to the bottom. Although based on a rather small number of observations, the data for 1971-75 would suggest a close relationship between larval abundance and spawning stock size - the regression fitted to these data, shown in figure 10, is significant at the 0.01 probability level.

The corresponding data for Division IVb shown in Figure 11 do not indicate any change in the stock size - larval abundance relationship with time. This may be because, in the shallower spawning depths in this area than in the northern area, the ability to fish very close to the bottom is less critical. The fitted regression line is again significant at the 0.01 level.

It would appear therefore that these surveys can supply a reasonably efficient estimate of the variations in size of the individual spawning stocks. This could be of great value as a means of monitoring developments if the advice of the Herring Assessment Working Group for the Area south of 62°N to prohibit fishing for North Sea herring were to be adopted by NEAFC. The value of these surveys would be greatly increased if the estimates from the individual stocks were in absolute, rather than relative, terms so that the individual stock estimates were additive to give a value for the North Sea population as a whole. This would seem to demand: (a) more frequent surveys in each spawning area so that the individual cruise estimates could be integrated over the entire hatching period, (b) more investigations on

the basic biology of the larval stage to provide better estimates of larval growth and of egg and early larval mortality. The first of these requirements may be met with the integration of the surveys currently carried out by all member countries into a single programme. Institutes should be encouraged to devote more attention to investigating the problems raised under (b).

5. Summary

5.1 The gear currently in use by ICES member countries for sampling small herring larvae in the North Sea was reviewed. It was strongly recommended that all countries which are not using filtering cones of 60 mesh/inch nylon material (295 µ) should change to this type at the earliest opportunity.

5.2 It is recommended that all countries participating in the North Sea Herring Larval Surveys should use an acoustic or pressure transducer to allow them to fish accurately from within 5 metres of the bottom in a true oblique haul.

5.3 It is recommended that an intensive programme for sampling pre-metamorphosis herring larvae should be undertaken by participating countries in conjunction with the North Sea Young Herring Surveys, using a modified Isaac-Kidd net, for which a detailed specification is given in Appendix 1. The recommended methods of handling this net are described in Chapter 2.2.

5.4 The agreement of the German Democratic Republic and of Poland to participate in the International Herring Larval Surveys in the North Sea co-ordinated by ICES was warmly welcomed. It is hoped that the surveys conducted by the USSR in this area will also be incorporated into the ICES programme by 1977. This will permit the more intensive sampling and greater survey frequency which are required if the full potential value of these surveys is to be realised.

5.5 A schedule of the minimum survey requirements in each spawning area and the minimum sampling intensity within a survey was drawn up (Chapter 3.2).

5.6 The results of the surveys carried out from 1967-75 were evaluated as an index of annual variations in spawning stock size. The analysis carried out suggests that in the north-western and central areas of the North Sea the larval surveys provide a useable index of variations in the sizes of the spawning stocks in these areas. In the Southern North Sea and English Channel the ranges in stock size and larval abundance have been too narrow during the period covered by these surveys to give a measure of their usefulness. The requirements for integrating these indices for the individual stocks into an index for the North Sea population as a whole are briefly touched on (Chapter 4.).

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Anon. 1976b Monograph on Oceanographic Methodology 1976 No 1. RC 7104. Appendix 1. UNESCO. Press.

TABLE 1: Surveys used in calculating annual abundances of early larvae.

Year	Shetland	Buchan	Whitby-Dogger
1967	8–22/9	11–24/9	3–8/9 10–13/10
1968	2–14/9	2–14/9	3–5/9 15–23/10
1969	4–16/9	3–25/9	9–11/9* 6–14/10
1970	11–29/9	8–29/9	26/8–11/9 8–16/9 6–12/10
1971	31/8–9/9 16–27/9	6–8/9 9–16/9	7–15/9 15–23/9 2–7/10 12–20/10
1972	6–11/9 12–21/9	13–20/9	3–13/9 19–27/9 30/9–6/10 17–26/10
1973	28/8–3/9 7–14/9 18–25/9	27/8–6/9	4–12/9 18–26/9 27/9–6/10 16–24/10
1974	7–19/9 23/9–2/10	1–12/9 16–19/9	27/8–1/9 2–9/10
1975	3–19/9 10–25/9	3/9–2/10	15/9–23/9* 8/10–14/10 21/10–29/10

* In 1969 and 1975 the evidence from the abundance of larvae in the size category 10–15 mm suggests that none of the surveys had not sampled the peak abundance of the <10 mm size category. Accordingly to correct for this, in these years the abundance of the 10–15 mm category was taken into account in calculating an abundance index of the <10 mm category.

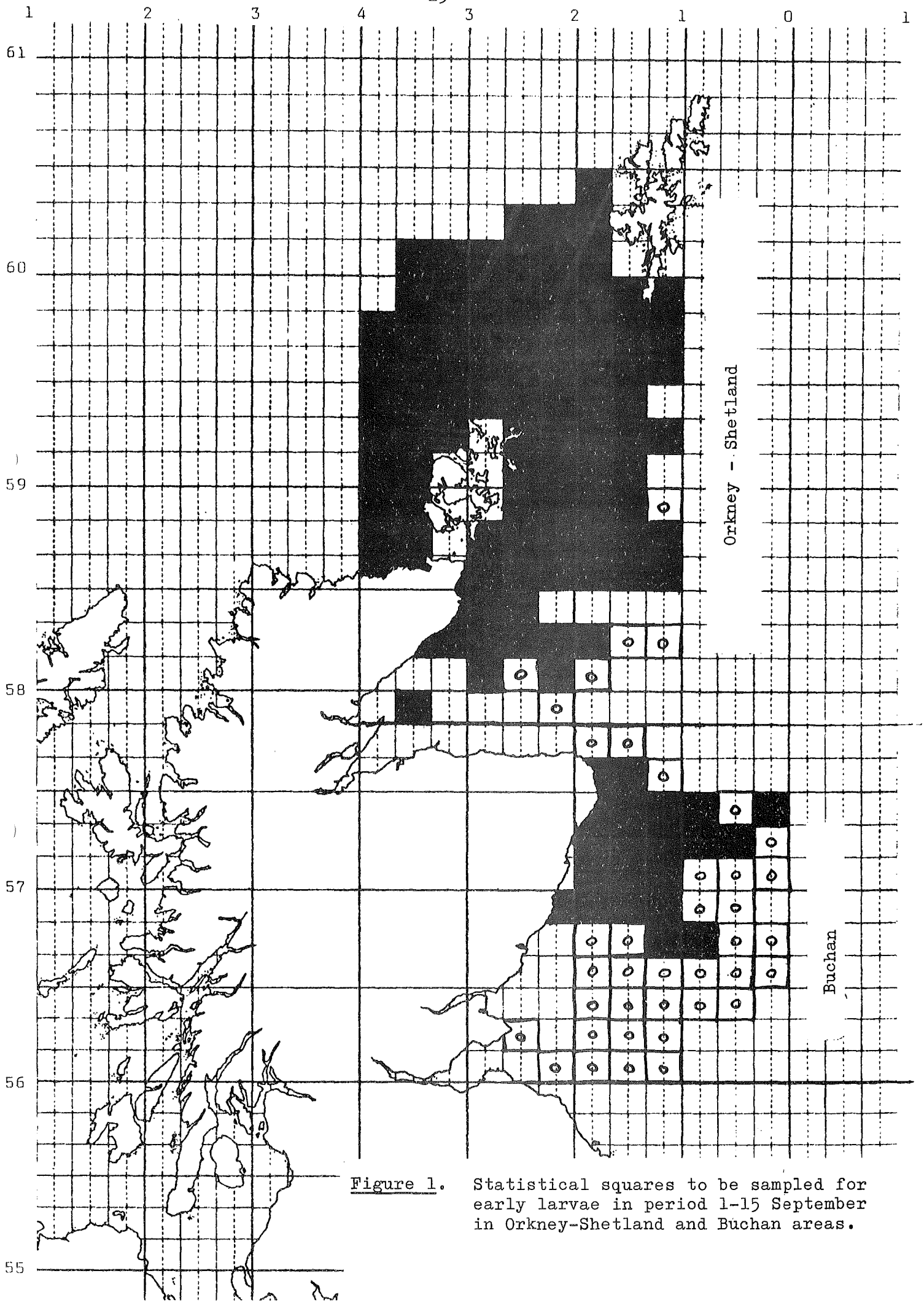


Figure 1. Statistical squares to be sampled for early larvae in period 1-15 September in Orkney-Shetland and Buchan areas.

