Spring plankton surveys of the Irish Sea in 1982, 1985, 1987, 1988, and 1989: hydrography and the distribution of fish eggs and larvae

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1. INTRODUCTION

Between March and June of 1982 and 1985 a series of plankton surveys was carried out in the western Irish Sea to calculate the seasonal production of the larvae of *Nephrops norvegicus* L. (Nichols *et al.*, 1987). The samples were also analysed for fish eggs and larvae. Since then, in 1987, 1988 and 1989 there have been further surveys targeted at the spring ichthyoplankton of the area. These later surveys had a wider geographical but more limited temporal coverage than those in 1982 and 1985 and formed part of a joint research programme conducted by the Ministry of Agriculture, Fisheries and Food (MAFF) and the Plymouth Marine Laboratory of the Natural Environment Research Council. This programme was set up to study the timing and magnitude of the primary production cycle and its effect on fish recruitment. Brander and Dickson (1984) suggested that, since the 1920s, commercial fish yields per unit area were lower in the Irish Sea than in the North Sea. This difference was thought to be linked to properties of the production cycle in the Irish Sea resulting in lower recruitment. Although the joint research programme was targeted primarily at cod (*Gadus morhua* L.) and sprat (*Sprattus sprattus* L.), the eggs and larvae of all fish species were quantified in the samples.

2. SURVEY COVERAGE

Table 1 summarises the geographical and temporal coverage of the surveys. The area most extensively sampled was the western Irish Sea (latitudes 52°40'N to 54°30'N and west of longitude 4°40'W). Limited sampling was also carried out to the east of the Isle of Man and off the North Wales coast. In 1987 sampling was confined to the western Irish Sea from 14-24 May, whilst in 1988 extensive sampling was carried out in the above area and east of the Isle of Man between 20 April and 2 May. The survey area west of 4°40'W was covered by a regular grid of 45 sampling stations between 20 and 24 April 1988. Following this survey additional sampling was carried out between 25 April and 2 May on an irregular grid pattern. When combined for plotting purposes the variation in station density across the area generated a confused picture of species distribution using bubble plots. In order to overcome this problem, species abundances within a 10 nautical mile square were aggregated. They were then plotted as an arithmetic mean at a single point in the centre of the square. In 1989 sampling was also undertaken off the North Wales coast. Data from these surveys have been pooled by year.

3. SAMPLING METHODS AND EQUIPMENT

3.1 Shipboard plankton sampling

All plankton samples were taken with a modified version of the Lowestoft 76 cm diameter high-speed sampler first described by Beverton and Tungate (1967). This was modified by increasing the overall length from 2.13 m to 2.75 m and by fitting a conical nose cone with an aperture of 40 cm diameter instead of the hemispherical one (Milligan and Riches, 1983). The sampler was fitted with a 270 µm aperture mesh resulting in an open area to nose cone aperture ratio of 12:1. The sampler was deployed at a nominal speed of 2.5 m s^{-1} in a double oblique tow from the surface to within 2 m of the seabed. Veering and hauling speeds were manually adjusted to ensure that each depth band was sampled equally. On recovery, the net was carefully washed down and the sample collected from the end bag. Each sample was then fixed in a 4% (w/v) formaldehyde solution and returned to the laboratory for analysis.

The sampler, towed on a multi-cored electric cable, was fitted with both internal and external electronic flowmeters. Output was logged directly using a deck unit and used to calculate the volume of water filtered on each deployment (Milligan and Riches, 1983). The

Table 1. Geographical areas and timing of surveys described in this report

Date	Location-full coverage	Location-incomplete coverage
9-12 April 1982	western Irish Sea	east of Isle of Man
27 April-7 May 1982	western Irish Sea	east of Isle of Man
9-13 May 1982	western Irish Sea	
21-26 May 1982	western Irish Sea, east of Isle of Man	
31 May-5 June 1982	western Irish Sea	
15-19 April 1985	western Irish Sea	east of Isle of Man
11-17 May 1985	western Irish Sea	east of Isle of Man
27 May-6 June 1985	western Irish Sea, east of Isle of Man	
14-24 May 1987		western Irish Sea
20 April-2 May 1988	east of Isle of Man	western Irish Sea
16-28 April 1989		western Irish Sea, east of Isle of Man, north Wales coast

flowmeters were calibrated *in situ* on the sampler using a circulating water channel (Harding and Arnold, 1971). Under normal operating conditions, the sampler body accepts over ninety per cent of the theoretical volume of water offered to it at 2.5 m s^{-1}. Even under severe clogging, fifty per cent of this volume would still be filtered (Brander *et al.*, 1993).

3.2 Environmental sensors and water sampling

With the exception of the first survey in 1982 the plankton sampler was fitted with a Guildline CTD sensor package which was used to continuously monitor temperature and salinity throughout the deployment. On the first survey in 1982 only temperature and depth were monitored during deployments. On the subsequent surveys in 1982 the CTD data were observed on a deck unit and recorded as depth profiles on continuous chart records. For all other surveys, the data were logged on the shipboard computer concurrently during sampling.

Surface temperature and salinity were also monitored continuously throughout each survey. This involved pumping sea water over CTD sensors from an intake on the ship's hull, approximately three metres below the sea surface. In 1982 an in-house CTD system was used. This was changed from 1985 onwards to the Guildline CTD, matching the one on the plankton sampler. All CTD systems were routinely calibrated at the beginning and end of each survey. The levels of precision (as the standard deviation about the mean based on the manufacturer's calibrations) were ± 0.04 psu for salinity and ± 0.02°C for temperature. In addition, surface salinity samples were taken at most plankton stations, stored in glass bottles and returned to the laboratory for subsequent analysis. Salinity samples were analysed using an inductively coupled Autolab Salinometer, model 601, MkIII. These samples were used to check the performance of the CTDs.

In 1982 and 1985 surface sea water samples were also taken at most plankton stations for subsequent analysis for nitrate, nitrite, phosphate and silicate. Immediately after collection the samples were filtered through GF/C papers of 1μm nominal pore size. Nitrite and phosphate samples were collected in glass bottles and 1 ml of chloroform added. They were kept cool, and in the dark, and analysed within 10 days of the end of the survey, using the methods of Folkard (1978) for nitrite, and Murphy and Riley (1962) for phosphate. Silicate samples were stored in polythene bottles under identical conditions and analysed according to Folkard (1978).

3.3 Plankton sample sorting and sub-sampling

Initially the 1982 and 1985 samples were sorted only for the larvae of *Nephrops norvegicus* (Nichols *et al.*, 1987; Thompson *et al.*, 1986). The samples were subsequently analysed for fish eggs and larvae, with the exception of the third survey in 1985 from 19-26 May, which had an incomplete coverage of the area. The samples taken in 1987, 1988 and 1989 were sorted for all species. Fish eggs and larvae were picked out from all samples by eye and, whenever practicable, the whole sample was sorted. However sub-sampling was at times necessary. Aliquots were removed using a 20 or 30 ml measured scoop, as described by Harding and Nichols (1987).

The main source of information for the identification of the ichthyoplankton from these surveys was Russell (1976). This was supplemented by various identification sheets produced by the International Council for the Exploration of the Sea, (Saville, 1964; Macer, 1967; Nichols, 1971; Nichols, 1976, Demir, 1976). Using these sources, fish larvae were readily identified unless they had been badly damaged during collection or were prematurely hatched. For some groups such as the sandeels (Ammodytidae) and the group of Gadidae commonly called rocklings, individuals were not identified to the species level. Fish eggs were initially split into three groups on the basis of the presence or absence of oil globules. Those containing either a single or many oil globules could usually be identified to the species level. Eggs with no oil globules were more difficult to identify. Some of these species such as cod (*Gadus morhua*), sprat (*Sprattus sprattus*), long rough dab (*Hippoglossoides platessoides*), dragonet (*Callionymus spp.*) and plaice (*Pleuronectes platessa*) were identified because of their unique size or special features. Unidentified eggs in this group were recorded as egg diameters and the data presented accordingly.

3.4 Data analysis and data storage

The raw data from the shipboard logged systems and the sample analysis in the laboratory, were all permanently stored on a customised data base using INGRES version 5. The various data files are stored on the data base in a series of tables which are linked by having the content of certain fields in common. All routine calculations, calibration changes and conversions were carried out on the data base. For subsequent analysis and plotting, comma separated variable files were produced for use on a PC, where various proprietary software packages were employed. A full description of this data base system will be available as a Directorate of Fisheries Research internal report (Woolner, in prep.). The stratification parameter used in this report was routinely calculated in the shipboard logging software, from the formula given by Simpson (1981), when continuous profiles of salinity and temperature were logged during a plankton tow. It was also calculated for the second and subsequent surveys in 1982, which were not continuously logged, by processing the salinity and temperature values from the paper chart record, at 1 m depth intervals.

Plankton data are normally expressed as either number of organisms per m^3 or per m^2. The number per m^3 is obtained by dividing the numbers per sample by the volume filtered, calculated from the sampler flowmeters. The plankton distributions in this report are expressed as number of organisms per m^2 ($nos.m^{-2}$) which were obtained by multiplying the number per m^3 by the mean sampled depth during a deployment. Numbers per m^2 were plotted as bubble plots on the same linear scale for a species for all the surveys. Bubble diameter is linearly related to numbers per m^2 above a non-zero base-line (Surfer version 4, Golden Software, inc. Colorado, USA).

4. RESULTS

4.1 The physical environment

This section is intended as a brief introduction to the physical environment of the Irish Sea to allow the biological data to be placed in context. Fuller treatments of Irish Sea oceanography can be found in Robinson (1979), Bowden (1980), Procter (1981) and Dickson and Boelens (1988).

The bathymetry of the Irish Sea (Figure 1) plays an important role in determining the physical and biological processes which occur in it. The area is characterised by a deep water trough (>80 m) running centrally between the Irish coast and a line from the southern end of the Isle of Man to the western edge of Anglesey. This trough continues northwards through the North Channel, joining the Malin Shelf, and reaches a depth of 315 m at Beauforts Dyke. To the south the trough links with the Celtic Sea via St George's Channel. In the central area the trough shoals rapidly to the west whilst to the east it slopes more gently to generate a relatively shallow bay (<50 m) bordered by the North Wales coast, Cumbria and the Isle of Man (eastern Irish Sea).

Three primary forces are responsible for the movement of water within the Irish Sea, namely water density differences, tides and the weather (Bowden, 1980). Based on numerical models (Heaps and Jones, 1977; Heaps, 1979; Proctor, 1981), movement of seabed drifters (Ramster and Hill, 1969), direct current meter recordings and radioactive tracer distributions, a tentative scheme was presented for surface and bottom residual currents by Dickson and Boelens (1988). However, time-averaged circulation in the Irish Sea is relatively weak and shows no particular directionality over large areas. In addition, large seasonal changes can be expected. Due to the uncertainty about the patterns of residual flow in the Irish Sea, calculations of average flushing and residence times are at present unreliable. Of interest, in relation to plankton dispersal, is the possible existence of a south-going residual current along the Irish coast.

Tides from the Atlantic Ocean propagate through St George's Channel and the North Channel (Robinson, 1979). The two branches meet to form a standing wave to the south-west of the Isle of Man which is, therefore,

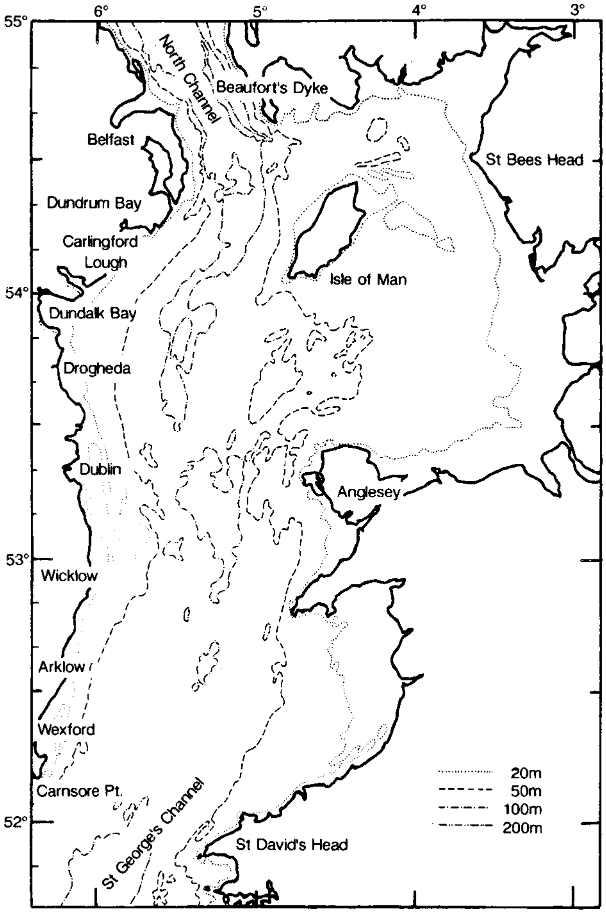


Figure 1. Bathymetry of the Irish Sea (Dickson and Boelens, 1988)

an area of weak tidal currents (Figure 2). This is reflected in the distribution of bottom sediments (Figure 3) with a large area of muddy deposits to the west and south-west of the Isle of Man. Surface waves depend on the duration and fetch of the wind. The Irish Sea is relatively sheltered so that the majority of waves are locally generated, steep and of fairly short period. Wave action during storms will have significant effects in the shallower areas to the east. Large surges in the Irish Sea can be generated by storms tracking between Inverness and the Shetlands. Surface currents in the Irish Sea are affected by wind stress, and transport of water through the North Channel can be, at least partly, correlated with the component of wind blowing along the Channel's axis. Circulation patterns in the Irish Sea are currently undergoing re-evaluation based upon recent data and improvements in modelling wind driven movements (Davies and Jones, 1992; Hill, *et al.*, in press).

The areas of the Irish Sea which are capable of becoming stratified, are principally determined by the degree of tidal mixing and the depth of the water. In most areas of the Irish Sea, tidal mixing is sufficiently strong to maintain a vertically homogeneous water column throughout the year. However, to the south-west of the Isle of Man, where the tidal flows are weak and the

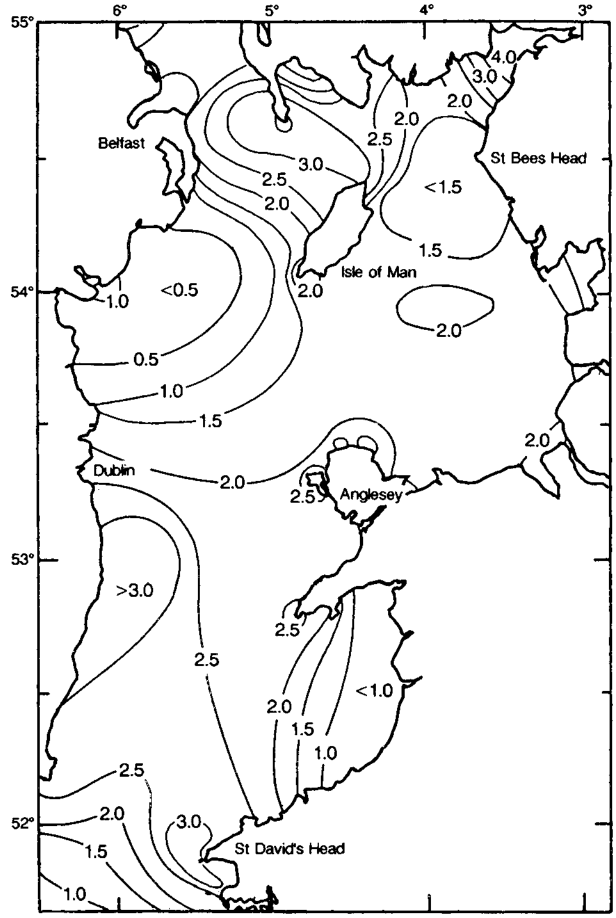


Figure 2. ***Maximum tidal stream amplitude at spring tide in knots. (adapted from Sager and Sammler, 1975)***

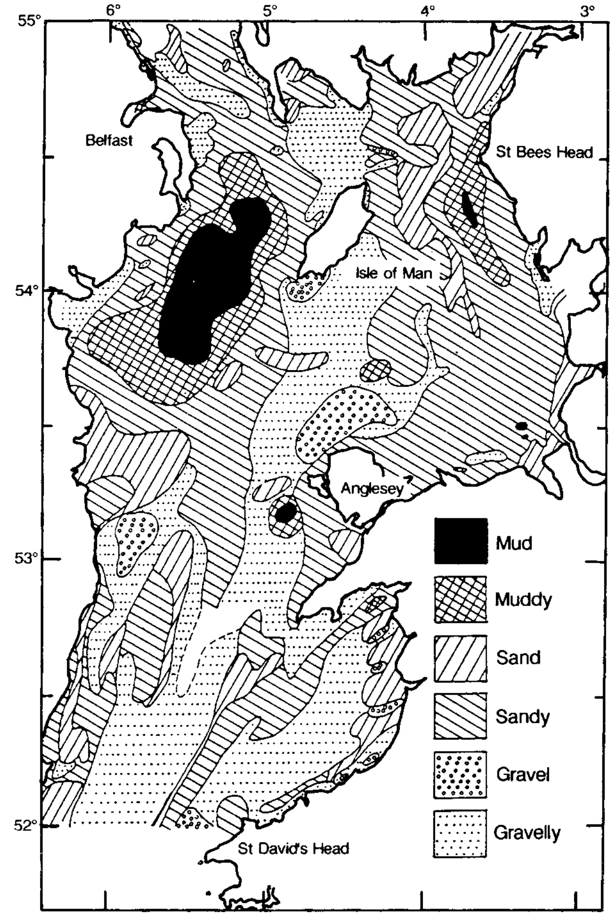


Figure 3. ***Simplified distribution of surficial sediment types in the Irish Sea. (Dickson and Boelens, 1988)***

water is deep, seasonal stratification, to a depth of 20-30 m, is established between April and October. A generalised scheme for the development of stratification, along an axis from Dundalk Bay to Anglesey, is presented in Figure 4. Stratification early in the year is aided by the inflow of cold, low salinity water from the Irish mainland leading to the development of a coastal front. Later on, warming reinforces stratification, leading to a frontal region along the Dublin Bay - Isle of Man axis (Fogg, *et al.*, 1985). Wind induced mixing will disrupt the average pattern, especially early in the year. Seasonal stratification also occurs in the eastern Irish Sea, but the haline contribution is of more importance in its development due to the effect of the riverine input. Stratification is marked in winter and spring, especially near the main river inputs but thermal stratification may develop in the summer. Due to the shallow water depth, the Liverpool Bay front is prone to disruption by wind-induced mixing.

The mean monthly surface temperatures in the Irish Sea for the period 1905 to 1954 (Anon., 1962) showed a steady increase from April through to August, thereafter decreasing to winter minima by March. In March, the mean surface temperature was less than 5.5°C off the English coast. The warmest water, between 7.5 and 8°C, occurred over the deeper water in the south-western Irish Sea. By April the mean surface temperature over the whole area had increased to between 7°C and 8°C. Between April and May the pattern changed with the greatest increase in mean surface temperature occurring in the shallower coastal areas. This pattern of warmer shallow water was firmly established by June. Mean surface temperatures were greater than 14°C in the eastern Irish Sea and less than 11°C over the deeper water. Near the English and North Wales coasts temperatures eventually reached 16 to 16.5°C by August. By November there was a return to the pattern of cooler coastal water with warmer surface temperatures occurring over the deep central trough.

The general pattern of surface temperature distributions in 1982 and 1985, from April to June, (Figure 5) was very similar to the historical monthly mean pattern (Anon., 1962) described above. The only exception to this was in early June 1982, in the centre of the western Irish Sea, where the surface temperatures were more than a degree higher than the historical mean for that month. The temperatures in the same area for the similar period in 1985 (27 May - 6 June) were two degrees lower than in 1982.

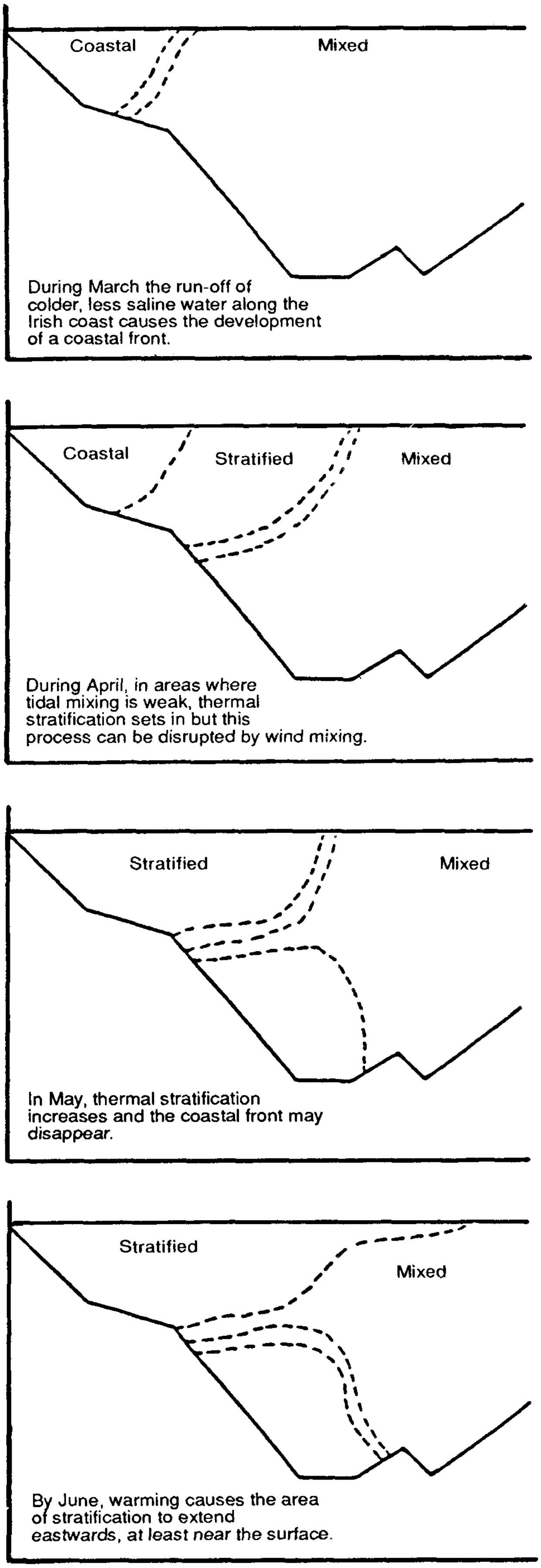


Figure 4. A schematic representation of the development of stratification in the western Irish Sea along an axis from Dundalk Bay to Anglesey

The mean monthly surface salinities for the period 1905 to 1954 (Anon., 1962) show an area of higher salinity (>34 psu) which persisted throughout the year, over the deeper water of the western Irish Sea. A narrow band of lower salinity surface water (<34 psu), at its widest in September and October, occurred off the Irish coast throughout the year. In the eastern Irish Sea mean surface salinity was <34 psu throughout the year. Off the English coast it reached a low of <31 psu in March and April.

The pattern of surface salinity distribution in the western Irish Sea in April and early May, 1982 (Figure 6) was similar to the historical mean monthly surface salinity for that period (Anon., 1962). However, during the second half of May and early June, 1982, there was a much larger area of lower salinity water (<34 psu) extending over most of the western Irish Sea. This incursion of low salinity water can be ascribed to fresh-water run-off from the rivers emptying into these areas. The degree to which surface salinity was lowered will depend on the volume of the run-off and the degree of mixing with more saline waters. The incursion of low salinity surface water was less apparent during the period of the three surveys in 1985 (Figure 6). The surface salinity distributions for that period were similar to the historical means for April, May and June (Anon., 1962).

Stratification parameters (Figure 7) show that a strong area of stratification developed in the western Irish Sea by late May 1982. The onset of stratification may be disrupted by wind mixing as shown during the 1985 surveys. Stratification values are not presented for the survey of 27 May - 6 June 1985 because of technical problems with the Guildline CTD, or for 1987, 1988 or 1989 due to the limited temporal coverage of these surveys.

The distribution of selected nutrients from surface water samples on the 1982 and 1985 surveys, is shown in Figures 8 to 11. Nitrate levels (Figure 8) declined rapidly in the surface waters close to the Irish coast and, in 1982, a distinct area of low concentration (<1 μmol l^{-1}) formed to the south-east of Carlingford Lough by June. Nitrite levels (Figure 9) were generally low (<0.5 μmol l^{-1}) throughout each series of surveys and did not show any particular patterns. Changes in surface phosphate levels (Figure 10) over the same period were barely detectable. The only point of interest in the distribution of phosphate was the high levels (2.3 μmol l^{-1}) detected off St Bees Head in Cumbria. This can be ascribed to discharges from a chemical processing plant on shore. In 1982 the levels of silicate (Figure 11) declined steadily over the survey period, from a high of >6 μmol l^{-1} off the Irish coast in early April, to <3 μmol l^{-1} by early June. A patch of low silicate concentration was detected to the south-west of the Calf of Man between 9 and 12 April. This appears to coincide with a less distinct area of reduced surface nitrate. The depletion may have been caused by a combination of phytoplankton growth and the onset of stratification. This pattern was not repeated in 1985 when surface silicate levels were more uniform. There was evidence of reduced silicate to the east of the Isle of Man.

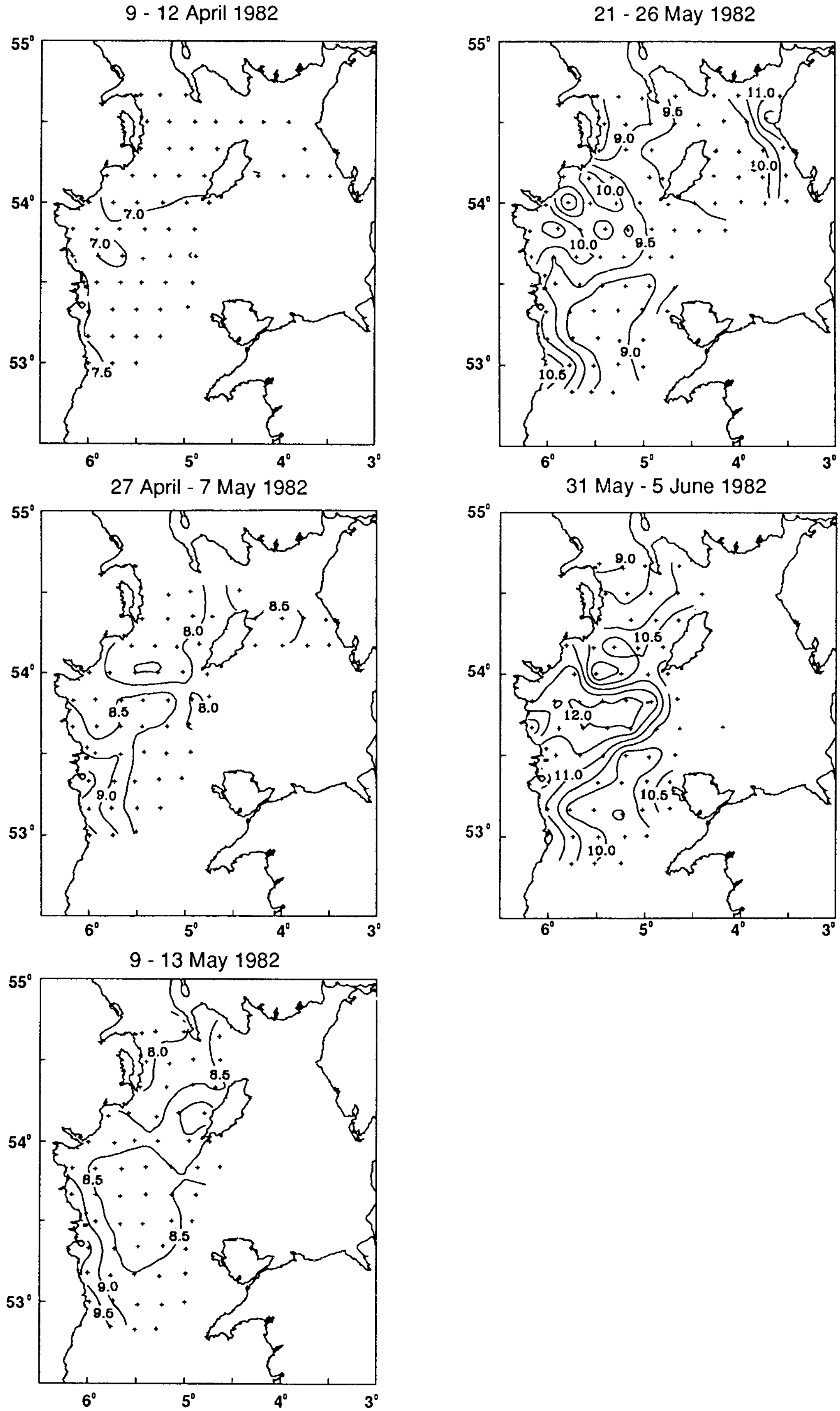
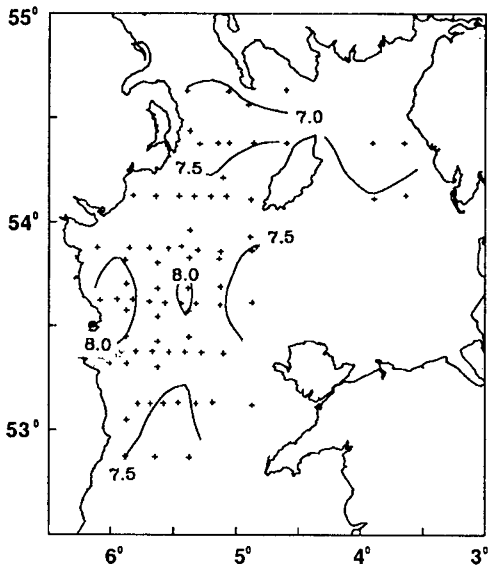
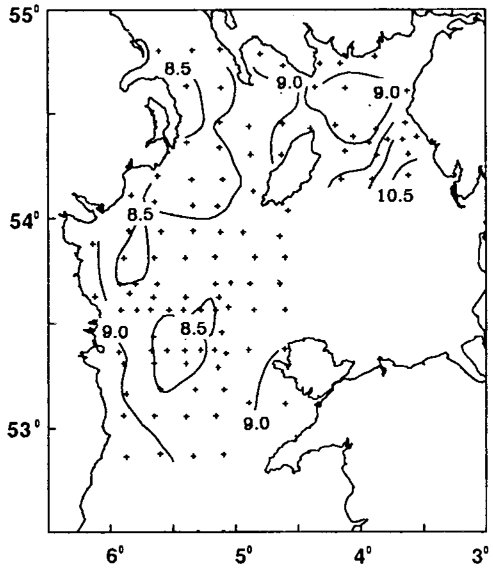


Figure 5. ***Surface temperatures (°C) on each of the surveys in 1982 and 1985***

15 - 19 April 1985



11 - 17 May 1985



27 May - 6 June 1985

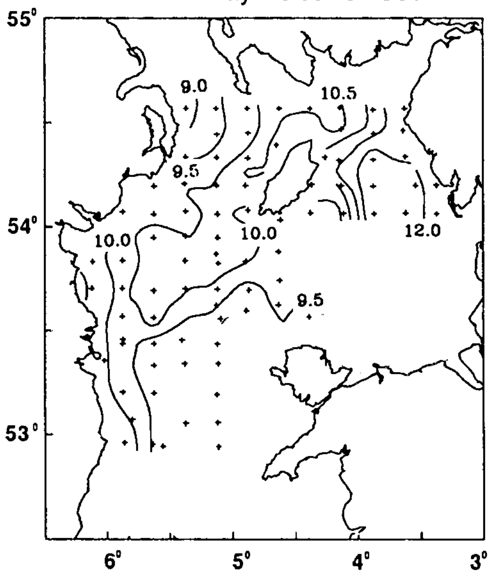


Figure 5 continued

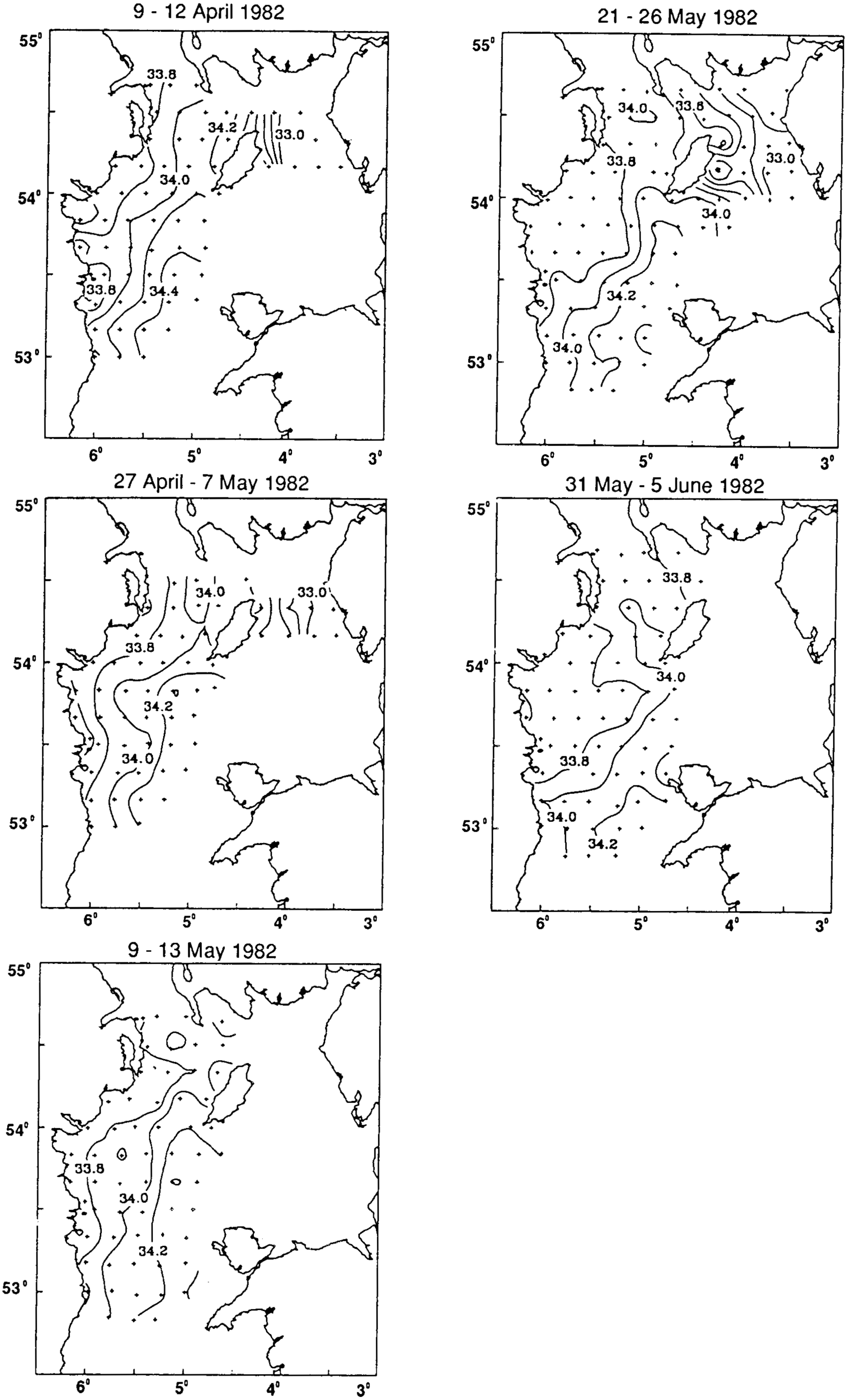


Figure 6. ***Surface salinities (psu) on each of the surveys in 1982 and 1985***

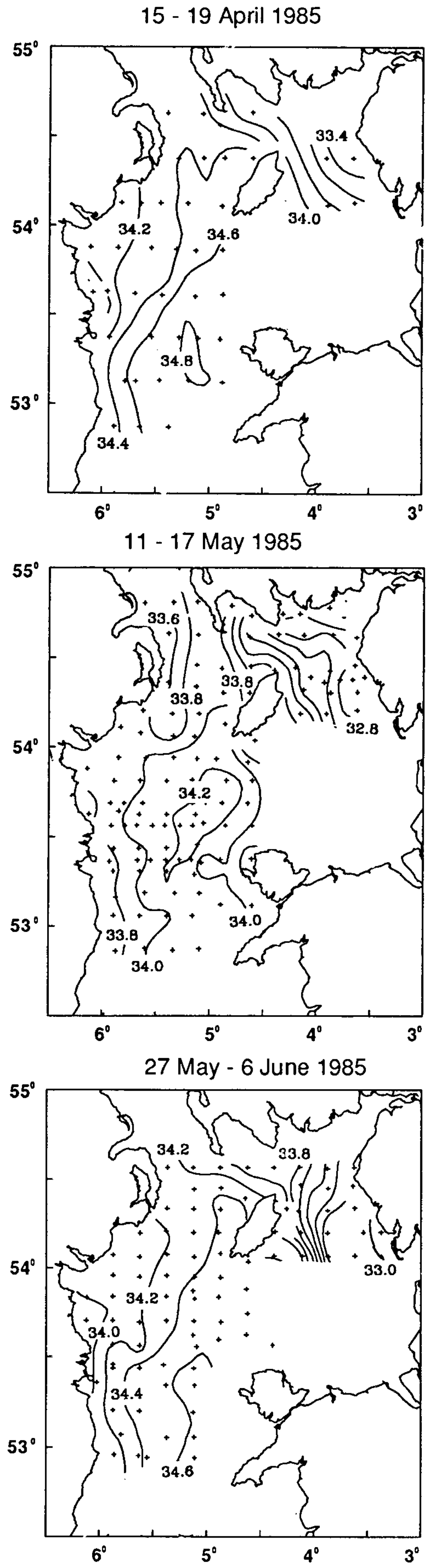


Figure 6 continued

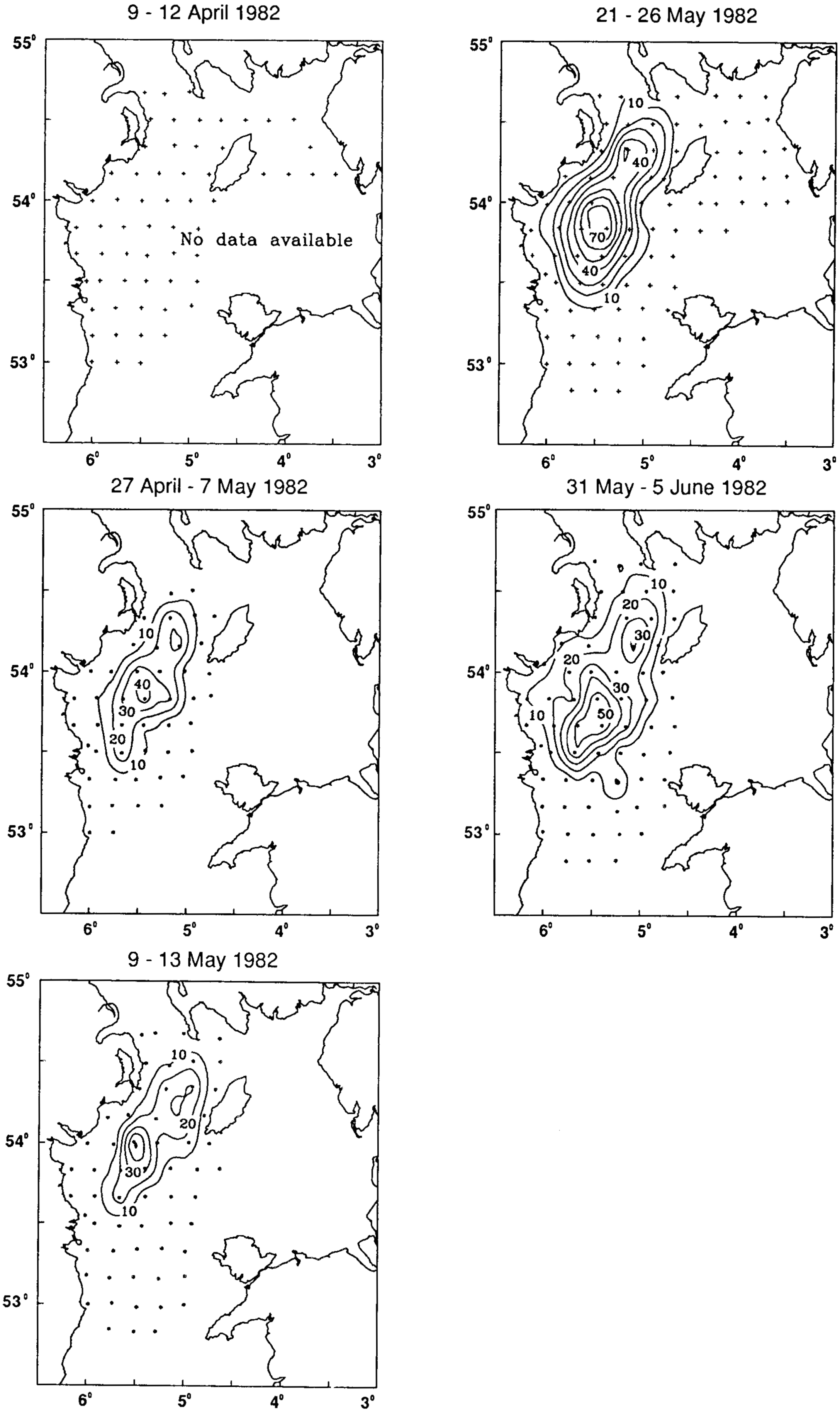
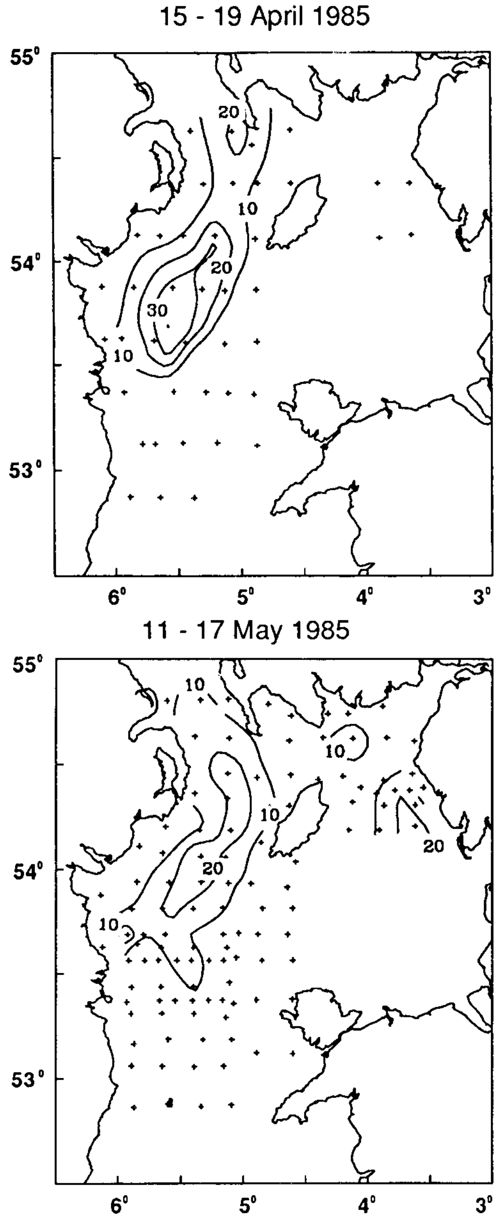


