

ROINN NA MARA

HERRING LARVAL SURVEYS
OFF THE
WEST AND NORTH WEST COASTS
1984-1986

by

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and

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Herring larval surveys provide an index of the size of the herring stock which spawns each October and November along the Donegal, Mayo and Galway coasts. This index is then used as a basis for determining the total allowable catch (TAC) for the stock and subsequently the national quotas. As well as detecting trends which occur in the stock sizes the surveys also indicate the locations and the times at which the main spawnings occur. This Leaflet gives details of the distribution of the larvae and seasonal variations in their abundance. It is intended to extend the area covered by these surveys in an effort to improve the reliability of the estimates of stock sizes obtained.

Herring larval surveys have been conducted off the west and northwest coast in ICES Divisions VIa S and VIIb each year since 1981. The surveys, during the years 1981-1983, have been described by Grainger and McArdle (1984, 1985). The surveys from 1981 to 1983 have been carried out by the MFVs Johnamlin, Iuda Naofa and Shay Og. The purpose of the surveys has been to monitor the spawning of herring in autumn and thereby to provide an index (the larval index) of the size of the spawning stock. This index is then used by the ICES Herring Assessment Working Group to calculate the appropriate catches which may be taken from the spawning stock. The surveys, therefore, are extremely important to the fishing industry because the results obtained directly influence the TACs which are set each year and hence the quota which is allocated to the Irish fleet.

The surveys take place at fortnightly intervals during October and November and cover the area extending from the mouth of the Shannon to the Inishowen peninsula. Over this area approximately 250 plankton samples which include herring larvae are taken each year at predetermined stations. By doing the surveys in this manner it is hoped to cover the entire spawning period and spawning area of the autumn spawning component. No surveys have been carried out at other times of the year so no assessments are made on herring which may spawn during winter or spring.

Since 1982 the herring stocks along the west (Div VIIb) and northwest coast (Div VIa south) have been considered as a single unit for management purposes and the surveys are carried out by Irish vessels.

Methods

The sampling methods are identical to those described by Grainger and McArdle (1985). The surveys have been carried out using a grid system on which the sampling stations are approximately 18km apart. At each station a Dutch-modified Gulf III plankton sampler with 275µm aperture mesh was towed from the surface to the bottom and back while the vessel was steaming at 5 knots. Where possible the sampler was shot until it reached the bottom in order to pick up the most recently hatched larvae.

The volume of water filtered through the plankton sampler was recorded at each station by means of a flow meter mounted in the nose of the sampler. The surface temperature was recorded at each station and, immediately after each tow plankton samples were preserved in 4% formaline. All herring larvae were removed, identified, counted and measured for length.

The number of larvae in the water column below each square metre of sea surface was subsequently calculated (numbers/m² = numbers/m x water depth) for each of three size groups (<10mm, 10-15mm and >15mm) at each station. The number/m² was then multiplied by the area of the sea represented at each station (approx 399 square km) and the resulting figures were summed for all stations to give an estimate of the total abundance of each size category for each cruise.

This method of obtaining a larval abundance index uses only the smallest larvae caught during sampling - i.e. those that are less than 10mm. This restriction is necessary because of the different spawning periods and because of the drift of larvae after hatching from eggs. Otherwise it is possible that samples taken in different areas and at different times may be the progeny of the same spawning group. This possibility is reduced if only the smallest and most recently hatched larvae are used in the calculations of the abundance index.

However, the ICES Herring Larval Working Group has been repeatedly worried about many unsatisfactory aspects of this method which can create major inaccuracies in the final results. "The major difficulties with the larval abundance index (LAI) in most cases arises from the decision to use abundance of less than 10mm larvae. These recently hatched larvae may have a very patchy distribution in space and in time. This has often led to extremely high values in a few rectangles which then drive the index for that sampling period. Such patchiness also leads to some hatching cohorts being completely missed by the present survey methods. This large variability inevitably leads to a high variance in the larval index. The temporal coverage of the spawning areas in 10-15 day periods may also lead to complete hatching cohorts being missed." (Anon 1986).

This problem of high variability in the larval abundance indices which does not represent high variability in the spawning stock has stimulated attempts to obtain other indices of spawning stock which are still based on larval abundance. Studies have, therefore, been developed which make use of all larvae - not just the smallest ones.

These studies attempt to relate the growth rate and the mortality rates of all larvae to back-calculate the total number of larvae produced and this figure, called the larval production estimate (LPE), is considered to give a more accurate indication of changes which are occurring in the spawning stock.

The 1986 Larval Survey Working Group also examined the fecundity estimates (the number of eggs produced) from various stocks in order to calculate estimates of the spawning stock biomass from the larval production estimate described above. The spawning stock biomass (SSB) was calculated from the resulting ratios.

Larval Production Estimates
No. of eggs/kg SSB

Fecundity estimates of herring from Div VIaS and VIb have been obtained from McArdle (1982). The spawning stock biomass calculated from this method, however, assumes no egg mortality, which obviously is not the case, and the Working Group stressed that the estimates of SSB should not be taken as absolute values. At the present state of knowledge it is not possible to calculate reliably a figure for the mortality rate of the eggs.

Results

The larval abundance indices (LAI) and the larval production estimates (LPE) are given in the following table, together with estimates of fecundity and spawning stock biomass from the LPE (Anon 1987).