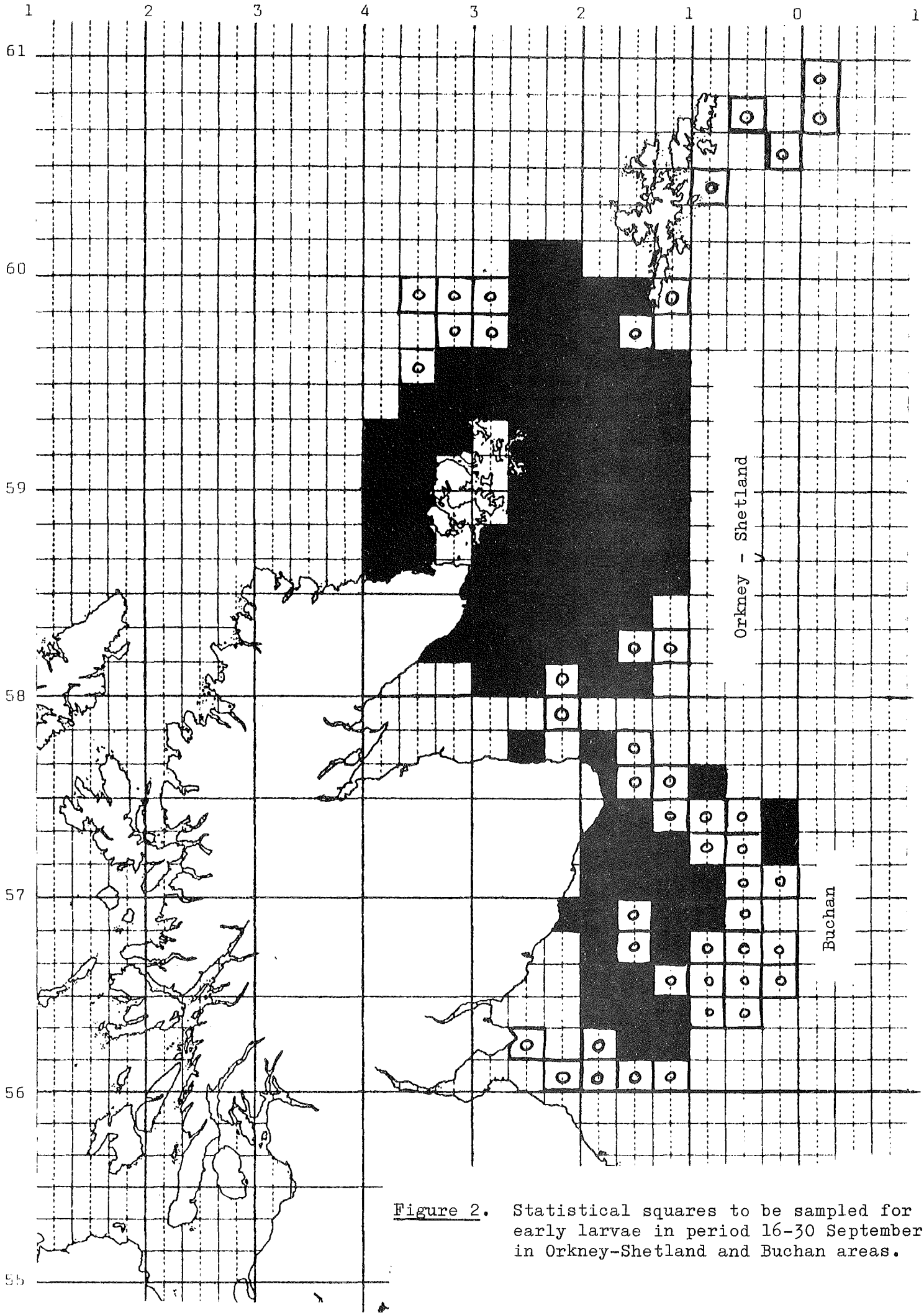


Figure 2. Statistical squares to be sampled for early larvae in period 16-30 September in Orkney-Shetland and Buchan areas.

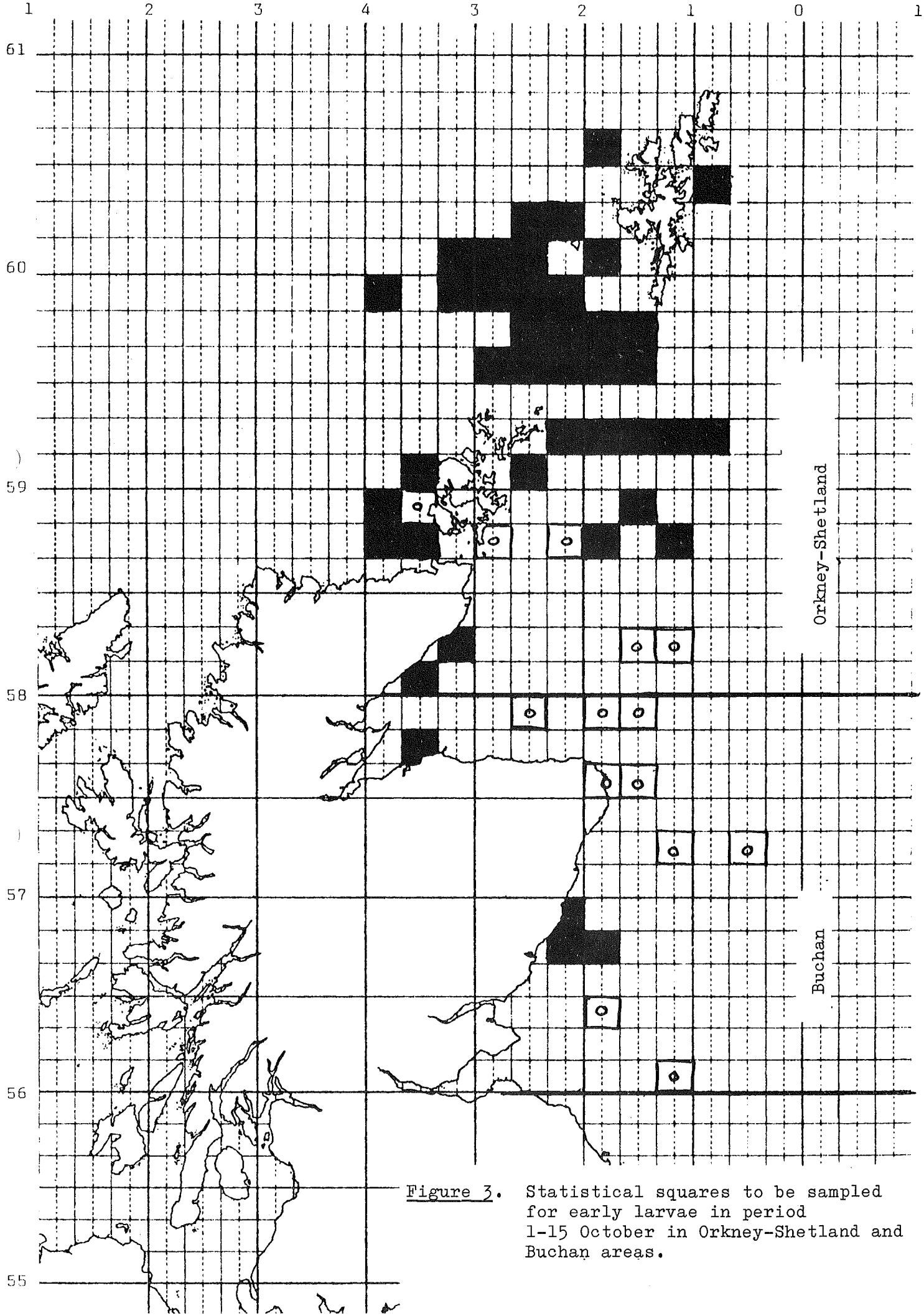


Figure 3. Statistical squares to be sampled for early larvae in period 1-15 October in Orkney-Shetland and Buchan areas.