Figure 7. Stratification parameters ($J\ m^{-3}$) on four surveys in 1982 and on two surveys in 1985



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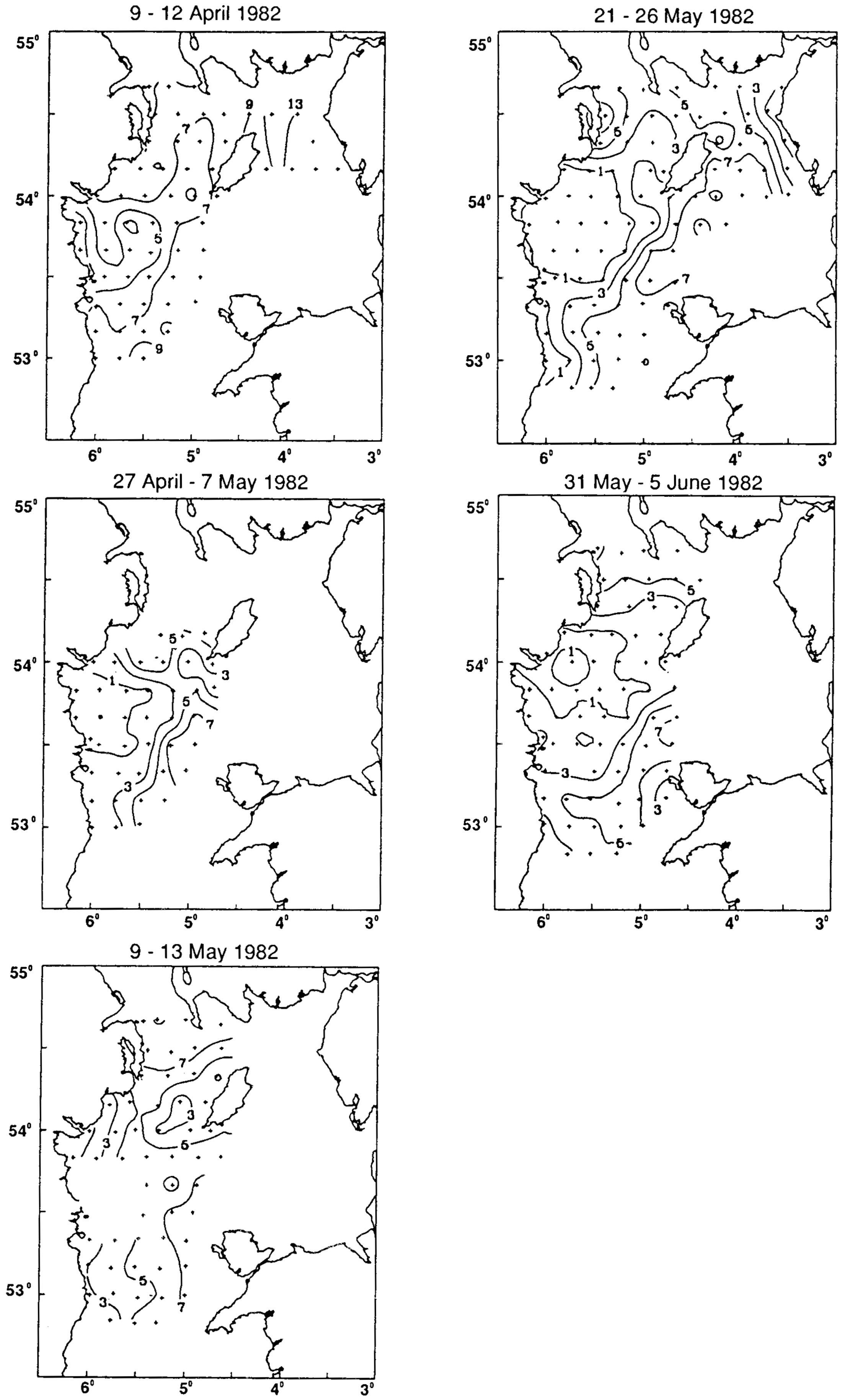


Figure 8. ***Surface nitrate values (µ mol.l-1) on each of the surveys in 1982 and on two surveys in 1985***

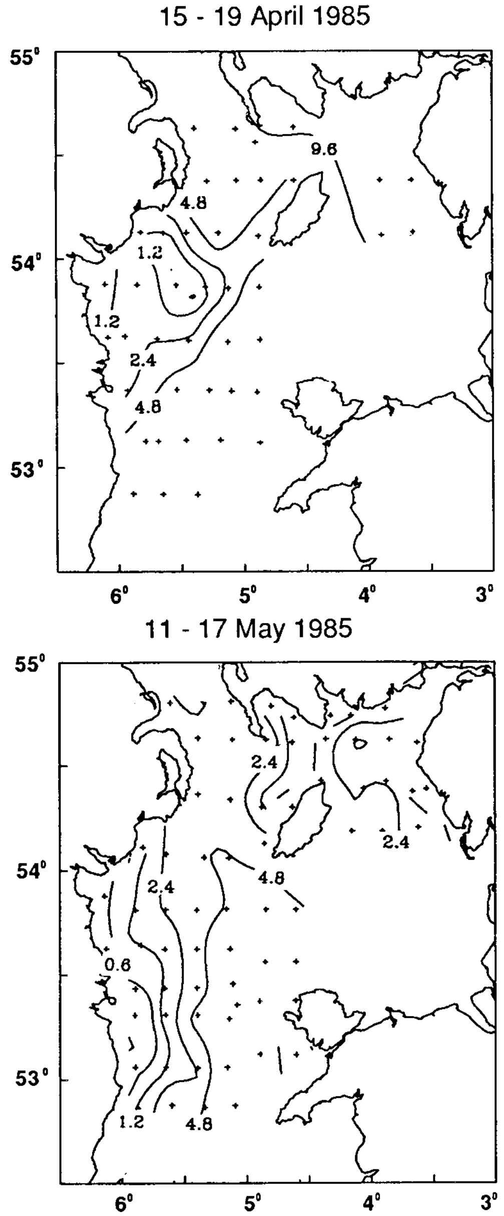


Figure 8 continued

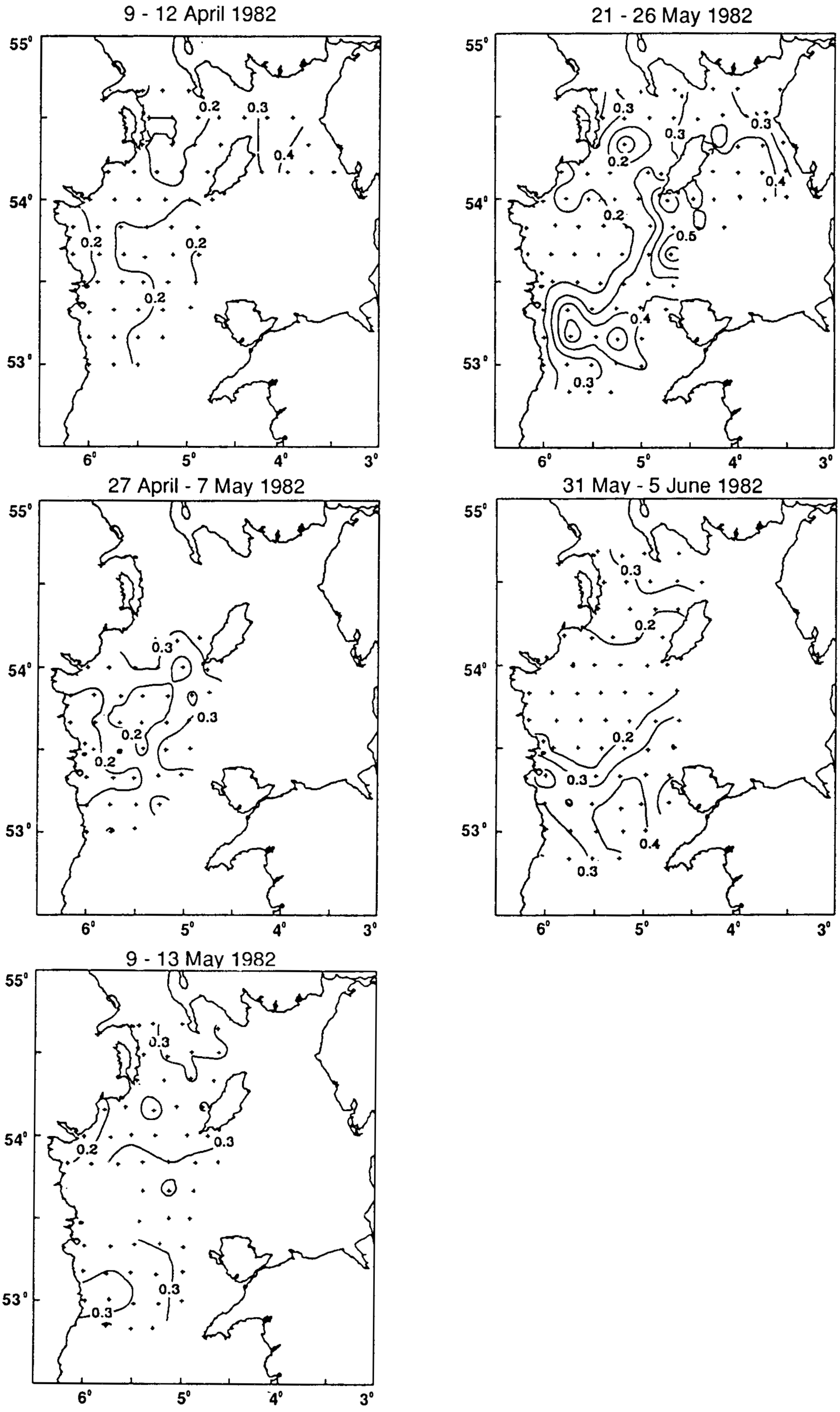


Figure 9. ***Surface nitrite values (µ mol.l⁻¹) on each of the surveys in 1982 and on two surveys in 1985***

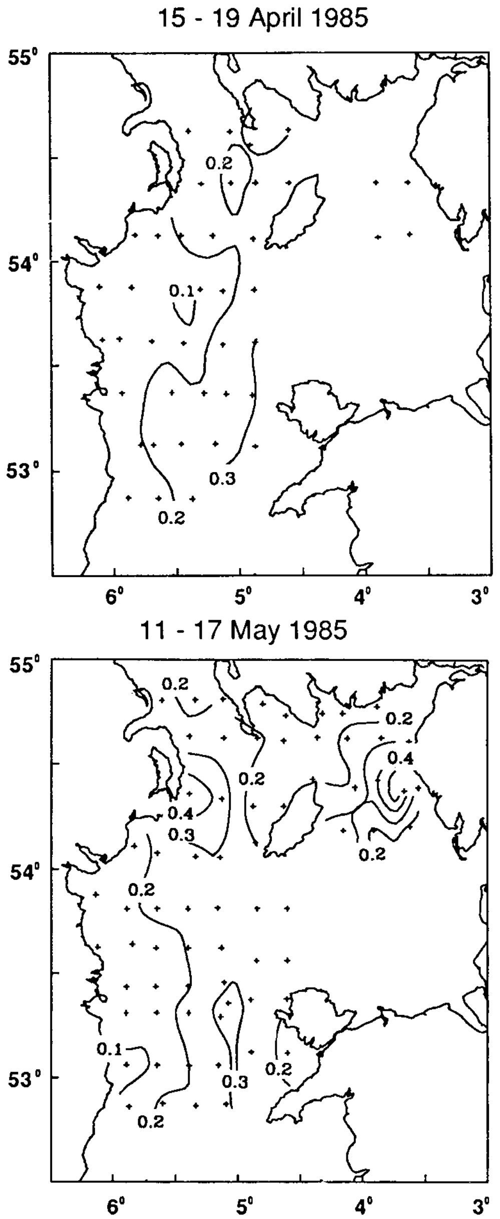


Figure 9 continued

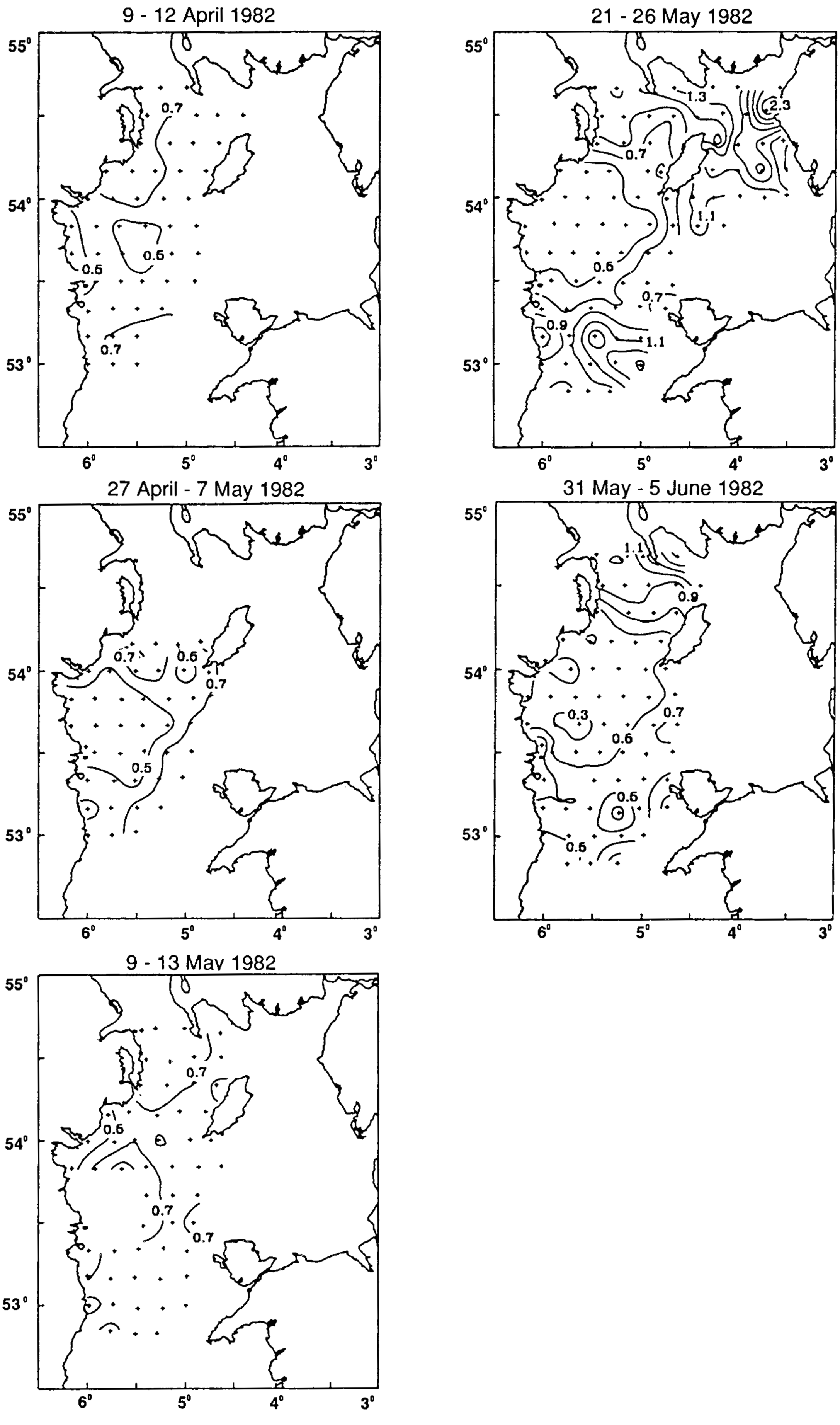


Figure 10. ***Surface phosphate values (μ mol.l^{-1}) on each of the surveys in 1982 and on two surveys in 1985***

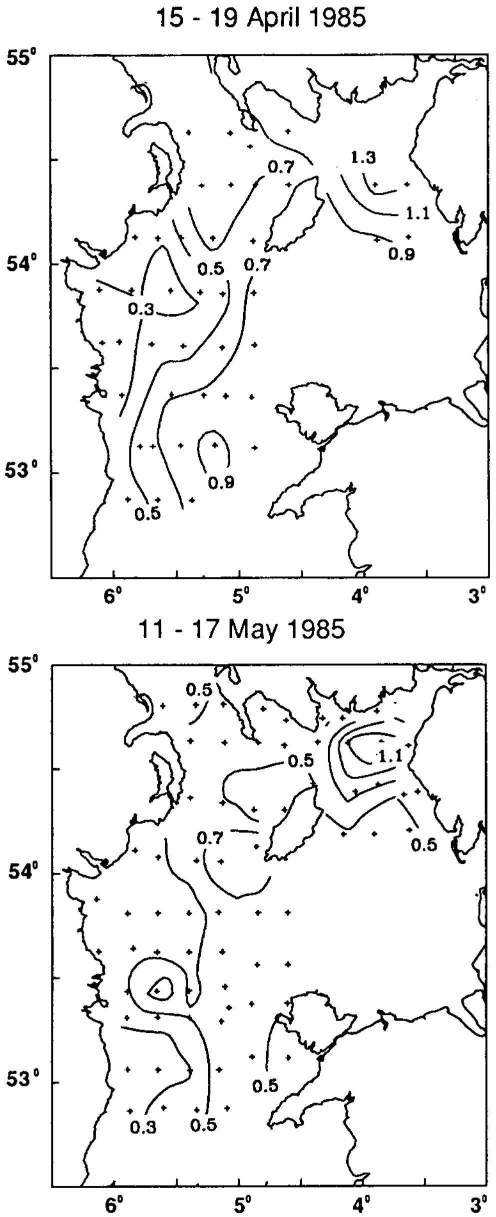


Figure 10 continued

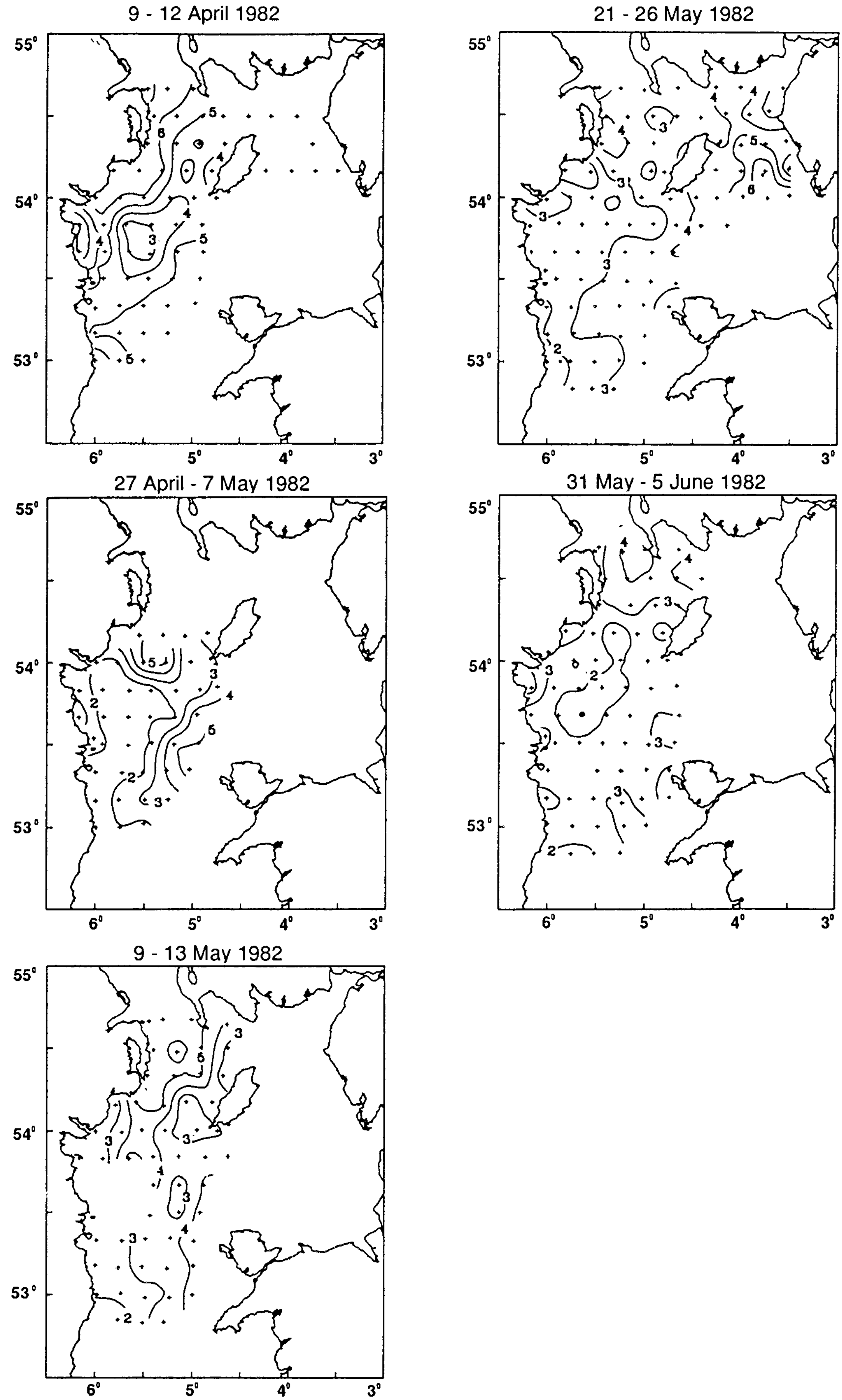


Figure 11. ***Surface silicate values (µ mol.l^{-1}) on each of the surveys in 1982 and on two surveys in 1985***

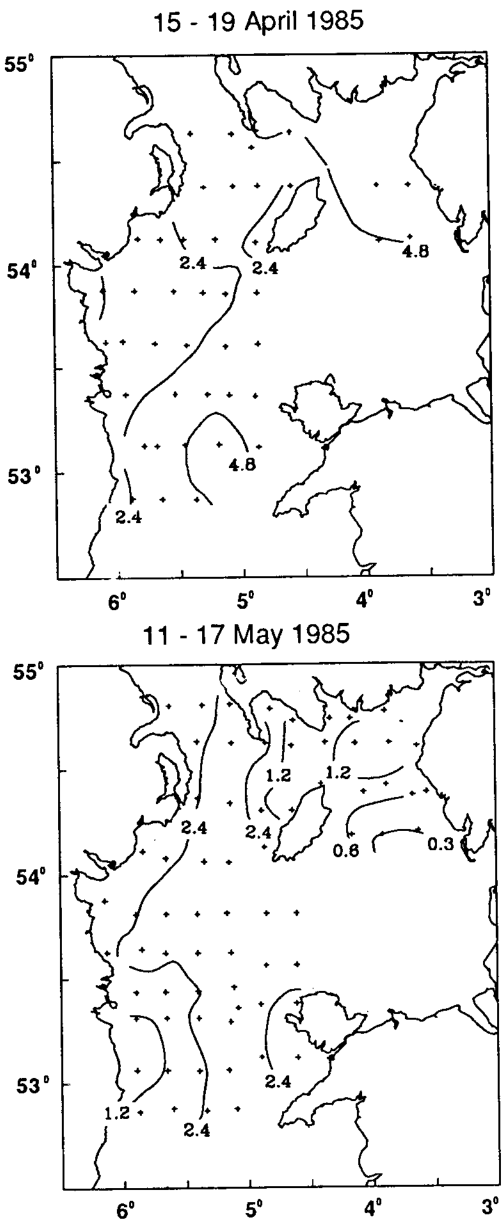


Figure 11 continued

4.2 The ichthyoplankton

From the surveys in 1982, 1985, 1987 and 1989, totals of 21 species of fish eggs and 40 species of larvae were identified. A further 3 groups of eggs and 7 groups of larvae were recorded at the family or genus level only because of the difficulty in identifying them to the species level (e.g. Onos spp., Triglidae, Ammodytidae, Gobiidae). In addition a large group of unidentifiable eggs were measured, generating an egg diameter size distribution. As an example of the data available on this unidentified group, the egg size distribution is shown for six selected stations on the surveys in 1982 (Figure 12 (a-f)). By considering the species of larvae present in the sample and the species egg size range given by Russell (1976), it is possible to speculate on the unidentified egg species composition at each station. At most stations whiting and dab were the dominant species of larvae with unidentified eggs. They were found together with a mixture of other species usually including flounder, pout whiting, poor cod and pollack. A good example of a mix of all these species was found on 12 April (Figure 12(b)), whilst the other examples shown have either no eggs or only a few eggs in the size range below 0.9 mm diameter. This group of small eggs were tentatively identified as the eggs of the dab. This qualitative assessment is speculative, time consuming and has not been routinely made for these surveys.

On some stations in all years some Clupeidae larvae were not positively identified to species, because of damage to small specimens. The majority of these were undoubtedly sprat and they have therefore been grouped together and plotted with that species. All species and taxonomic groups are listed in Tables 2(a-f). These tables also give the maximum concentration

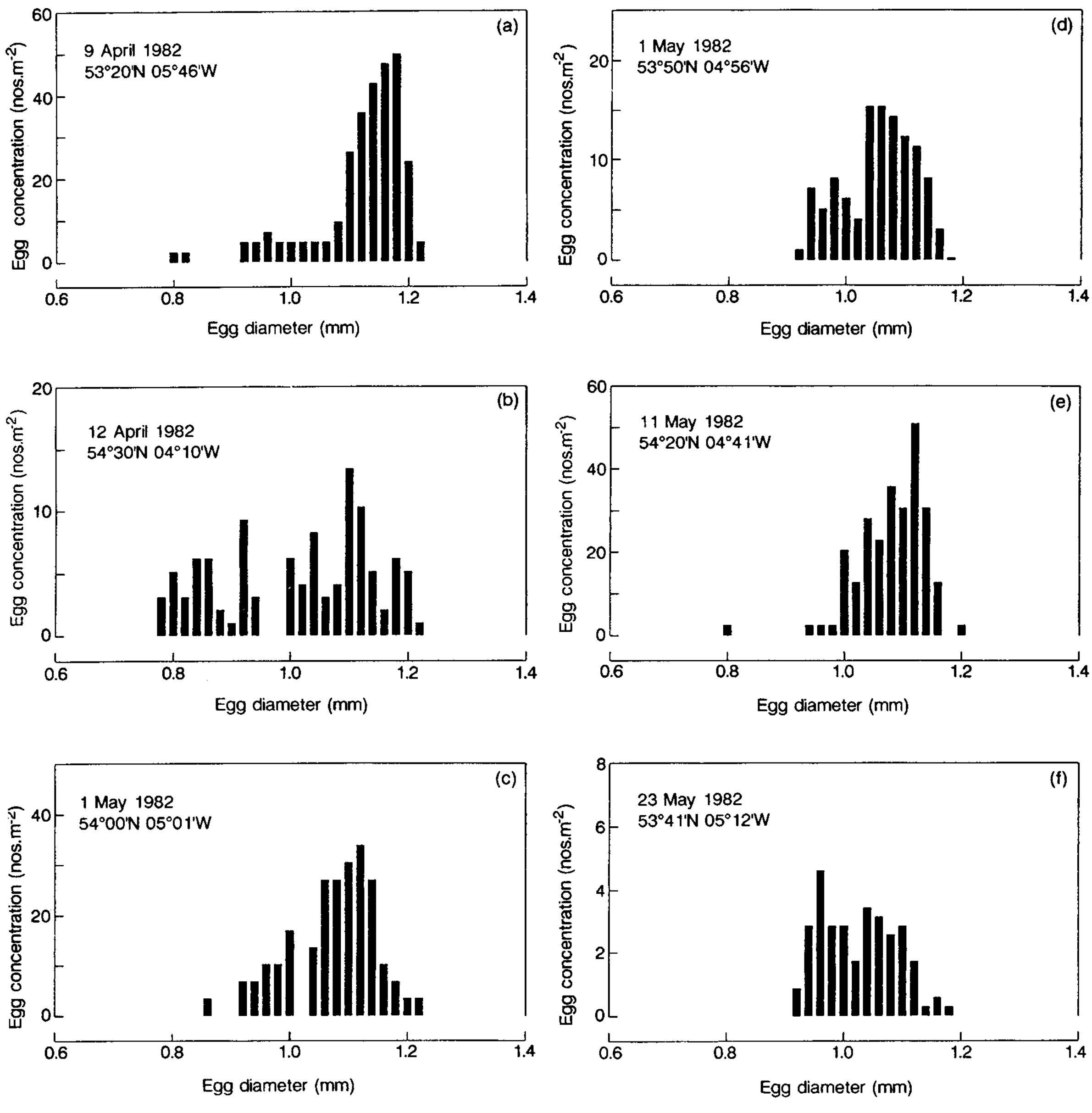


Figure 12. Plots of egg concentration against egg diameter for unidentified measured eggs from selected stations

recorded on each survey and occurrence as a percentage of the stations where a positive record was obtained.

The distributions of total eggs (Figure 13) and total larvae (Figure 14) in all the survey years, show that some spawning occurred over the whole area. However, the highest egg abundances usually occurred close to the Irish coast and between the Isle of Man and the Cumbrian coast. Seventeen of the species recorded are of commercial importance in the Irish Sea, contributing to a total demersal catch which averaged 39 662 tonnes (sd. 4907 tonnes) over the period 1981 to 1987 (ICES region VIIA). Details of the distribution of the most abundant species, including most of the commercially important species, are given below.

4.2.1 *Sprattus sprattus* (Sprat)

This was by far the most abundant species in the area in the egg stage with concentrations of up to 5075 eggs per m^2 off Dundrum Bay in late May 1982 (Figure 15). Peak concentrations in all the other survey years were an order of magnitude lower. The highest abundances in all the surveys tended to be either close to the Irish coast or east of the Isle of Man. There is no major fishery for adult sprat in the Irish Sea, therefore it is not possible to say whether the inter-annual differences in egg abundances were related to changes in adult stock size. However, fluctuations in sprat biomass in the North Sea are well documented. The annual catch rates of over 600 000 tonnes in the mid-1970s fell to only a few hundred tonnes by the mid-1980s. Similar changes have also occurred in the English Channel.

The geographical distribution of larvae (Figure 16) tended to reflect that of the eggs. Peak concentrations occurred in April and early May. The larvae subsequently disperse and in 1982 occurred over virtually the whole survey area although the highest concentrations remained close to the coast. Coombs *et al.* (1992) linked the distribution of larvae with the greater abundance of their preferred food organisms in coastal regions. Inter-annual differences in larval concentrations are not so marked as for eggs although the area of occurrence was more widespread in 1982 than in subsequent survey years.

4.2.2 *Argentina sphyraena* (Lesser silver smelt)

A few eggs of this species occurred on all surveys but were most abundant and most widely distributed in mid-April 1985 (Figure 17). The larvae were sparse and barely featured in the distributions in 1987, 1988 and 1989 (Figure 18). This species is not common in the Irish Sea and would not be expected to spawn there in large numbers.

4.2.3 *Gadus morhua* (Cod)

The main spawning area for this species, off the coast of County Down south to Dublin Bay, can be clearly seen from the first surveys in 1982 and in 1985. Spawning also occurs east of the Isle of Man and in an area southwest of the Isle of Man. A single survey in late April 1989 (Figure 19) shows that some spawning also occurred off the North Wales coast with egg concentrations of up to 53 m^{-2}. Most of these cod are from a single Irish Sea population, although Agnew (1988) presents some evidence to suggest that cod from the Celtic Sea also enter the Irish Sea to spawn off the coast of County Down. Spawning is reported to occur from late February to April, slightly later to the east of the Isle of Man (Brander, in press). Thus the peak of egg production had probably passed before the first of these surveys, explaining the fact that the highest concentration of eggs in 1982 was found in the first survey. Cod larvae were widely dispersed over the western Irish Sea and off the Cumbrian coast in all the years covered in this report (Figure 20). The Irish Sea supports a cod fishery which has averaged total annual landings of 11 748 tonnes (sd. 2702 tonnes) over the period 1981-1990.

4.2.4 *Melanogrammus aeglefinus* (Haddock)

The eggs of this species are similar in size (1.2 -1.7mm diameter) to those of cod (1.16 - 1.89 mm diameter). When they occur together, they are only separable in the late development stage when the embryo is well pigmented (Russell, 1976). On these surveys eggs in the overlapping size range were recorded as cod unless they could be positively identified as haddock from the late stage embryo.

Haddock eggs were positively identified on only one station in the western Irish Sea in 1982 and on three stations in mid-April 1985. On each occasion only one egg was recorded in the sample. Haddock larvae have a distinctive shape and pigmentation and can be easily separated from the larvae of other species. In 1982 they were recorded, in low concentrations, at a total of only four stations (Figure 21). The larvae were more abundant in 1985 with concentrations of up to 5 m^{-2} occurring in the western Irish Sea in mid-April. Larvae also occurred, at concentrations of <1 m^{-2}, at six stations on the 1988 survey and on one station in 1989. From the distribution of larvae in April 1985 it can be seen that they occur in the same area as the larvae of cod. It is likely therefore that a small proportion of the eggs recorded as cod in 1985 were actually haddock eggs. Annual landings of haddock from the Irish Sea have averaged 600 tonnes over the period 1981-1987, with a high of 1287 tonnes in 1987.

4.2.5 *Merlangius merlangus (Whiting)*

The eggs of this species are not separately identified but are included in a group of measured eggs with no oil globules. Their eggs are spherical and range in diameter from 0.97-1.32 mm. The species is widely distributed in this area which is reflected in the larval distributions (Figure 22). From these distributions it can be concluded that spawning probably began during March and continued through to May. Spawning probably occurs over a wide area with the main centres indicated by the areas of highest larval numbers off the Irish coast, south-west of the Isle of Man and east of the Isle of Man. Highest larval concentrations of 78.8 m^{-2} and 53.8 m^{-2} were recorded in early May 1982 and mid-April 1985 respectively. Larval concentrations in the 1987, 1988 and 1989 surveys were considerably lower. Amongst commercially caught species whiting contribute the second highest annual landings from the Irish Sea. Catches have recently declined from over 17 000 tonnes in 1981 to a low of 6932 tonnes in 1991.

4.2.6 *Trisopterus luscus (Bib, Pout whiting)*

The eggs of this species range in diameter from 0.9-1.23 mm and cannot be readily separated from those of similar size with no oil globules. However, the larval distributions in 1982 and 1985 (Figure 23), suggest that spawning occurred away from the Irish coast, began in early April and extended throughout May. The larvae occurred mainly to the east and south-east of the deep water area, which stratifies in the summer months, and were not common on the Irish coast. The landings of this species are not recorded separately from other small gadoids, but are quite small, in the region of 200 tonnes per annum.

4.2.7 *Pollachius pollachius (Pollack)*

The eggs of this species, which range in diameter from 1.1-1.22 mm, are similar in size to those of *Merlangius merlangus* and *Trisopterus luscus* and cannot therefore be separately identified. From the larval distributions in 1982 (Figure 24), spawning appears to have begun in March and extended through most of May. The distribution and abundance of larvae in the other years support this conclusion. The larvae are not abundant in the western Irish Sea with maximum concentrations of only 3.6 m^{-2} in 1982 and 3.9 m^{-2} in 1985. In all the survey years the maximum concentrations of larvae occur along the eastern edge of the central stratified area. The commercial landings of this species have averaged 434 tonnes per annum between 1981 and 1987.

4.2.8 *Molva molva (Ling)*

This is a deep-water species reputed to spawn mainly in depths of around 200 m (Wheeler, 1969). Nevertheless the eggs of this species were recorded on these surveys with a maximum concentration of 18.9 m^{-2} at the end of April 1989 (Figure 25). They were rare in shallow coastal waters and to the east of the Isle of Man. No eggs were taken on the initial survey in 1982 suggesting that spawning had not yet begun in early April. Some eggs occurred on the surveys as late as early June. Maximum egg concentrations were higher in 1985, 1988 and 1989 than in 1982 and occurred in the second half of April. Larvae were also present suggesting that spawning began earlier in those years than in 1982. This pattern suggests a spawning period which may extend from mid-April to June in this area. The distribution of larvae was similar to that of the eggs in all survey years (Figure 26). Larval abundance was low with a maximum concentration of 3.1 m^{-2} in 1985 and 2.9 m^{-2} in 1989, both occurring in the second half of April. This species is taken commercially and annual landings have averaged approximately 300 tonnes over the period 1981 to 1987.

4.2.9 *Merluccius merluccius (Hake)*

Hake are not common in the area of the Irish Sea covered on these surveys. Although annual landings from the Irish Sea have averaged 1523 tonnes over the period 1981-1987, most of those were probably taken outside the area covered on these surveys. Hake eggs were recorded, as single specimens only, at three stations in 1982 and at one station in 1987. Hake larvae were recorded at one station, 25 km west of Anglesey, on the 1989 survey, at a concentration of <1 m^{-2}.

4.2.10 *'Onos' spp. (Rocklings)*

This group of species is ubiquitous in North West European shelf waters occurring over a wide range of habitats and depths. Four species occur in the Irish Sea, *Gaidropsarus meditteraneus* (shore rockling), *Gaidropsarus vulgaris* (three-bearded rockling), *Enchelyopus cimbrius* (four-bearded rockling) and *Ciliata mustela* (five-bearded rockling). *G. meditteraneus* spawns inshore in June and July and is therefore not likely to feature significantly in these surveys. However, the other three species may have been present since *G. vulgaris* spawns in shallow water in January and February, *E. cimbrius* spawns in deeper water (>50 m) from May to August and *C. mustela* spawns off-shore in winter and spring although the adults occur in the littoral zone. Maximum egg concentrations occurred close inshore in early April 1982, but this pattern was not repeated in the other survey years, when the highest egg numbers were away from the coast (Figure 27). Larvae were widely distributed over the area on all the surveys confirming the likelihood of a complex mixture of species (Figure 28).

4.2.11 *Triglidae (Gurnards, Gurnets)*

Neither the eggs nor larvae of this group are routinely identified to genus or species. Ehrenbaum (1905-09) remarked that even following artificial fertilization the egg and larval stages of this group were so similar that certain identification might never be possible in plankton samples. Four species occur in the Irish Sea. The commonest is *Eutrigla gurnardus* (grey gurnard) which spawns from January to June. The three other species are *Aspitrigla cuculus* (red gurnard) which spawns from April to August, *Trigloporus lastoviza* (streaked gurnard) spawning from June to August and *Trigla lucerna* (tub gurnard), the largest of the gurnards, which spawns from May to July. Neither *T. lastoviza* nor *T. lucerna* are common in the Irish Sea. The eggs and larvae recorded on these surveys are most likely to be those of either the *E. gurnardus* or *A. cuculus*. The egg distributions on all the surveys show that spawning was distinctly away from the coast in the western Irish Sea, although the habitat requirements do not deter adults from these shallow areas (Figure 29). Some spawning does occur in shallower water as the season progresses. This is particularly noticeable off the Cumbrian coast and in the Solway Firth in 1985, but is also apparent off the Irish coast in mid-May 1987. It is possible that the later spawnings, in shallower water, are of *A. cuculus*. Numbers of larvae are low with a maximum concentration of 4.1 m^{-2} in early May 1982. They occur mainly off-shore with the maximum concentrations in the mixed water regimes, south and east of the stratified area of the western Irish Sea (Figure 30). *E. gurnadus* is the only gurnard of commercial importance in this area. Landings of gurnards from the area over the period 1981-1987 have averaged 207 tonnes per annum.

4.2.12 *Cottidae (Bullheads and Sculpins)*

The younger larvae stages of the Cottidae family are not easily identified to species and have therefore been recorded as Cottidae. Specimens in good condition and some of the later stages were identified to species. Three species occurred as larvae in these surveys *Myoxocephalus scorpius* (Bull-rout), *Taurulus bubalis* (Sea scorpion), and *Taurulus lilljeborgi* (Norway bullhead) (Tables 2(b), 2(d), 2(f)). For presentation, their numbers have been combined with unidentified specimens and plotted as Cottidae (Figure 31). They are a shallow water family with a benthic egg generally requiring a rocky or weedy substrate for adhesion. They occur mainly in coastal waters on these surveys with the highest concentrations around the coast of the Isle of Man.