Year	LAI	LPE	Fecundity Egg/kg	SSB tonnes
1981	58	254	142,000	179,000
1982	76	198	144,000	138,000
1983	68	192	141,000	136,000
1984	36	81	143,000	57,000
1985	26	84	143,000	59,000
1986	62	124	143,000	87,000

It is extremely difficult to interpret the trends in stock size indicated by the larval surveys. Both the LAI and the LPE seem to indicate that the spawning stock was rather stable during the period 1981 to 1983 but dropped dramatically in 1984 and remained at a low level in 1985. The 1986 surveys, however, indicated a substantial

improvement in both larval types of indices which would, therefore, indicate a recovery in spawning stock. The fishery in 1987 and reports from fishermen would appear to confirm that such a recovery has now taken place. On the other hand fishermen in 1986 reported a general scarcity of herring for the greater part of that year. When the results of the larval surveys were discussed at the 1987 Herring Assessment Working Group scientists tended to be influenced more by the poor results of the 1984 and 1985 surveys rather than by the 1986 survey.

It was considered unlikely that the stock could have made such a dramatic recovery because catches in the area had been consistently above the level recommended by the ACFM (Advisory Committee on Fisheries Management). This has resulted in recommended catch levels for 1988 which are considerably lower than in recent years. The 1987 Herring Working Group has also pointed out that the larval surveys in 1985 may have underestimated the total production because the first survey in that year did not take place until 8 October and may have missed an important part of the early spawning.

The Working Group also points out that the 1984 survey failed to detect the increase in the stock which resulted from the recruitment of the very strong 1981 year class. This year class which first entered the fishery as two year old fish in 1983, would have spawned for the first time in 1984 and should have brought about a substantial increase in larval production in that year.

Time of Spawning

The Larval Working Group also examined the hatching periods and peak hatching time for the area, based on growth and mortality rates. It has been shown previously (Grainger and McArdle 1984, 1985) that spawning in this area first occurs in the northern part (i.e. Tory Island - Inistrahull area) and then moves progressively south. The peak hatching times for the whole area vary from year to year and depend on the water temperature and also on the amount of spawning that occurs in the north of the area in relation to the south. An analysis of the larval production of the surveys carried out since 1981 is shown below.

Calculated hatching periods and peak hatching time, based on growth rate of 0.35mm per day

	Hatching Period	Peak Hatching
1981	13 Sept - 23 Oct	23 Sept
1982	23 Sept - 12 Nov	23 Oct
1983	23 Sept - 2 Nov	13 Oct
1984	23 Sept - 23 Oct	23 Oct
1985	23 Sept - 23 Oct	23 Oct
1986	13 Sept - 23 Oct	23 Sept

The above figures indicate that 80% of the hatching usually takes place between 13 September and 2 November. Apart from 1981, when hatching appeared to be very early, the main hatching usually takes place between 13 October and 23 October. The hatching time of eggs depends on the temperature of the water, which may range between 10 C - 12 C and the actual main spawning time would have been the first and second week of October.

Area of Distribution

The area of distribution of the larvae for the early surveys (1981-83) have been shown in a series of charts produced by Grainger and McArdle (1985). The area of distribution for 1984, 1985 and 1986 are shown in Figs. 2-10. The distributions are shown for the three size categories i.e. less than 10mm; 10-15mm; and greater than 15mm. The distributions are shown for each of the three surveys that have taken place in each of those years. The distributions can be summarised briefly as follows.

THE 1984 SURVEYS

The first survey (3-16 October) indicated that the highest concentrations of small larvae were found off the northwest Donegal coast (i.e. Malin Head - Tory Island - Aranmore Island), and also south of Achill Island. No large larvae were found during this survey. The second survey (16-31 October) found small larvae over most of the survey area with the exception of the most southerly stations in Galway Bay. Again no large larvae were found during the survey. The third survey (2-15 November) again located quantities of small larvae west of Aranmore Island (Co. Donegal) and also off the Co. Clare coast. Medium sized larvae were well scattered throughout the survey area but large larvae were found only the most north easterly stations.

THE 1985 SURVEYS

The first survey (8-16 October) showed the highest concentration of small larvae north east of Tory Island. Small larvae were also scattered over most of the inshore area surveyed in Donegal Bay and along the Donegal coast. Very few larvae appeared in any of the southern stations. Considerable numbers of larvae were also found in most of the northern stations. During the second survey (22-29 October) the highest numbers of small larvae were found west of Slyne Head indicating considerable spawning in the area. Very few small larvae were found elsewhere. In the third survey (11-17 November) small larvae were again restricted to only one area i.e. west and north of the Aran Islands in Galway Bay.

THE 1986 SURVEYS

The first survey (29 Sept - 5 Oct) was carried out a week earlier than in 1985 because it was felt that the 1985 survey missed out some of the early spawning. The highest concentrations of early spawned larvae were found north west of Malin Head, off Rathlin O'Beirne I, and off Achill Island. During the second survey (13-29 October) small larvae were distributed over a large area but were particularly abundant north of Aranmore Island, Co. Donegal and west of Tory Island.

High concentrations were also located off Achill Island and between the Aran Islands, Co. Galway and Slyne Head. During the third survey (31 October - 6 November) small larvae were still located in high numbers off Achill Island and also around the Stags of Broadhaven but were poorly distributed in the northern areas.

DISCUSSION AND CONCLUSION

The larval surveys, which have now been carried out each year since 1981, have not yet proved to be a reliable method of monitoring the spawning population. This is mainly because of the large variation that occurs in the larval abundance index, calculated from the small larvae. The alternative index, based on the total larval production and utilizing all larvae taken during the surveys, may provide a more consistent and reliable method of monitoring stock size. This method, however, relies heavily on the presence of high numbers of large larvae and these have been very scarce in all the surveys.