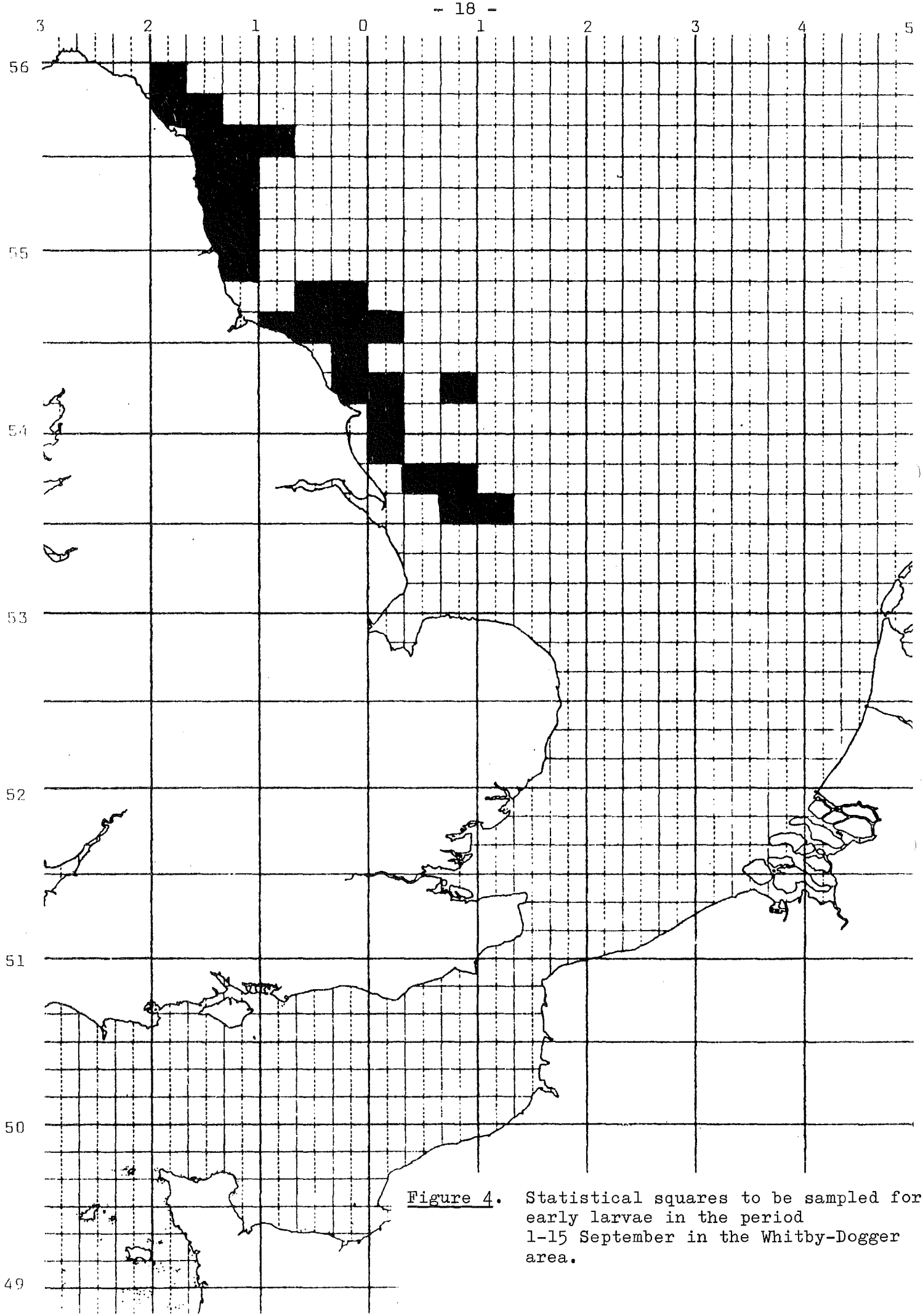


Figure 4. Statistical squares to be sampled for early larvae in the period 1-15 September in the Whitby-Dogger area.

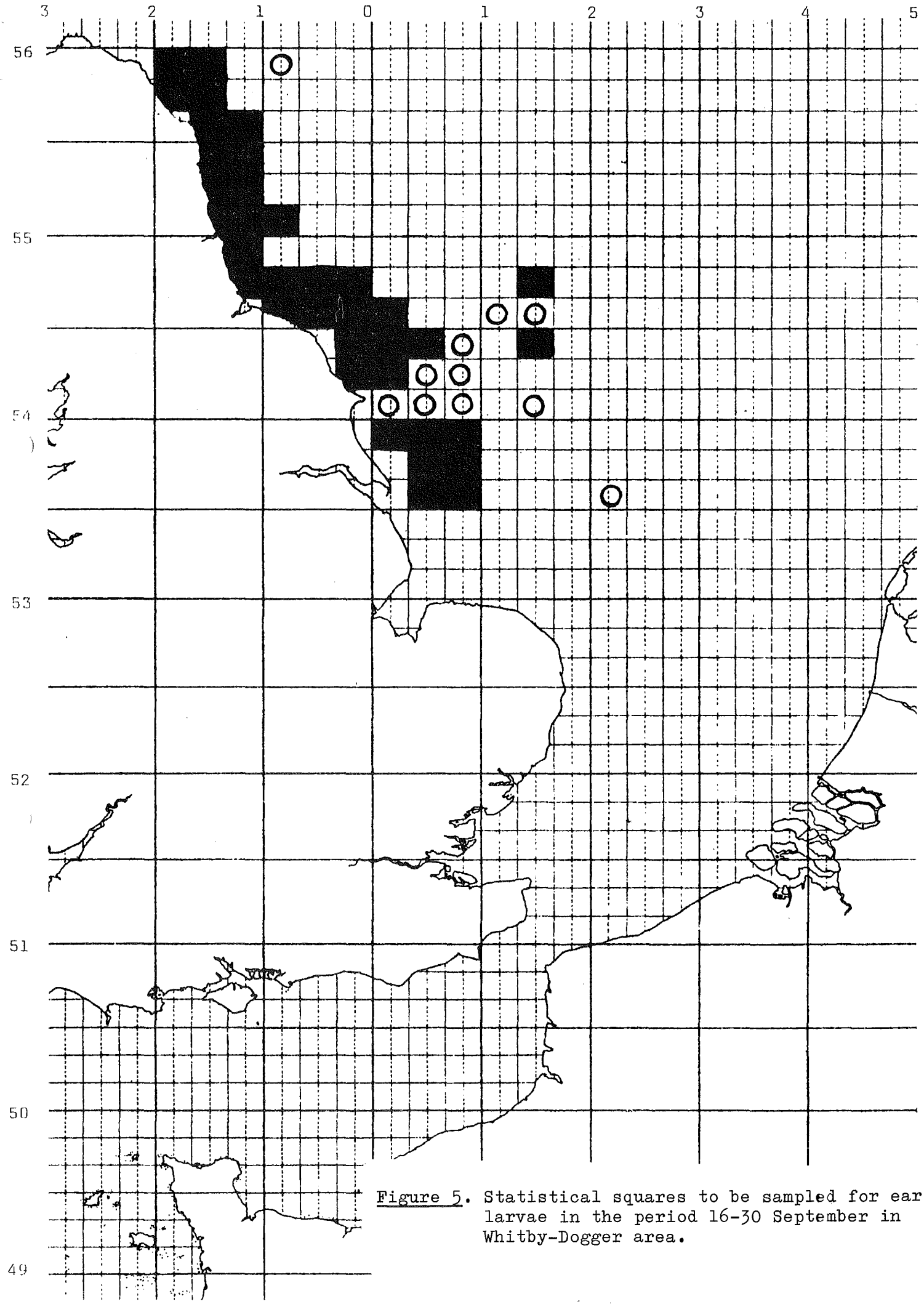


Figure 5. Statistical squares to be sampled for early larvae in the period 16-30 September in Whitby-Dogger area.