4.2.13 *Liparis spp. (Sea Snails)*

The sea-snails, *Liparis spp.*, are another shallow water group with a benthic egg most commonly occurring close to the coast. These surveys show that their larvae are not confined to the immediate vicinity of the coast but do also occur in the mixed water regimes off-shore (Figure 32).

4.2.14 *Pholis gunnellus (Butterfish)*

The eggs of this species are benthic and most commonly occur inshore on a rocky substrate. They may also be found off-shore on sand or mud where the eggs may be laid in bivalve shells (Wheeler, 1969). Their spawning period in the Irish Sea is from January to March (Qasim, 1956). The larvae occurred in low numbers over quite a wide area on all the surveys (Figure 33). The maximum concentration of 46.4 m^{-2}, in mid-May 1985, occurred some 20 nautical miles off Dublin Bay. This area was also the centre of their distribution in mid-April 1985 and in early April 1982.

4.2.15 *Ammodytidae (Sandeels)*

Four out of the five species of Ammodytidae occur in the Irish Sea although one of these, *Ammodytes tobianus*, spawns in the autumn and is therefore unlikely to feature as larvae in spring surveys. Of the other three species, *Ammodytes marinus* is common off-shore and spawns from January to March, *Gymnammodytes semisquamatus* spawns from April to July and *Hyperoplus lanceolatus*, which is very common and widely distributed, spawns in April and May. The eggs of this group are all benthic but the larvae appear in the plankton soon after hatching. They remain planktonic until reaching lengths of >25 mm. The larvae in these surveys have not been identified to species, although it is possible using descriptions by Macer (1967) and Russell (1976). In all the surveys the larvae were widespread occurring over a wide range of depth and habitat. The highest concentrations occurred on the first surveys in 1982 (70 m^{-2}) and 1985 (193 m^{-2}) (Figure 34). From this, one can conclude that the peak concentration probably occurred before early April and that the majority of the larvae are those of *A. marinus*. However the larvae of *G. semisquamatus* and *H. lanceolatus* may also be present in April and May. There is no commercial industrial fishery for sandeels in the Irish Sea.

4.2.16 *Callionymiidae (Dragonets)*

The eggs and larvae of the two species commonly occurring in this area have not been separately identified from these surveys. *Callionymus lyra* (common dragonet) is reputed to spawn from late January through to August (Russell, 1976) in shallow water <50 m depth. *Callionymus maculatus* (spotted dragonet) spawns April to August and tends to favour deeper water than *C. lyra*. There is no information on the spawning of *C. reticulatus* (reticulated dragonet) in the Irish Sea. This species is uncommon but has been recorded from the northern Irish Sea (Wheeler, 1969). It is reputed to frequent shallow water and in the English Channel may spawn from April to September (Demir, 1972). The distributions of eggs and larvae are therefore likely to be mainly a mixture of *C. lyra* and *C. maculatus*, the former being the more common in this area. The eggs were abundant throughout the survey period in 1982, with maximum concentrations >120 m^{-2} on each of the five surveys respectively (Table 2(a)). Similarly, in 1985, egg concentrations reached peaks in excess of 100 m^{-2} on each of the surveys (Table 2(c)). The eggs were found mainly in the coastal and mixed water areas of the western Irish Sea and were generally abundant in the stations sampled to the east of the Isle of Man (Figure 35). Larval concentrations were lower but the larvae were distributed more widely than the eggs. Although more abundant in the coastal and shallow water areas, they were also found in the central stratified zone (Figure 36). From the low abundance of larvae on the first survey in 1982, it appears that spawning had just begun in early April. Larval abundances were higher in the mid-April surveys in 1985 and 1989 suggesting that spawning may have begun earlier in those years. The species is of no commercial interest.

4.2.17 Gobiidae (The Gobies)

These are a large group of fish common in inshore waters although some species do occur below 100 m. All the genera produce benthic eggs with varying substrate requirements for adhesion. As many as eleven members of this group may occur in the Irish Sea. Their larvae are not well described, and although easy to recognise as a group, because of their prominent swim bladder and characteristic pigmentation, they are not routinely identified to species. Perhaps not surprisingly the larvae were widely distributed over the whole area on all the surveys with maximum recorded concentration of 103.5 m^{-2} in early May 1982 (Figure 37).

4.2.18 Scomber scombrus (Mackerel)

Although the main spawning area for the western stock of this species is along the edge of the continental shelf, the spread of spawning into shallower water areas during late spring is known to occur. This was very apparent in the 1982 surveys (Figure 38) with a maximum egg concentration of 997 m^{-2} recorded at the end of May (this compares with a maximum concentration of 4900 m^{-2} on the edge of the continental shelf in 1983). Eggs were much less abundant in 1985 with a maximum concentration of 58.7 m^{-2} recorded on the last survey. On the single surveys in 1987, 1988 and 1989 eggs occurred at a total of only seven stations with a maximum concentration of 1.7 m^{-2}. Larvae were not abundant in this area (Tables 2(b), 2(d), 2(f)) even on the 1982 surveys and have therefore not been plotted. Recent recorded commercial landings of mackerel from the Irish Sea have fluctuated from a high of 7713 tonnes in 1983 to a low of 181 tonnes in 1987.

4.2.19 Phyrnorhombus norvegicus (Norwegian topknot)

The larvae occurred on these surveys from late April through to June (Figure 39). They were mainly confined to the coastal and mixed water regimes, although in the last survey in 1985 they were more widely distributed. The highest concentration of larvae (4.8 m^{-2}) occurred on the single survey in late April 1989, off the North Wales coast.

4.2.20 Pleuronectes platessa (Plaice)

The spawning of plaice in the Irish Sea is reported to occur between February and April (Simpson, 1959) and would therefore be declining by the time of the first of the surveys detailed in this report. The three main spawning areas in the Irish Sea, one off the Irish coast, one between the Isle of Man and the Cumbrian coast and the third area off the North Wales coast, all feature on these surveys. Spawning off the Irish coast appeared to be much more extensive than indicated by the 1953 egg surveys of Simpson (1959) and those of Griffith (1971). Their surveys indicated small spawnings off Dundrum Bay, Dundalk Bay and the Skerries, with a maximum egg concentration in 1971 of 8 m^{-2}. The early April survey in 1982 showed that egg concentrations of up to 26 m^{-2} occurred all along the coast from Dundrum Bay to Dublin Bay (Figure 40). This more extensive spawning area was confirmed in the mid-April survey of 1985. Fewer eggs were recorded in this area in the 1988 and 1989 surveys, which took place at the end of April. The spawning area off the North Wales coast was only sampled once, in late April 1989, when plaice eggs occurred at a maximum concentration of 20.7 m^{-2}. Larval distributions off the Irish coast in April and early May 1982 (Figure 41) show some southerly and easterly movement when compared with the egg distributions. Of the commercial flatfish in Irish Sea, the catches of plaice are the highest with mean annual landings over the period from 1981 to 1990 averaging 4328 tonnes (sd. 931 tonnes).

4.2.21 Platicthys flesus (Flounder)

The eggs of this species range in diameter from 0.8-1.13 mm and are indistinguishable from eggs of similar size in the plankton such as those of *L. limanda* and *T. luscus*. Although the adult frequents coastal areas, estuaries and brackish waters, it is known that their spawning occurs off-shore. The distribution of the larvae on these surveys confirms that pattern with some larvae occurring well off-shore (Figure 42). The highest numbers of larvae occurred east of the Isle of Man. Peak spawning of this species in the Irish Sea must occur in or before early April, with the greatest numbers of larvae being recorded on the first surveys in

1982 and 1985. This species is of no commercial interest in this area.

4.2.22 *Limanda limanda* (Dab)

The planktonic eggs of the dab are small and do not contain oil globules. They range from 0.66 mm to 1.2 mm in diameter and are indistinguishable from other species with eggs of similar size. The larvae were very abundant in the Irish Sea with peak concentrations approaching 200 m^{-2} in April 1982, 1985 and 1989 (Figure 43). Larval concentrations in the 1988 survey were lower than this, with a maximum value of 60 m^{-2}. The greatest concentrations of larvae occur in the Irish coastal waters from Dundrum Bay to Dublin Bay. This pattern of distribution was particularly evident on the early surveys in 1982, and on the single survey in 1989. Larvae were more widely dispersed and abundant well off-shore on the other surveys. The larvae were also widespread and abundant east of the Isle of Man and off the North Wales coast whenever these areas were surveyed. Of the species of commercial interest, *L. limanda* is one of the most abundant in the larvae stages in this area. However the landings of dab have only averaged 380 tonnes per year (1981 to 1985). This can be attributed to the relatively small size of the adult and a lack of market demand.

4.2.23 *Microstomus kitt* (Lemon sole)

Eggs of this species can be only positively identified at a late stage of development when the characteristic pigmentation of the embryo can be seen. They were recorded on a few stations from late April to the end of May in 1982 and also in 1985 (Tables 2(a), 2(c)). The larvae were not abundant or widespread in any of the survey years, with a maximum concentration of <2.5 m^{-2} on all the surveys (Tables 2(b), 2(d), 2(f)) (Figure 44). The species is not abundant in the Irish Sea and annual landings have averaged only 282 tonnes over the period 1981 to 1987.

4.2.24 *Glyptocephalus cynoglossus* (Witch)

The planktonic eggs of this species, like those of the *Microstomus kitt*, can only be identified in the late embryonic stages. None were recorded in the 1982 and 1987 surveys and only a few in 1985, 1988 and 1989 (Tables 2(a), 2(c), 2(e)). Wheeler (1969) stated that spawning of this species occurred in the Irish Sea from late March to May and the timing of the occurrence of larvae on the surveys in 1982 and 1985 confirms that observation. The larvae were more abundant than those of *M. kitt* but had a similar distribution, being confined mainly to the areas of coastal and mixed water. Their distribution in 1985 was an exception to this pattern. They were widely distributed over the western area in that year with peak concentrations of 12.9 m^{-2} in April (Figure 45). A few larvae were recorded south-east of the Isle of Man on the single surveys in 1988 and 1989. *G. cynoglossus* is of minor importance commercially in this area with annual landings which averaged only 22 tonnes during the period 1981 to 1987.

4.2.25 *Hippoglossoides platessoides* (Long rough dab)

The eggs of this species are large (1.38-2.64 mm diameter) with a notably wide perivittelline space. As a result they are easily recognised in a plankton sample and can be readily sorted. They were, however, only recorded on a few stations in April 1982, 1985 and 1988 (Tables 2(a), 2(c), 2(e)) (Figure 46), suggesting that peak spawning occurred well before this time. Larval abundance was low with a maximum concentration of 4.5 m^{-2} in May 1985. The larvae occurred mainly in areas of deep stratified water in the western Irish Sea with no records from east of the Isle of Man. This species is not common in the Irish Sea and the commercial landings are not recorded.

4.2.26 *Solea solea* (Sole)

The main spawning areas for this species in the Irish Sea, are east of longitude 4°30'W, between the Solway Firth and the North Wales coast (Figure 47). These surveys show that some spawning also occurred in the western Irish Sea. Egg concentrations reached peaks of 68.4 m^{-2} to the south of the Calf of Man in early May 1982 and 24.2 m^{-2} in the same area in mid-April 1985. It can be inferred that spawning probably began in this area in early April since larvae were absent on the first survey in 1982 and only low numbers were recorded in the mid-April survey in 1985. The timing of peak spawning may vary annually but appeared to be later on the eastern side of the Irish Sea reaching maximum egg concentrations in that area of 46 m^{-2} in late May 1982 and 62 m^{-2} in late April 1989. In 1985 egg concentrations of 99 m^{-2} were found in the outer Solway Firth in mid-May. Large numbers of eggs (maximum concentration 79.4 m^{-2}) were also found off the North Wales coast on the single survey at the end of April 1989. Larvae were sparsely distributed on these surveys and concentrations were generally low except for a single station to the east of the Isle of Man in late May 1982 with a concentration of 29.6 m^{-2} (Figure 48). *Solea solea* is an important commercial species with a high market value. Annual landings averaged 1622 tonnes (sd. 324 tonnes) over the period 1981-1990.

4.2.27 *Buglossidium luteum* (Solenette)

The eggs of this species occurred in the mixed water regimes in all the surveys (Figure 49). They were not widely distributed but were more common in the east of the area on most of the surveys. Their larvae also occurred in low numbers (Table 2(b), 2(d), 2(f)) but have not been plotted. The species is of no commercial interest.

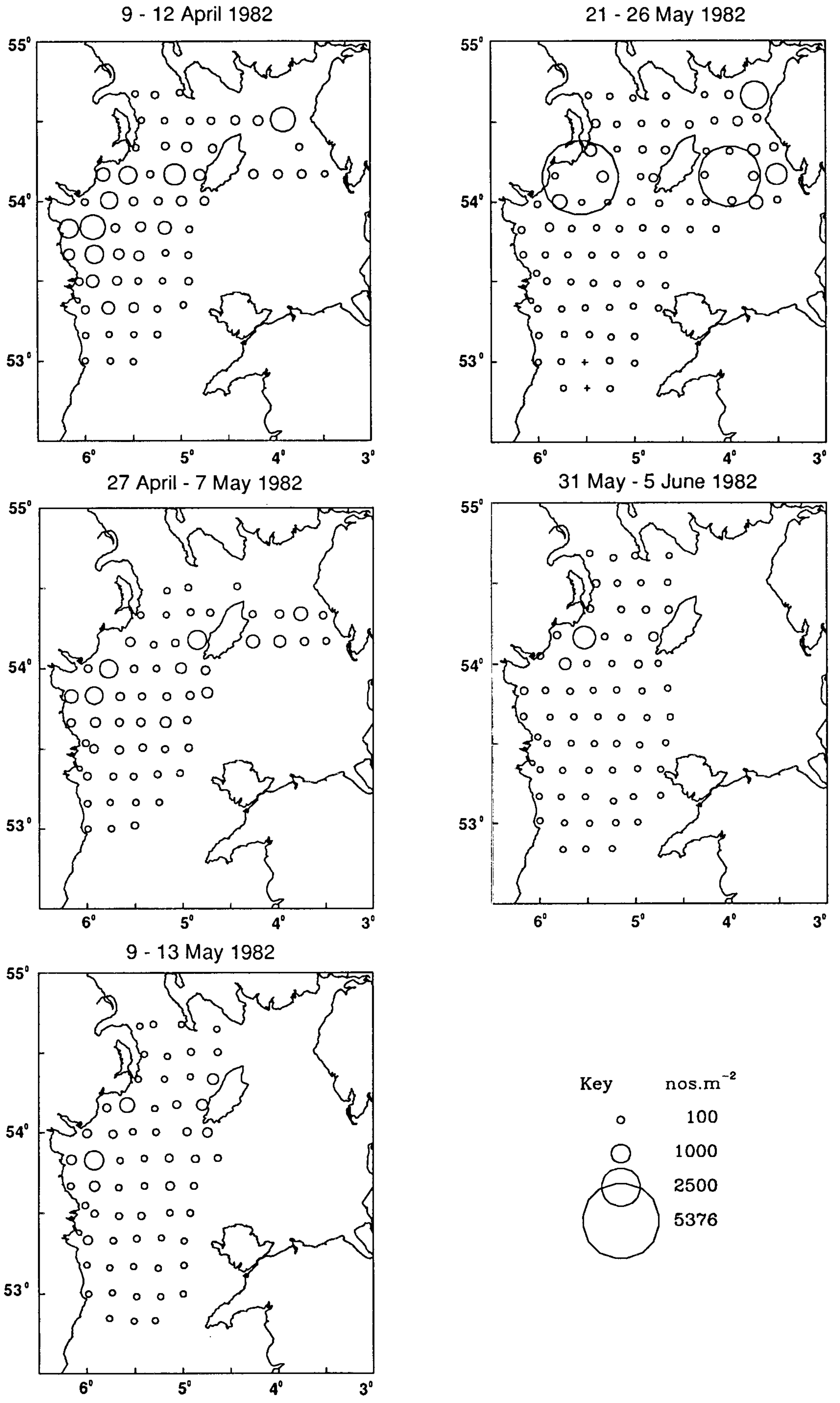
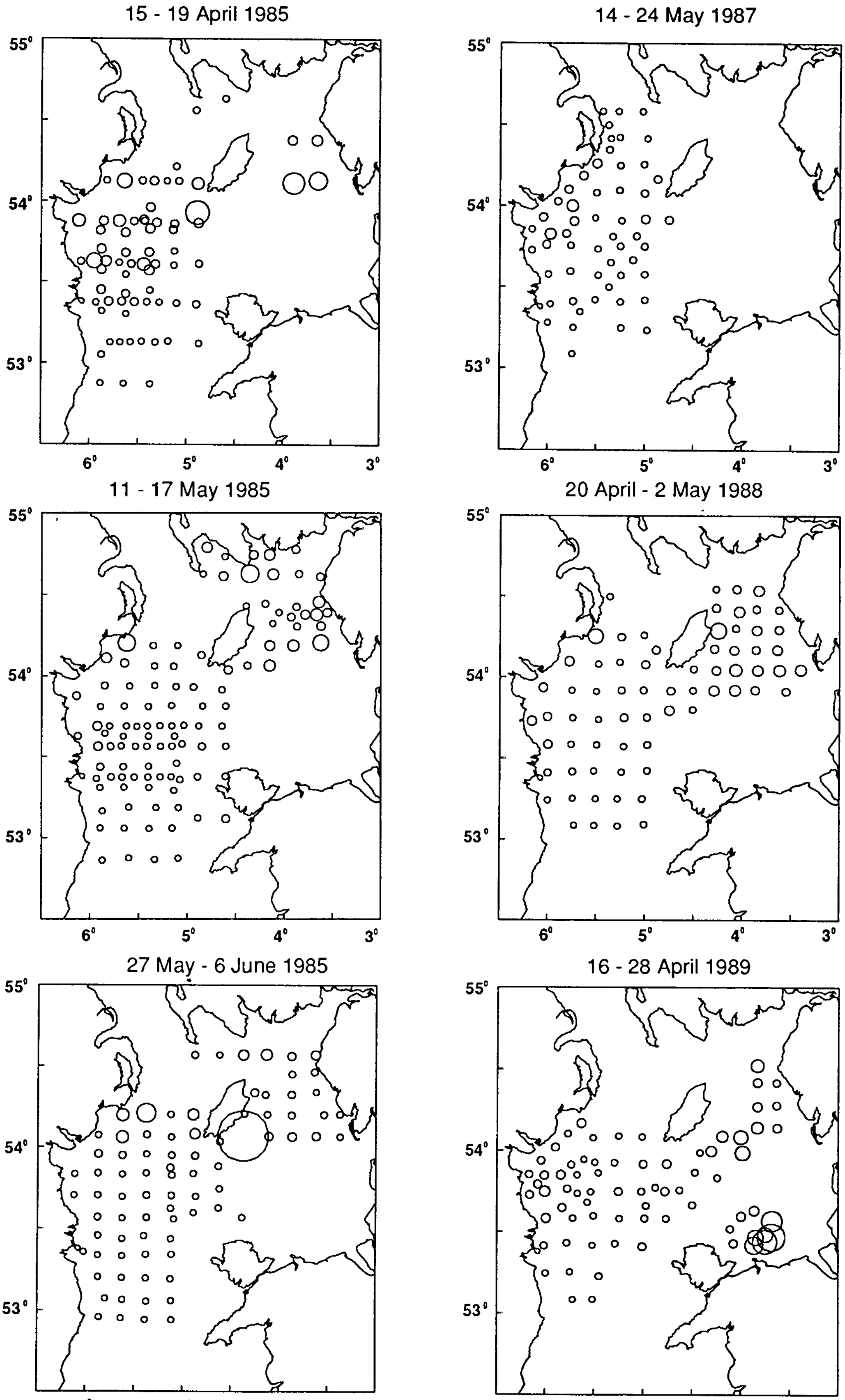


Figure 13. Total egg concentrations (nos.m^{-2}) for the surveys in 1982, 1985, 1987, 1988 and 1989



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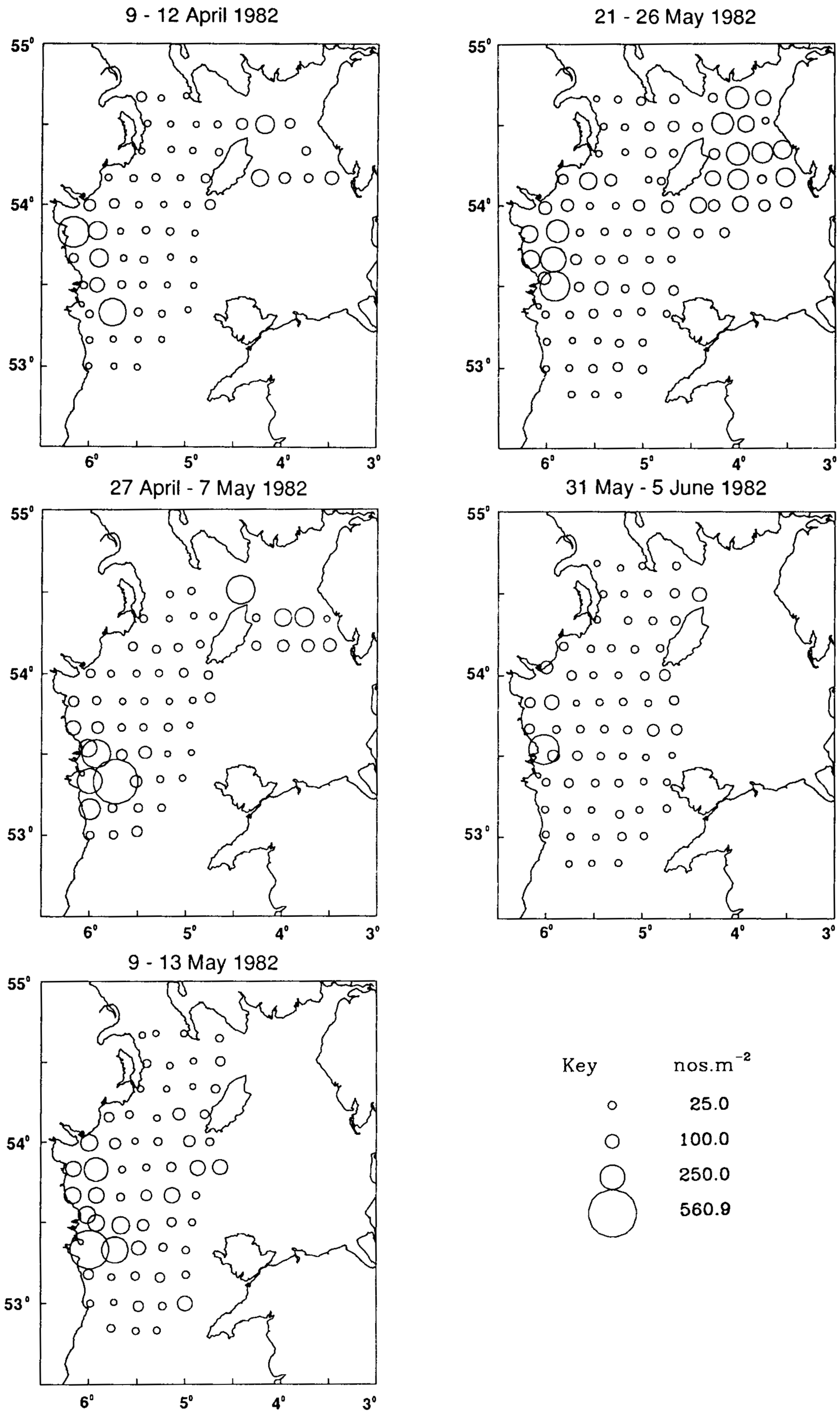
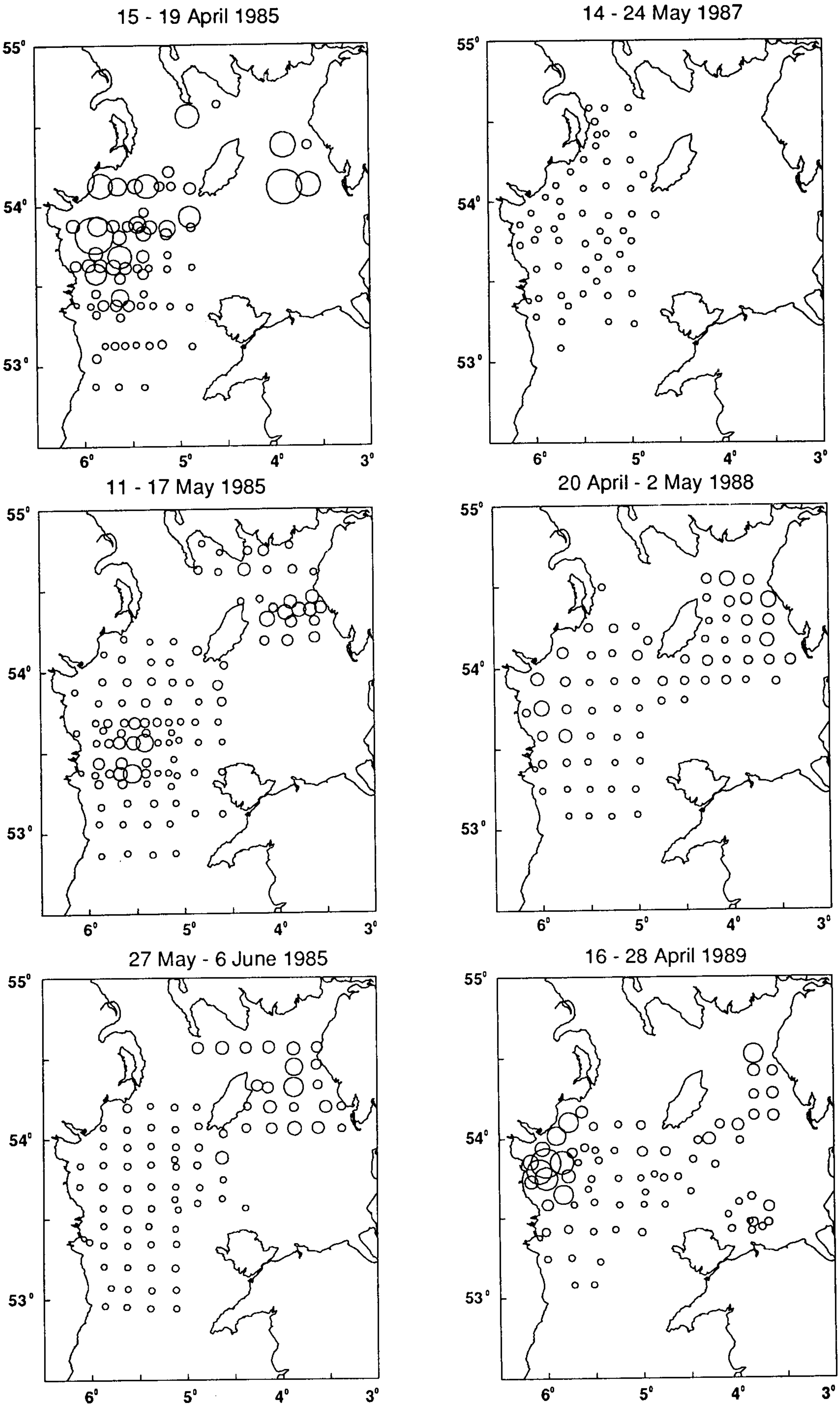


Figure 14. Total larvae concentrations (nos.m^{2}) for the surveys in 1982, 1985, 1987, 1988 and 1989



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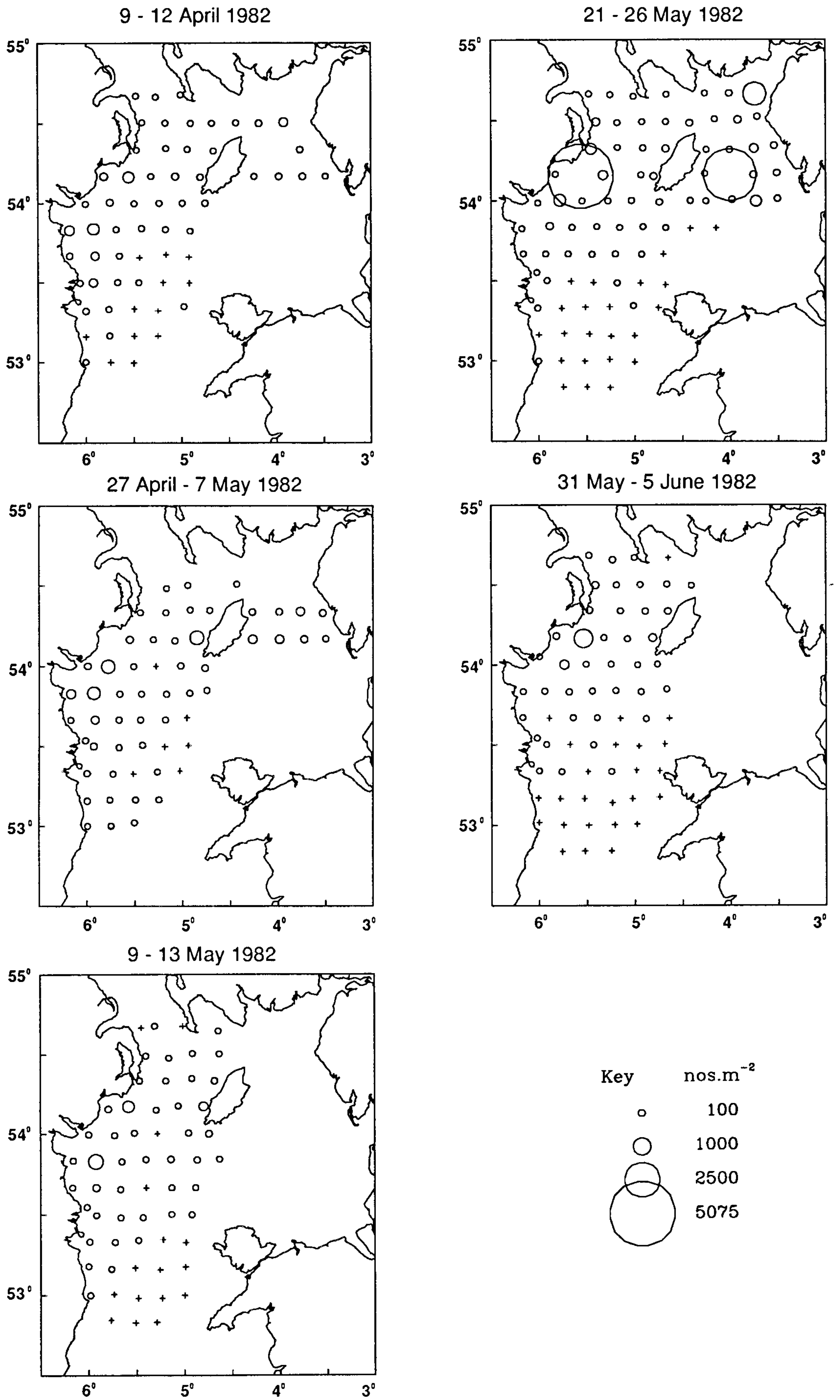
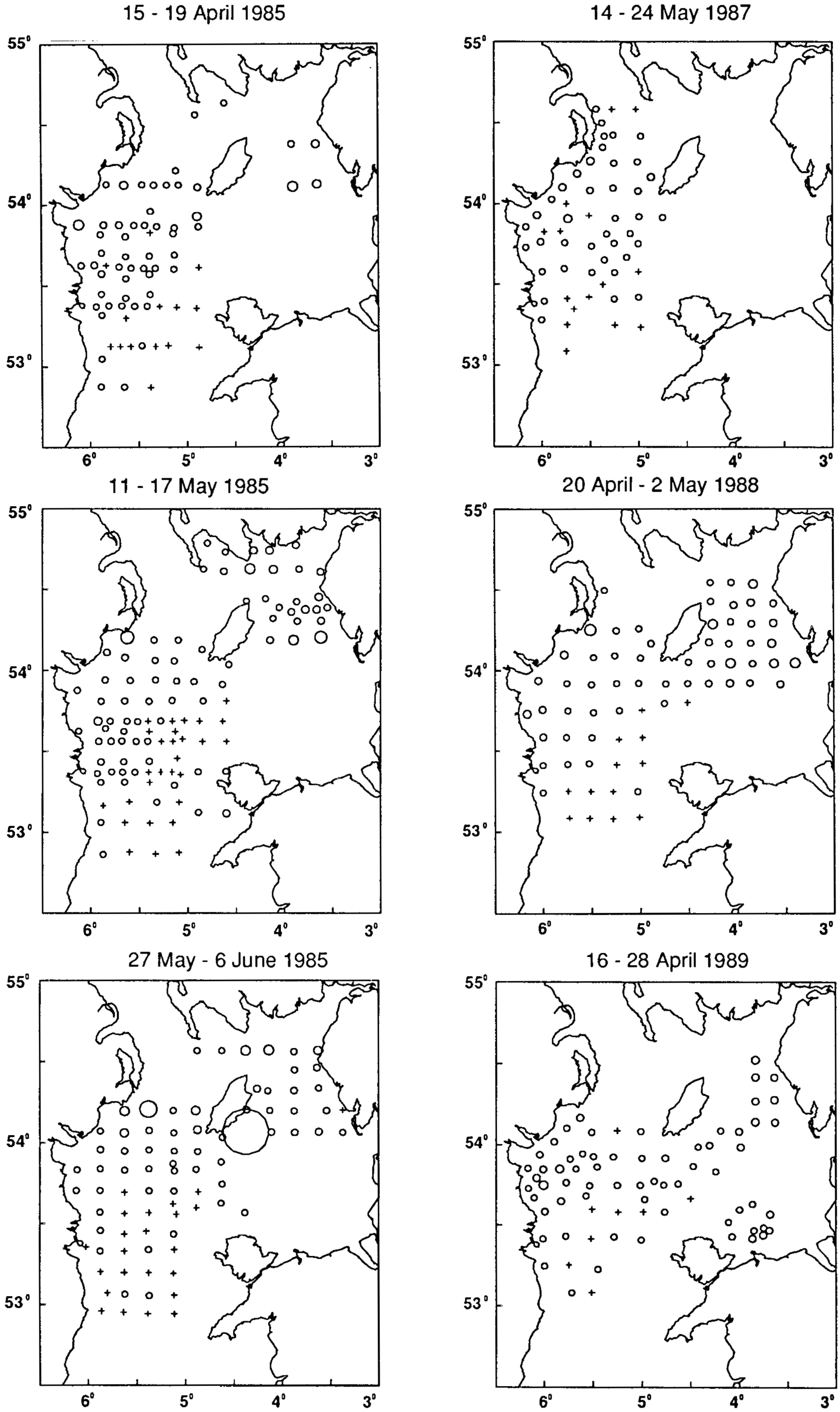


Figure 15. ***Total sprat (Sprattus sprattus) egg concentrations (nos.m^{-2}) for the surveys in 1982, 1985, 1987, 1988 and 1989***



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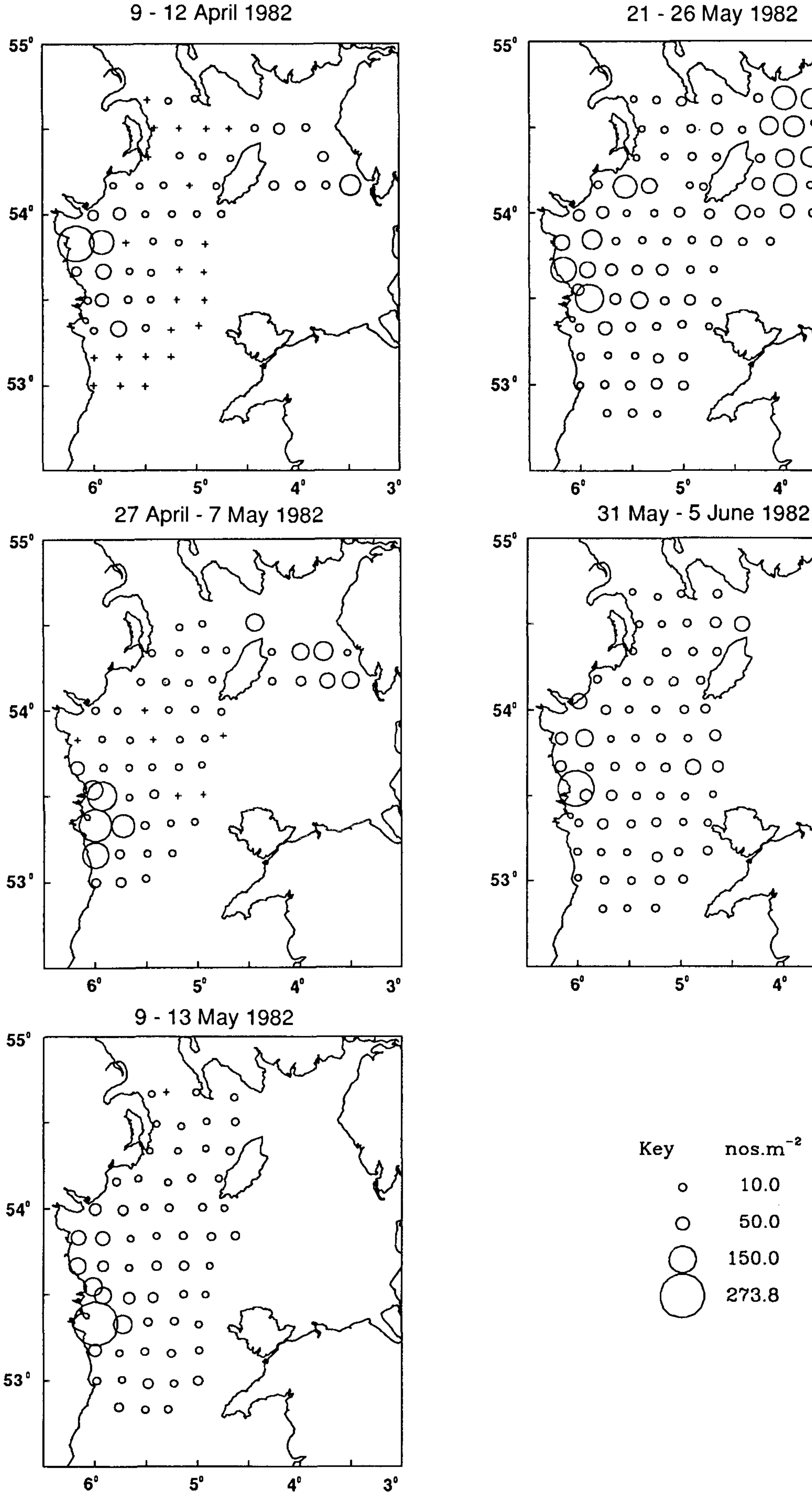
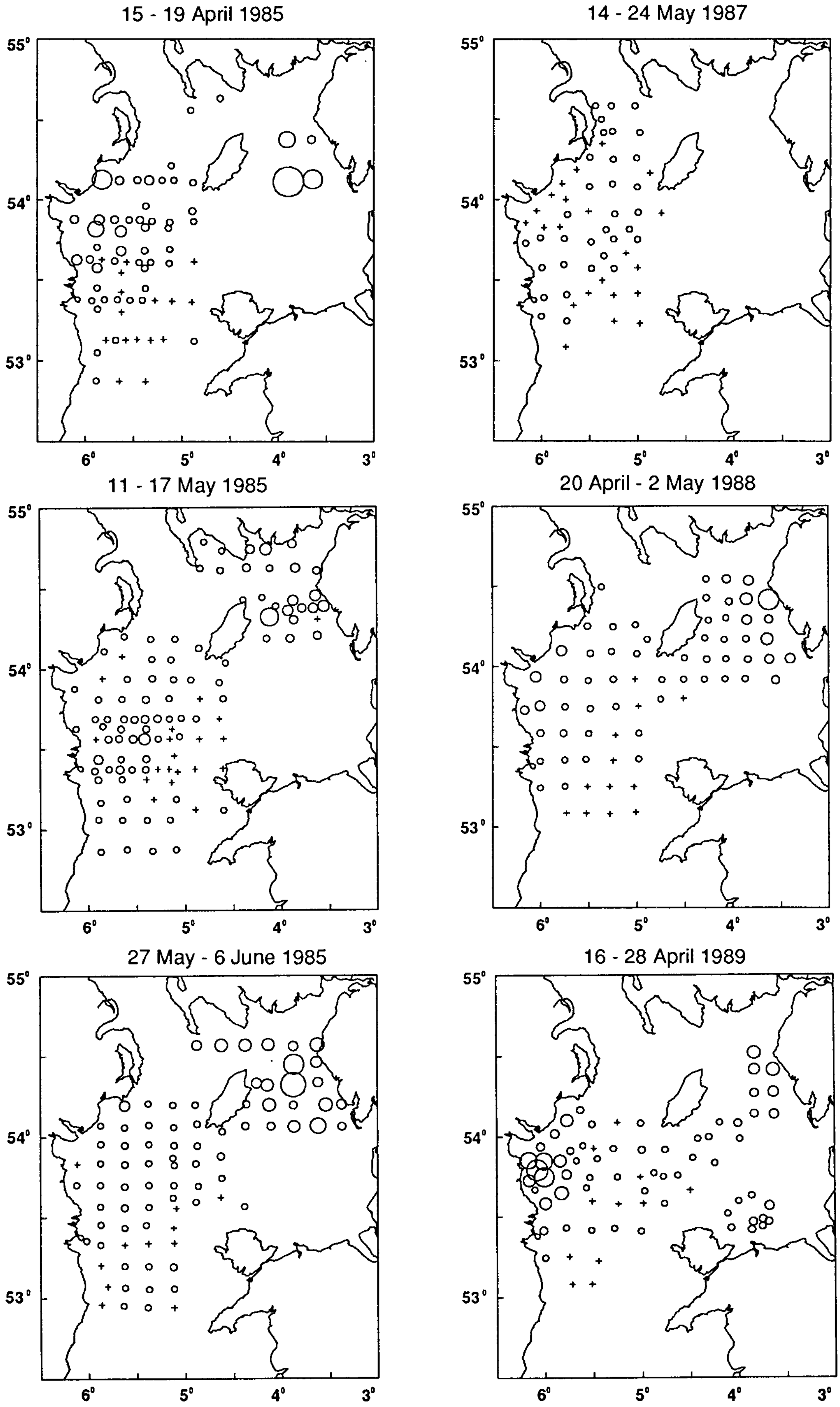