It is possible that they may be quickly carried by currents in a north easterly direction, towards the Scottish coast and therefore outside the survey area. For this reason the survey area was changed in 1987 and more stations were included off the Isle of Islay. Additional stations were also included off the mouth of the Shannon, and some of the stations in deeper water along the western boundary of the survey area were omitted. The north easterly stations are the only ones at which substantial numbers of large larvae have been consistently located.

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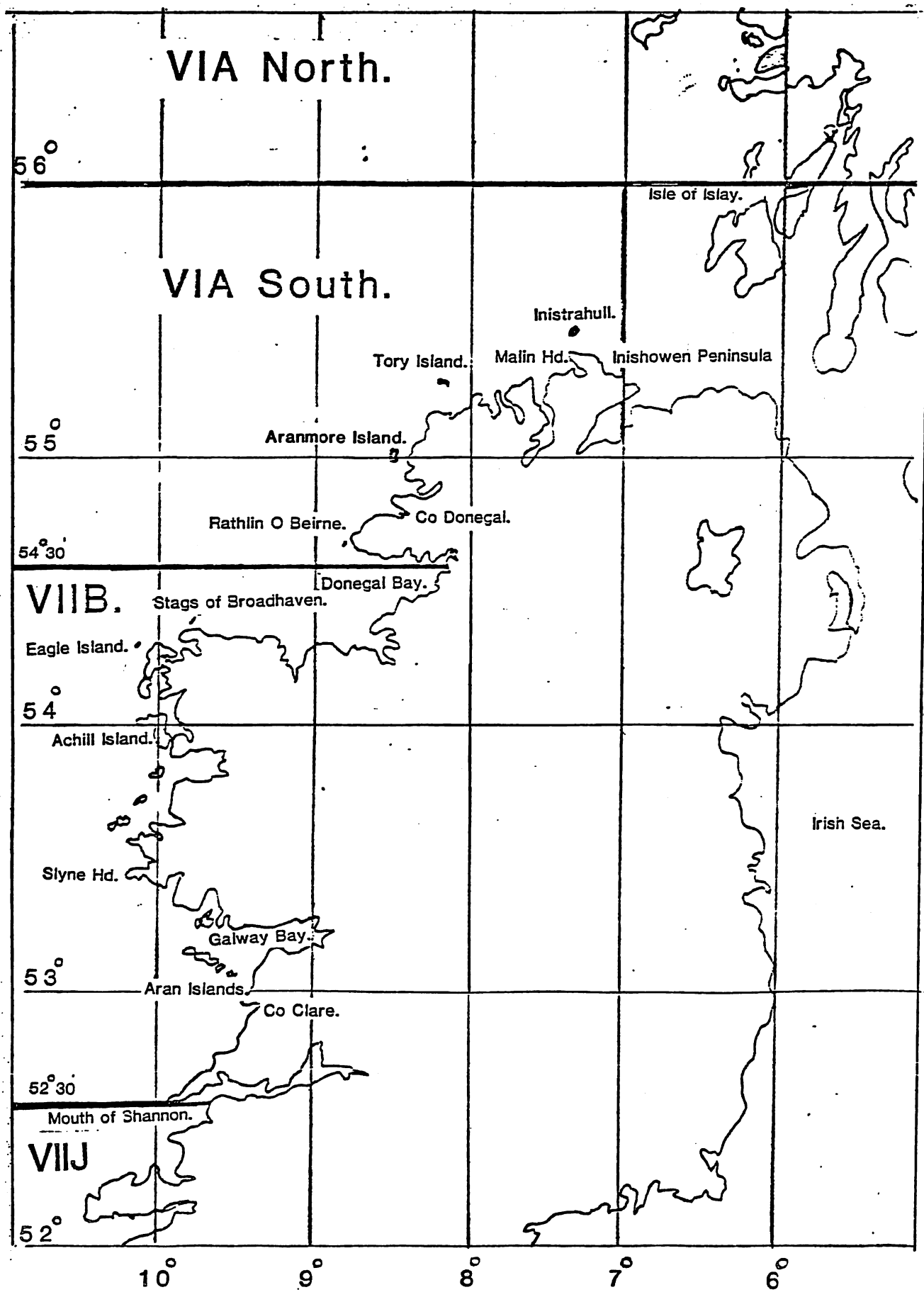


Fig. 1. Areas and place names mentioned in text.