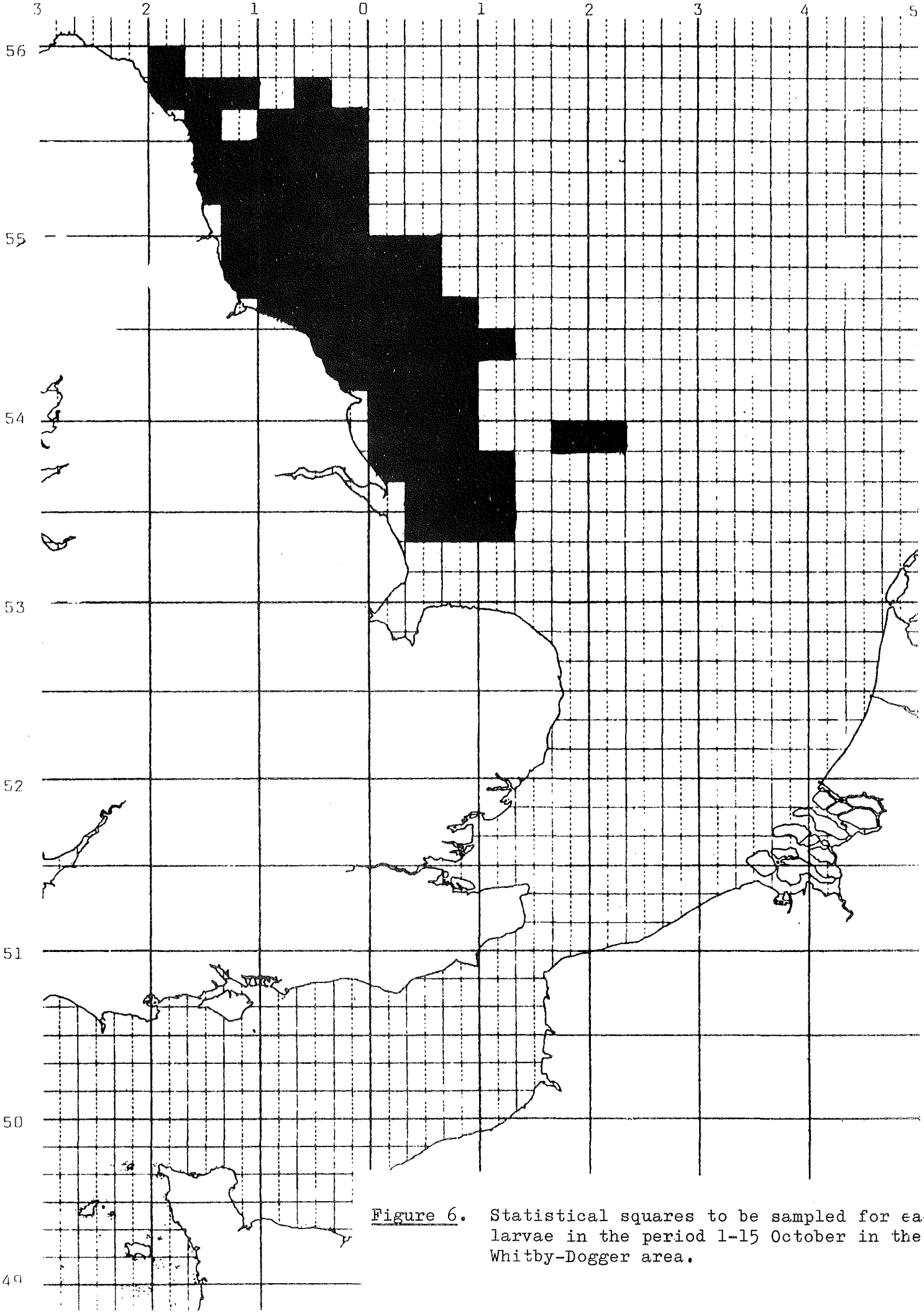


Figure 6. Statistical squares to be sampled for each larvae in the period 1-15 October in the Whitby-Dogger area.

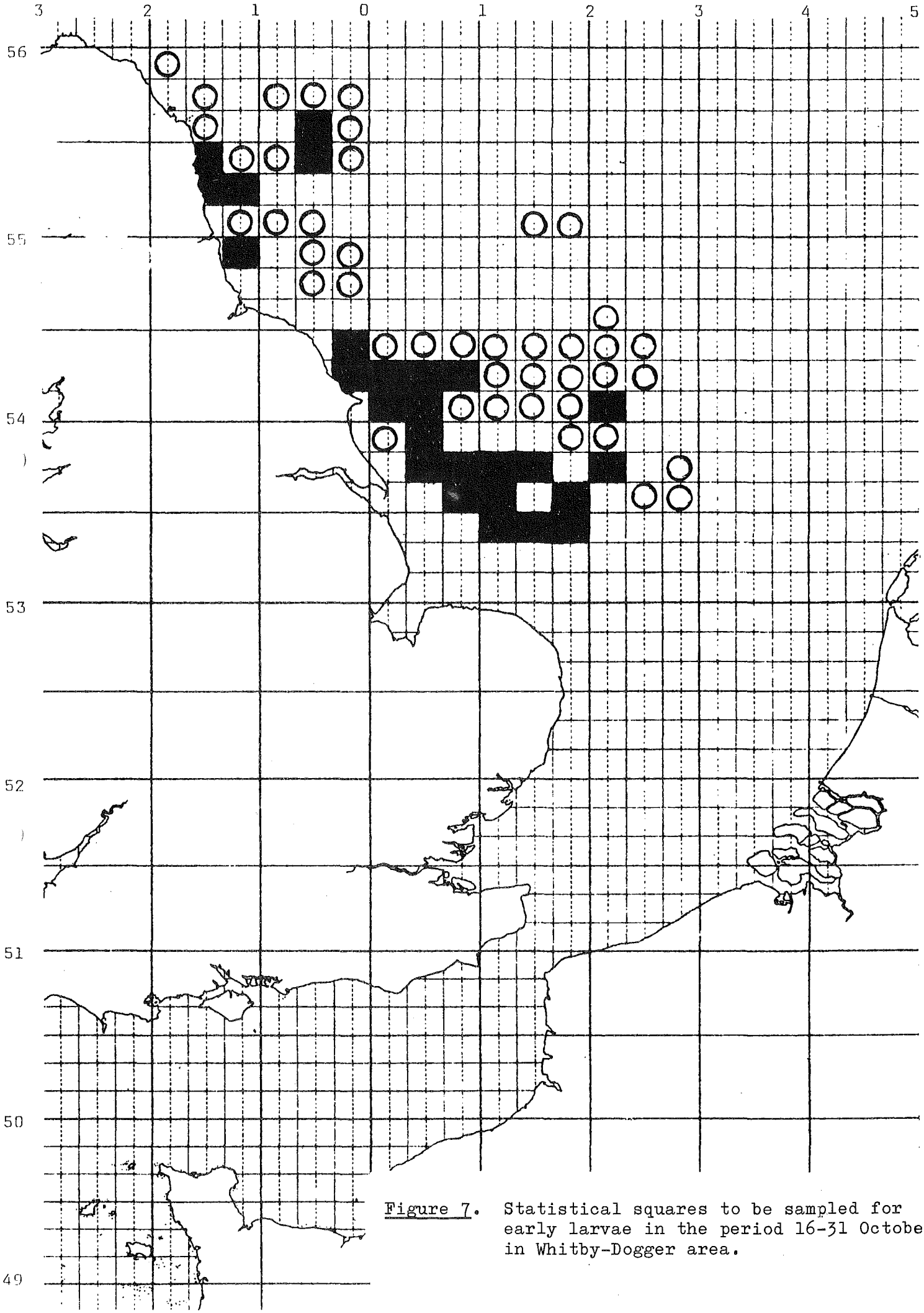


Figure 7. Statistical squares to be sampled for early larvae in the period 16-31 October in Whitby-Dogger area.