Figure 16. Total sprat (Sprattus sprattus) larvae concentrations (nos.m^{-2}) for the surveys in 1982, 1985, 1987, 1988 and 1989



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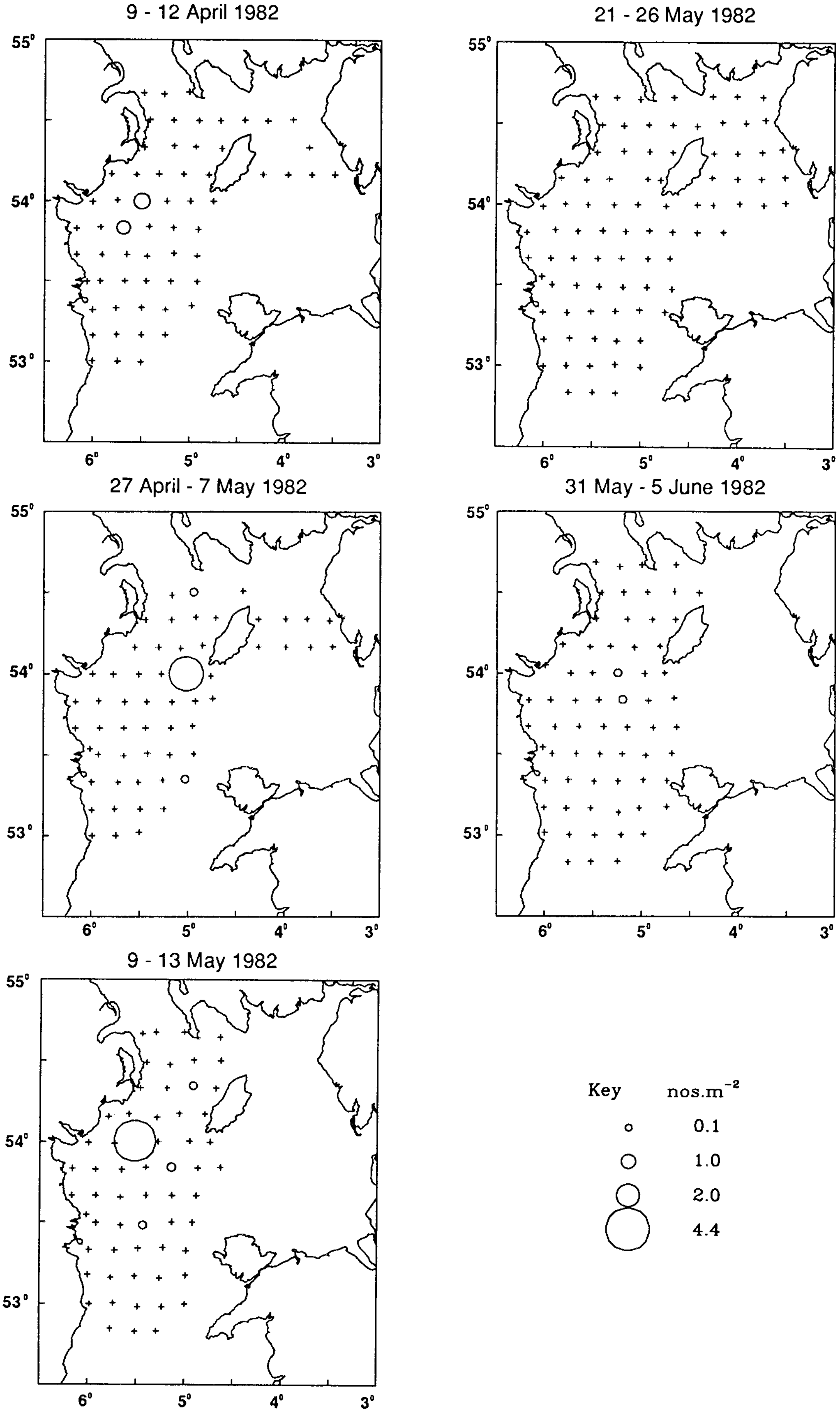
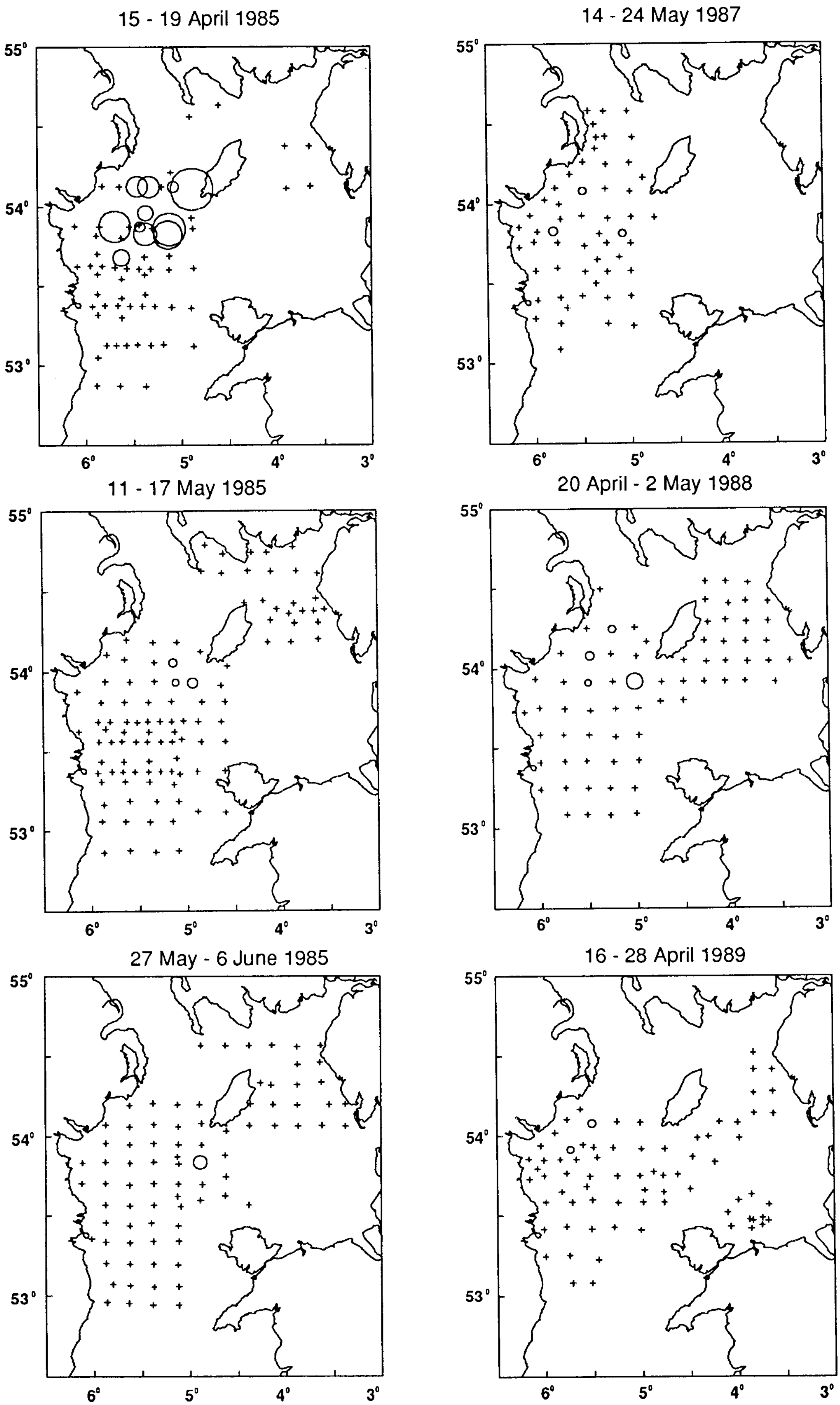


Figure 17.* *Total Argentina sphyraena egg concentrations (nos.m^{-2}) for the surveys in 1982, 1985, 1987, 1988 and 1989



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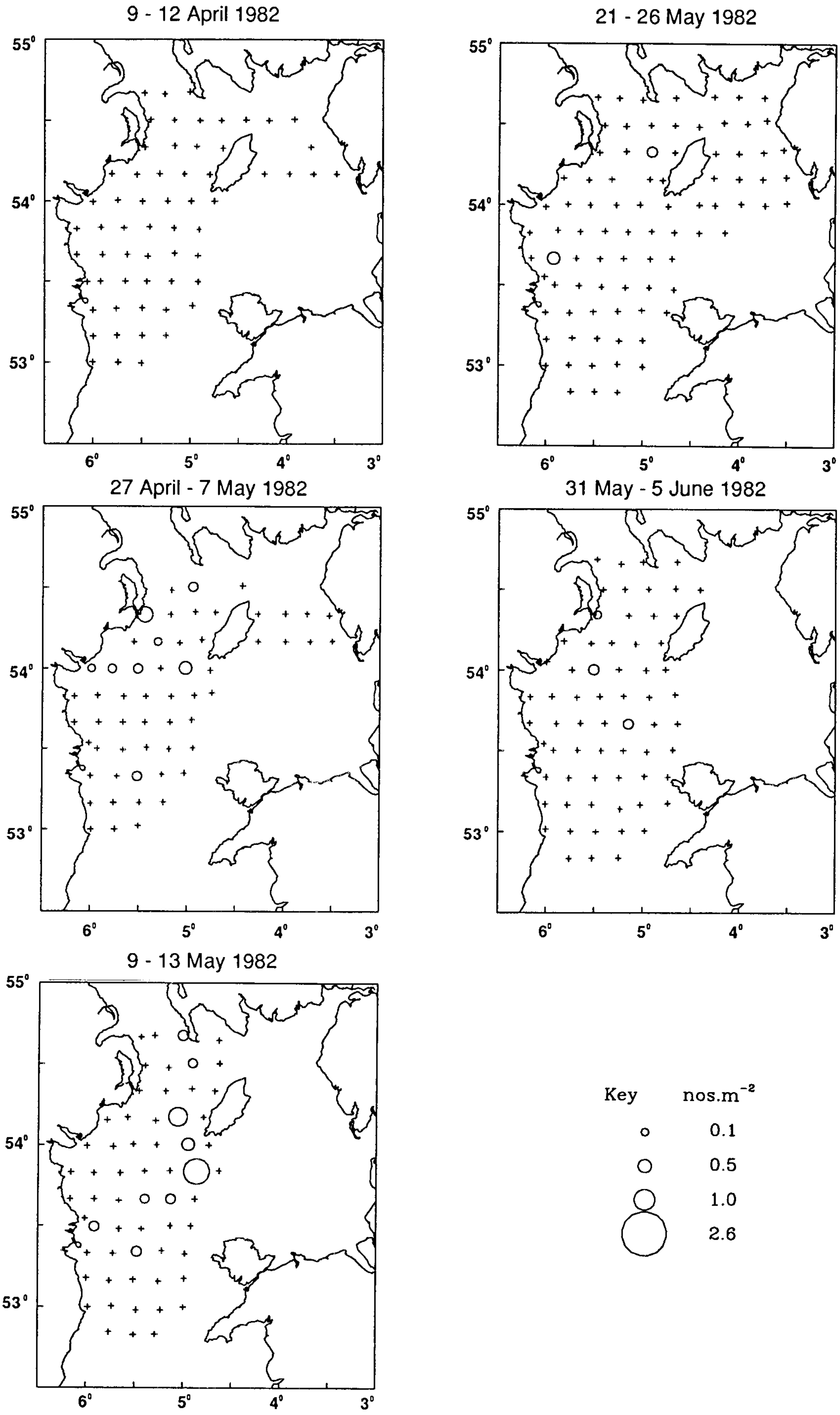
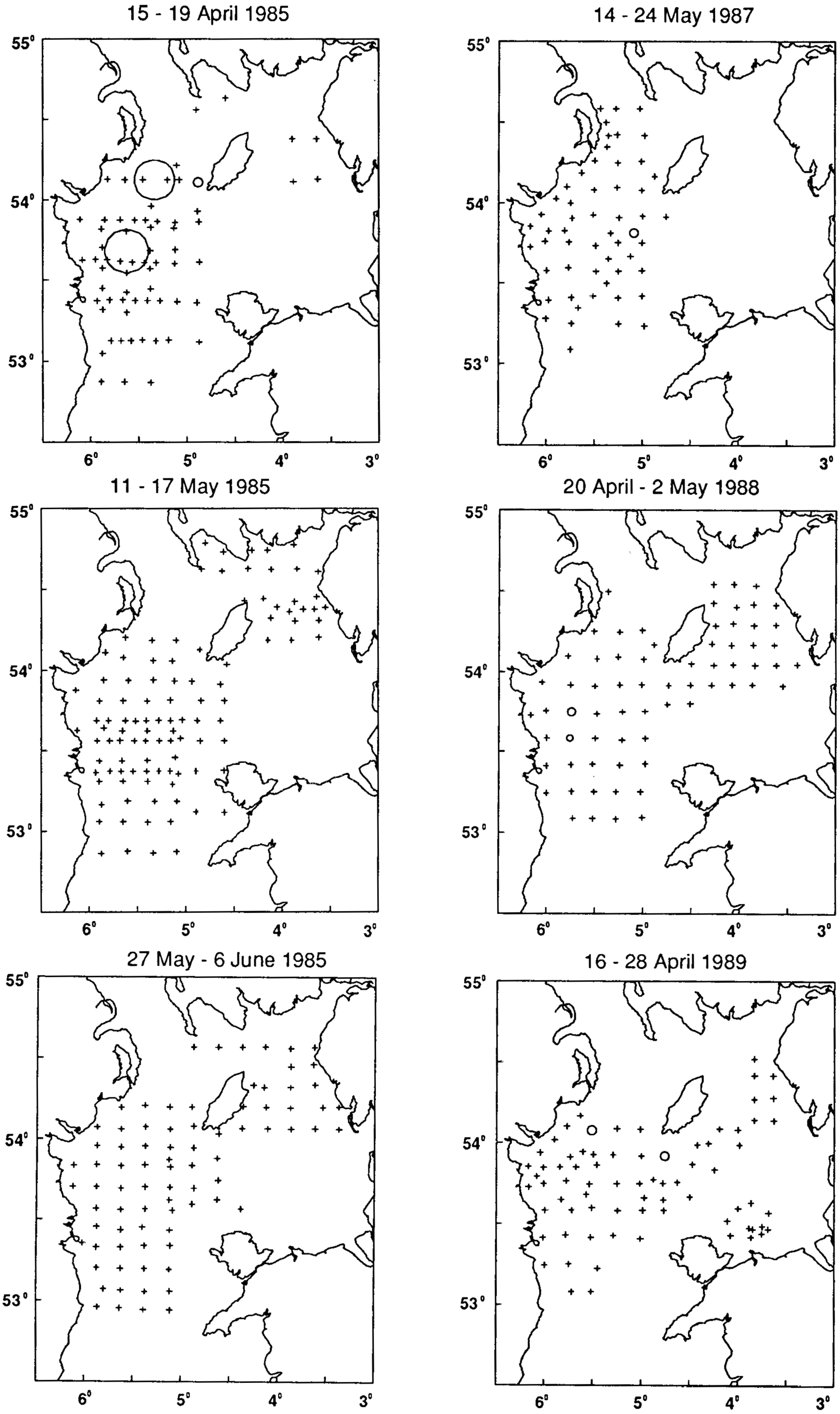


Figure 18. Total Argentina sphyraena larvae concentrations (nos.m⁻²) for the surveys in 1982, 1985, 1987, 1988 and 1989



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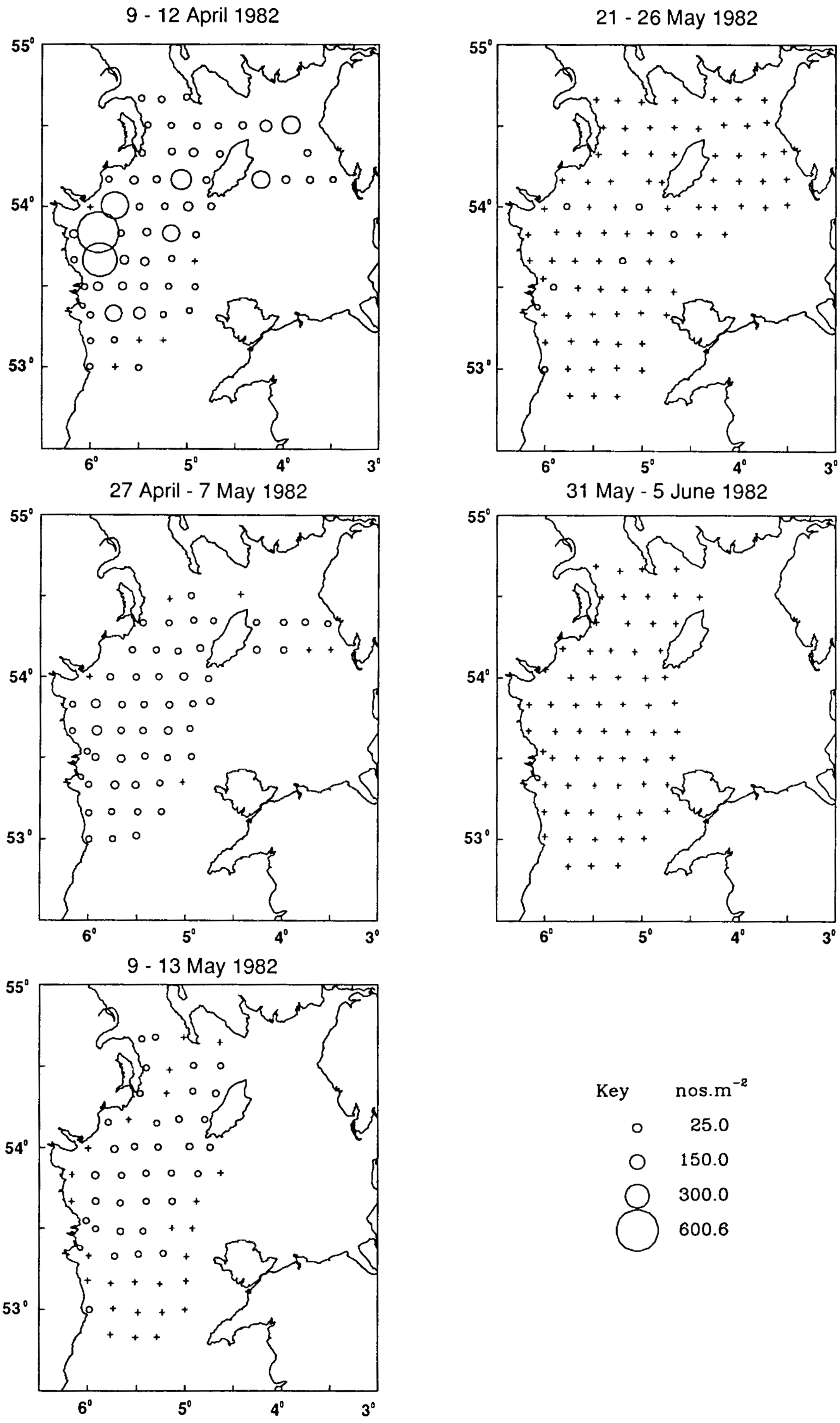
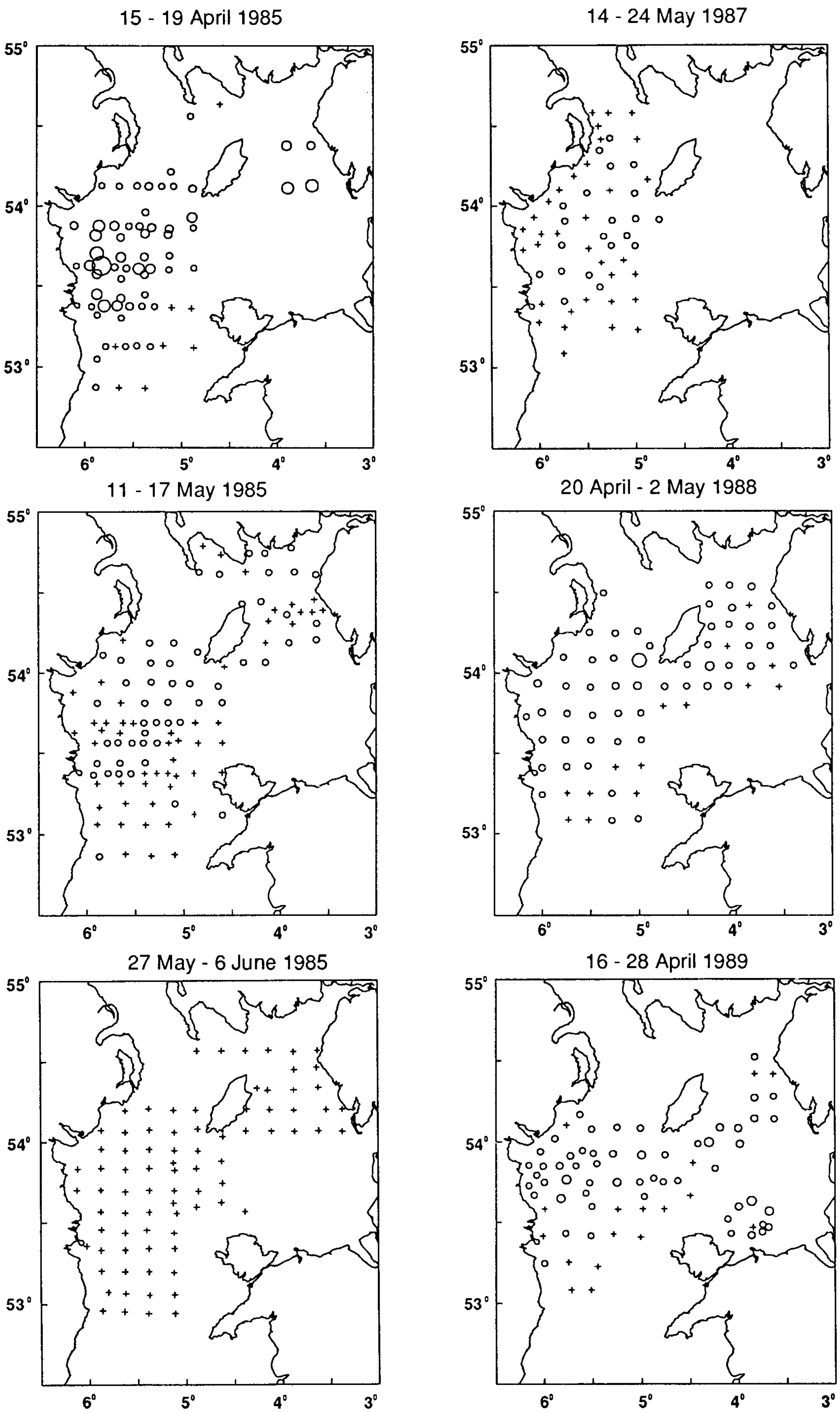


Figure 19. Total cod (Gadus morhua) egg concentrations (nos.m^{-2}) for the surveys in 1982, 1985, 1987, 1988 and 1989



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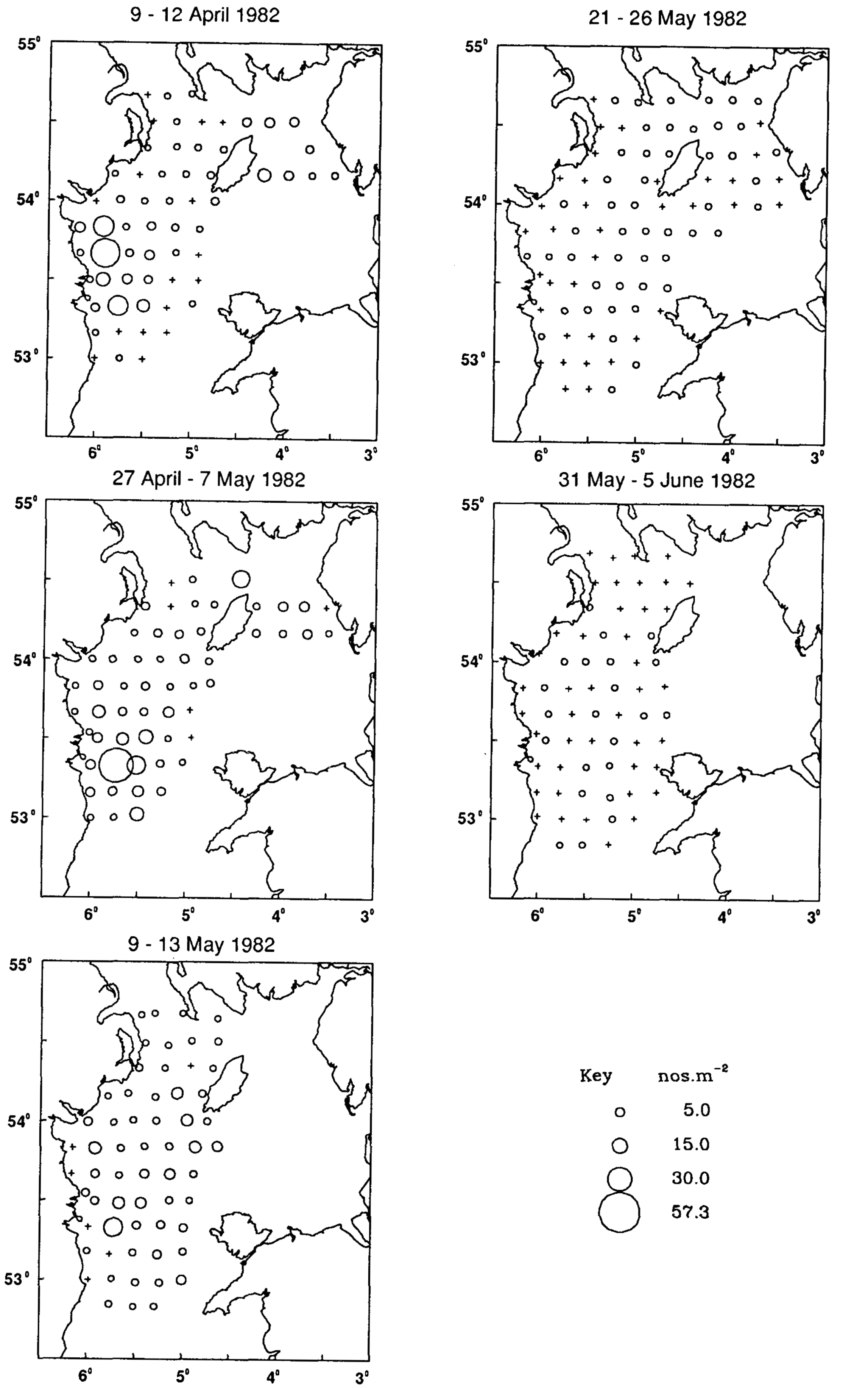


Figure 20. Total cod (Gadus morhua) larvae concentrations (nos.m^{-2}) for the surveys in 1982, 1985, 1987, 1988 and 1989

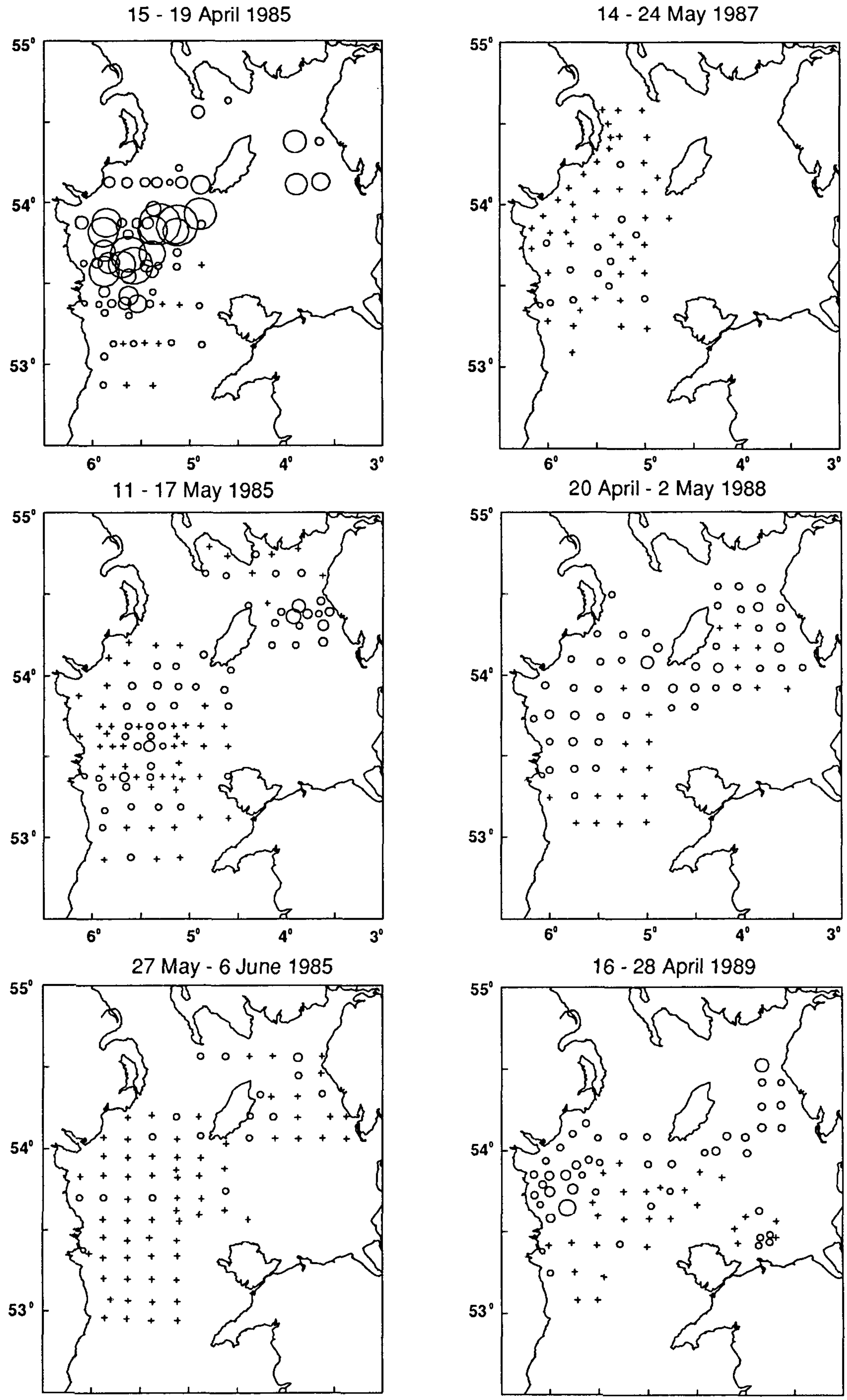


Figure 20 continued

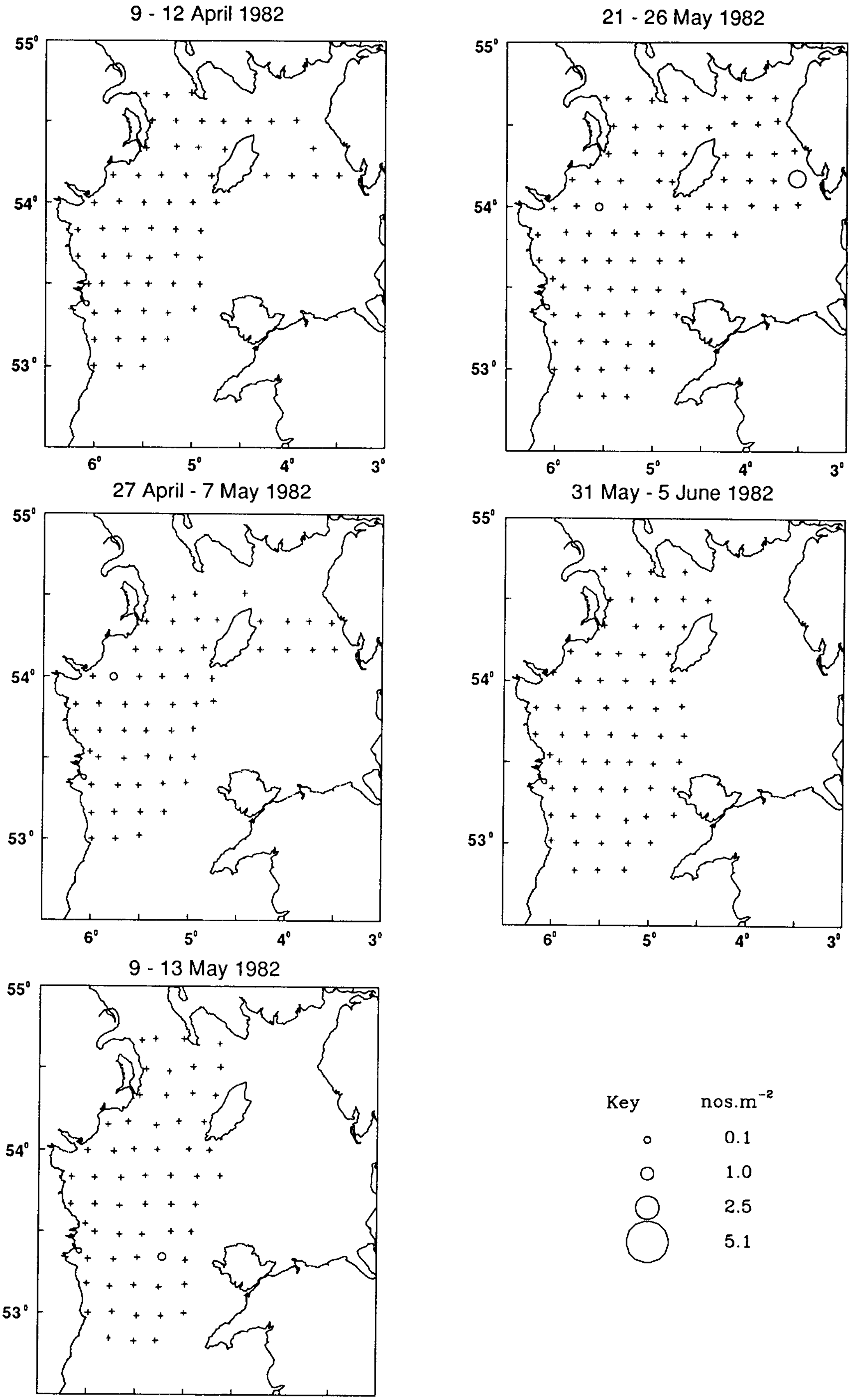
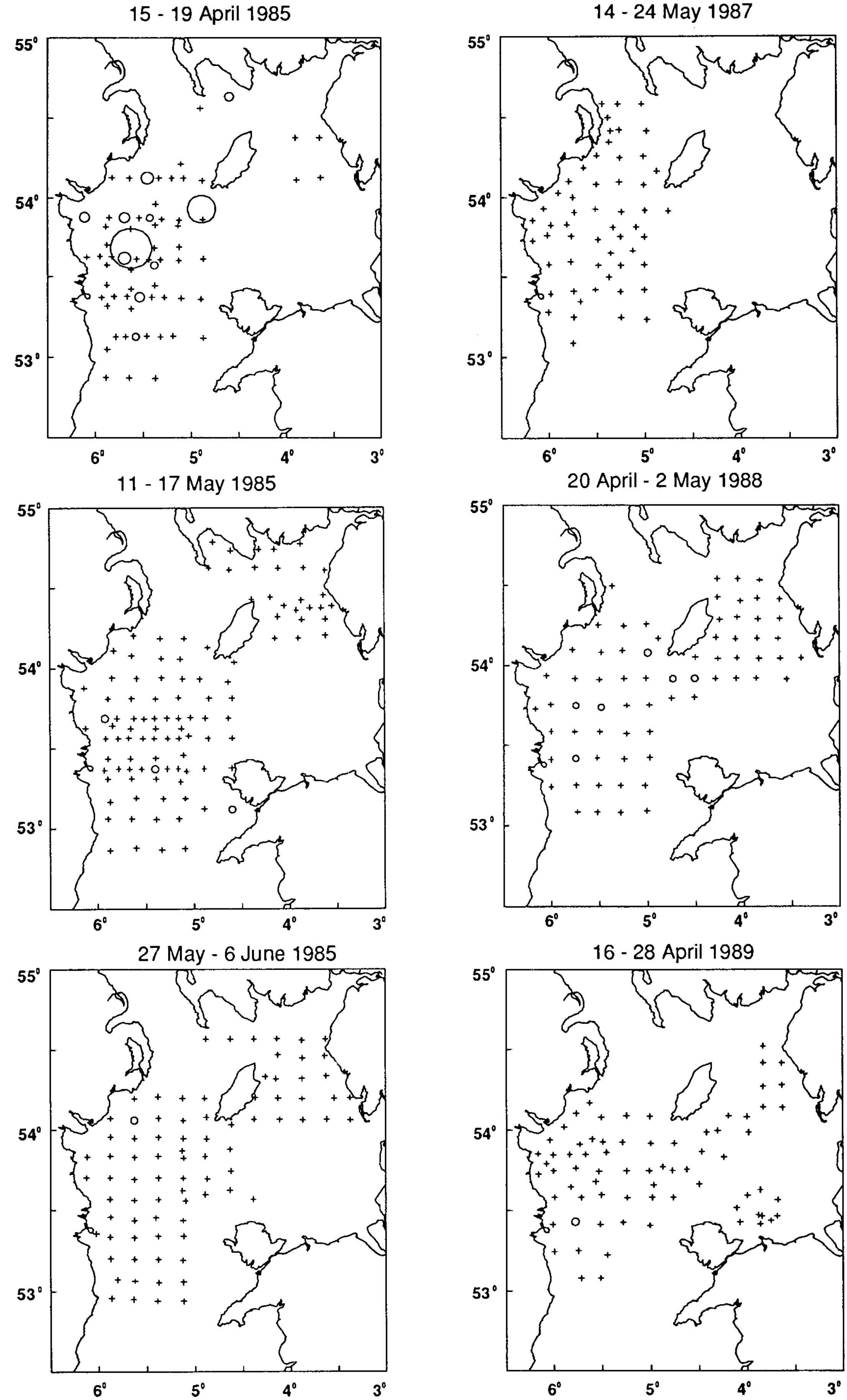


Figure 21.** **Total haddock (Melanogrammus aeglefinus) larvae concentrations (nos.m^{2}) for the surveys in 1982, 1985, 1987, 1988 and 1989