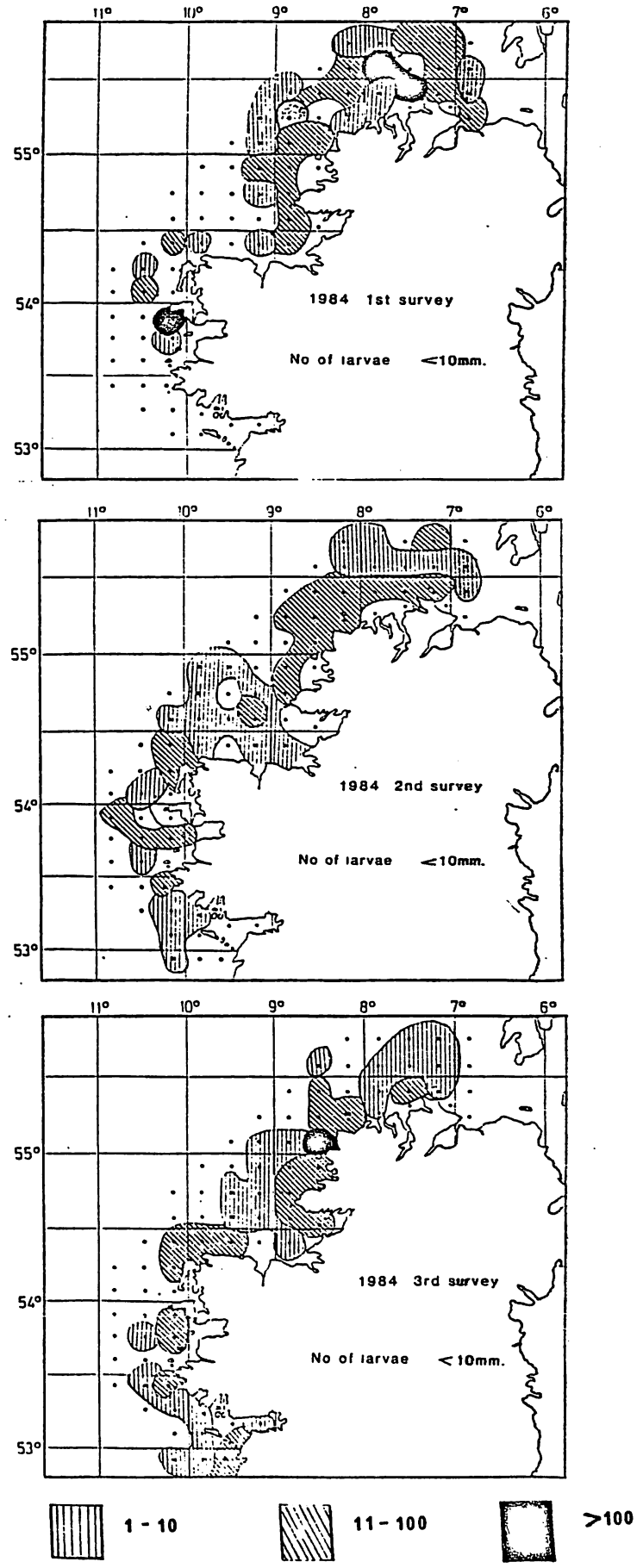


Fig 2. Distribution of larvae nos/m.²

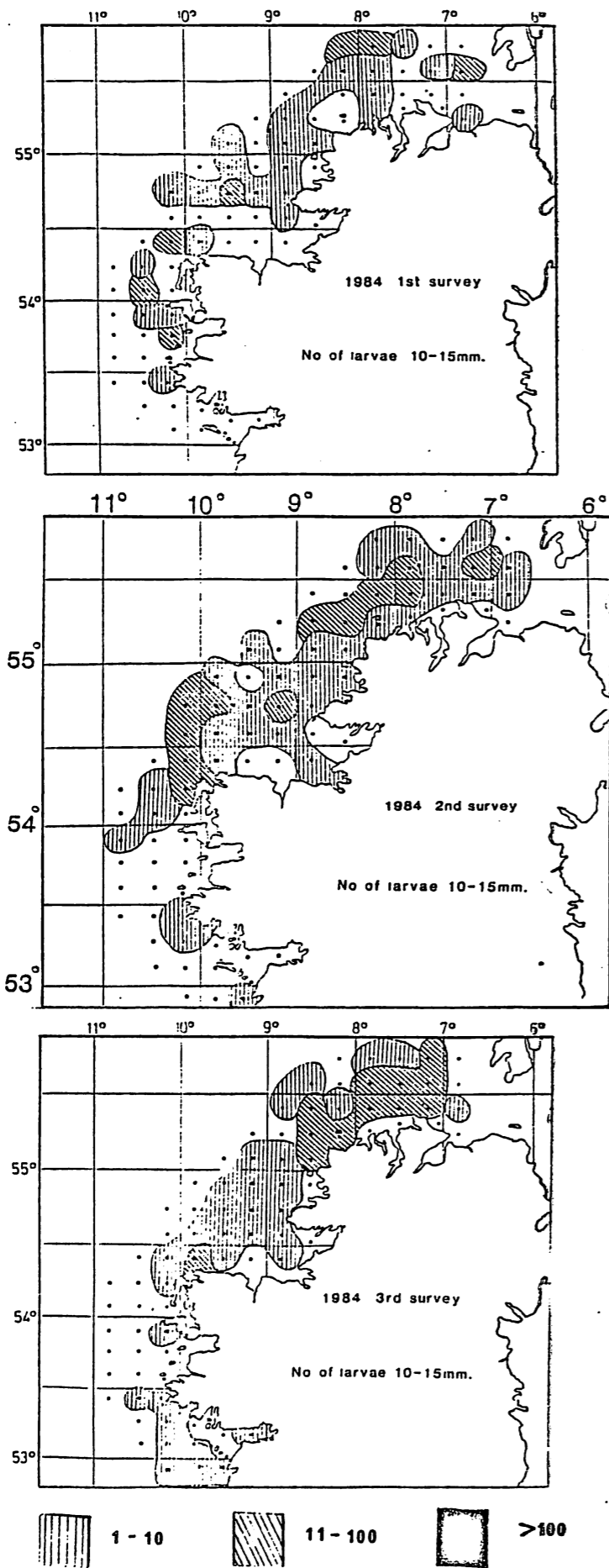


Fig 3. Distribution of larvae nos/m²