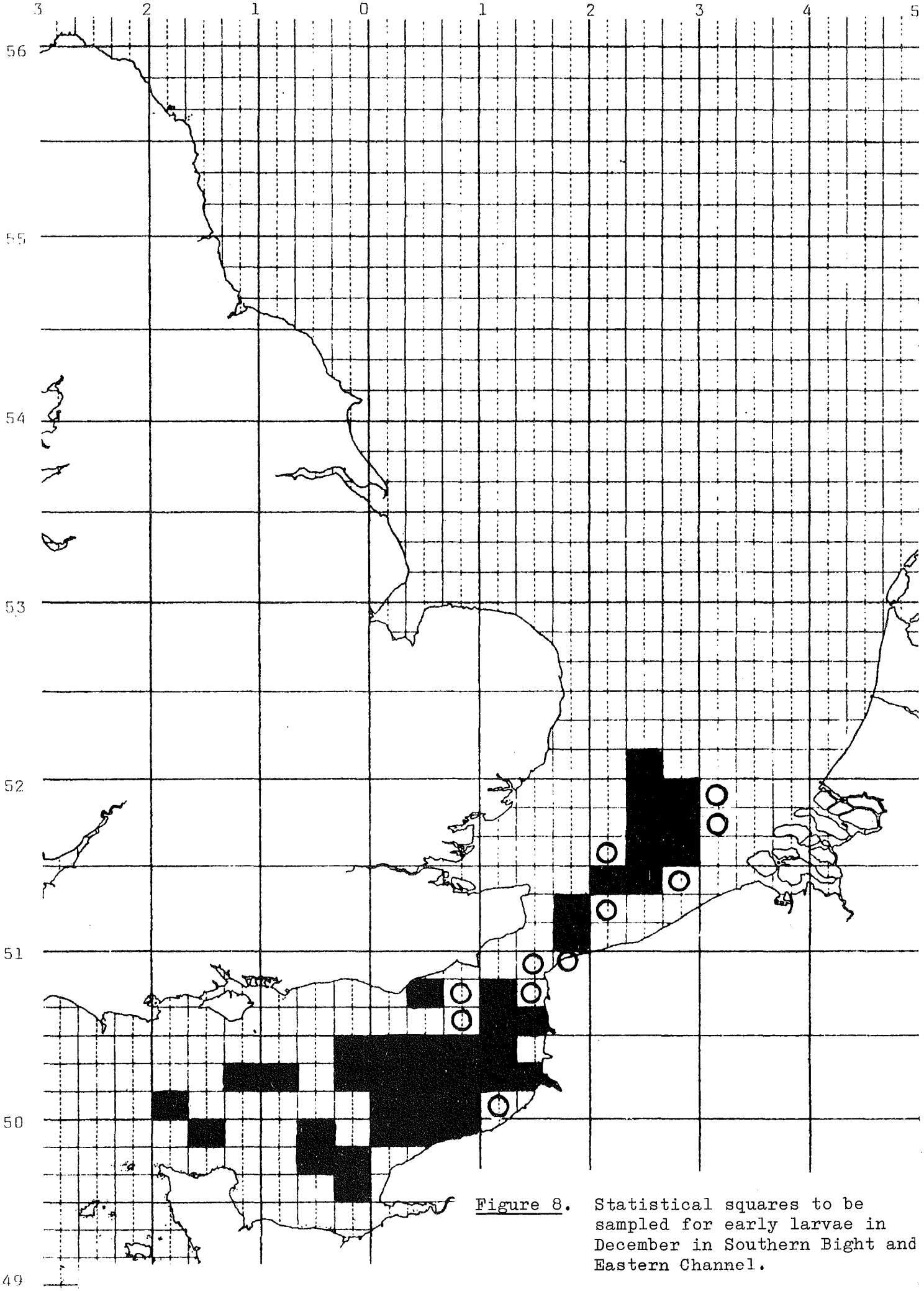


Figure 8. Statistical squares to be sampled for early larvae in December in Southern Bight and Eastern Channel.

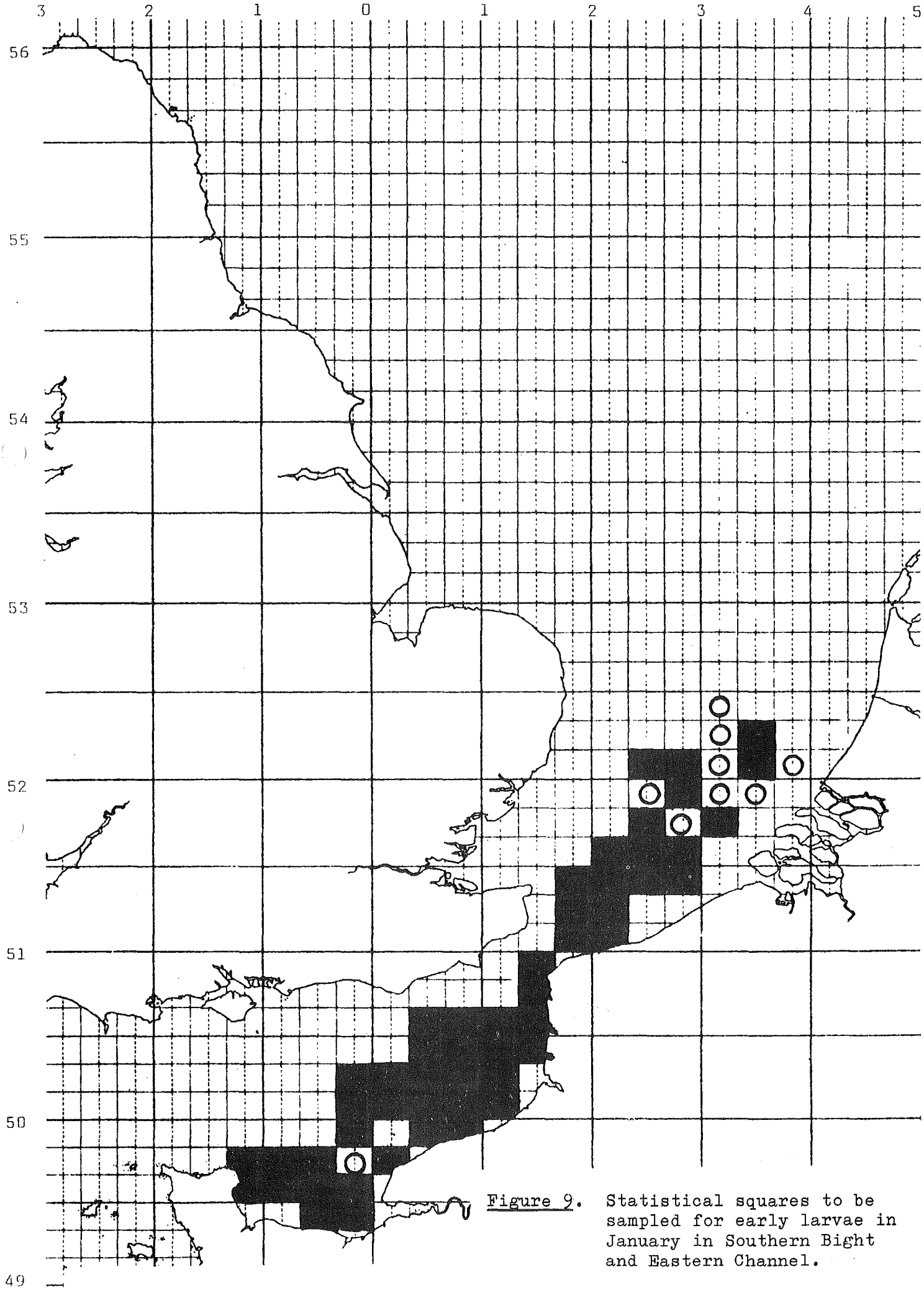


Figure 9. Statistical squares to be sampled for early larvae in January in Southern Bight and Eastern Channel.

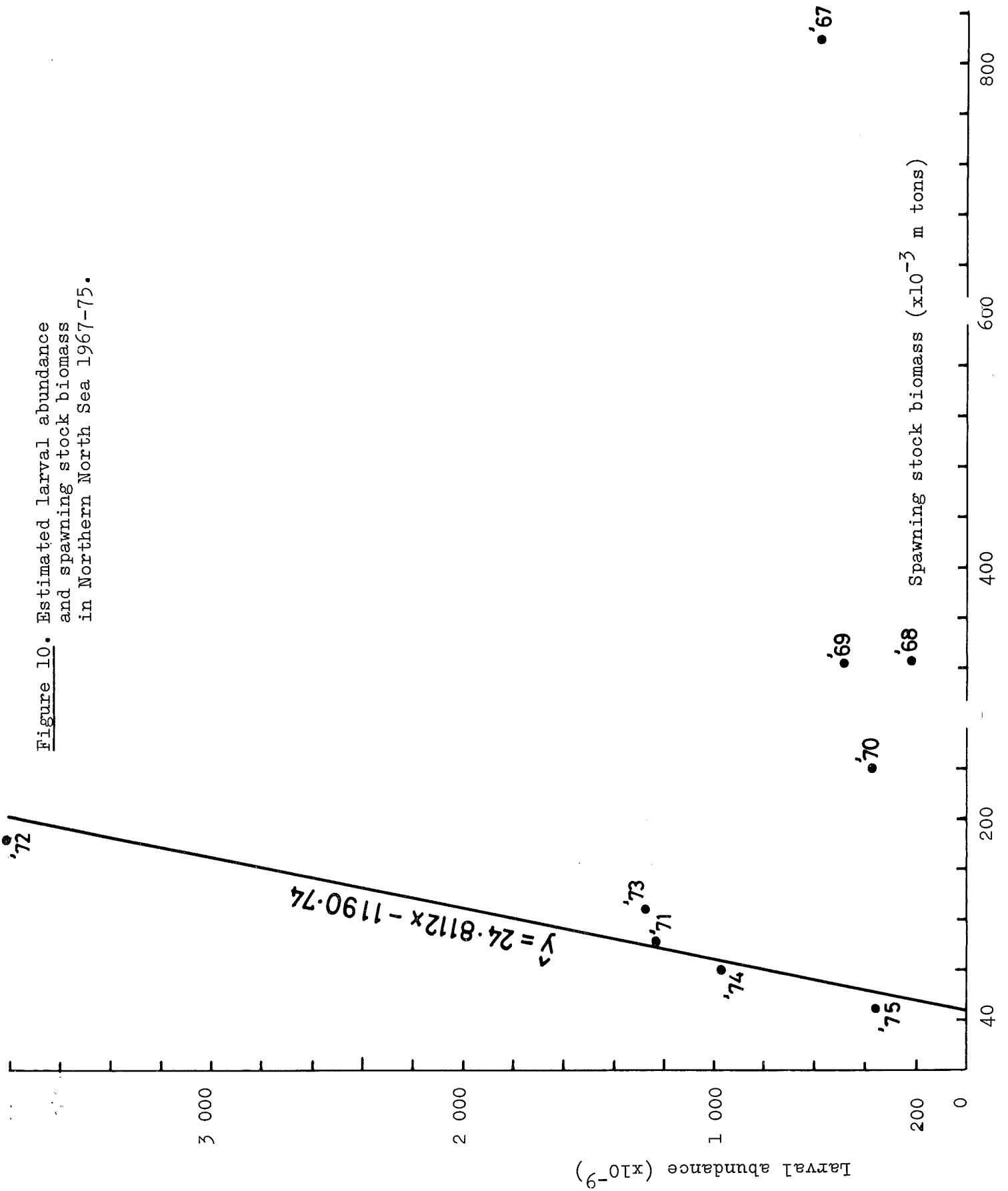


Figure 10. Estimated larval abundance and spawning stock biomass in Northern North Sea 1967-75.