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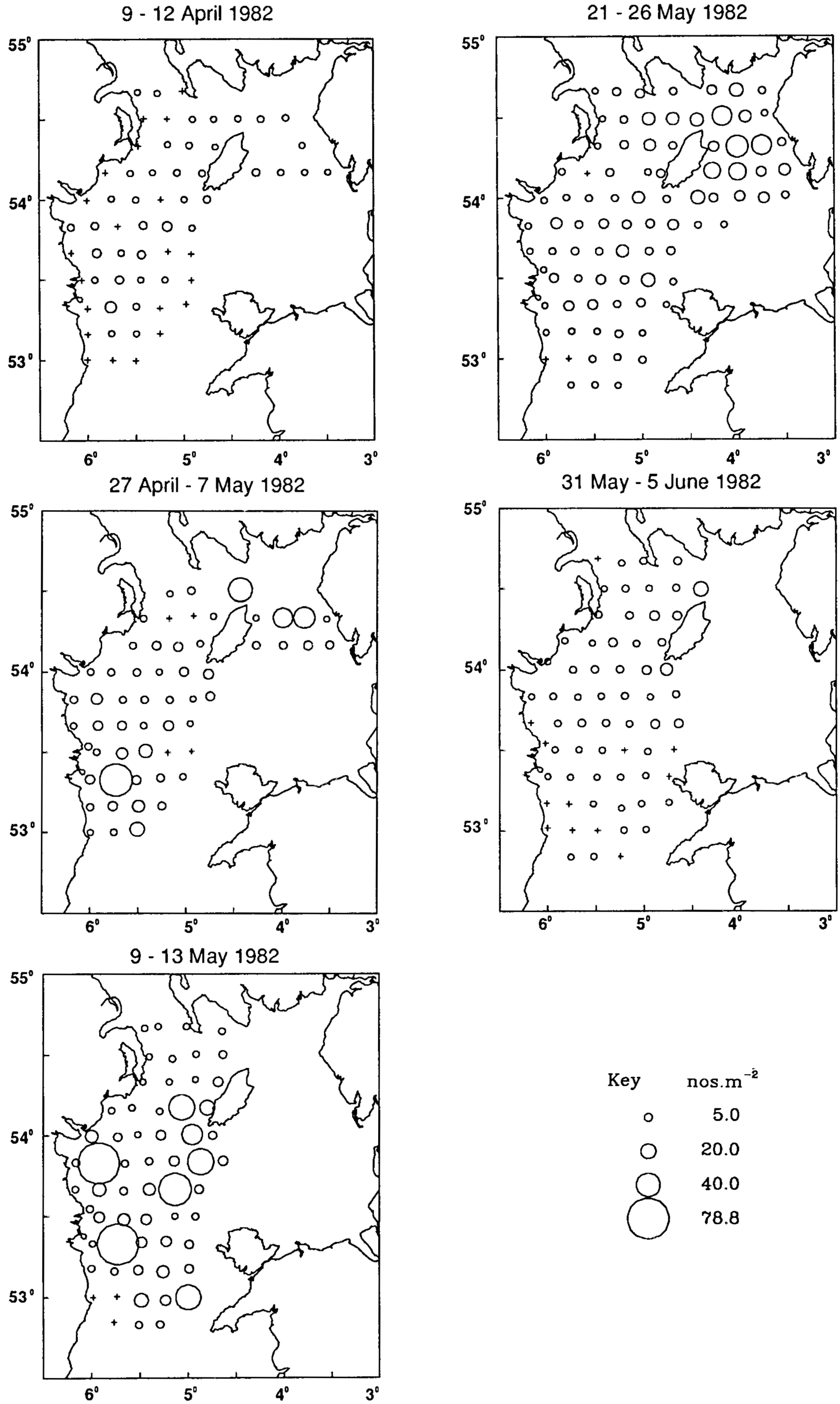
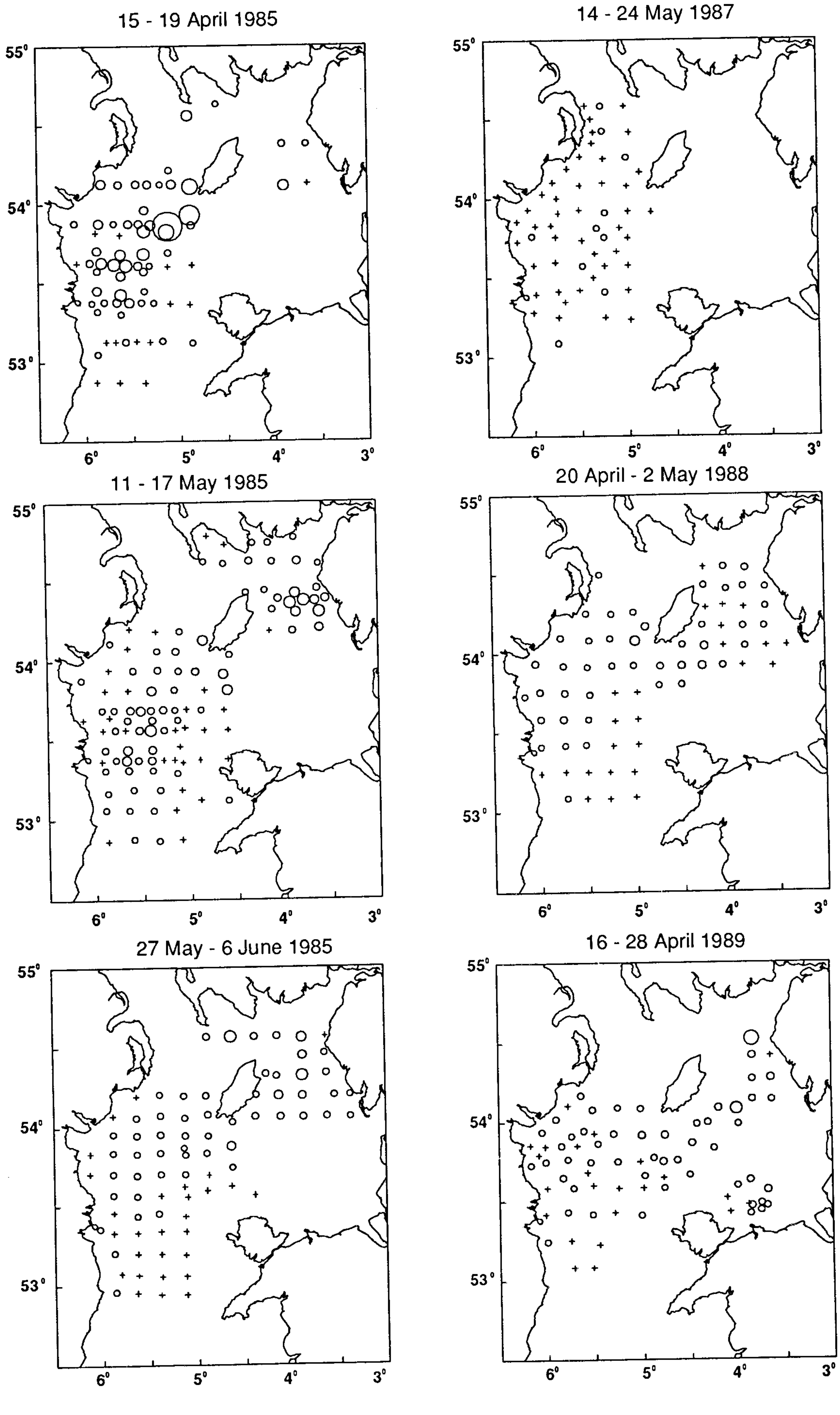


Figure 22. Total whiting (Merlangius merlangus) larvae concentrations (nos.m^{-2}) for the surveys in 1982, 1985, 1987, 1988 and 1989



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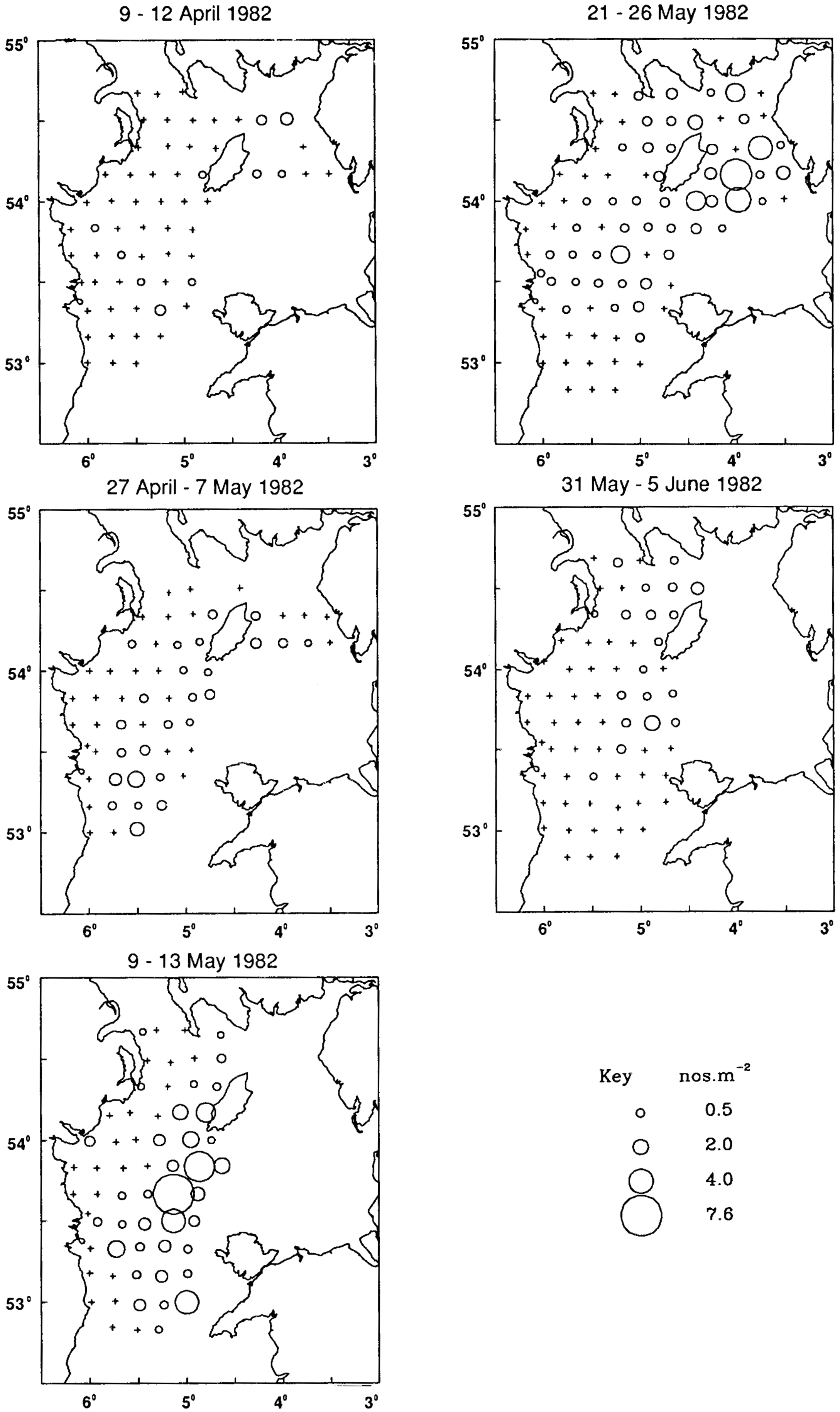
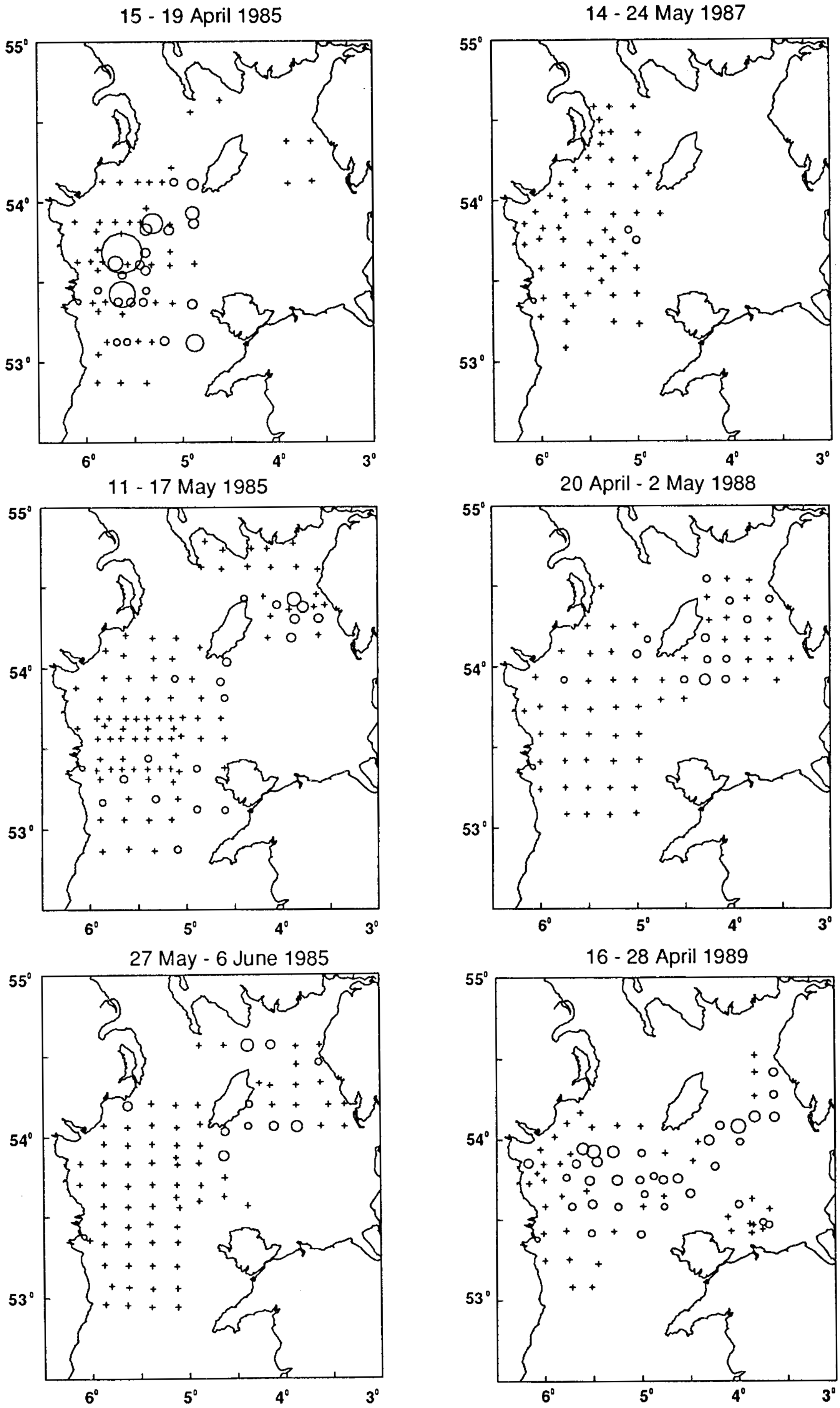


Figure 23. Total pout whiting (Trisopterus luscus) larvae concentrations (nos.m^{-2}) for the surveys in 1982, 1985, 1987, 1988 and 1989



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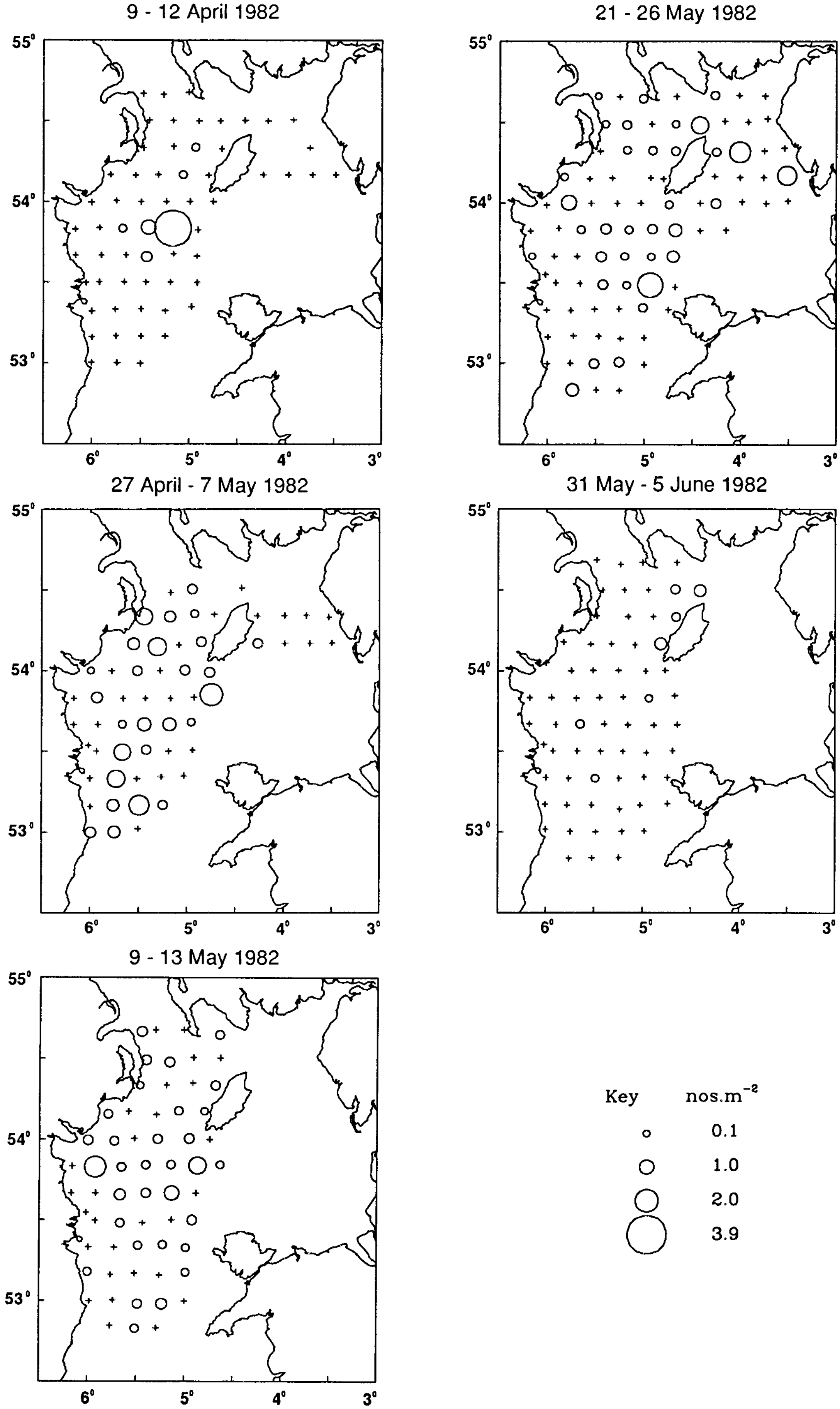
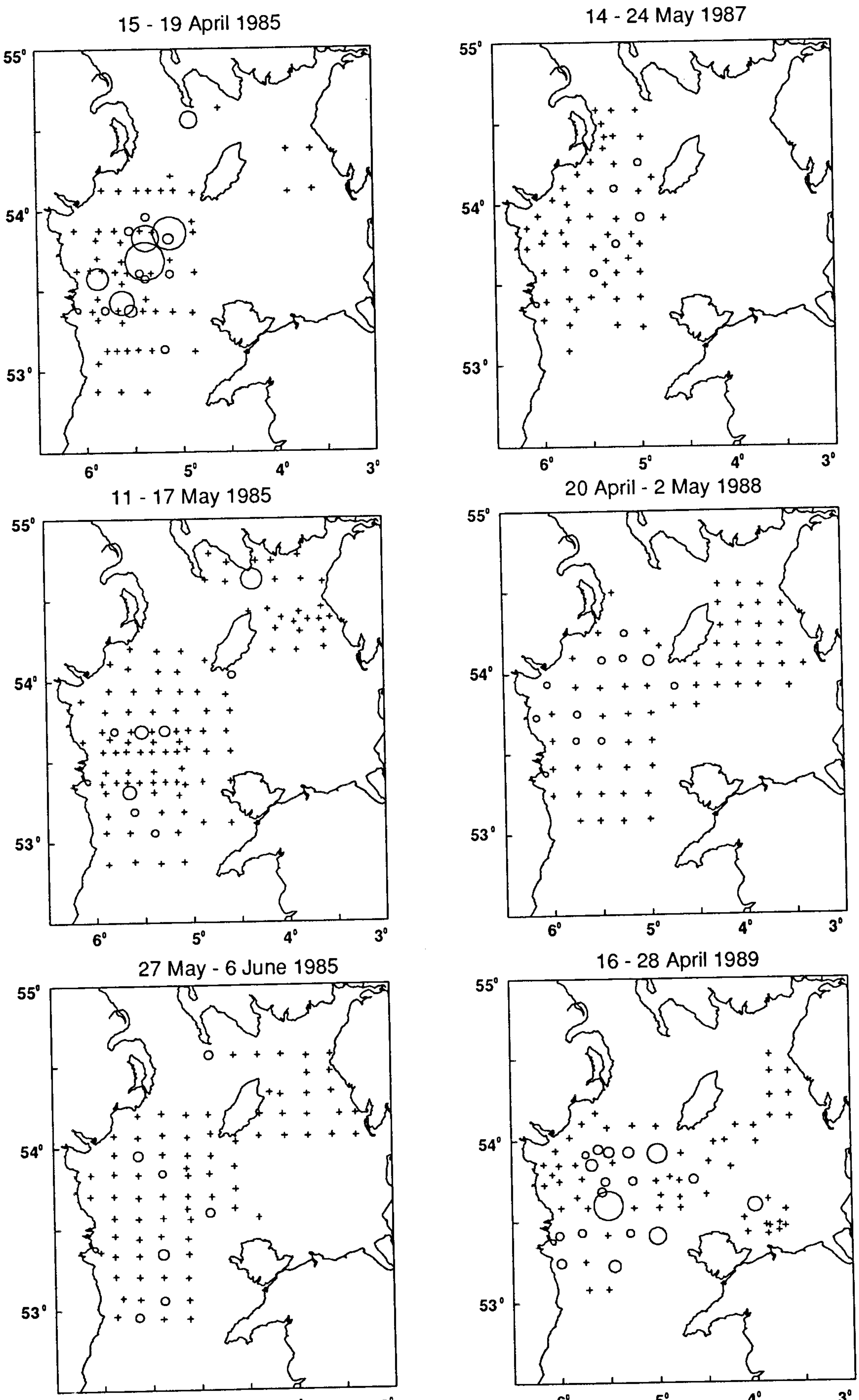


Figure 24. Total pollack (Pollachius pollachius) larvae concentrations (nos.m^{-2}) for the surveys in 1982, 1985, 1987, 1988 and 1989



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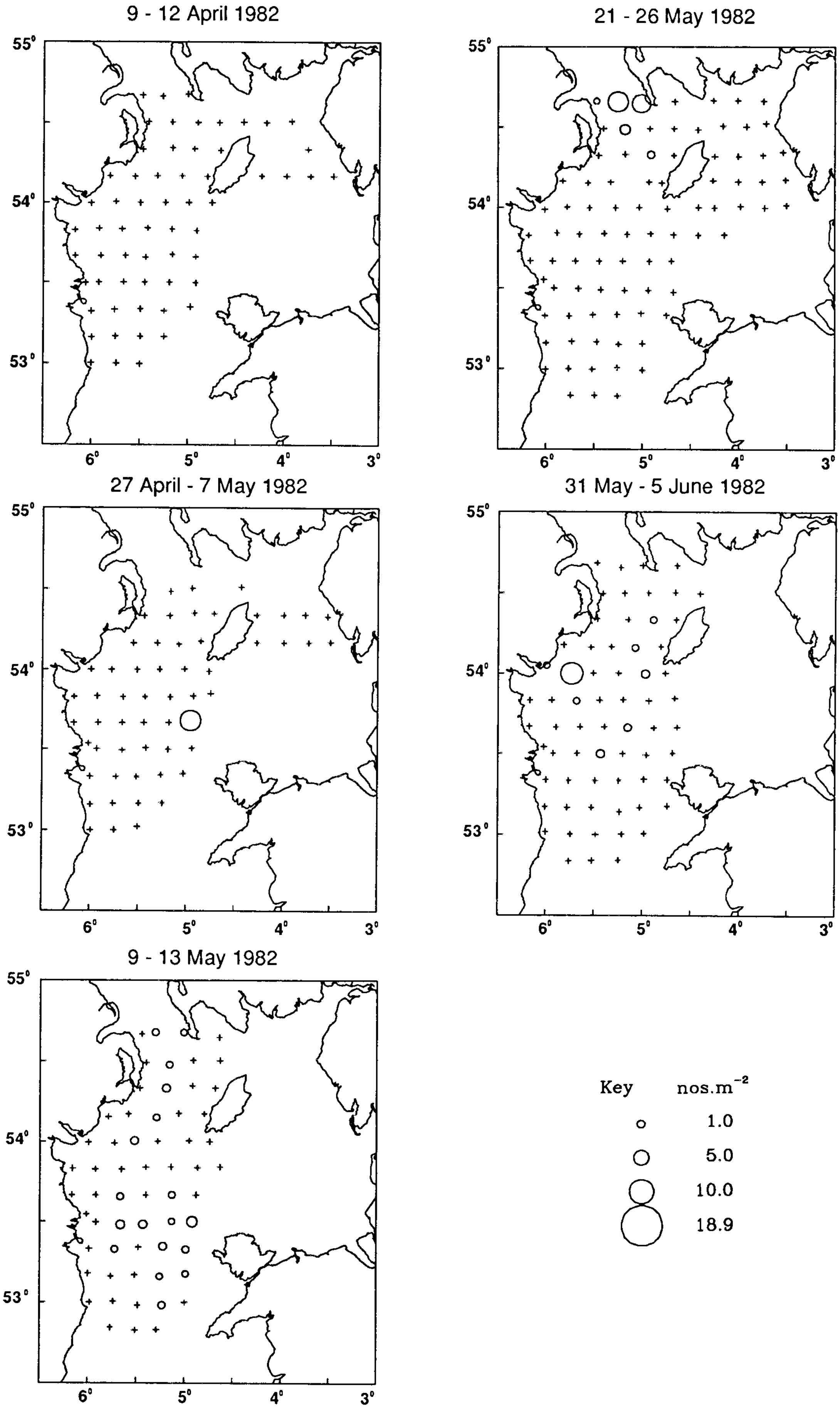
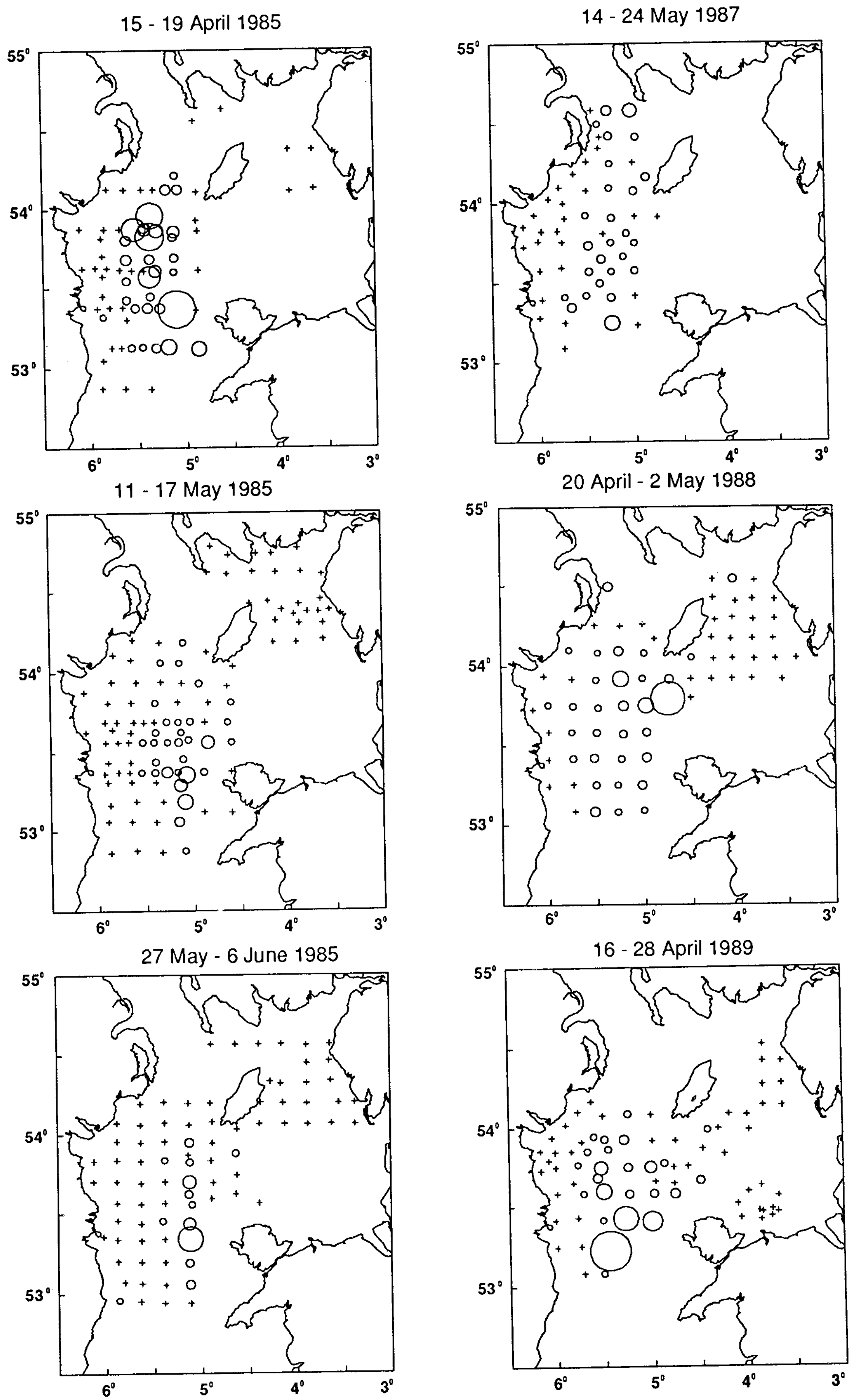


***Figure 25.** Total ling (Molva molva) egg concentrations (nos.m^{-2}) for the surveys in 1982, 1985, 1987, 1988 and 1989*



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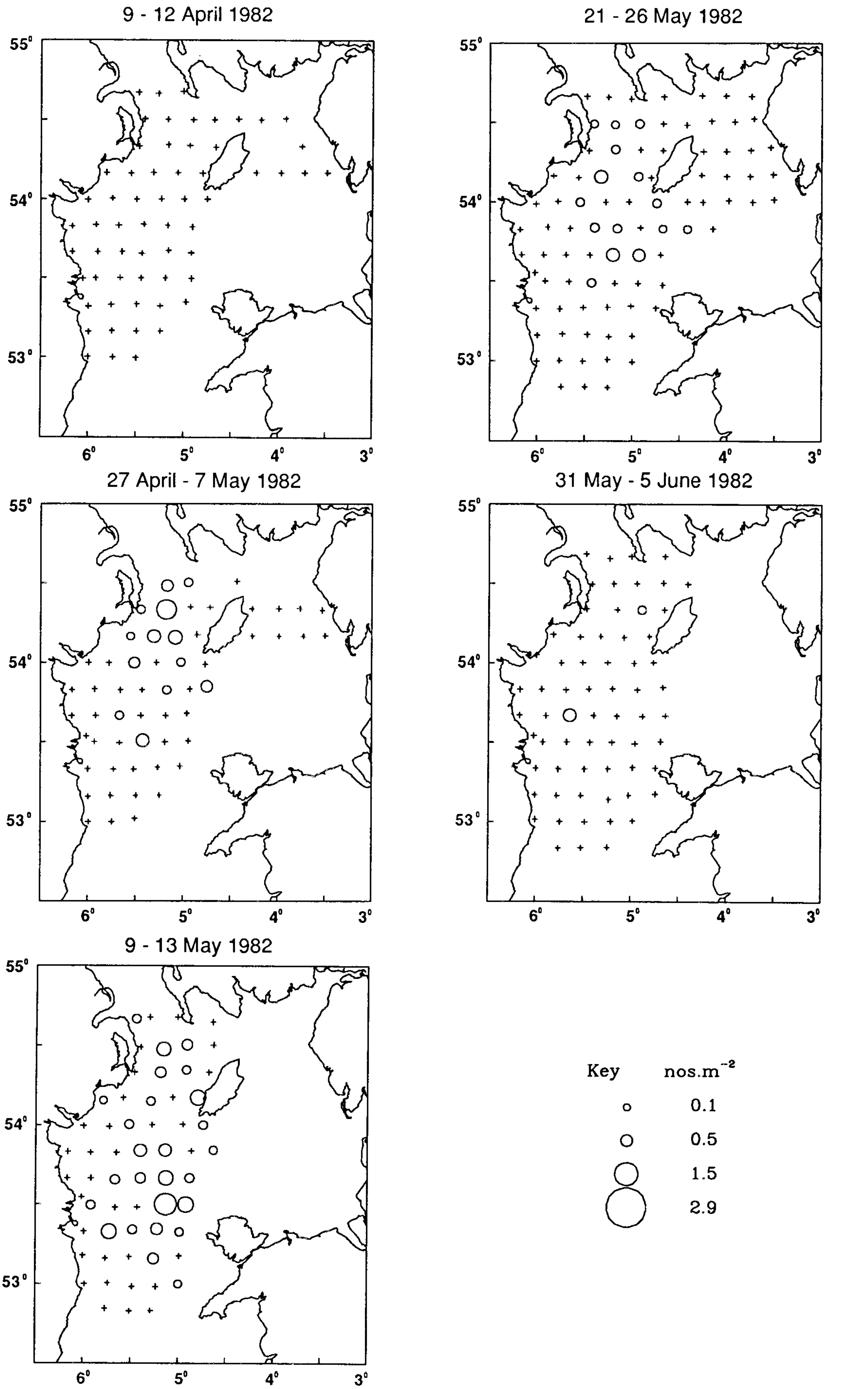


Figure 26. ***Total ling (Molva molva) larvae concentrations (nos.m⁻²) for the surveys in 1982, 1985, 1987, 1988 and 1989***

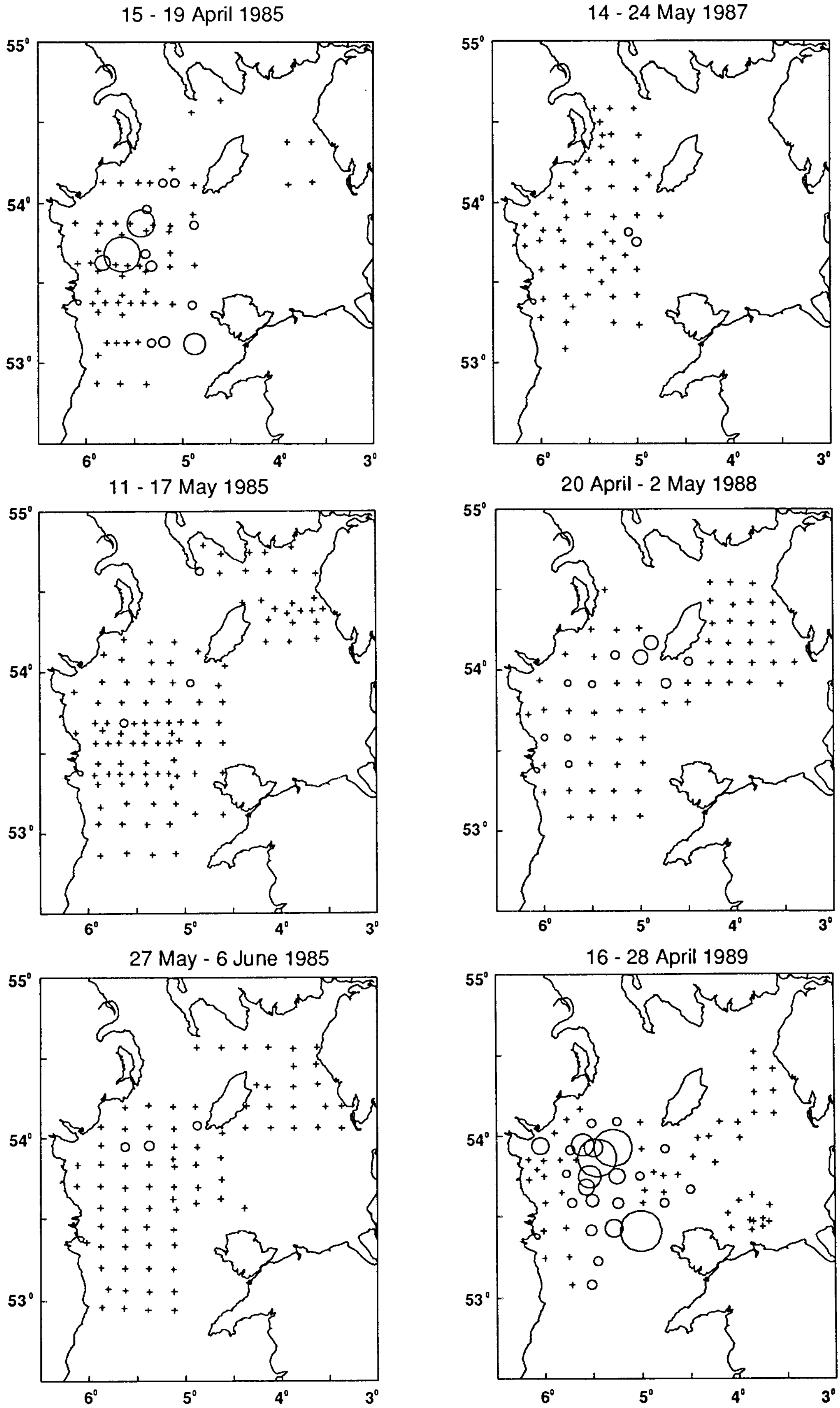


Figure 26 continued

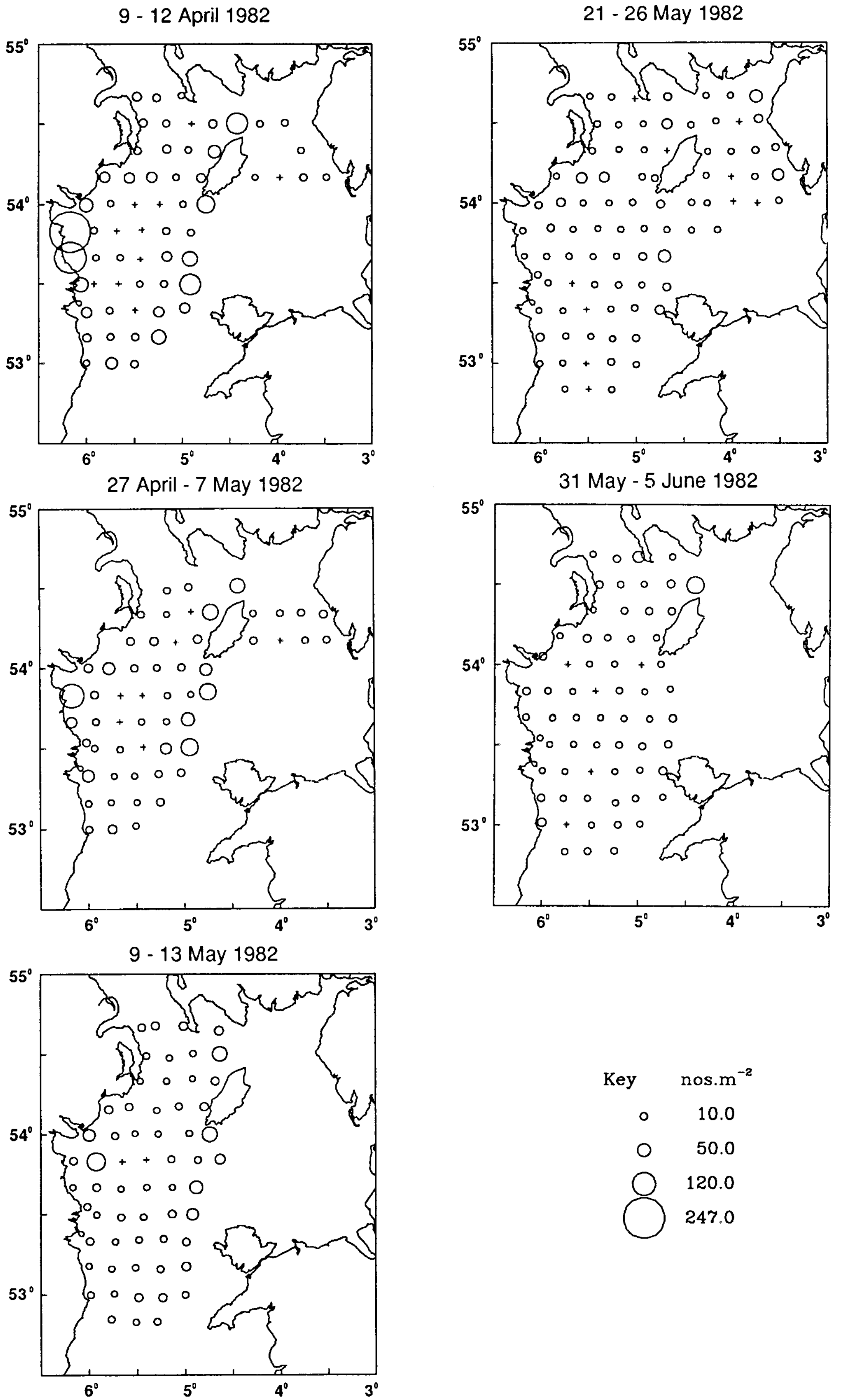


Figure 27. Total rockling (Onos spp.) egg concentrations (nos.m^{-2}) for the surveys in 1982, 1985, 1987, 1988 and 1989