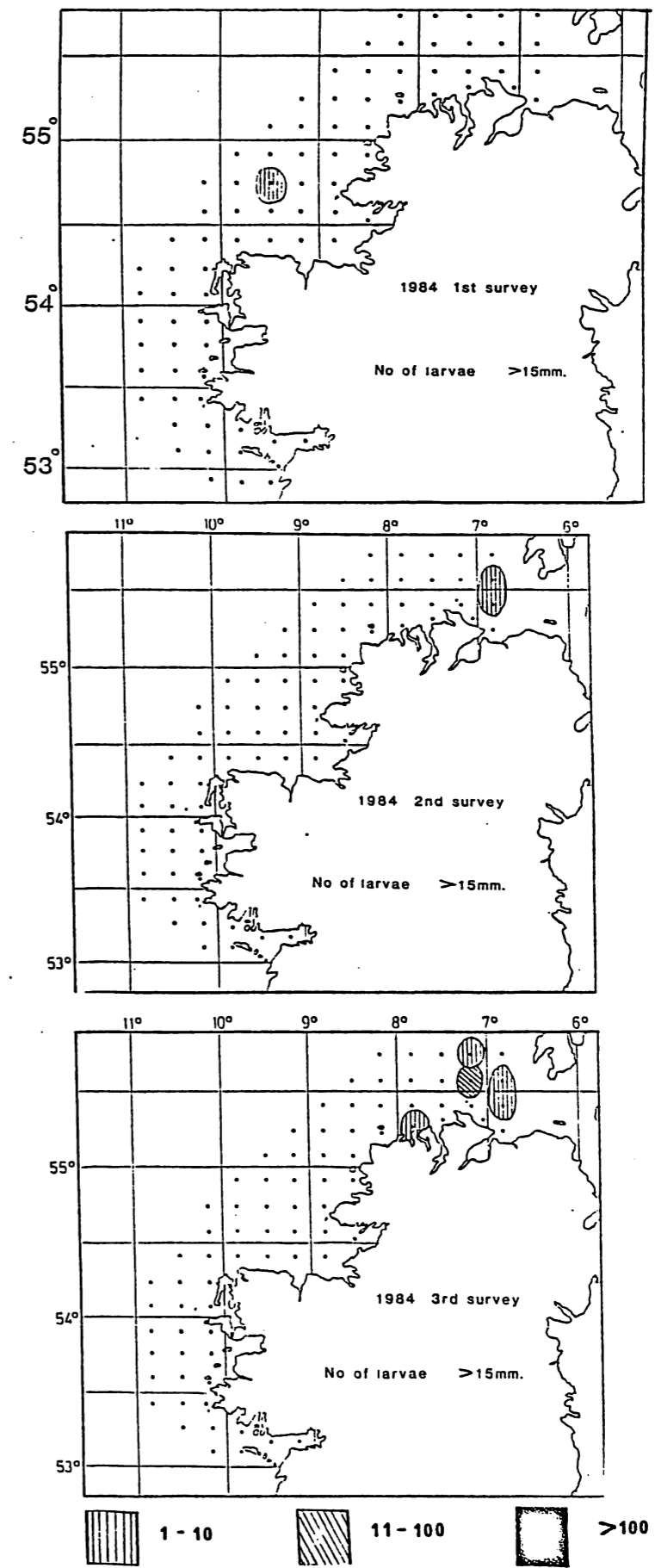


Fig 4. Distribution of larvae nos/m²

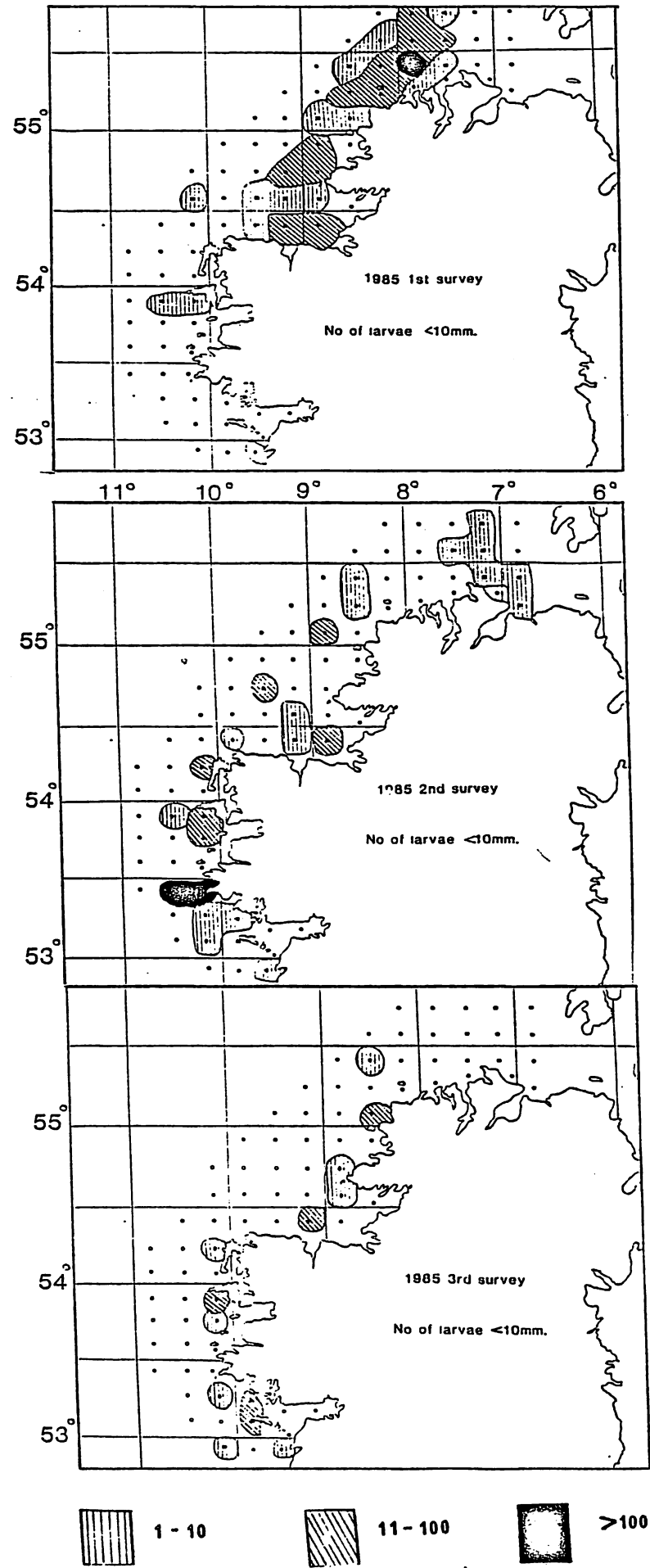