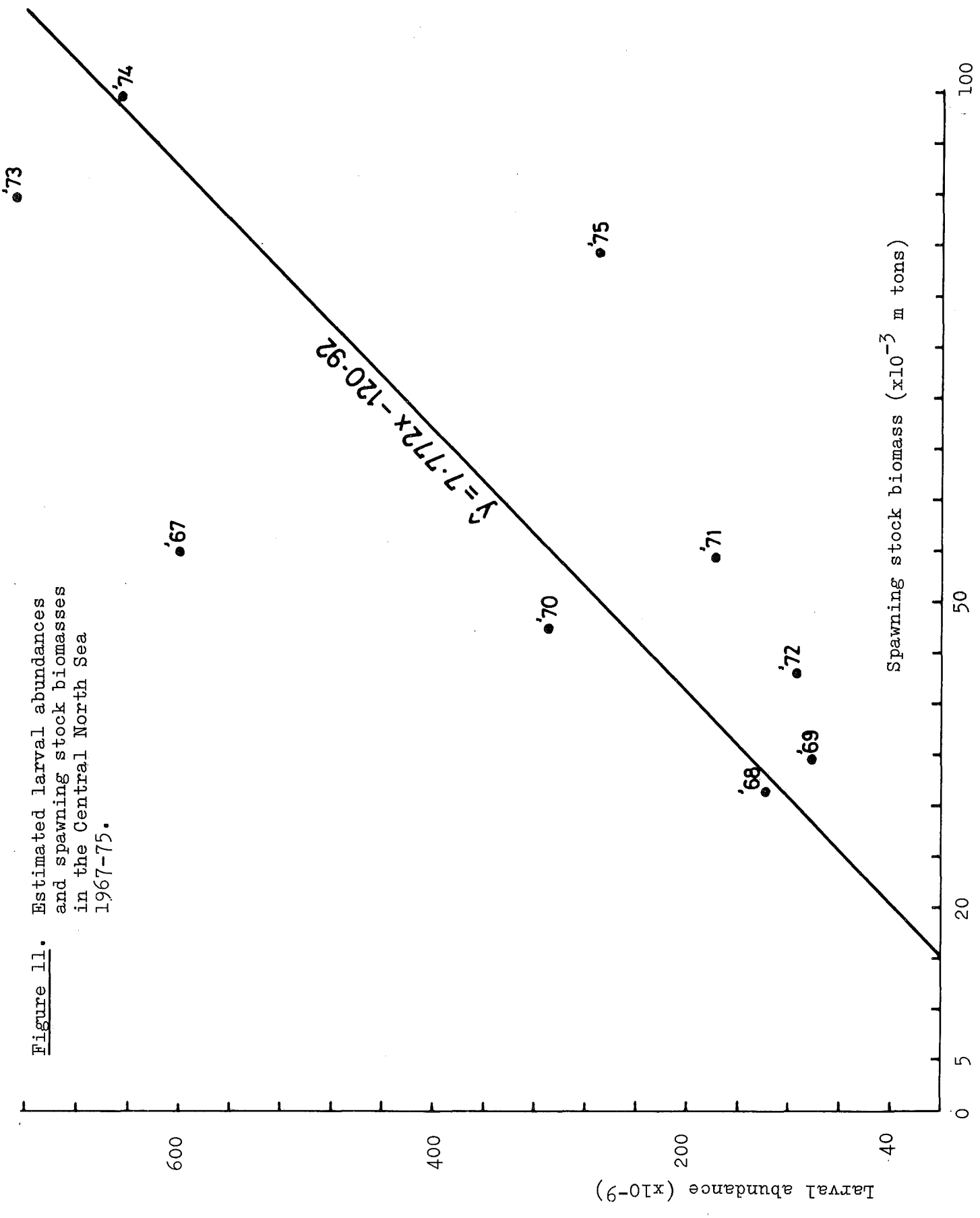


Figure 11. Estimated larval abundances and spawning stock biomasses in the Central North Sea 1967-75.

APPENDIX 1

A description of the modified ISAACS-KIDD midwater trawl recommended by the Working Group for late herring larval surveys in the North Sea.

Introduction

The first model of the Isaacs-Kidd Midwater Trawl (IKMWT) was described by Isaacs and Kidd (1953). Aron (1961) presented four modified versions (3-foot to 15-foot). The present recommendation is closely related to the IKMWT used in Swedish investigations since 1972, described by Lindquist (1972). The present version of the IKMWT is constructed to meet the requirements of easy handling by making the depressor of aluminium and by reinforcing the trawl to stand rough weather.

Over-all dimensions and methods of rigging

The recommended IKMWT has a total length of 13.2 m with an opening of 10 m^2 (Fig 1). The wire, 8 mm stainless steel, containing 133 threads arranged in 7 x 19 pattern, is capable of 3.9 tons tension. This rigging allows for a towing tension of approximately 11 tons in the ship wire.

Depressor

The depressor is made of 5 mm aluminium with a total length of 2.50 m (Fig 2). The vane area is 1.33 m^2 and the total weight approximately 25 kg. The details of attachment can be seen in Fig 3.

The net

The net if built up of four sections. The four mesh sizes are 25 mm, 16 mm, 11 mm and 5 mm respectively (Fig 4). The opening of the trawl is strengthened with wings and stronger meshes in the two first sections. The longitudinal seams are strengthened by taking 15-20 meshes together. All sections should be dark coloured.

Cod end

A 2-m cone of 1500 micron nylon rectangular mesh is attached inside the 5 mm netting with a zip fastener (Fig 5). A plastic bucket is attached to the cone (ø 11 cm, length 29 cm) with an 11 x 14 cm opening on the side. The bucket opening is fitted with the same netting as the cone.