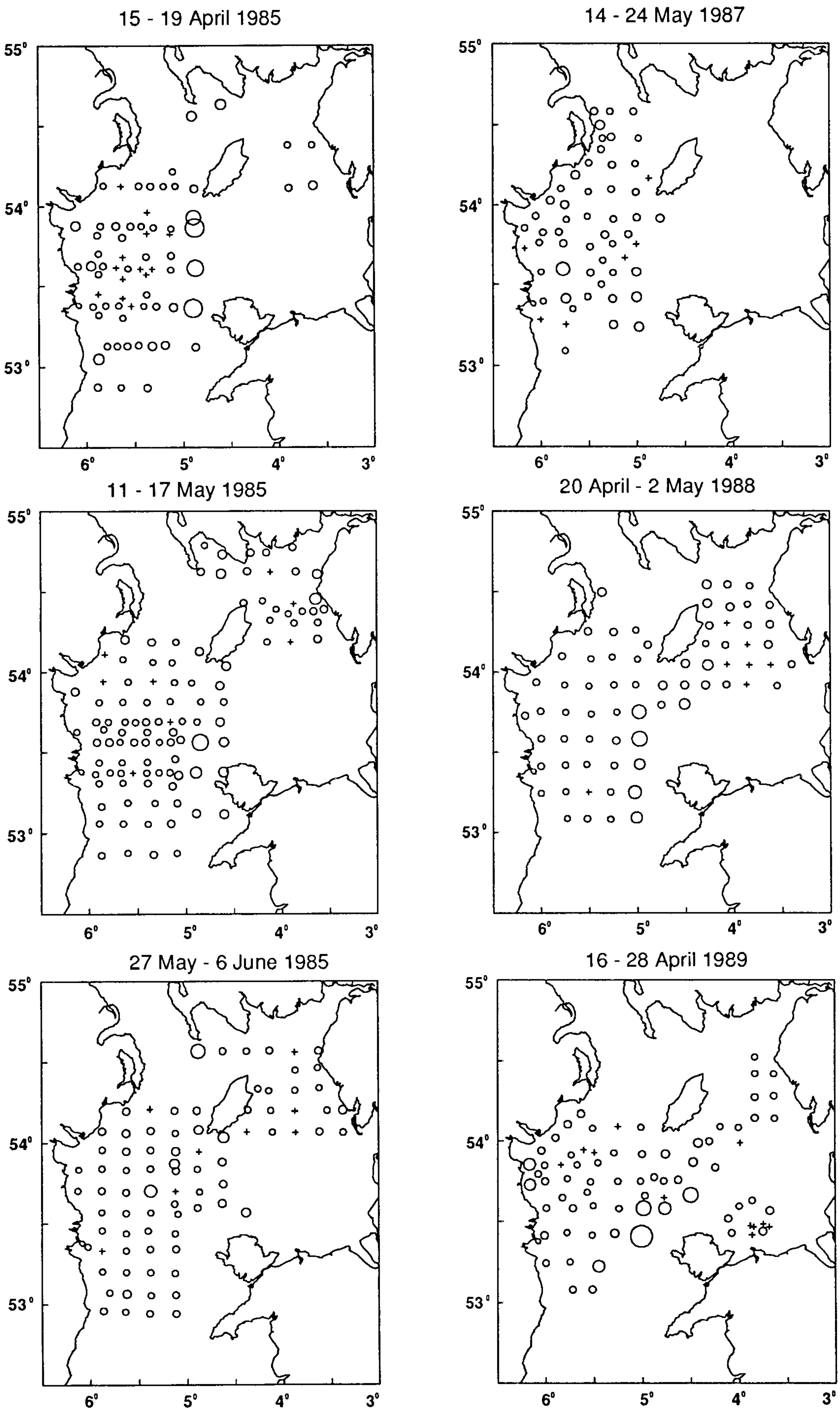


Figure 27 continued

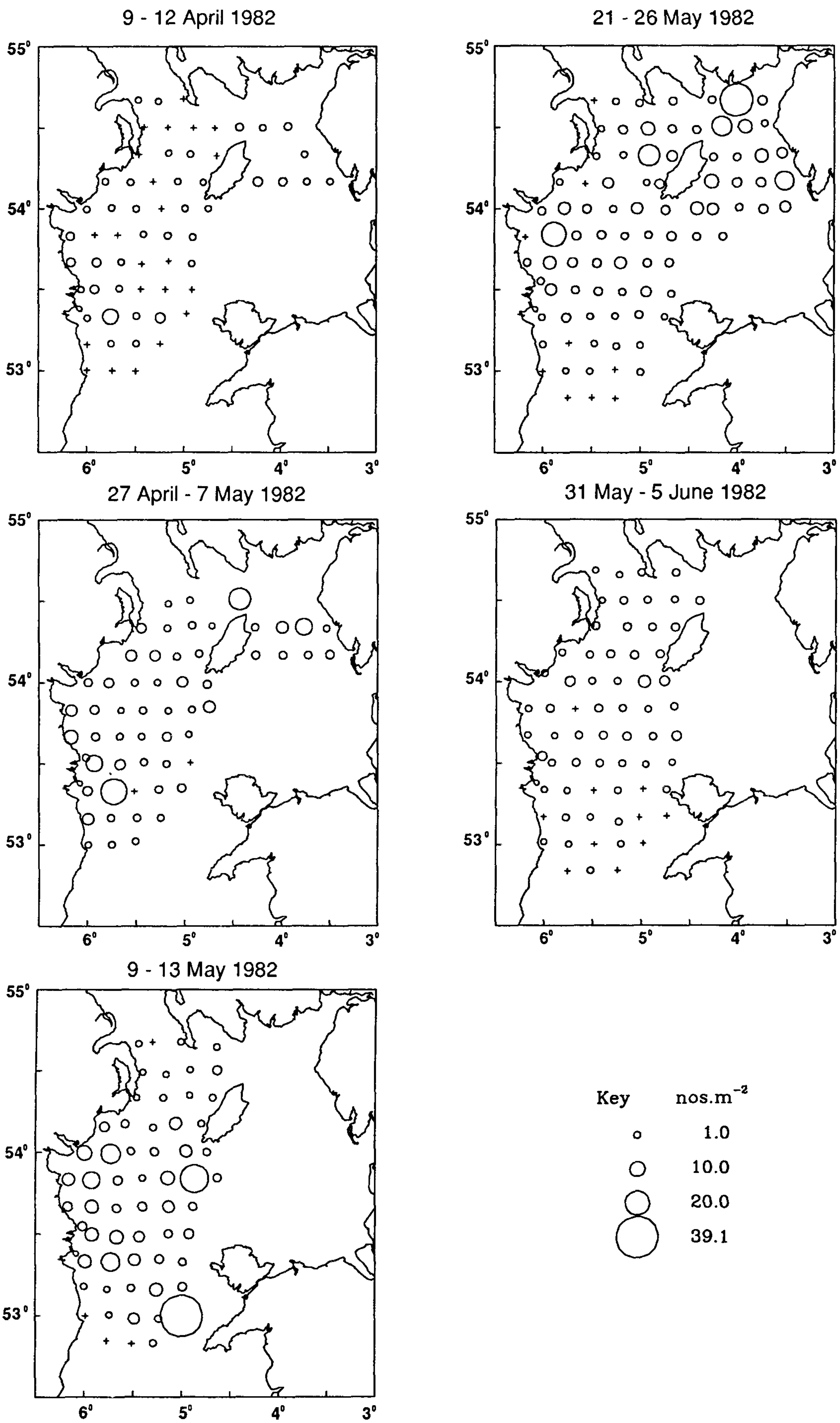
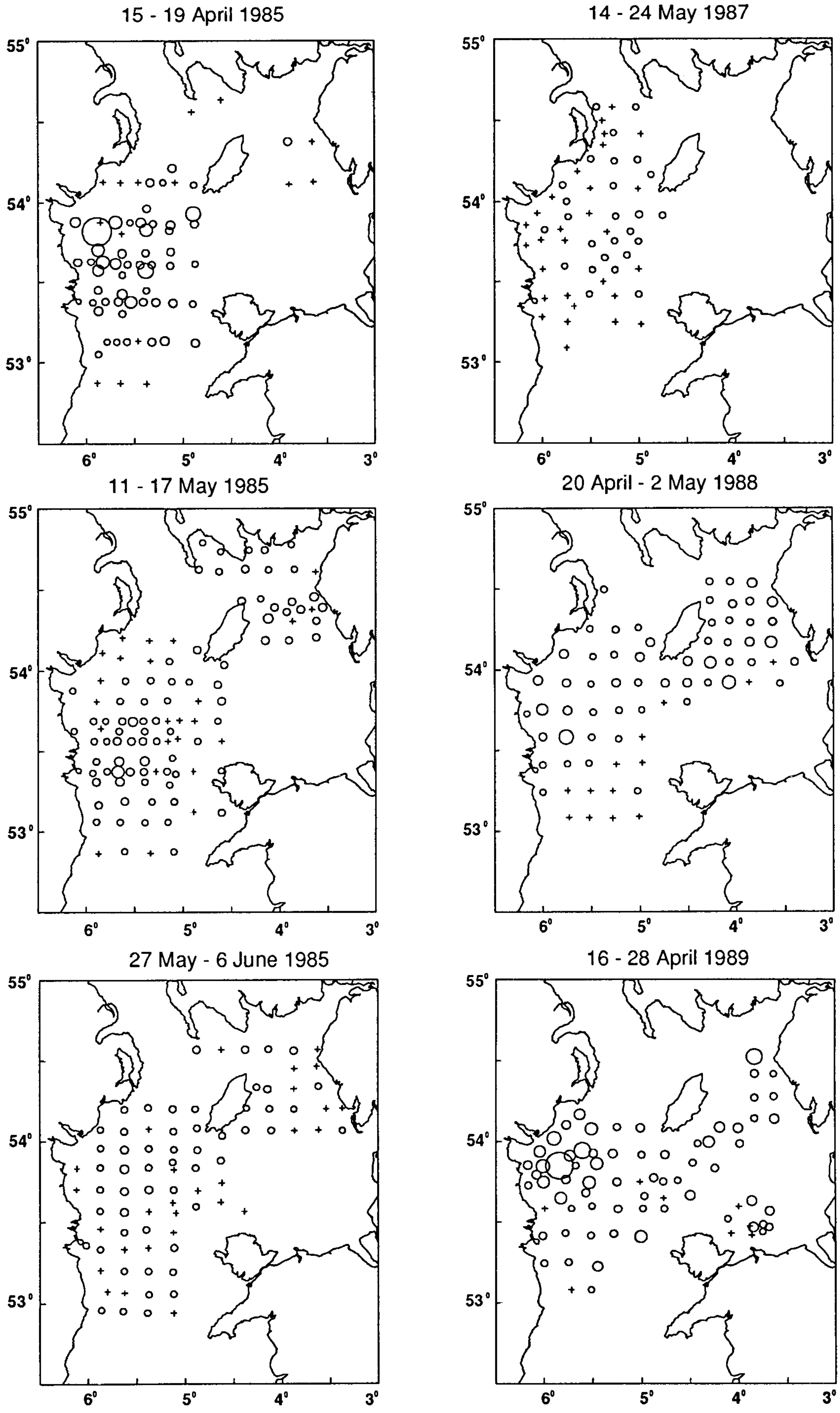


Figure 28. Total rockling (Onos spp.) larvae concentrations (nos.m^{-2}) for the surveys in 1982, 1985, 1987, 1988 and 1989



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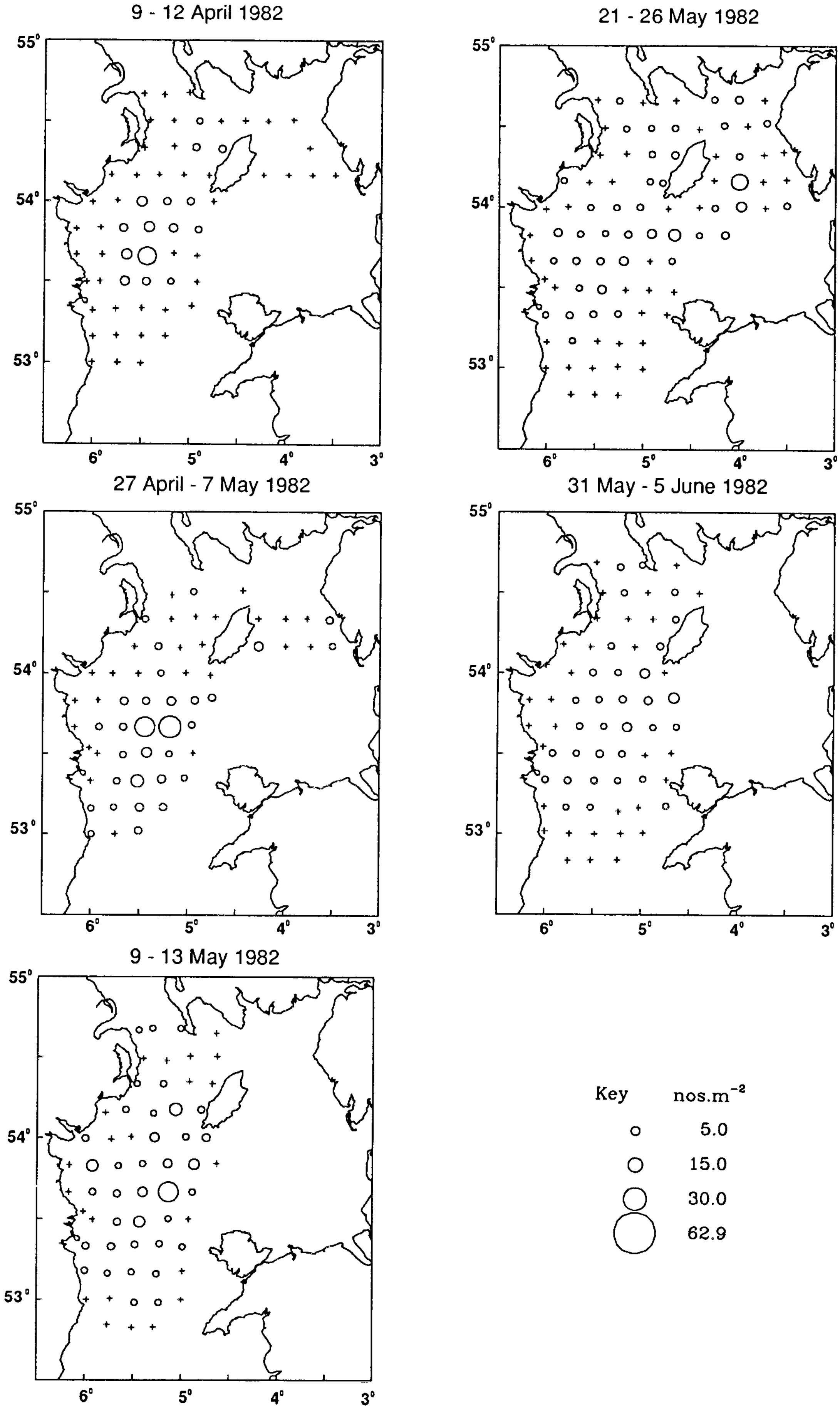
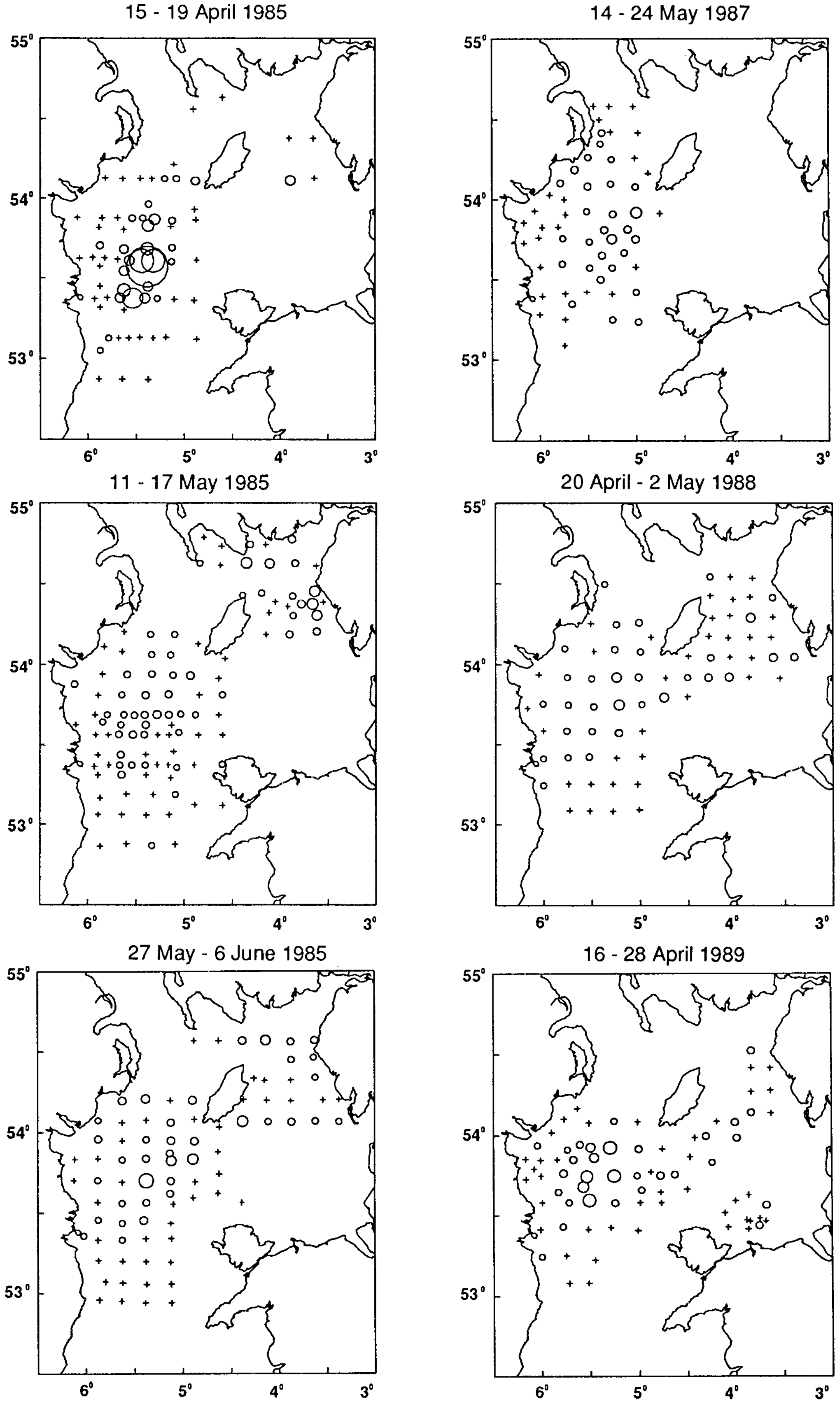


***Figure 29.** Total gurnard (Triglidae) egg concentrations (nos.m^2) for the surveys in 1982, 1985, 1987, 1988 and 1989*



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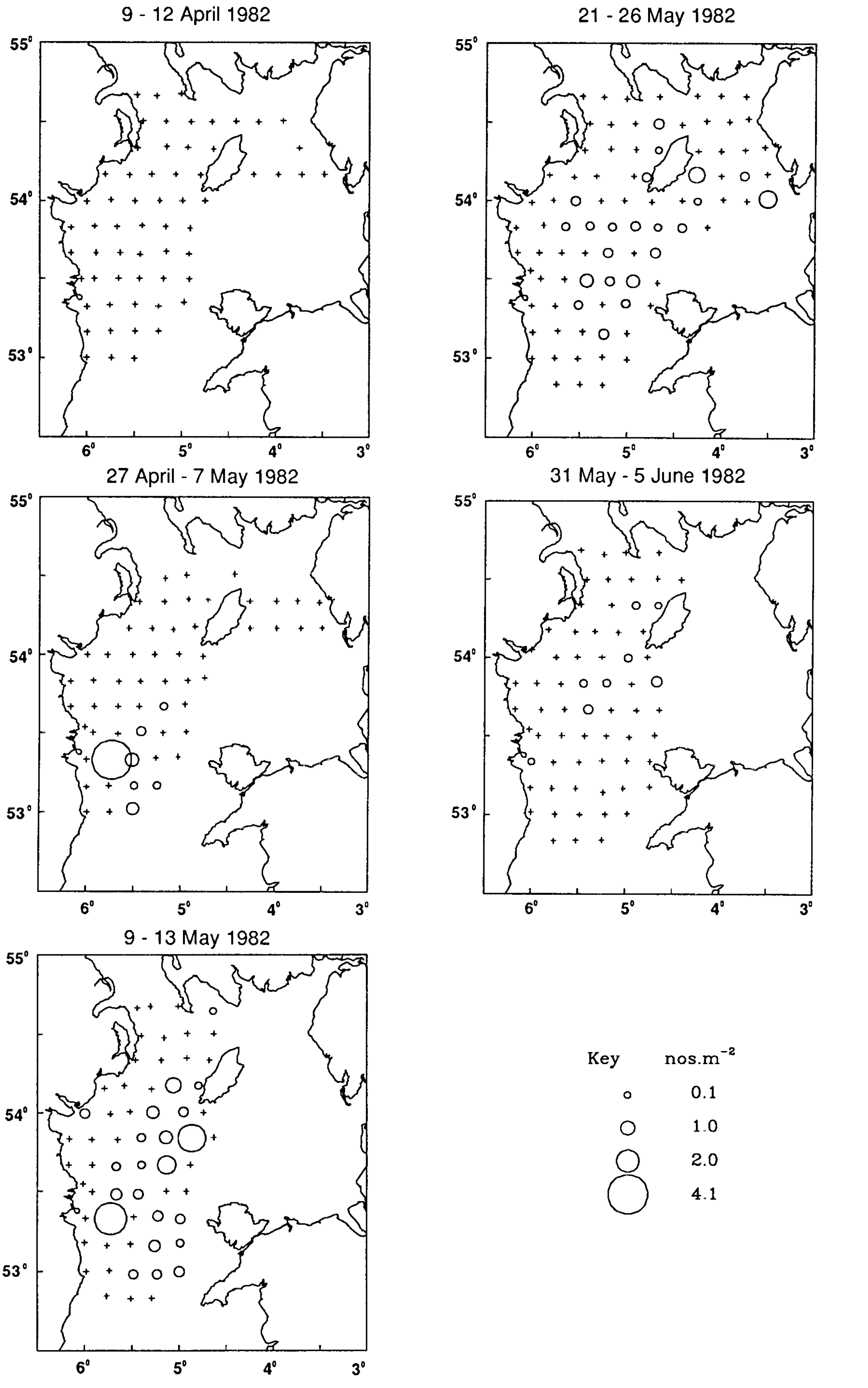

Figure 30. ***Total gurnard (Triglidae) larvae concentrations (nos.m^{-2}) for the surveys in 1982, 1985, 1987, 1988 and 1989***

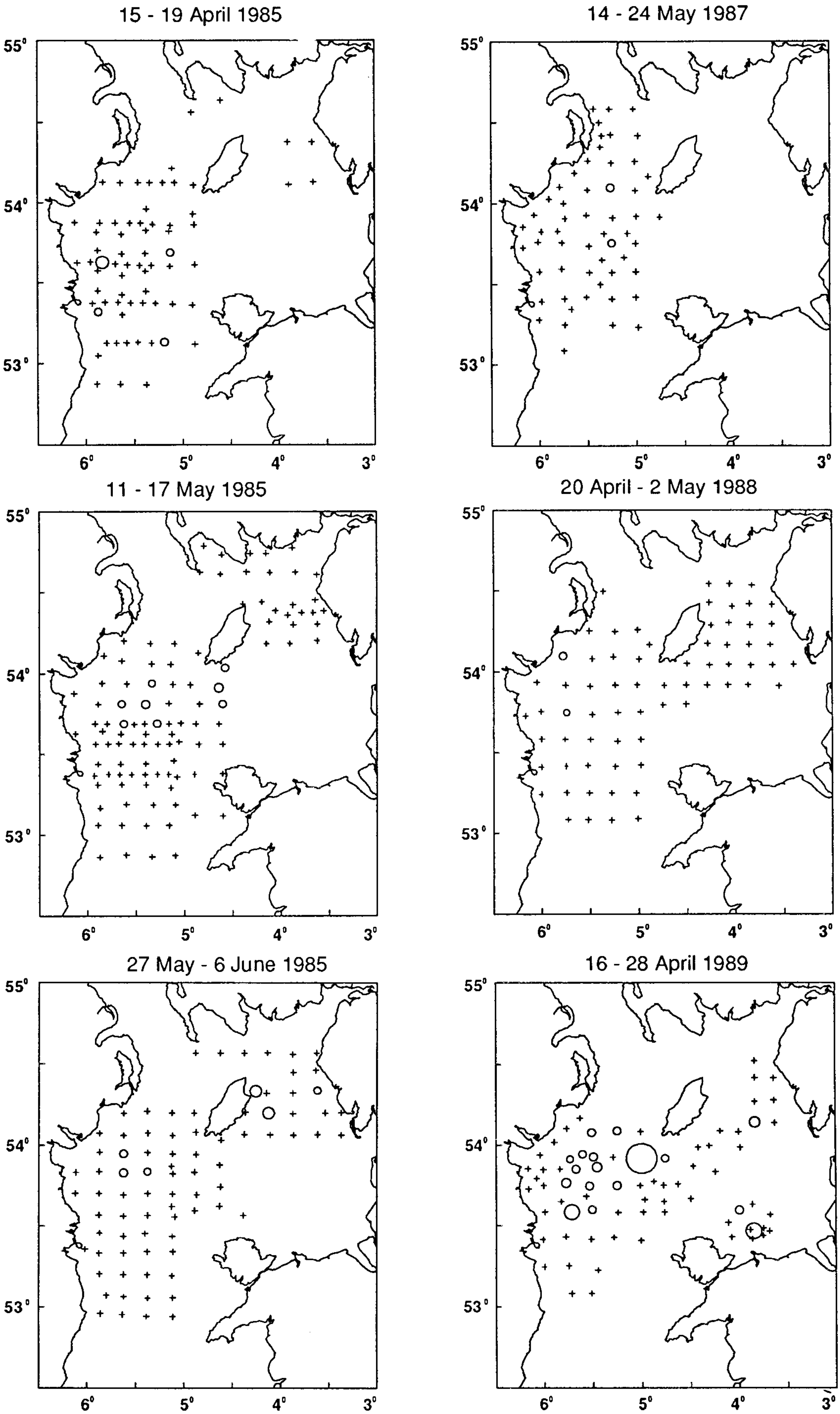

Figure 30 continued

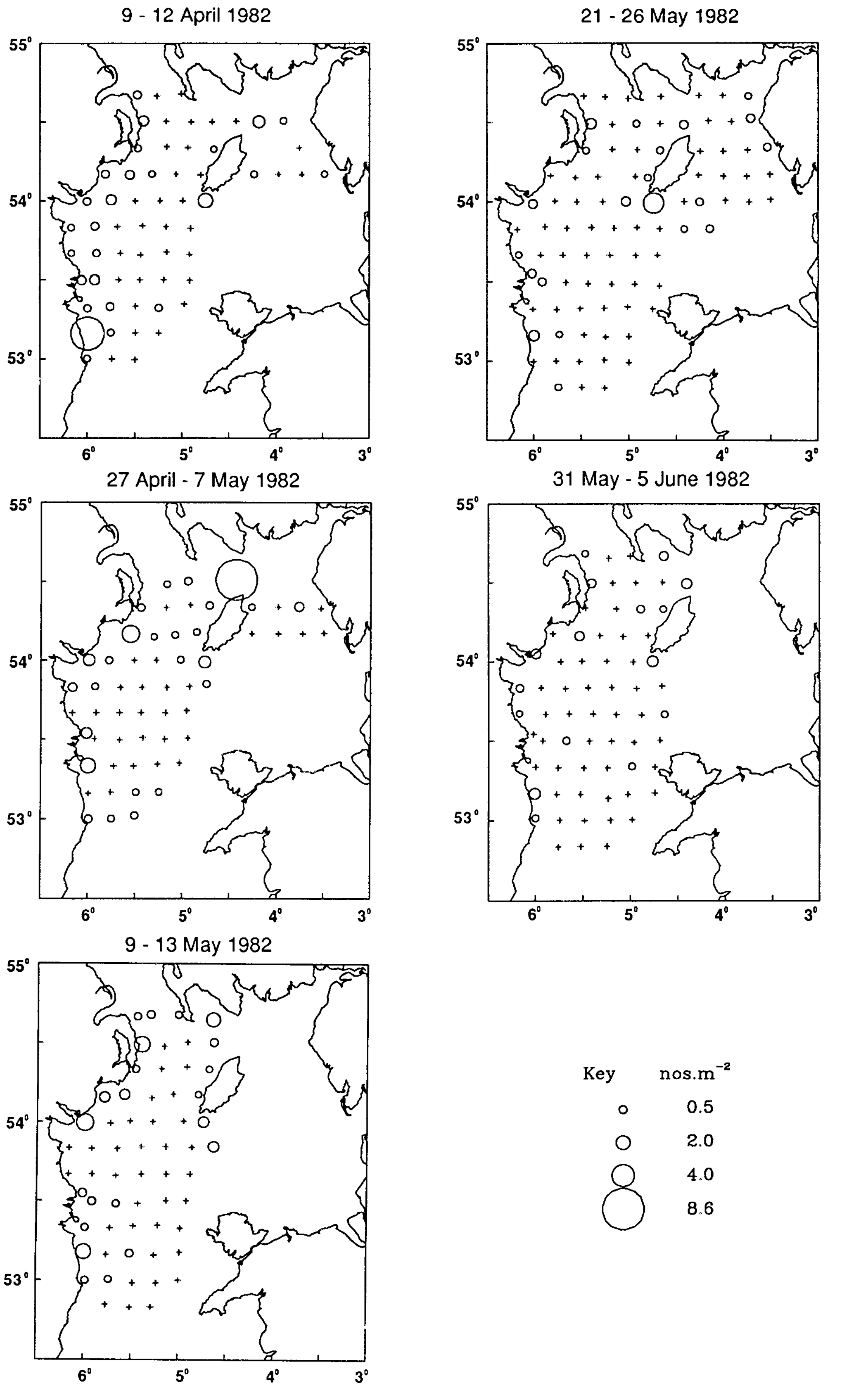

***Figure 31.** Total Cottidae larvae concentrations (nos.m^{-2}) for the surveys in 1982, 1985, 1987, 1988 and 1989*

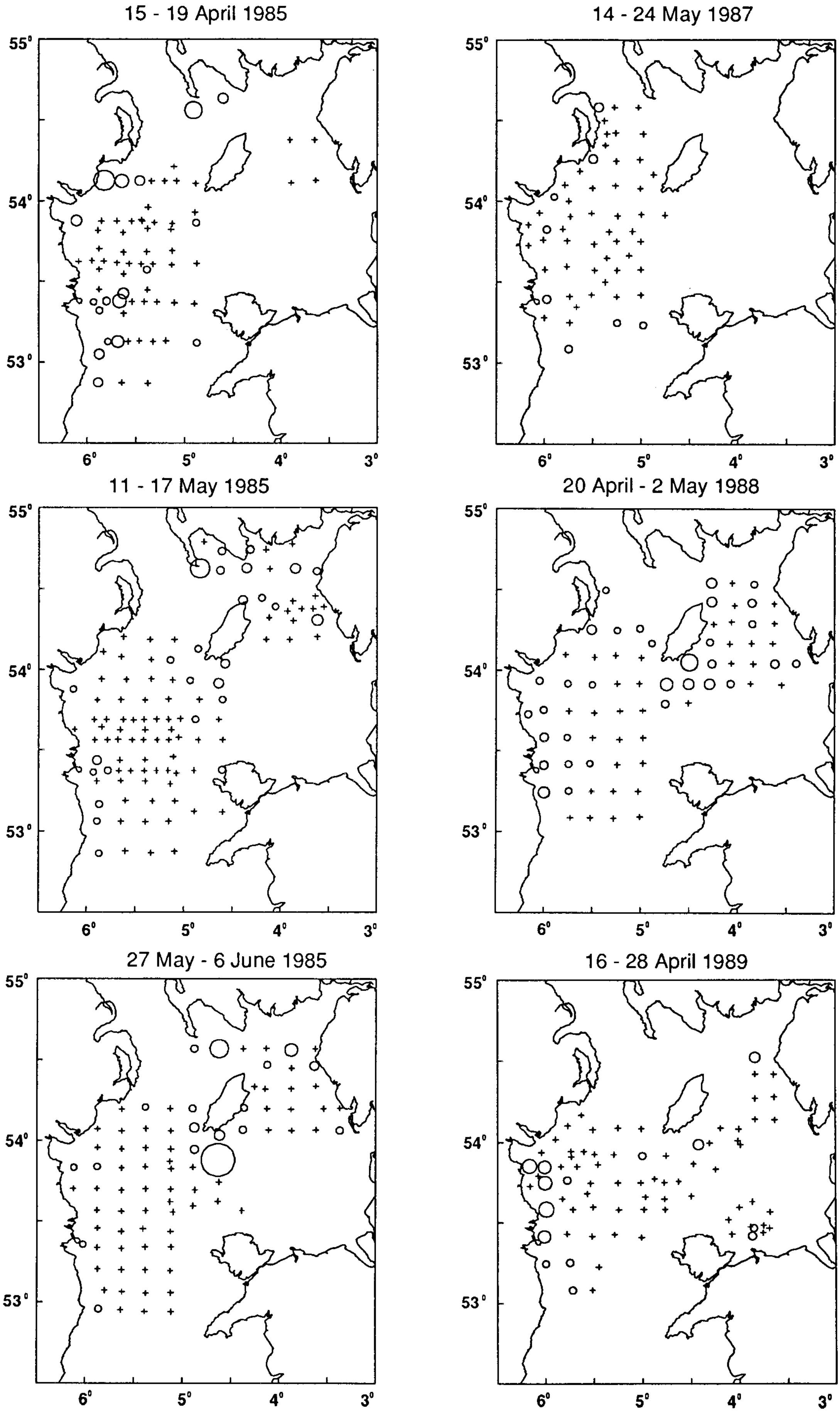

Figure 31 continued

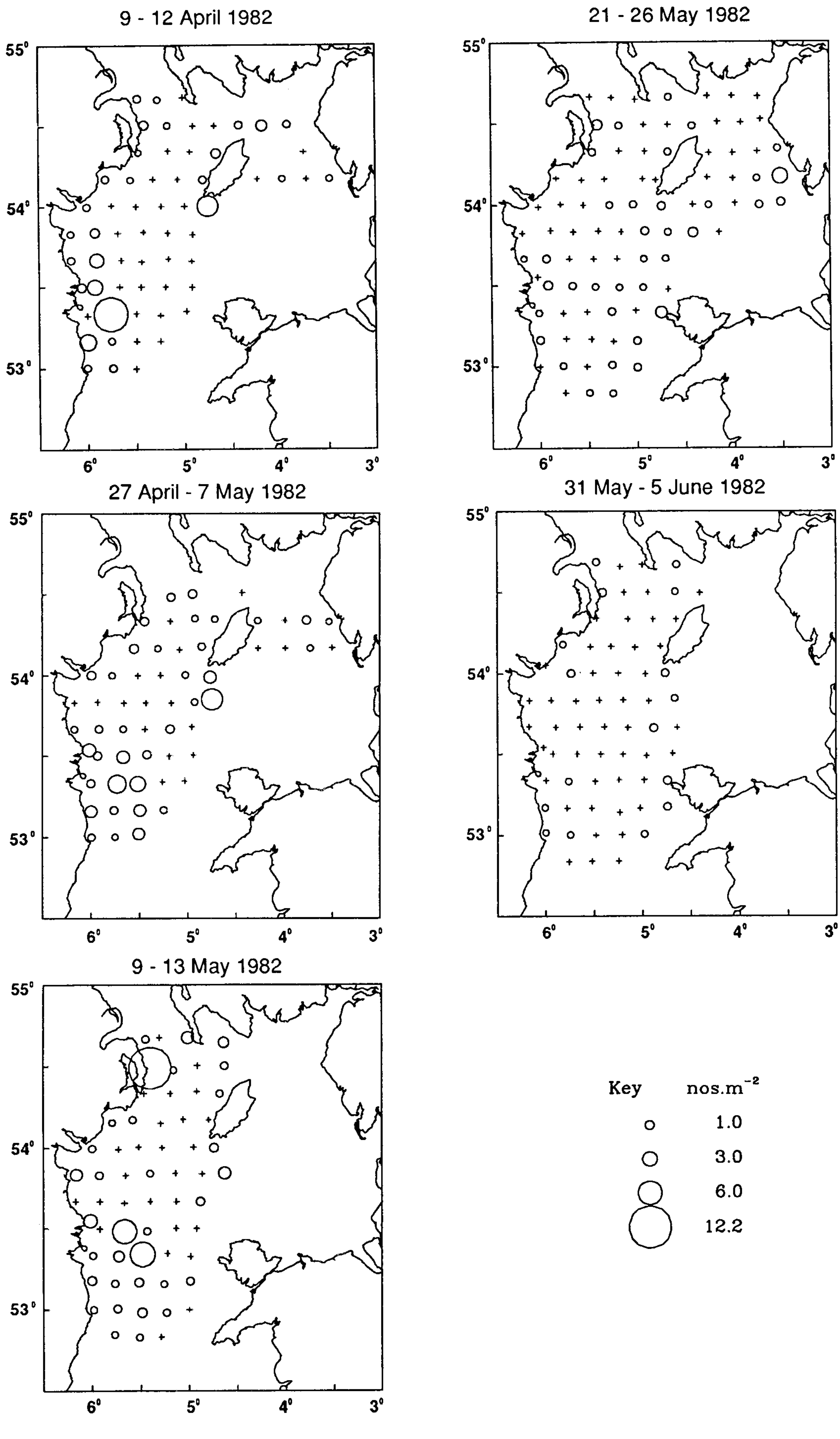

***Figure 32.** Total sea snail (Liparis spp.) larvae concentrations (nos.m^{-2}) for the surveys in 1982, 1985, 1987, 1988 and 1989*

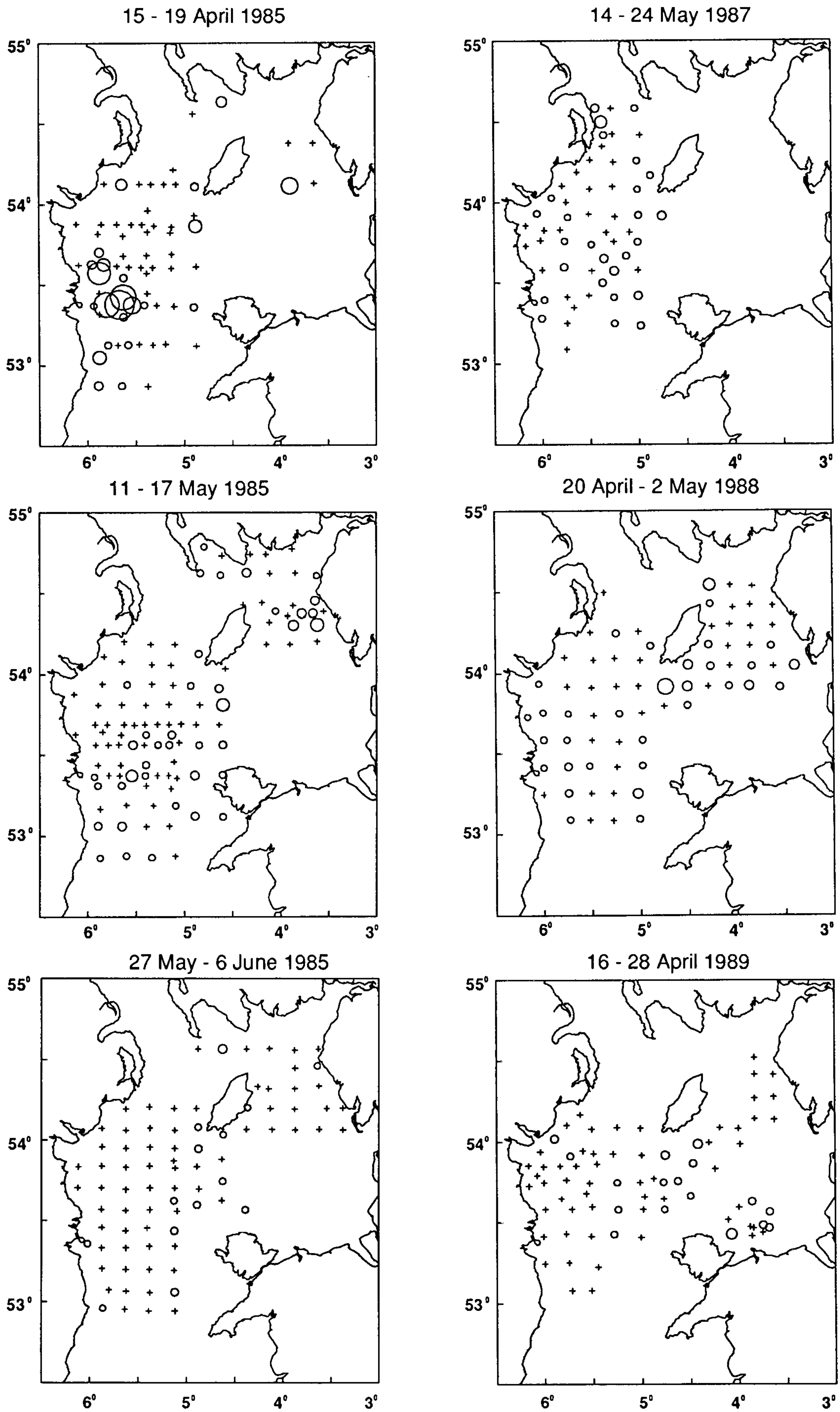

Figure 32 continued

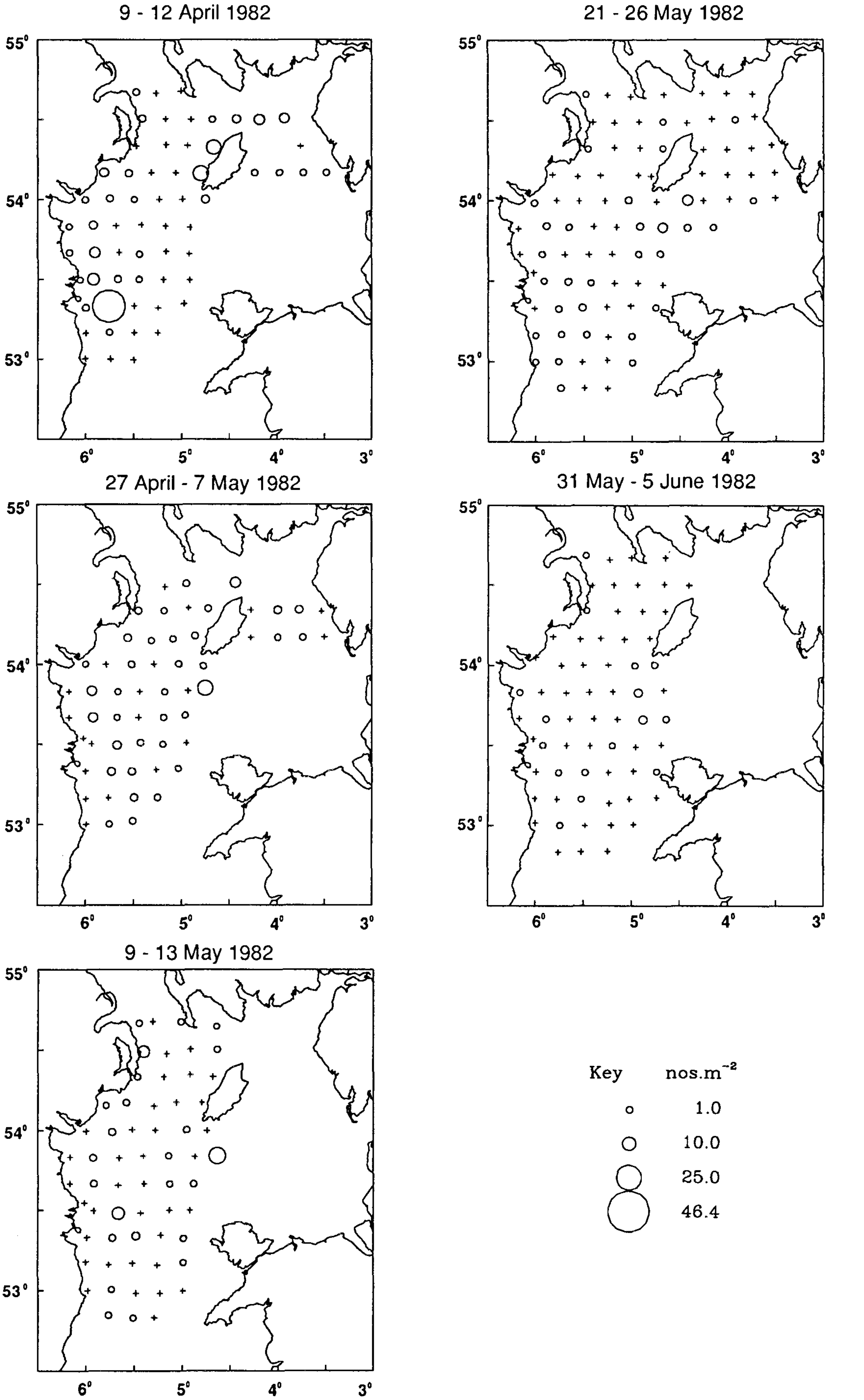

Figure 33. Total butterfish (Pholis gunnellus) larvae concentrations (nos.m^{-2}) for the surveys in 1982, 1985, 1987, 1988 and 1989