Fig 5. Distribution of larvae nos/m.²

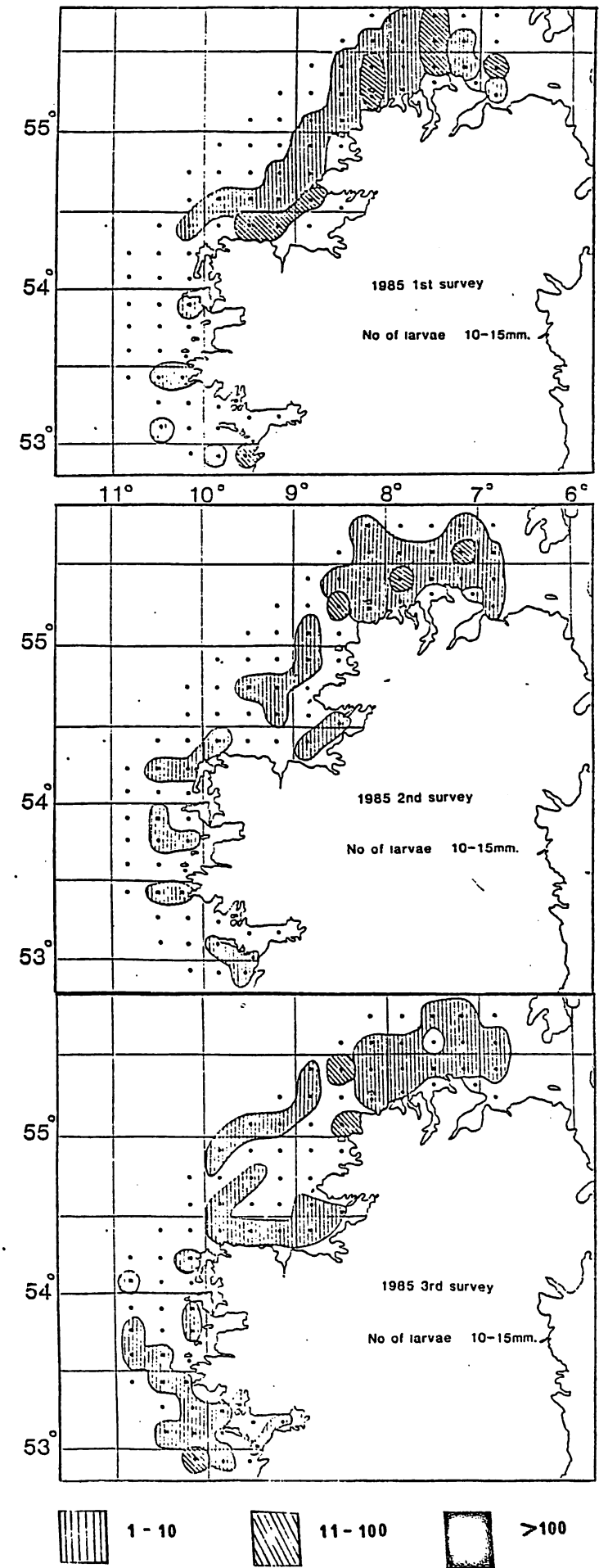


Fig 6. Distribution of larvae nos/m.²

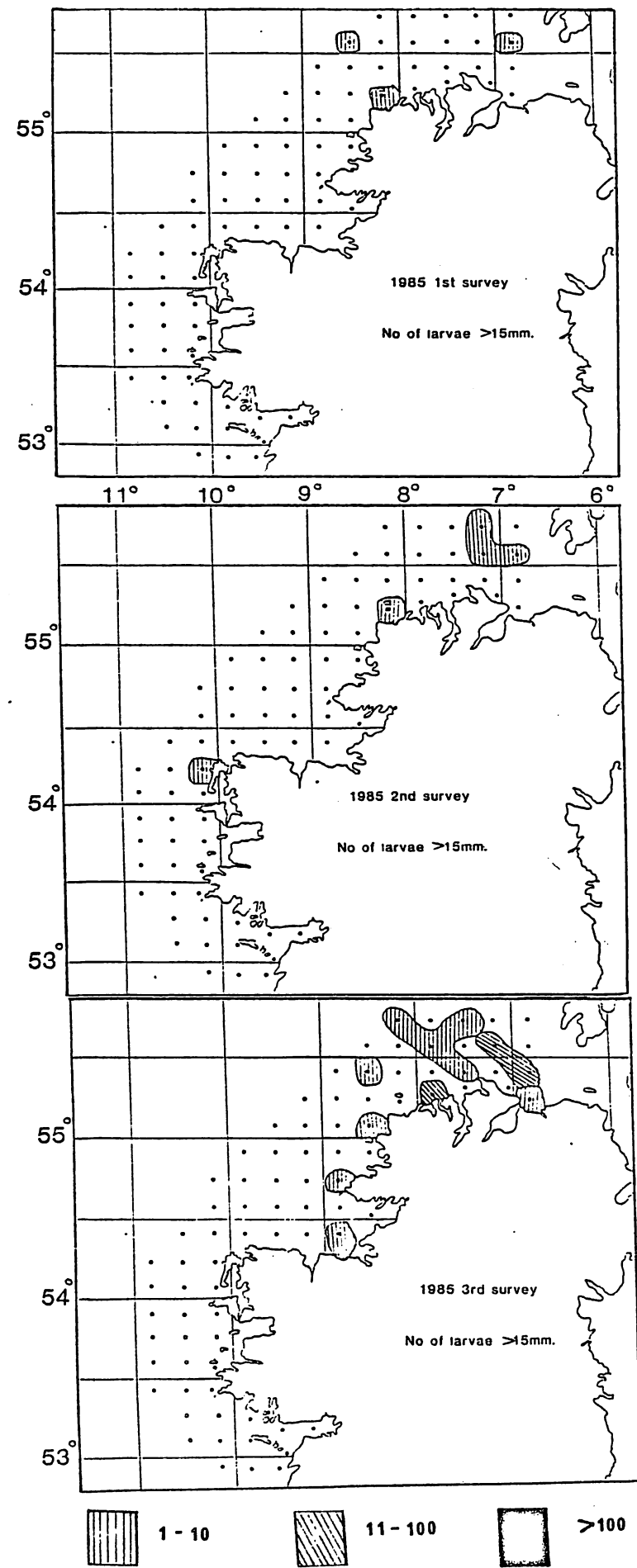