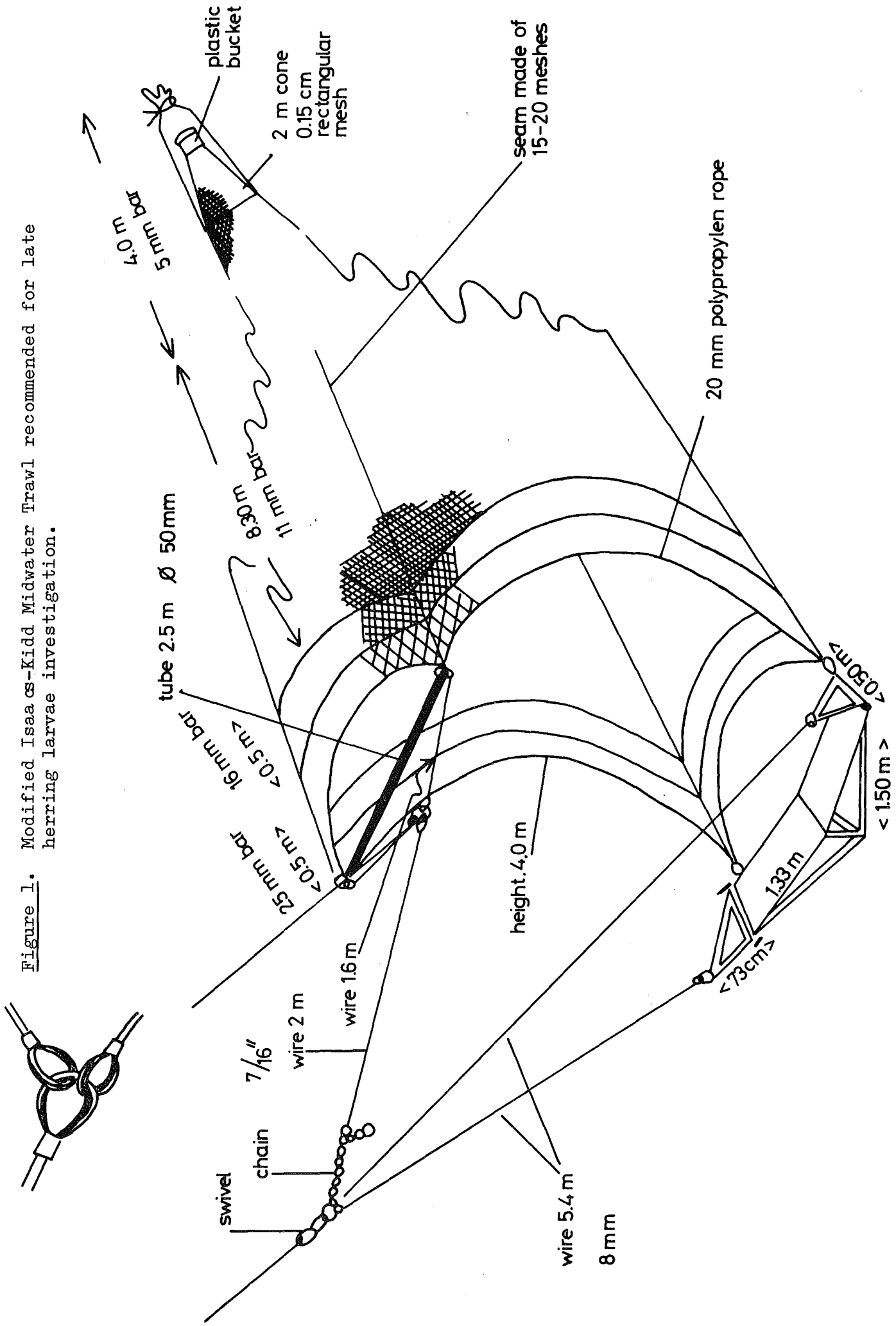
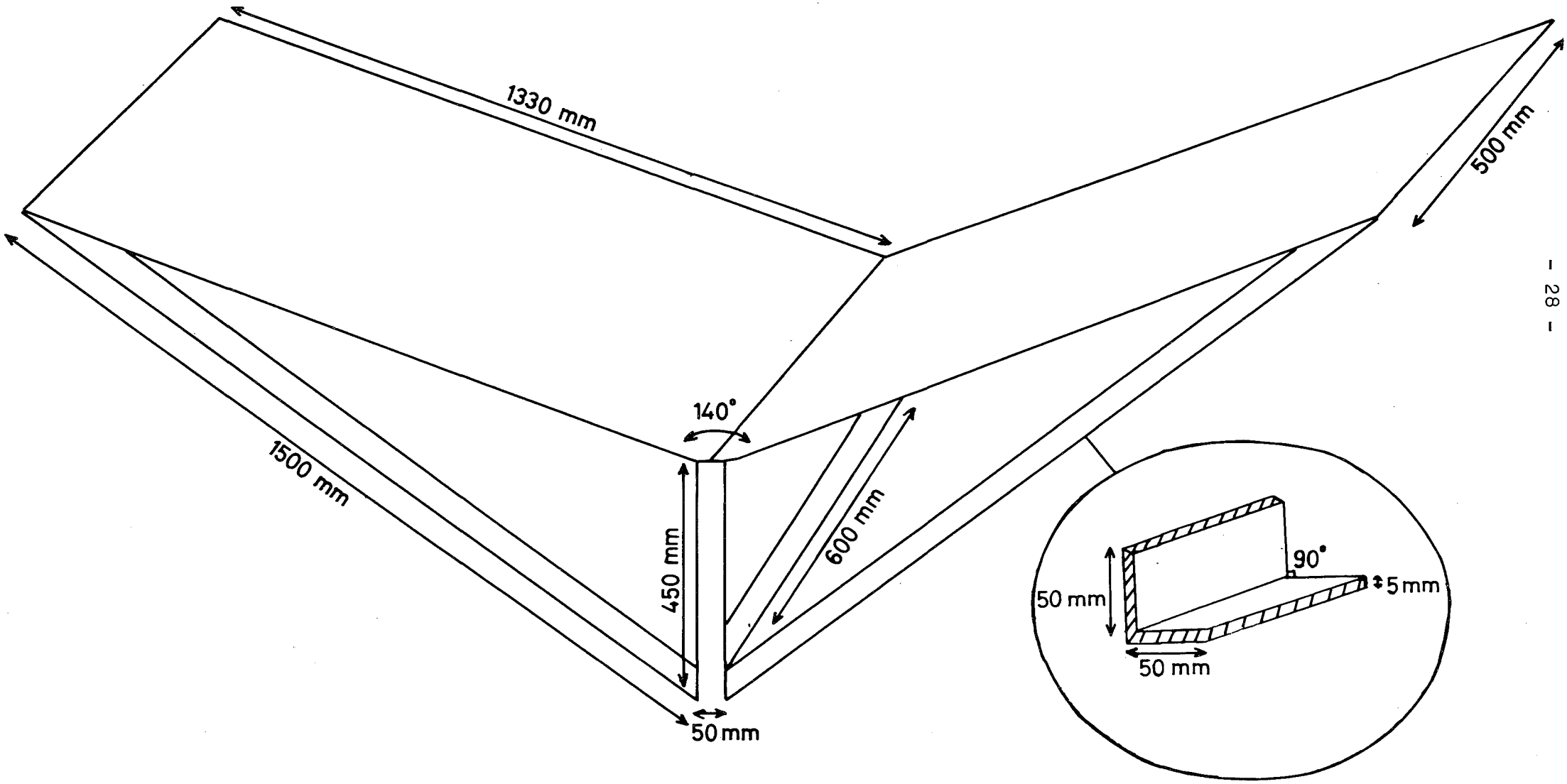


Figure 1. Modified Isaacs-Kidd Midwater Trawl recommended for late herring larvae investigation.

Figure 2. Depressor; front view.