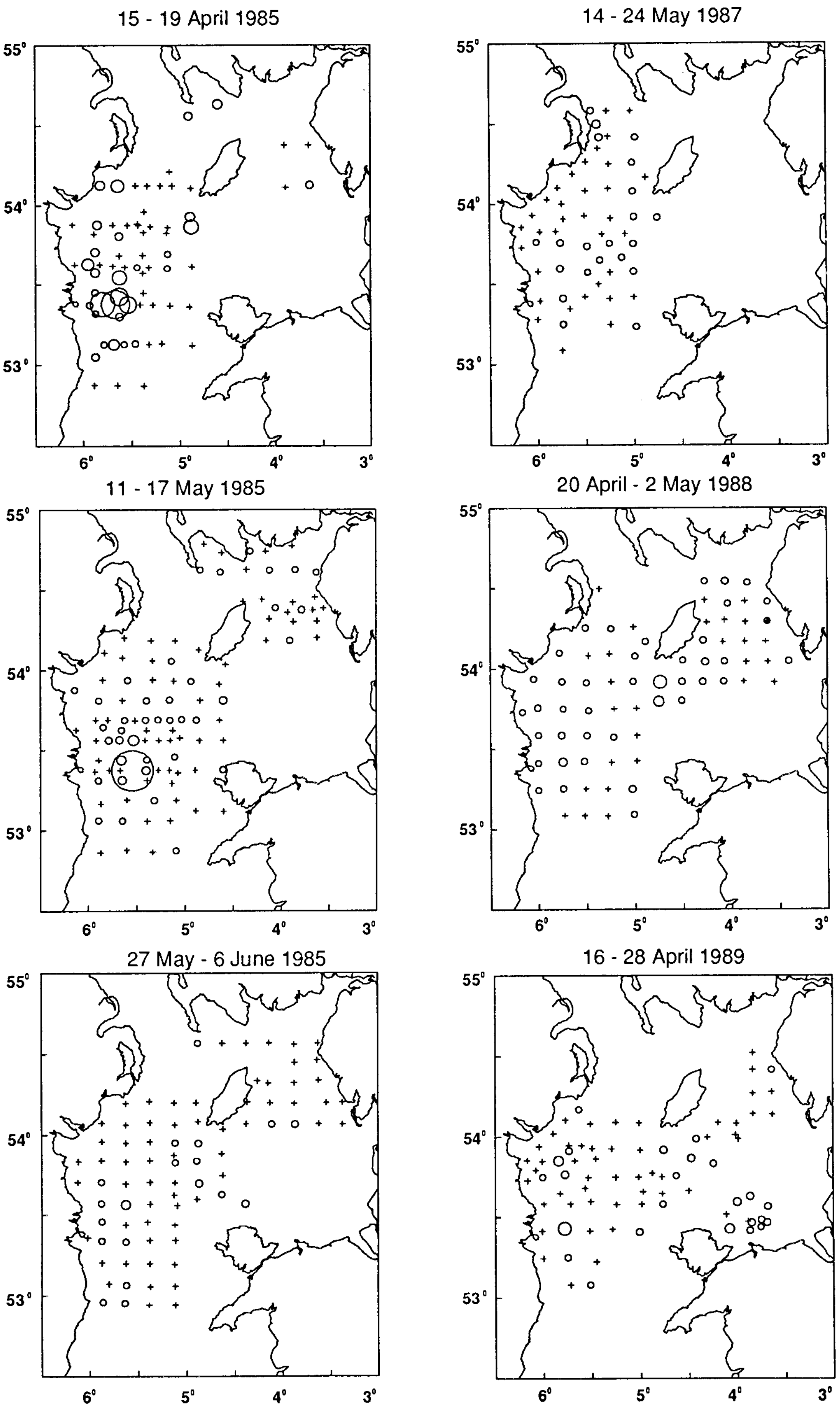

Figure 33 continued

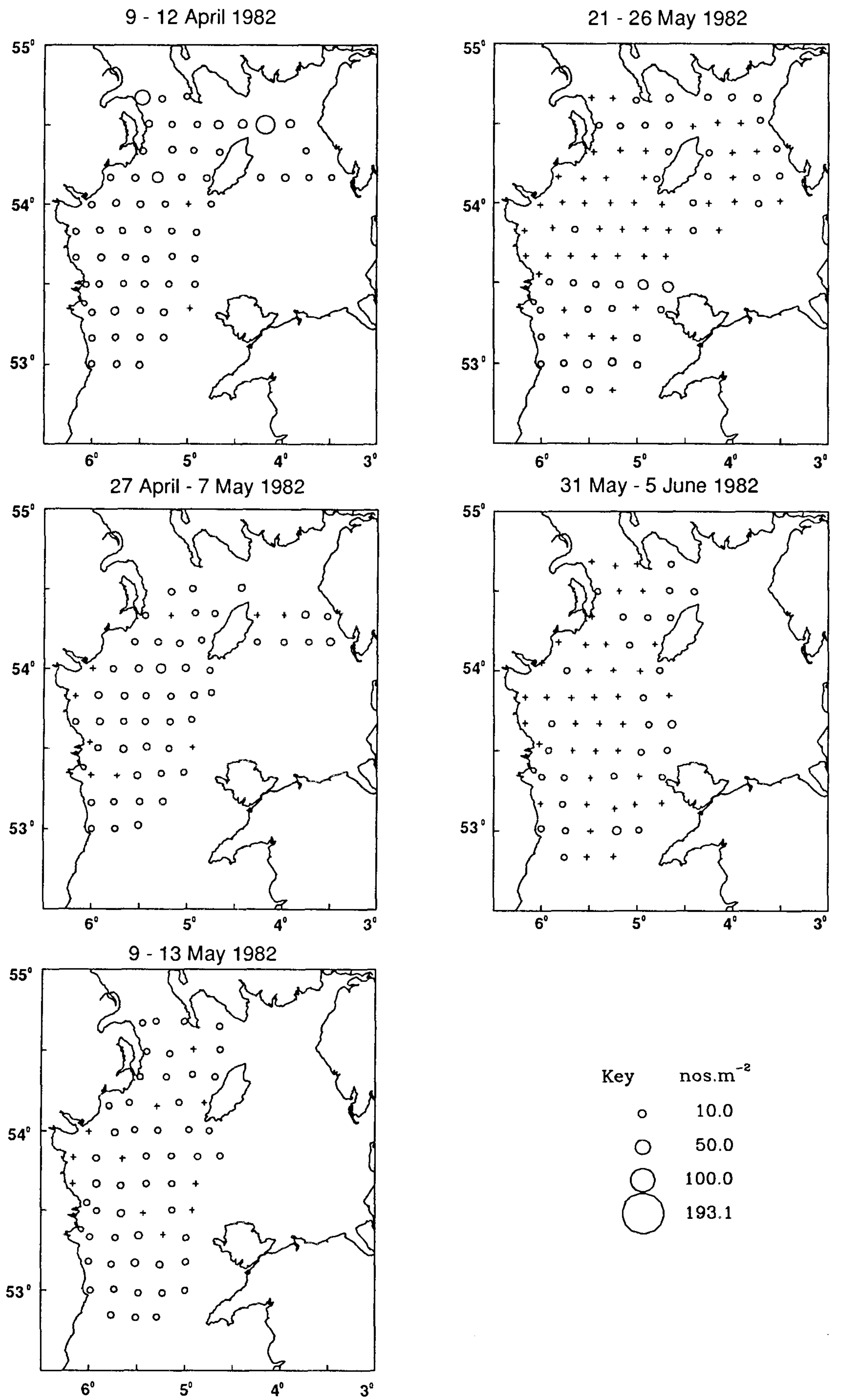

Figure 34. ***Total sandeel (Ammodytidae) larvae concentrations (nos.m^{-2}) for the surveys in 1982, 1985, 1987, 1988 and 1989***

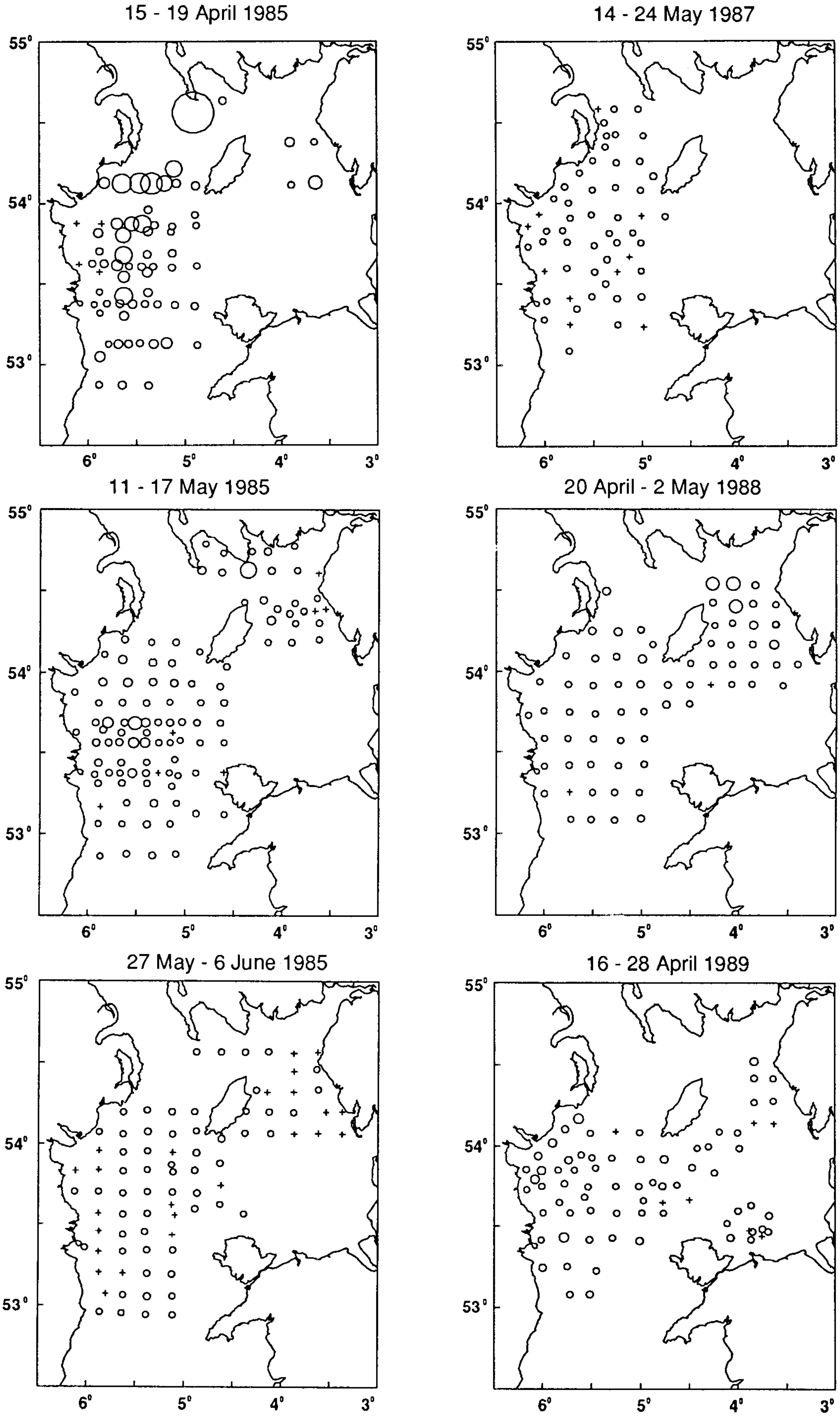

Figure 34 continued

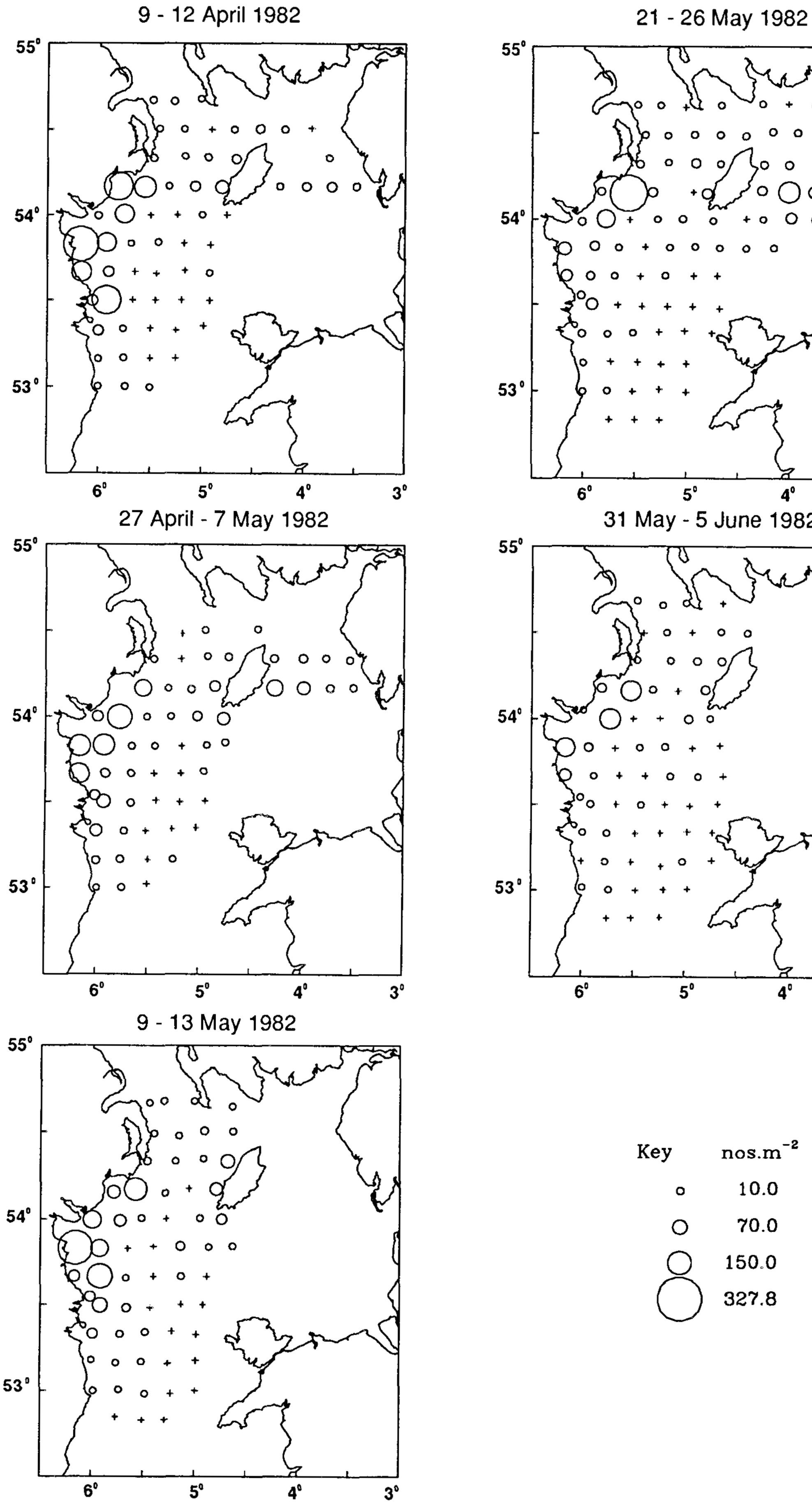

Figure 35.** **Total dragonet (Callionymiidae) egg concentrations (nos.m^{-2}) for the surveys in 1982, 1985, 1987, 1988 and 1989

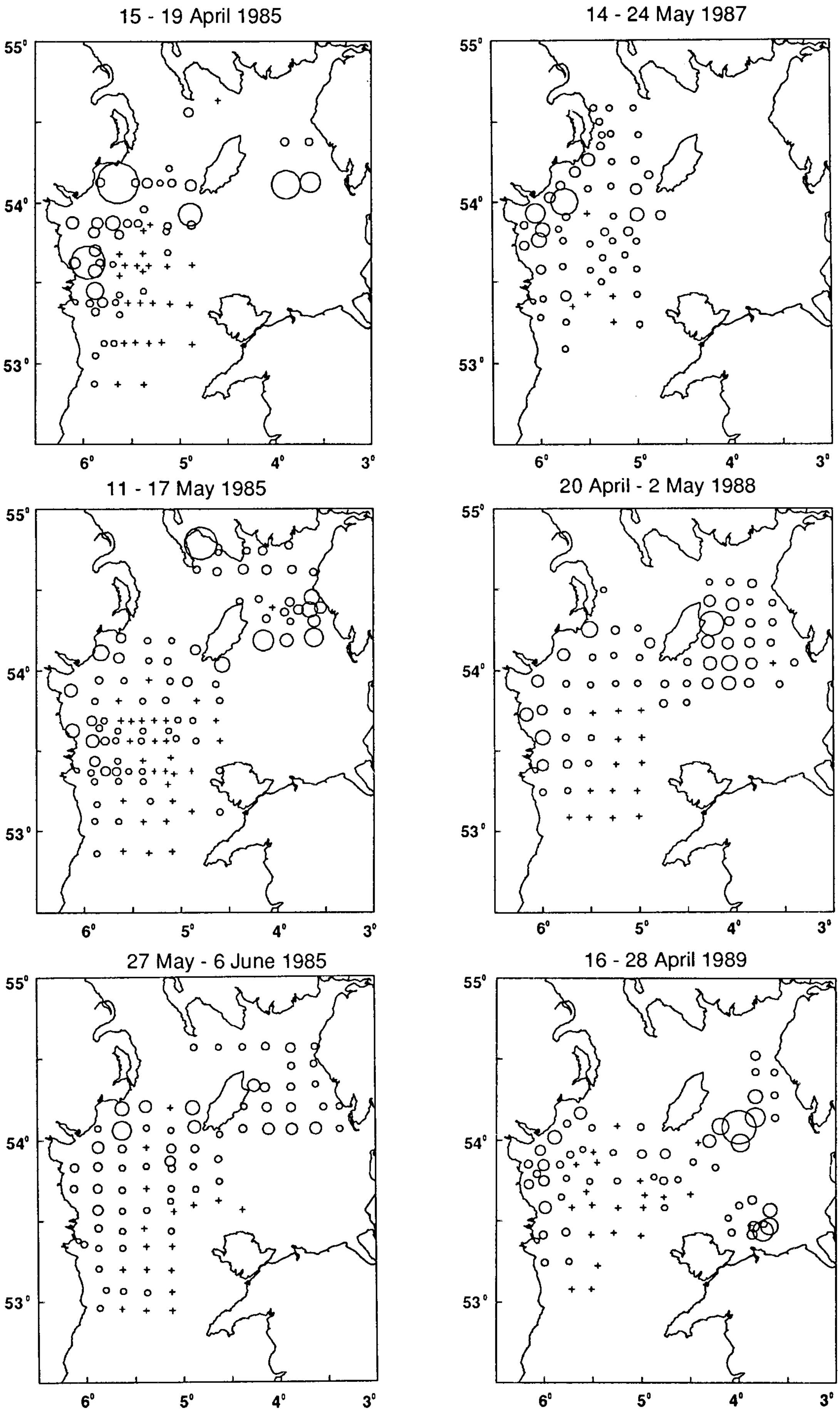

Figure 35 continued

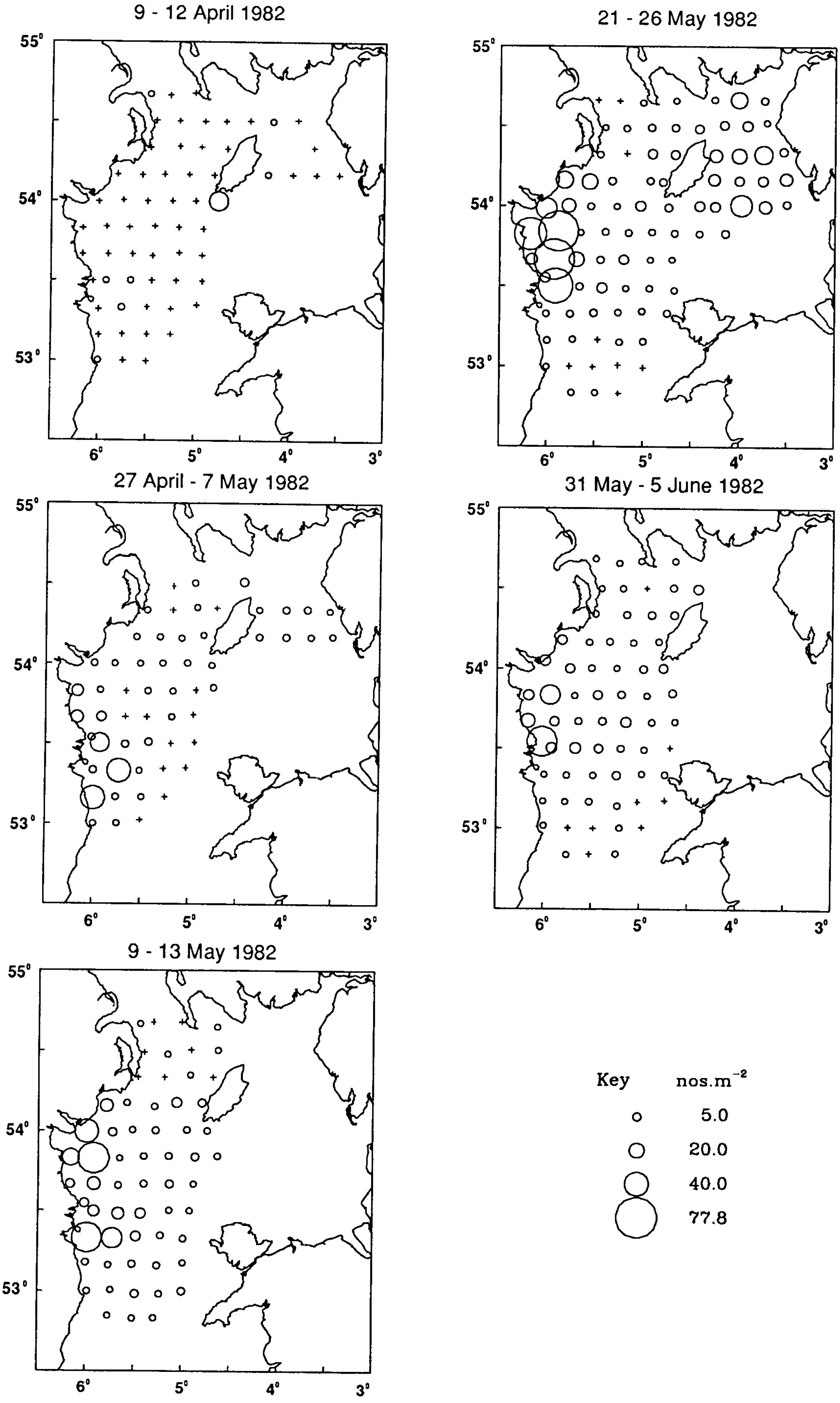

Figure 36. Total dragonet (Callionymiidae) larvae concentrations (nos.m^{-2}) for the surveys in 1982, 1985, 1987, 1988 and 1989

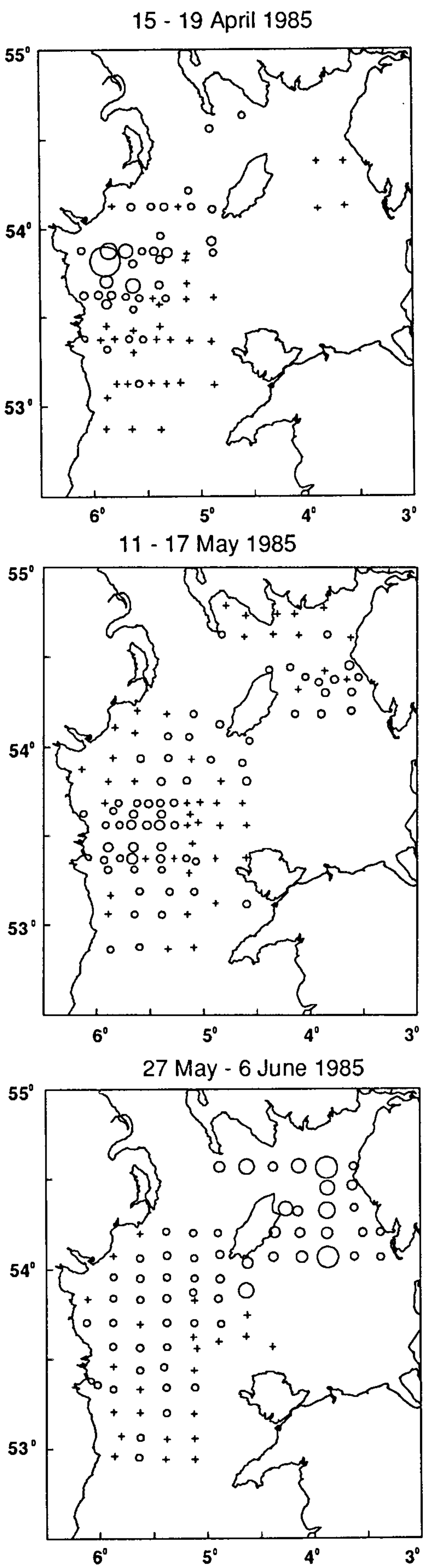

Figure 36 continued

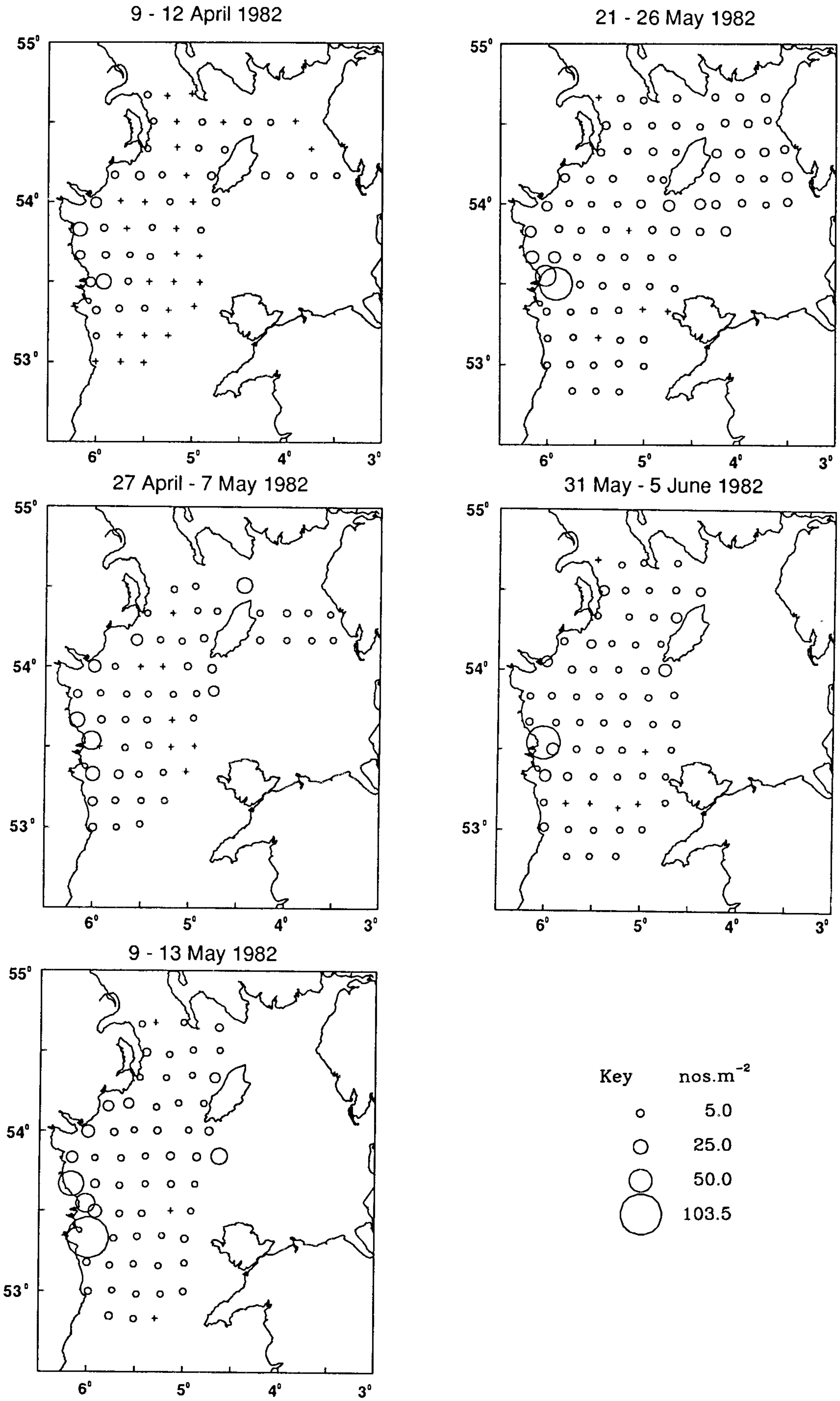

Figure 37. ***Total goby (Gobiidae) larvae concentrations (nos.m^{-2}) for the surveys in 1982, 1985, 1987, 1988 and 1989***

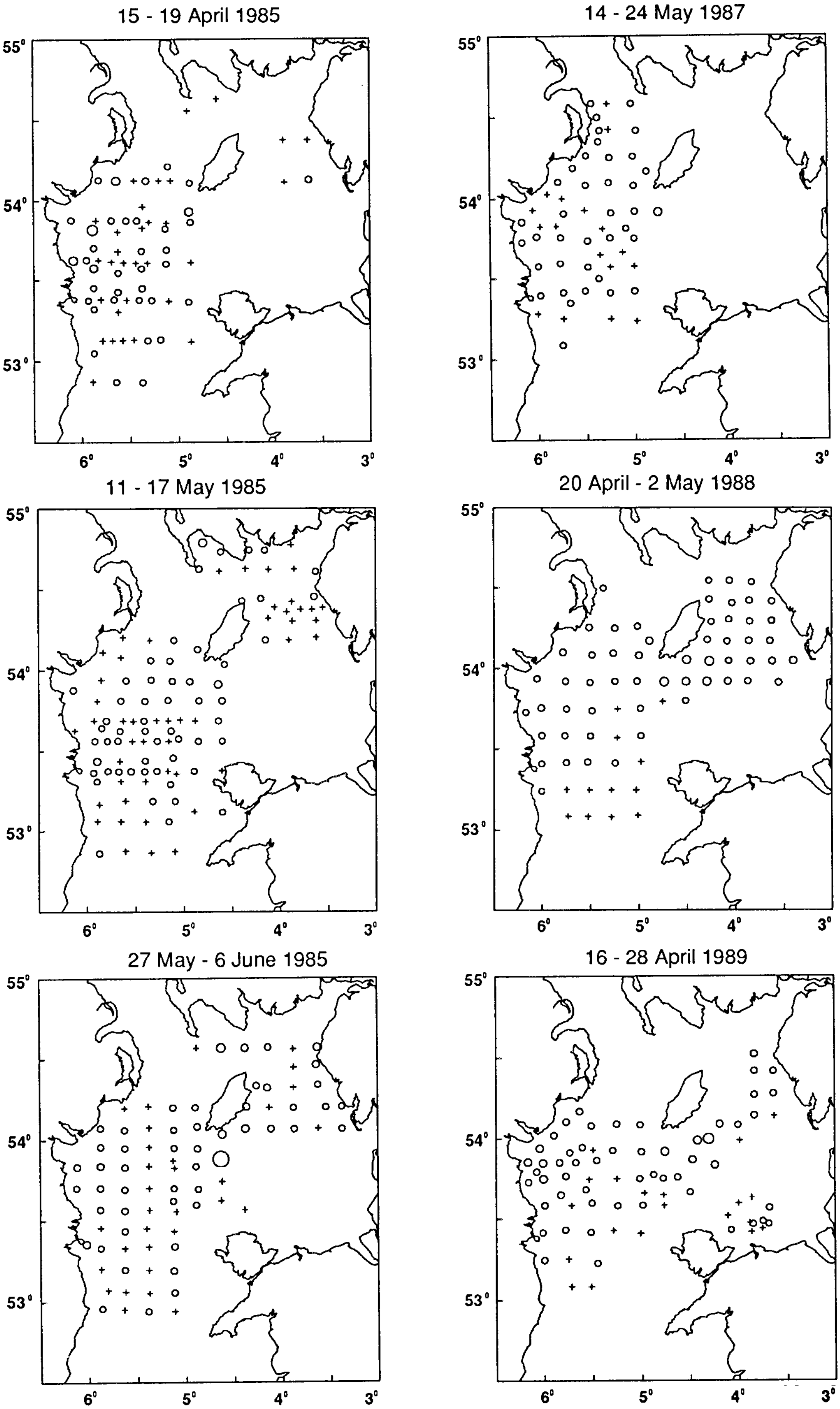

Figure 37 continued

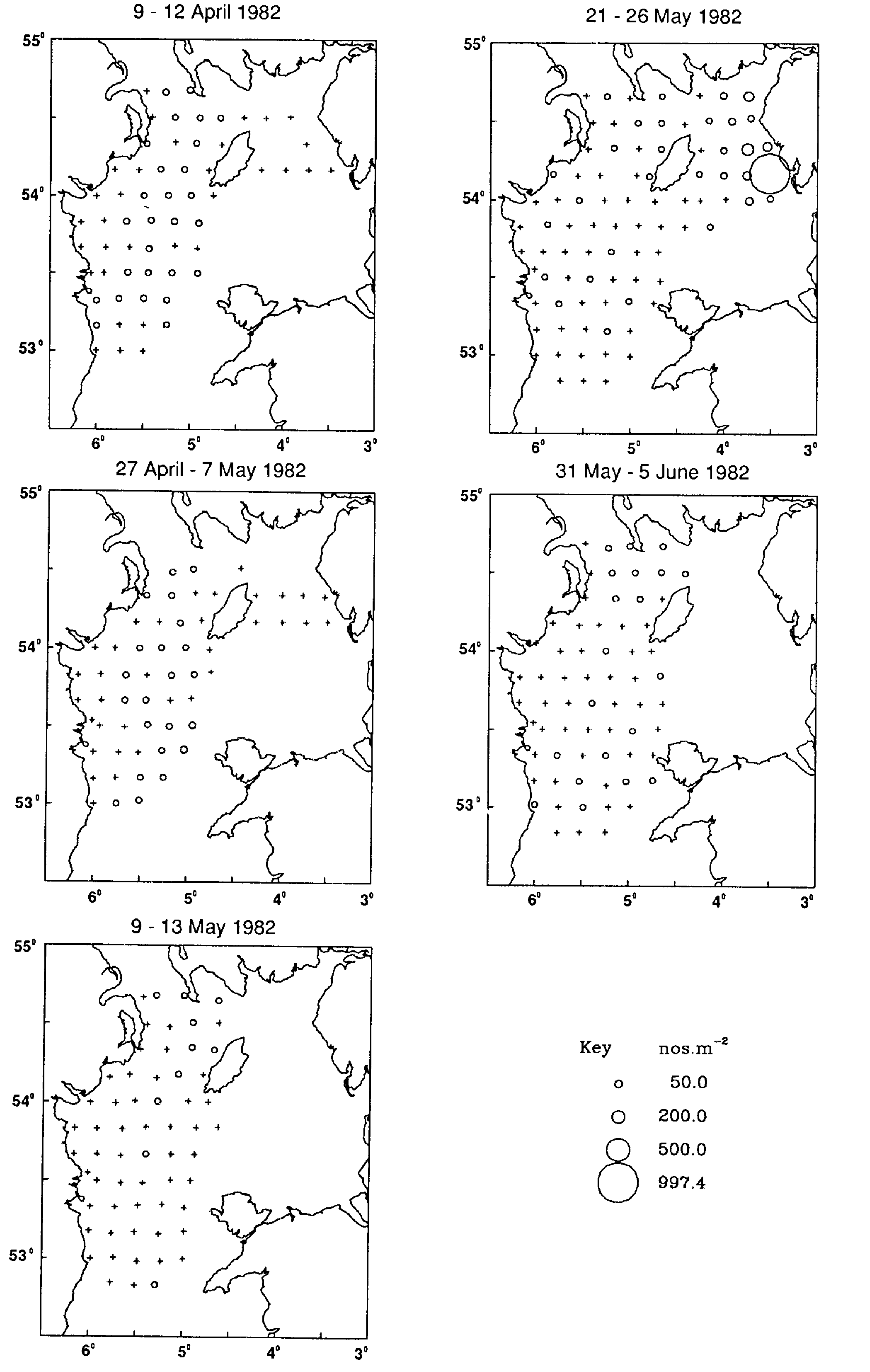

Figure 38. Total mackerel (Scomber scombrus) egg concentrations (nos.m^{-2}) for the surveys in 1982, 1985, 1987, 1988 and 1989