Fig 7. Distribution of larvae nos/m.²

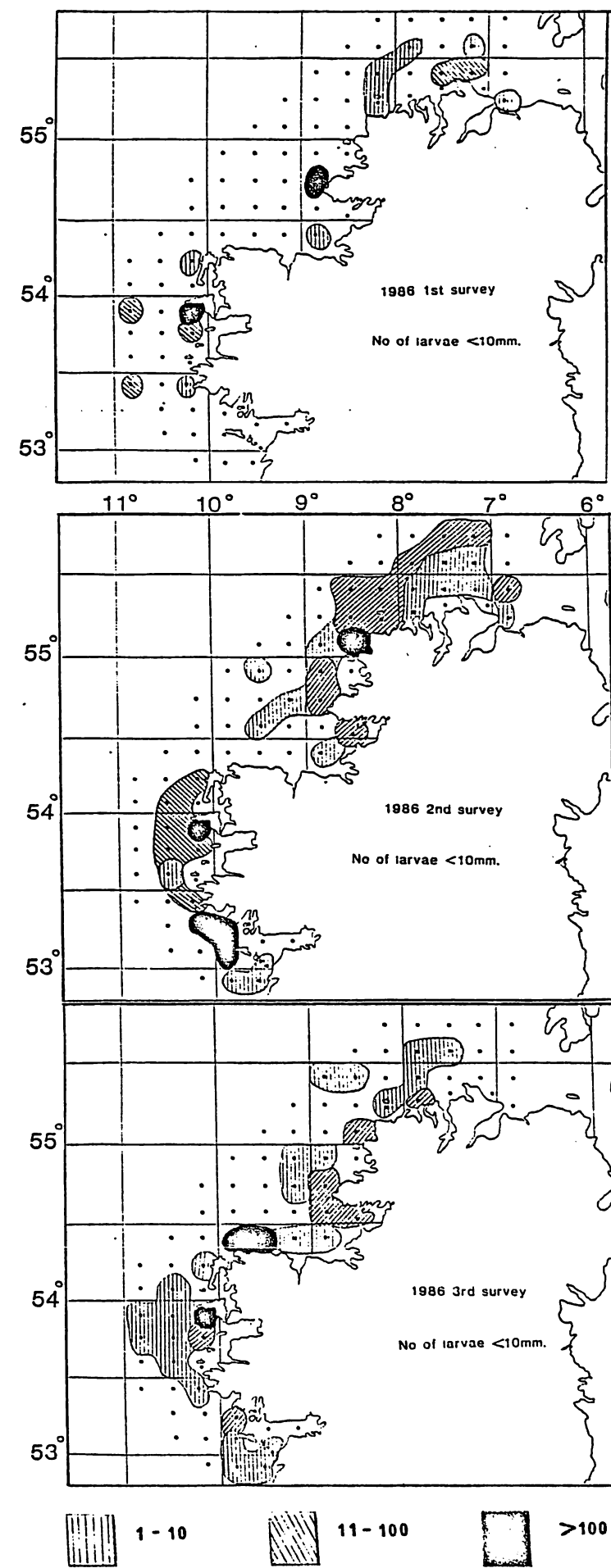


Fig 8. Distribution of larvae nos/m.²