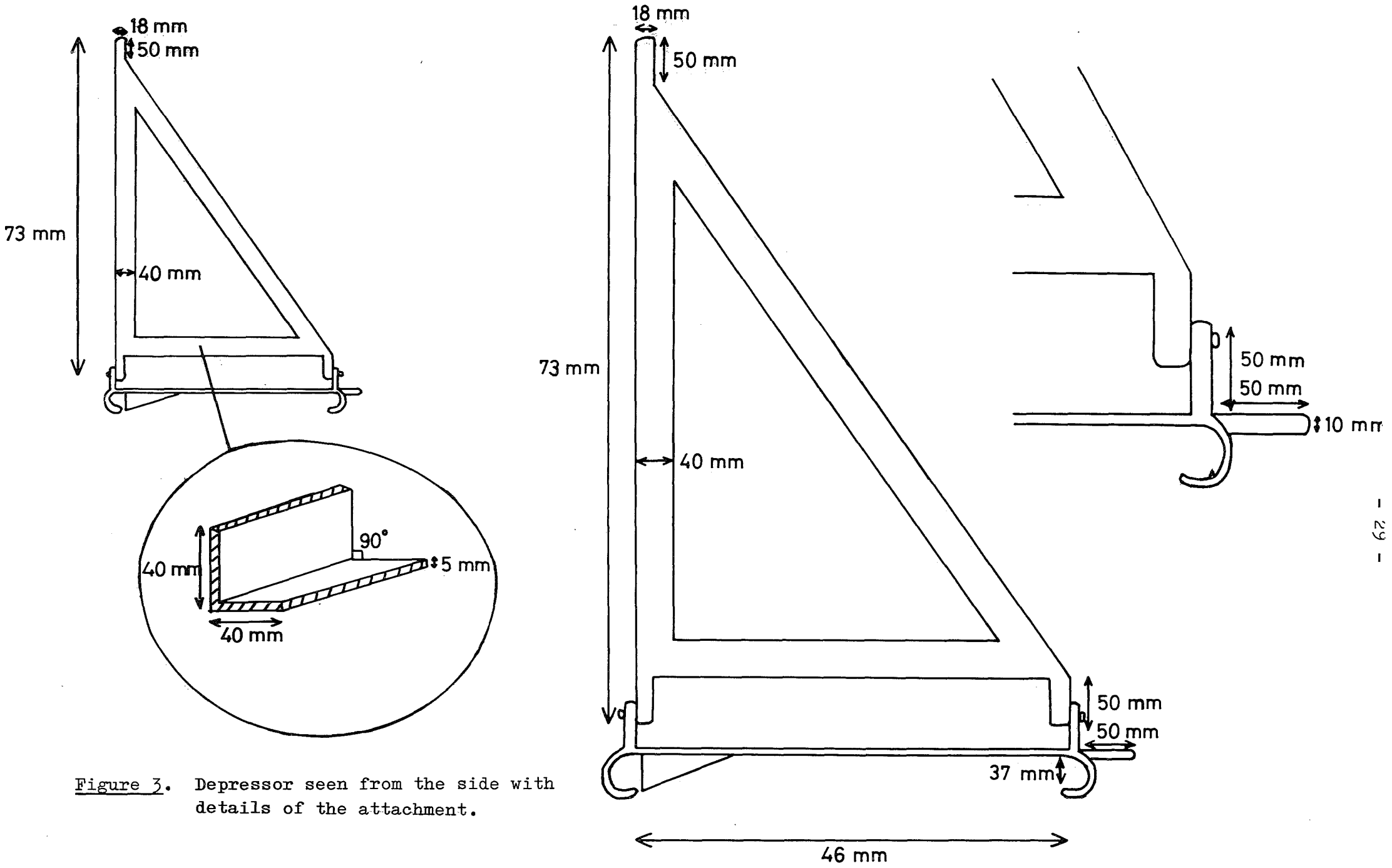


Figure 3. Depressor seen from the side with details of the attachment.

SECTION NO 1: bar 25 mm thread no 1[illegible]
NO 2: bar 16 mm thread no 8
NO 3: bar 11 mm thread no 6
NO 4: bar 5 mm thread no 1.5 (210/4) knotless

TOTAL LENGTH: 13200 mm

Figure 4. Detailed specification of netting of modified Isaacs-Kidd Midwater Trawl recommended for late herring larvae investigations.

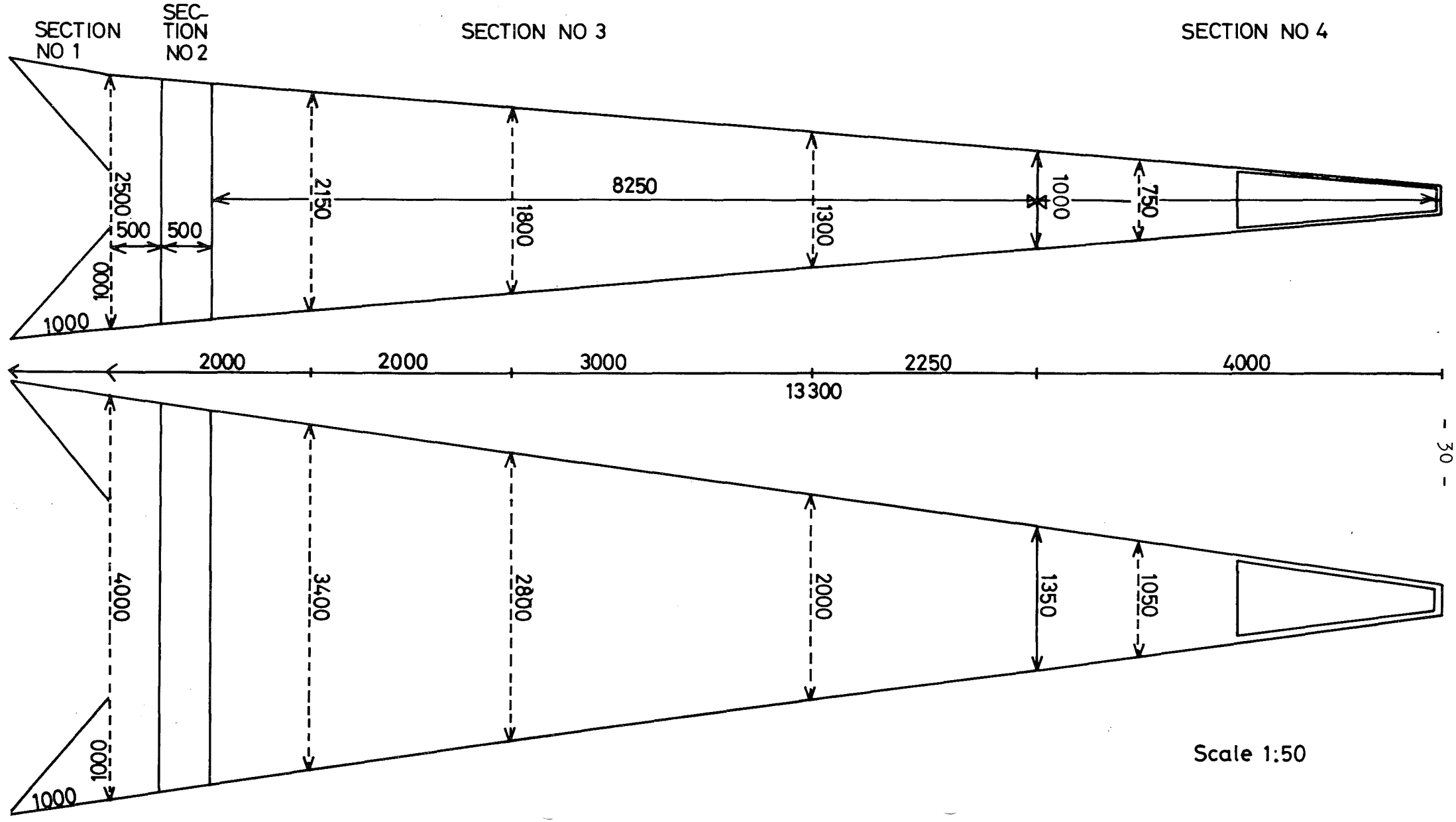


Fig. 5

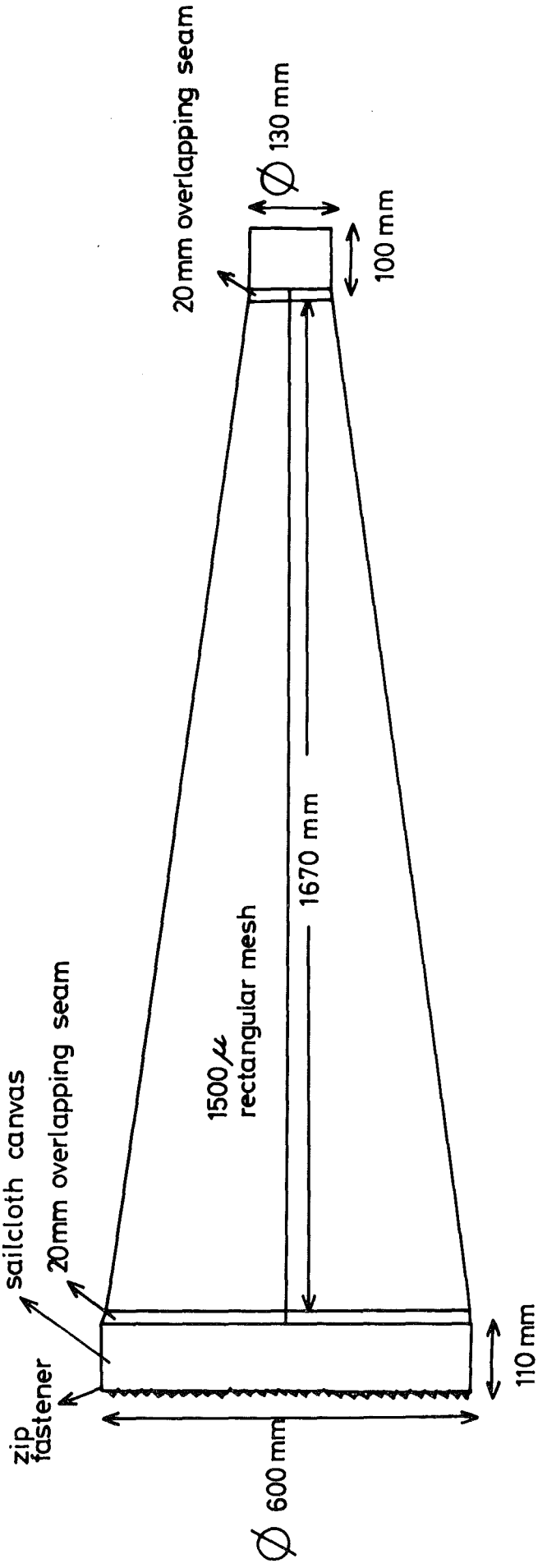


Figure 5. Cross section of the cod end inner cone. The cone is made of nylon-netting. 1500 micron rectangular mesh. The cone terminated in a plastic bucket (290 x 110 mm) with a 110 x 140 mm window covered by 1500 micron netting.