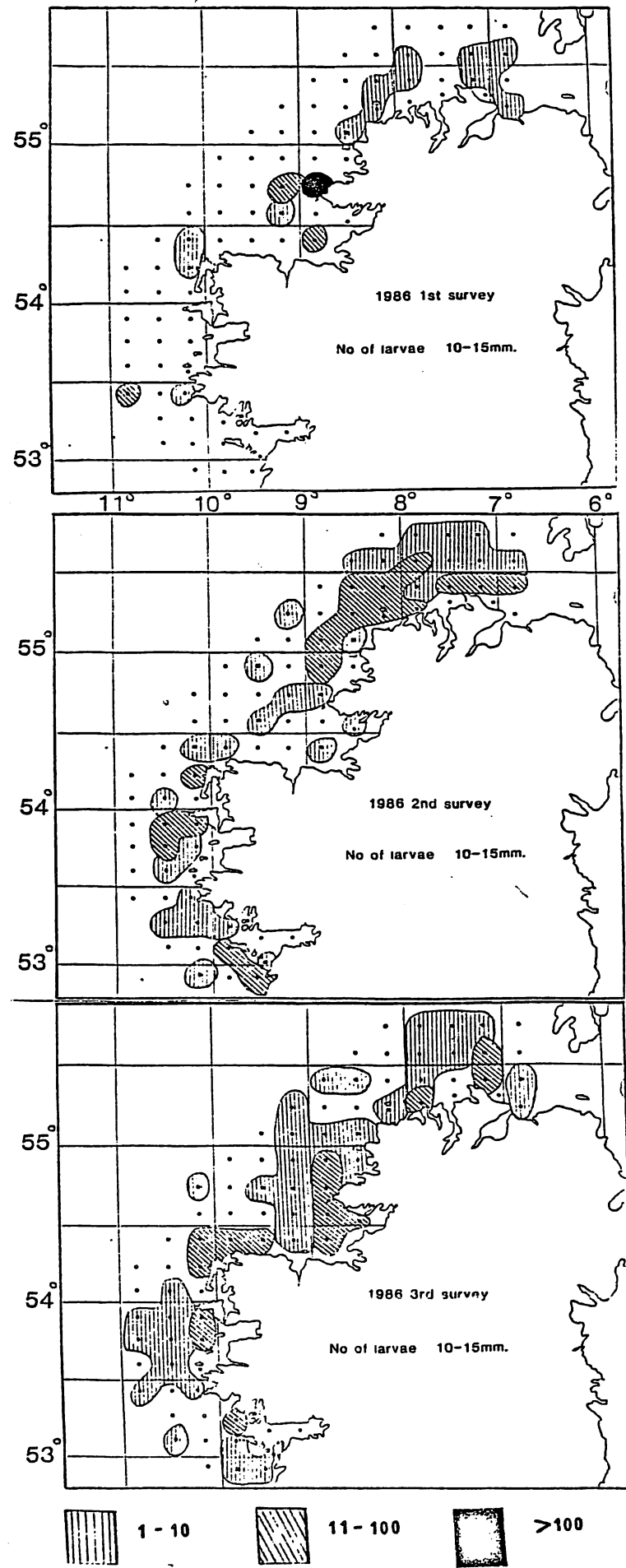


Fig 9. Distribution of larvae nos/m.²

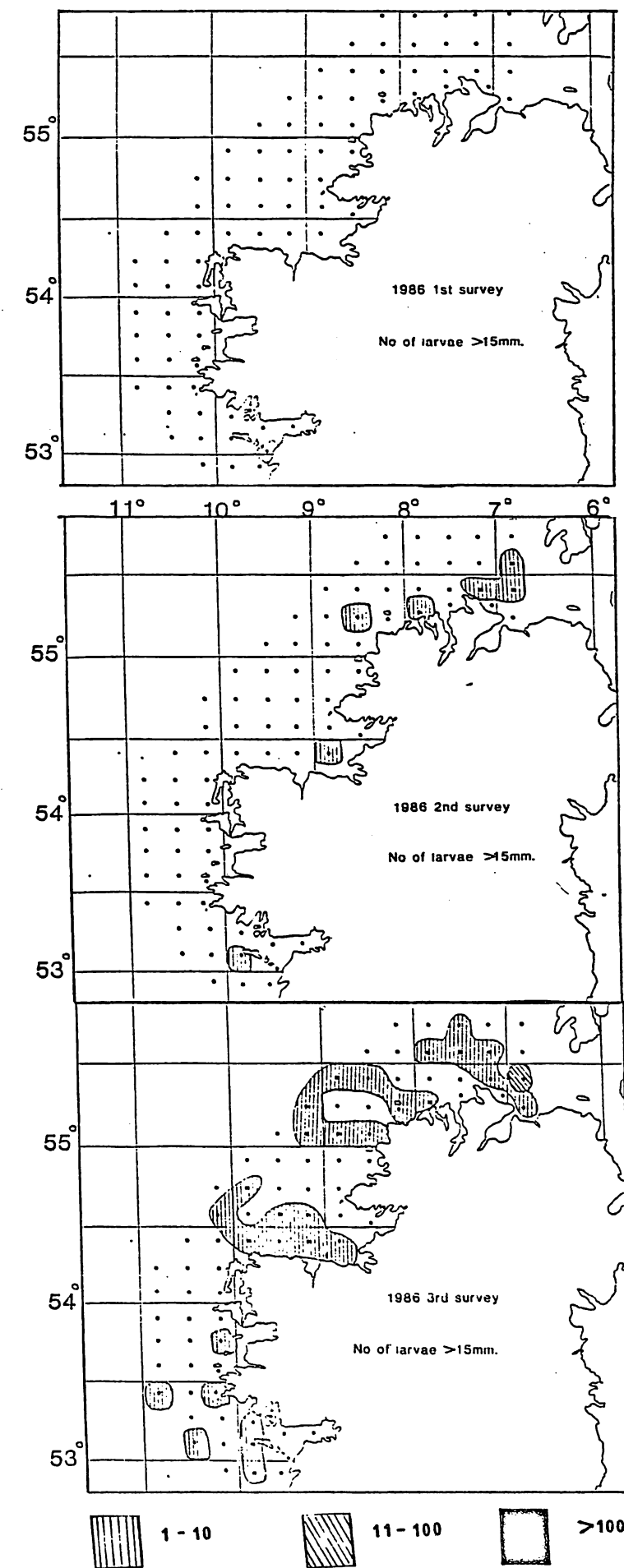


Fig 10. Distribution of larvae nos/m.²