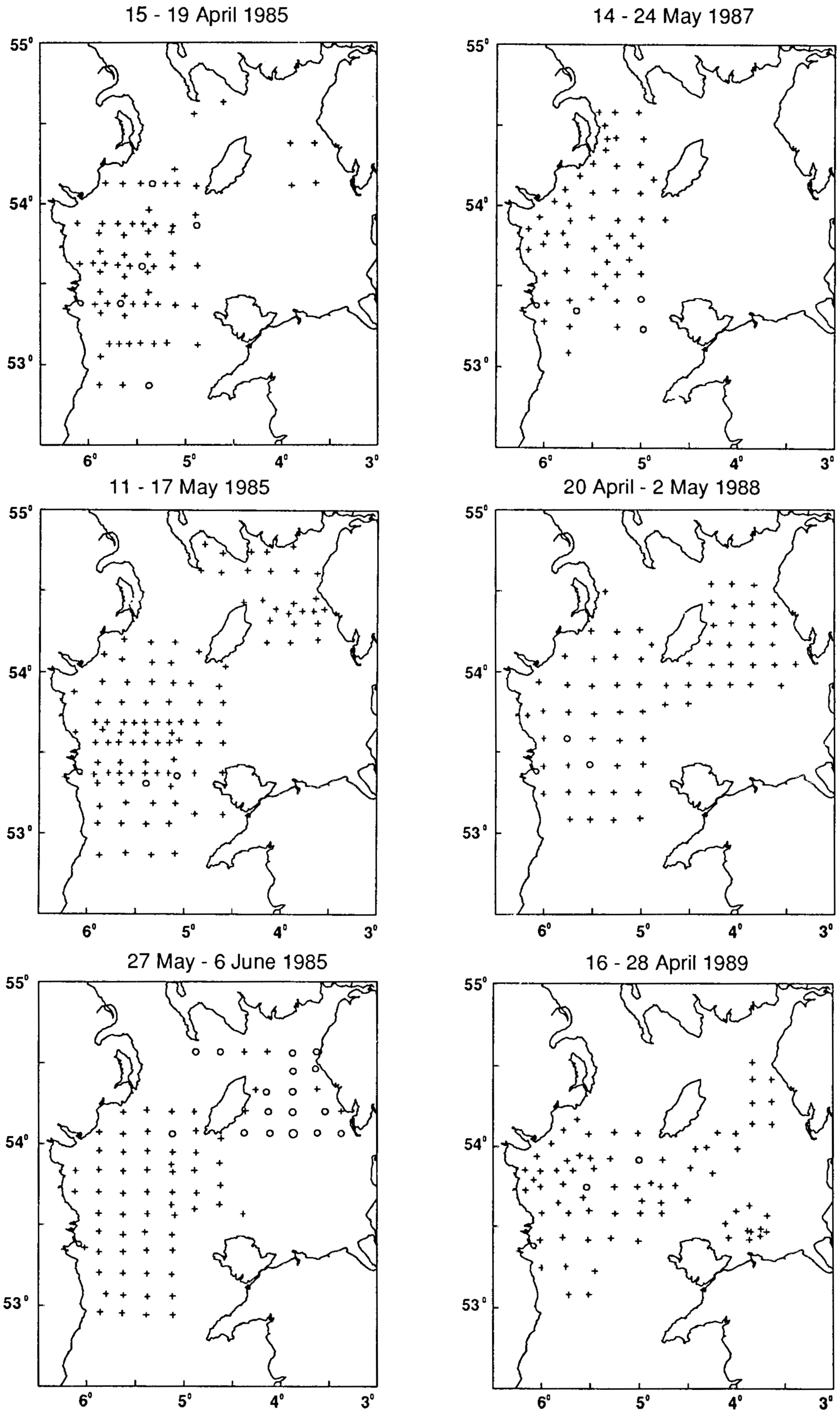

Figure 38 continued

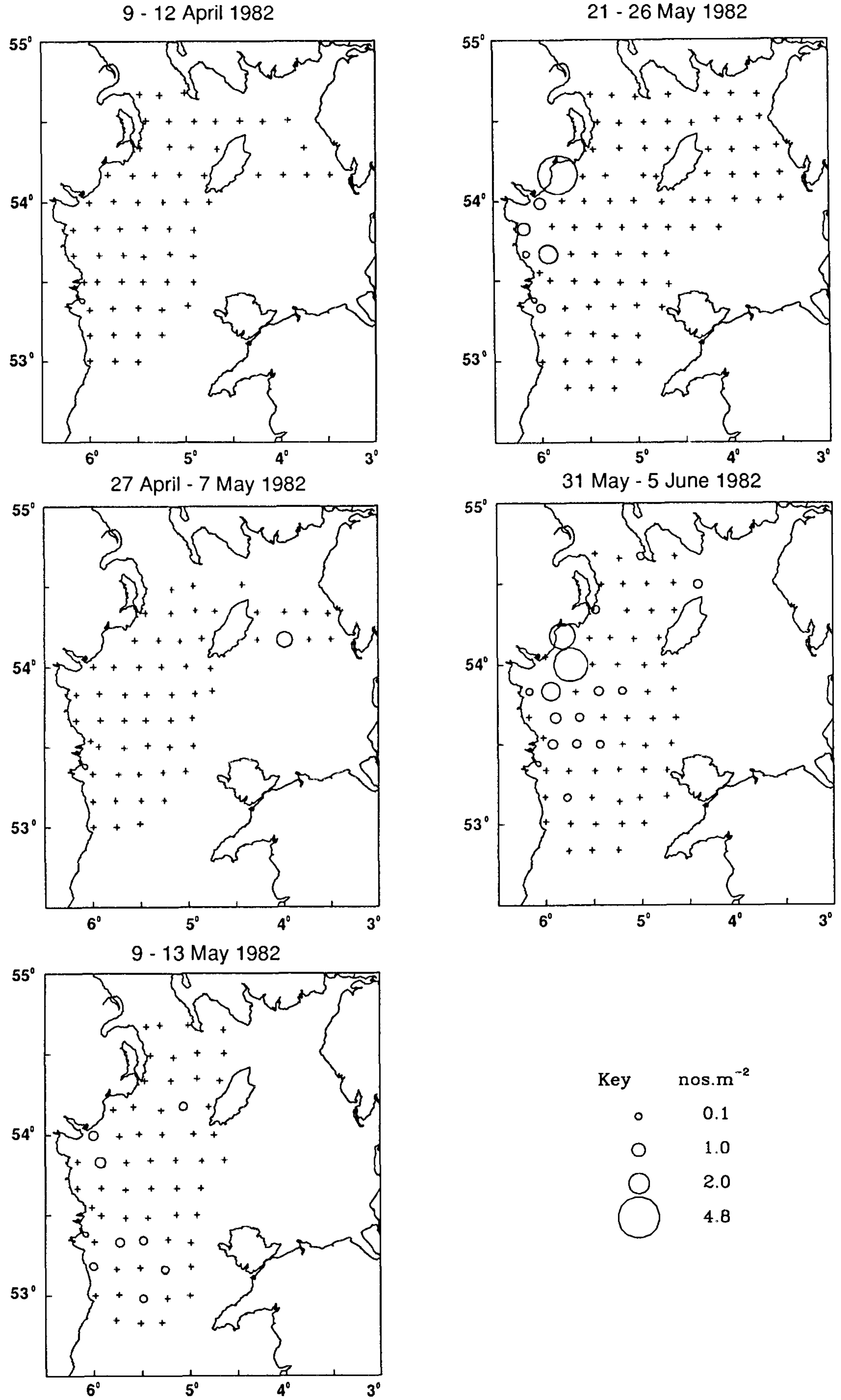

***Figure 39.** Total topknot (Phyrnorhombus norvegicus) larvae concentrations (nos.m^{-2}) for the surveys in 1982, 1985, 1987, 1988 and 1989*

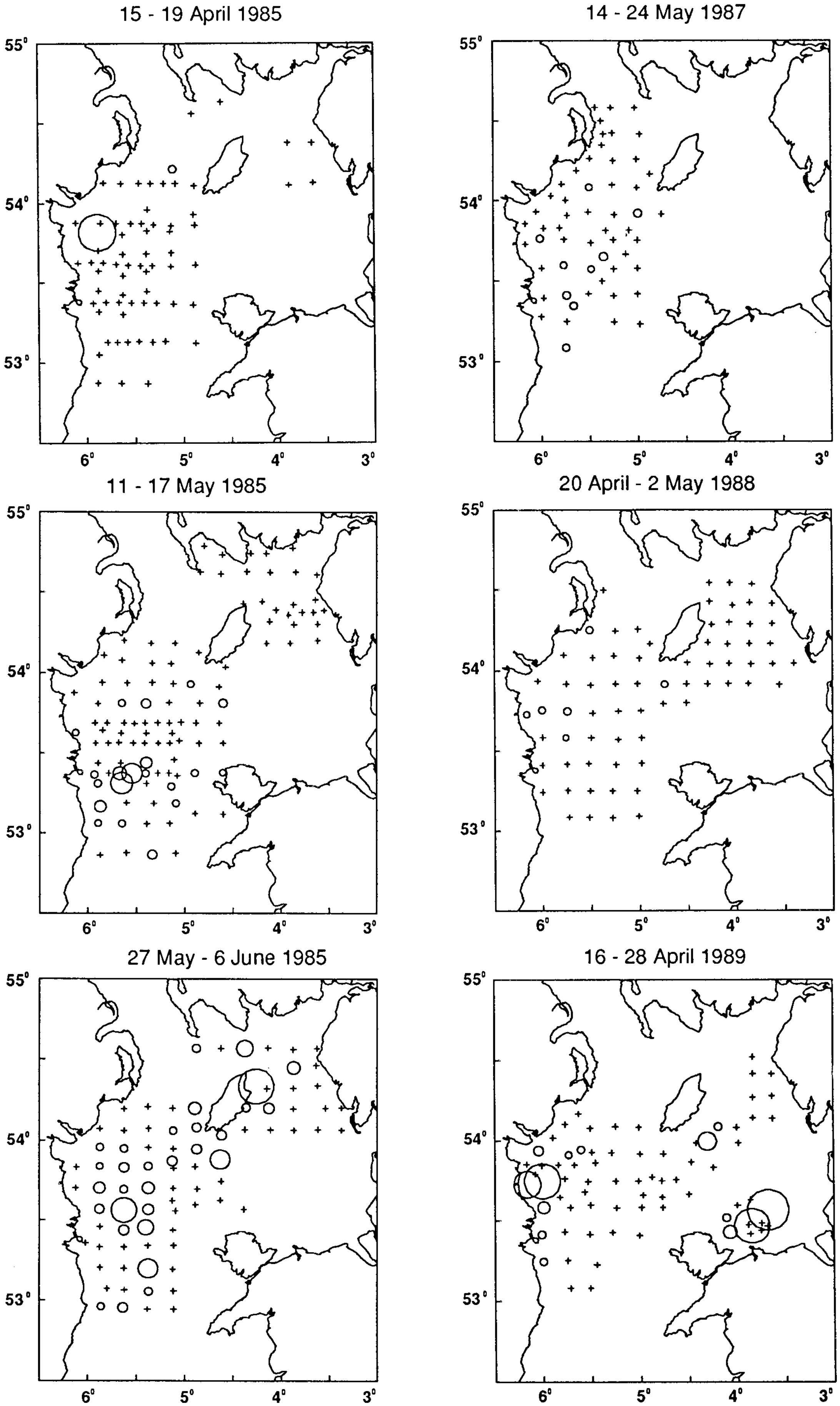

Figure 39 continued

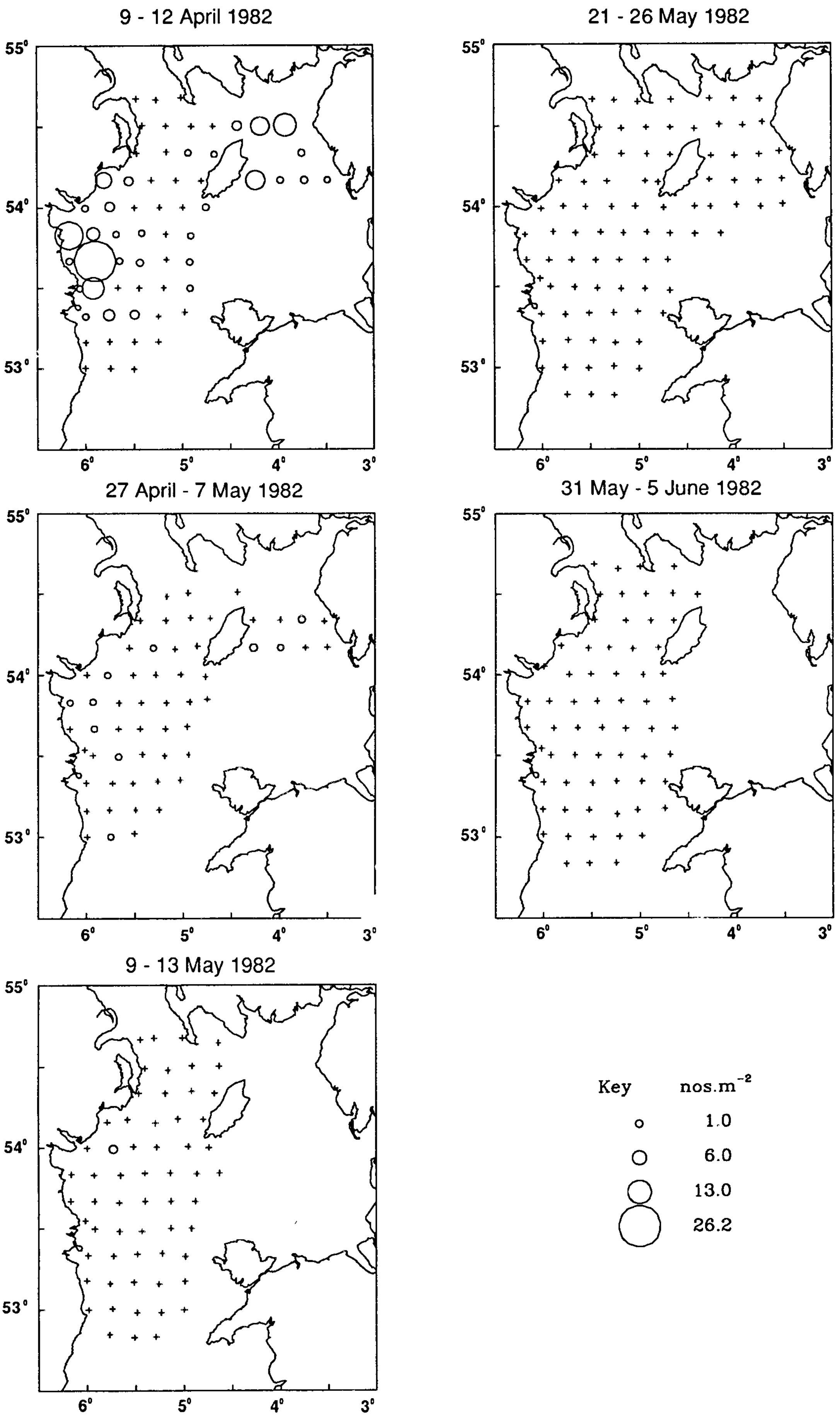

***Figure 40.** Total plaice (Pleuronectes platessa) egg concentrations (nos.m^{-2}) for the surveys in 1982, 1985, 1987, 1988 and 1989*

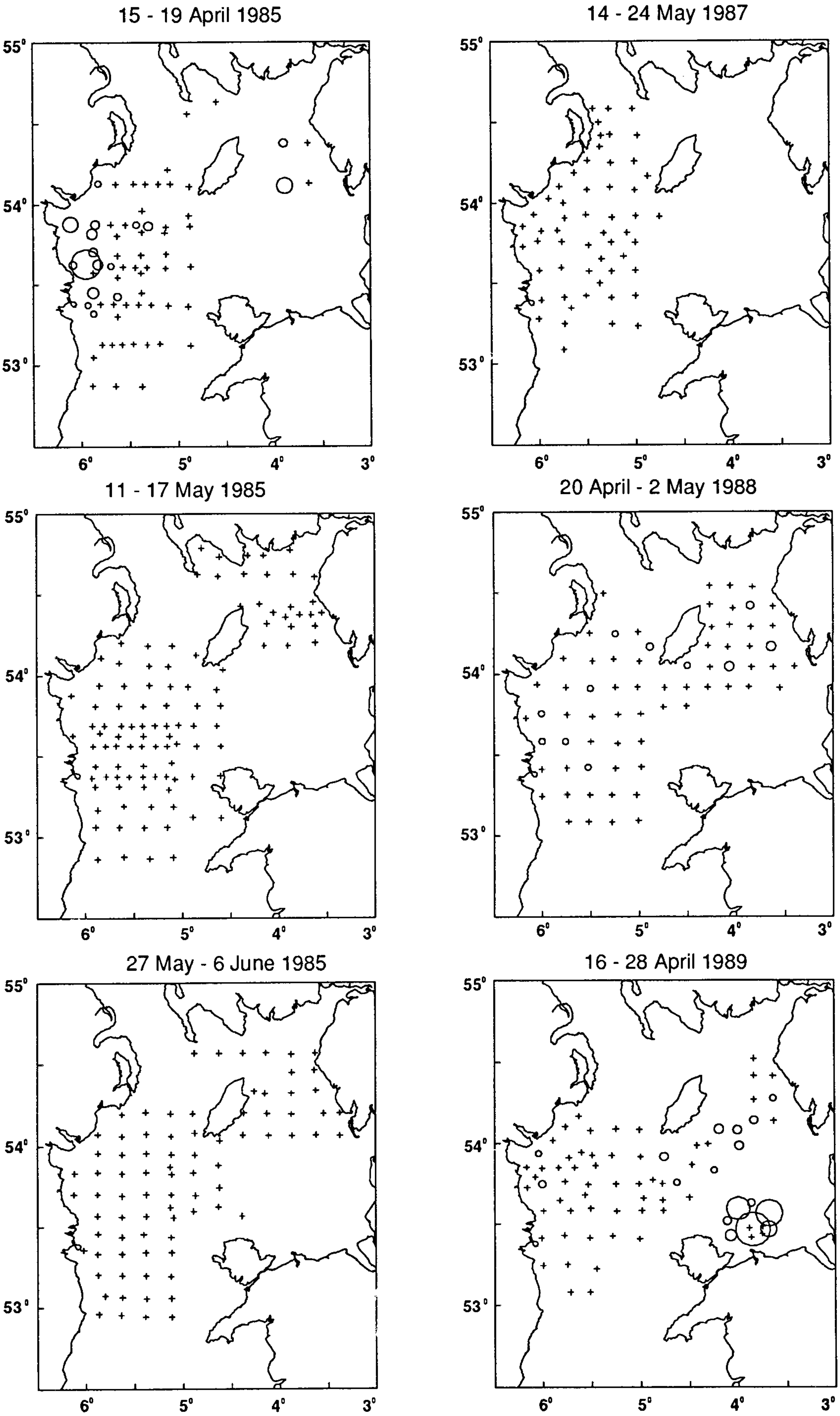

Figure 40 continued

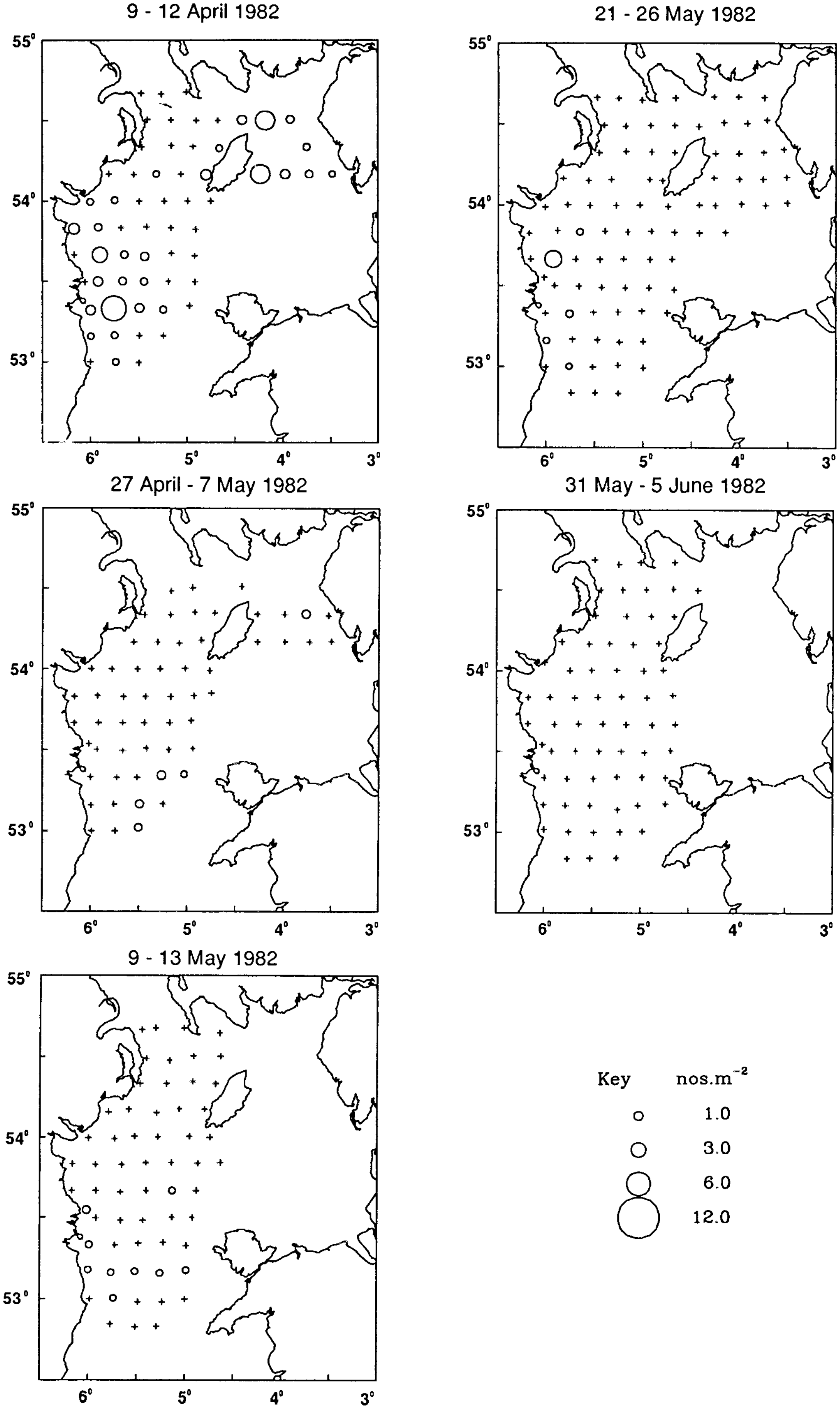

Figure 41. Total plaice (Pleuronectes platessa) larvae concentrations (nos.m^{2}) for the surveys in 1982, 1985, 1987, 1988 and 1989

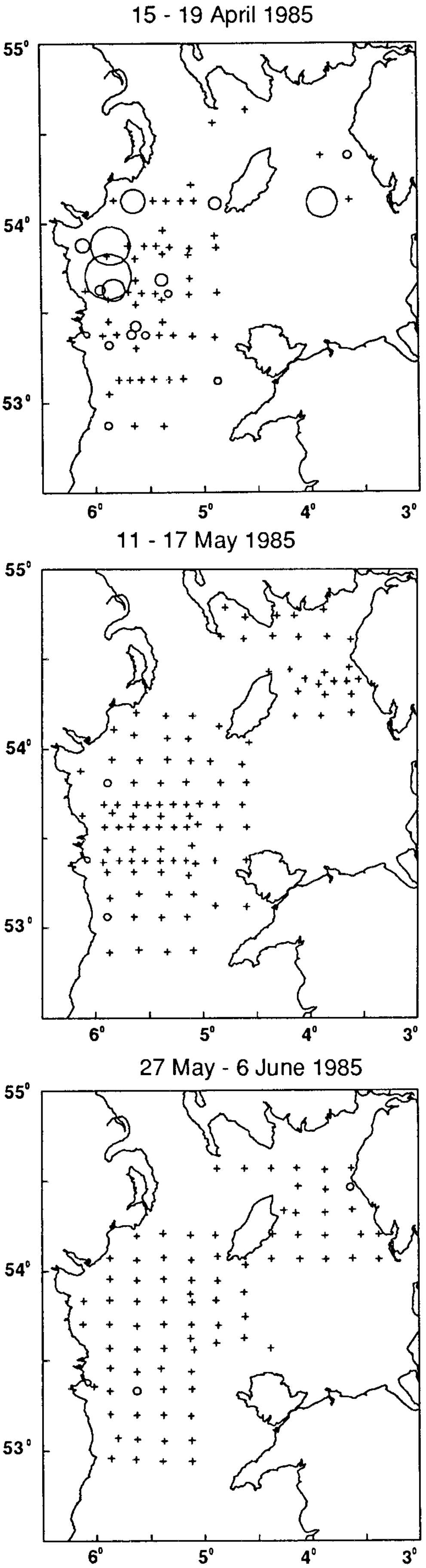

Figure 41 continued

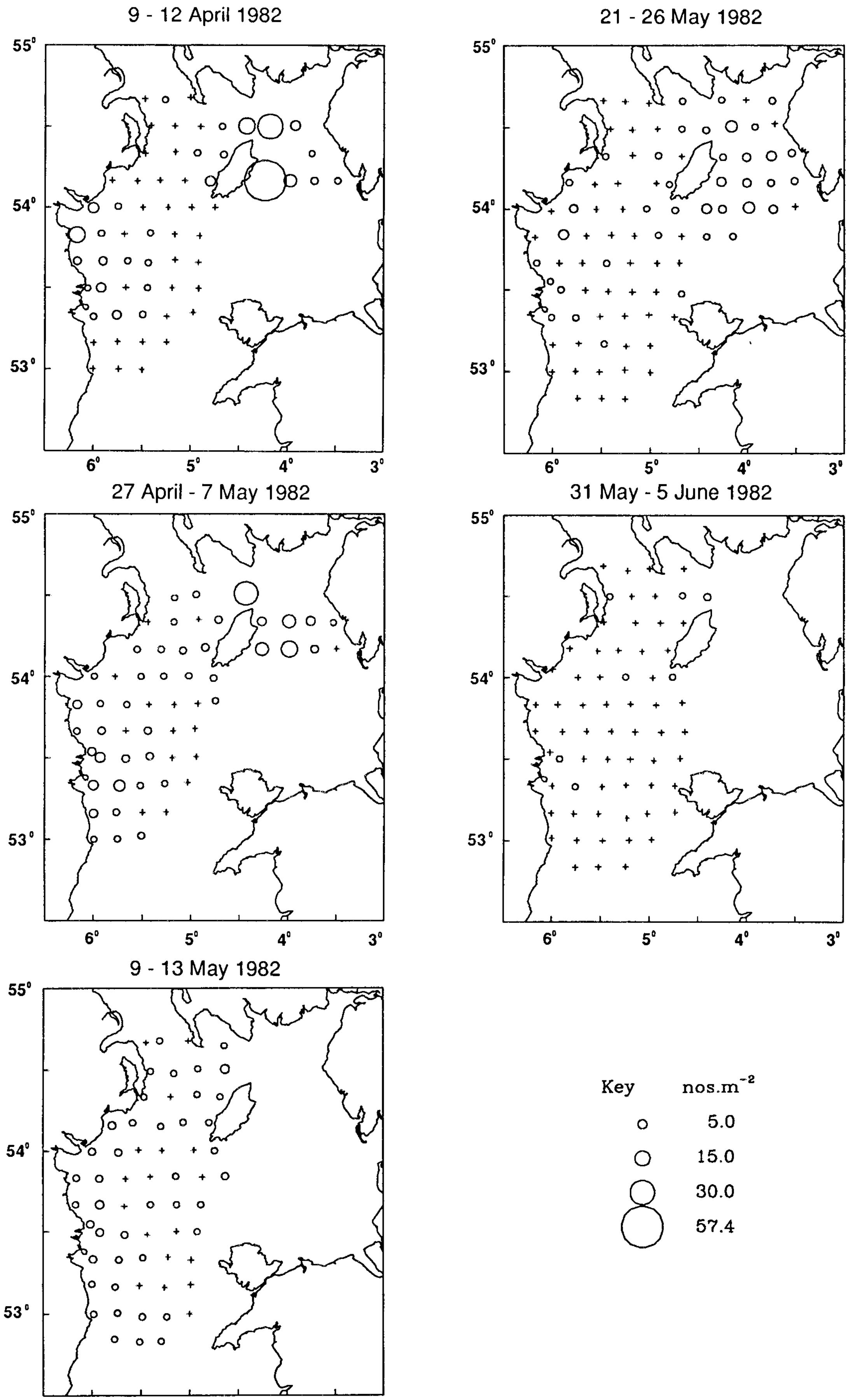

Figure 42. Total flounder (Platichthys flesus) larvae concentrations (nos.m⁻²) for the surveys in 1982, 1985, 1987, 1988 and 1989

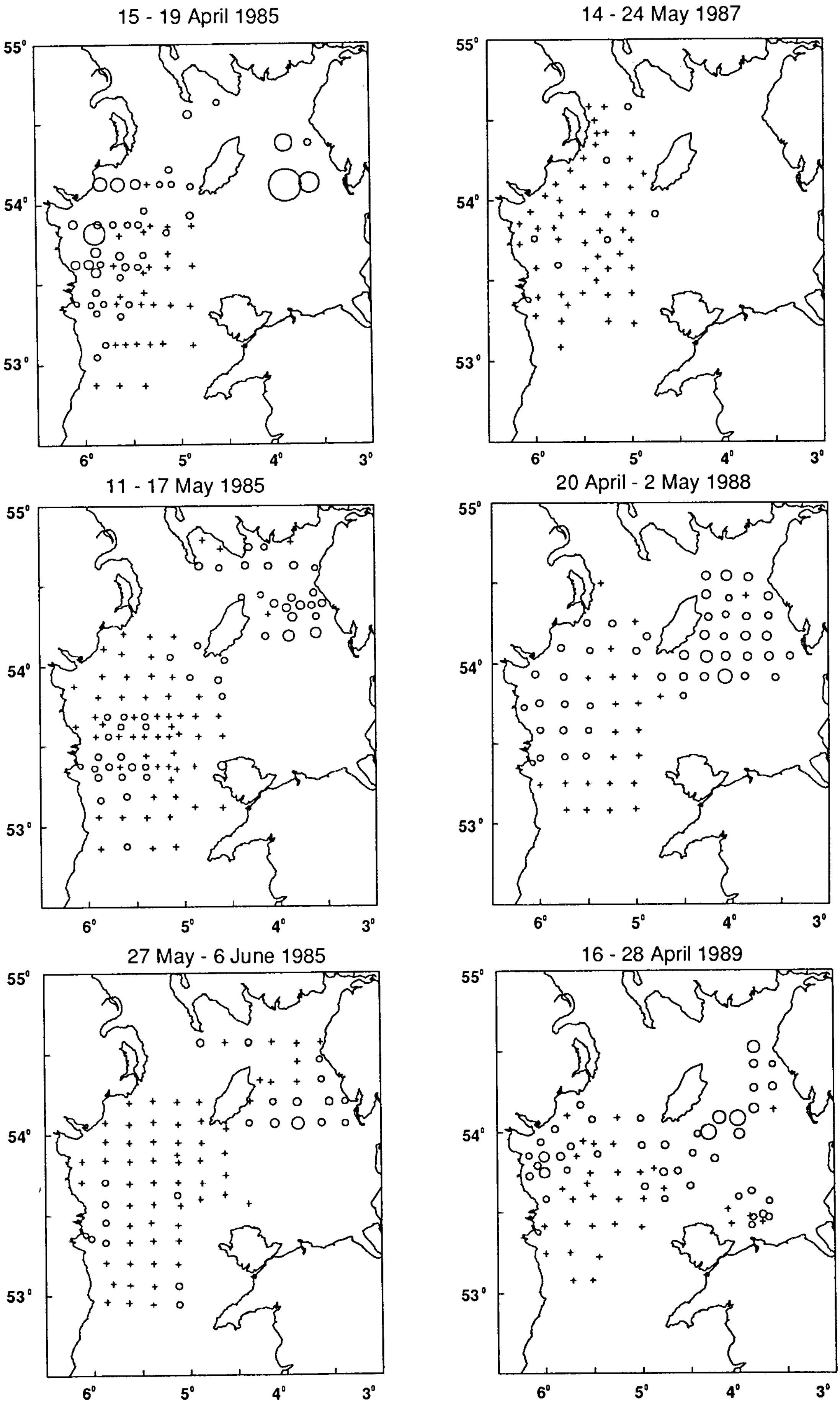

Figure 42 continued

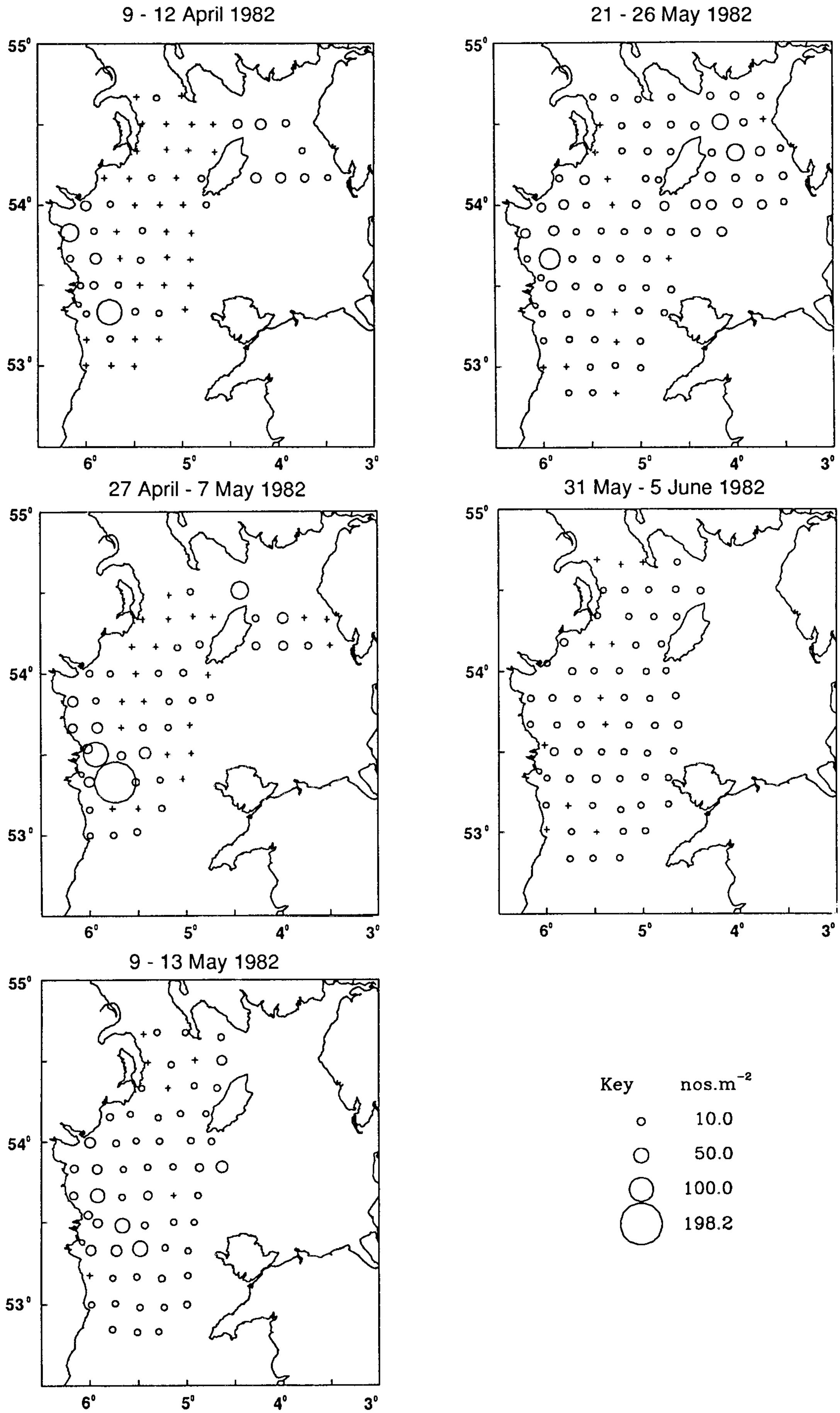

Figure 43. Total dab (Limanda limanda) larvae concentrations (nos.m^{-2}) for the surveys in 1982, 1985, 1987, 1988 and 1989

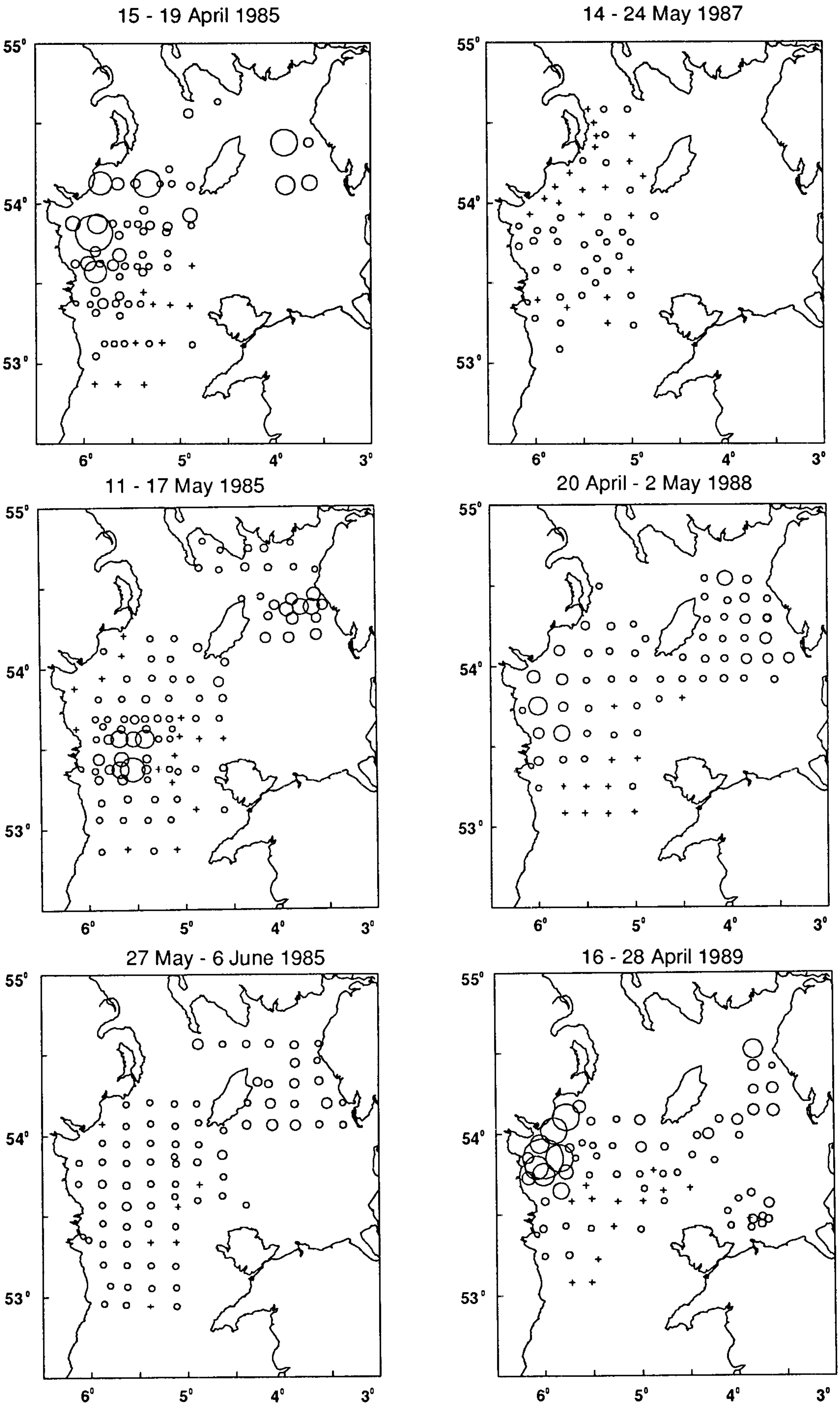

Figure 43 continued

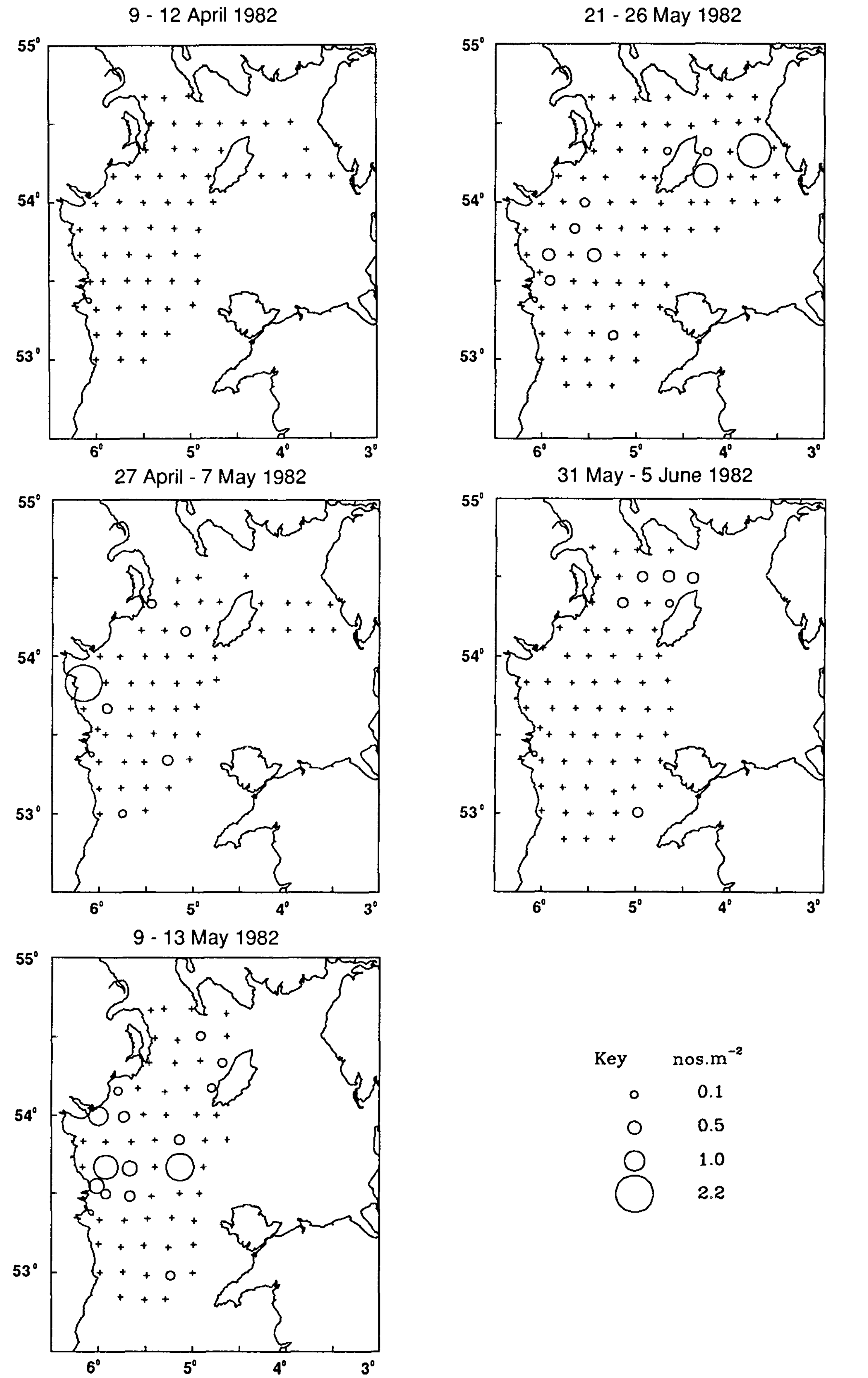

Figure 44. Total lemon sole (Microstomus kitt) larvae concentrations (nos.m^{-2}) for the surveys in 1982, 1985, 1987, 1988 and 1989

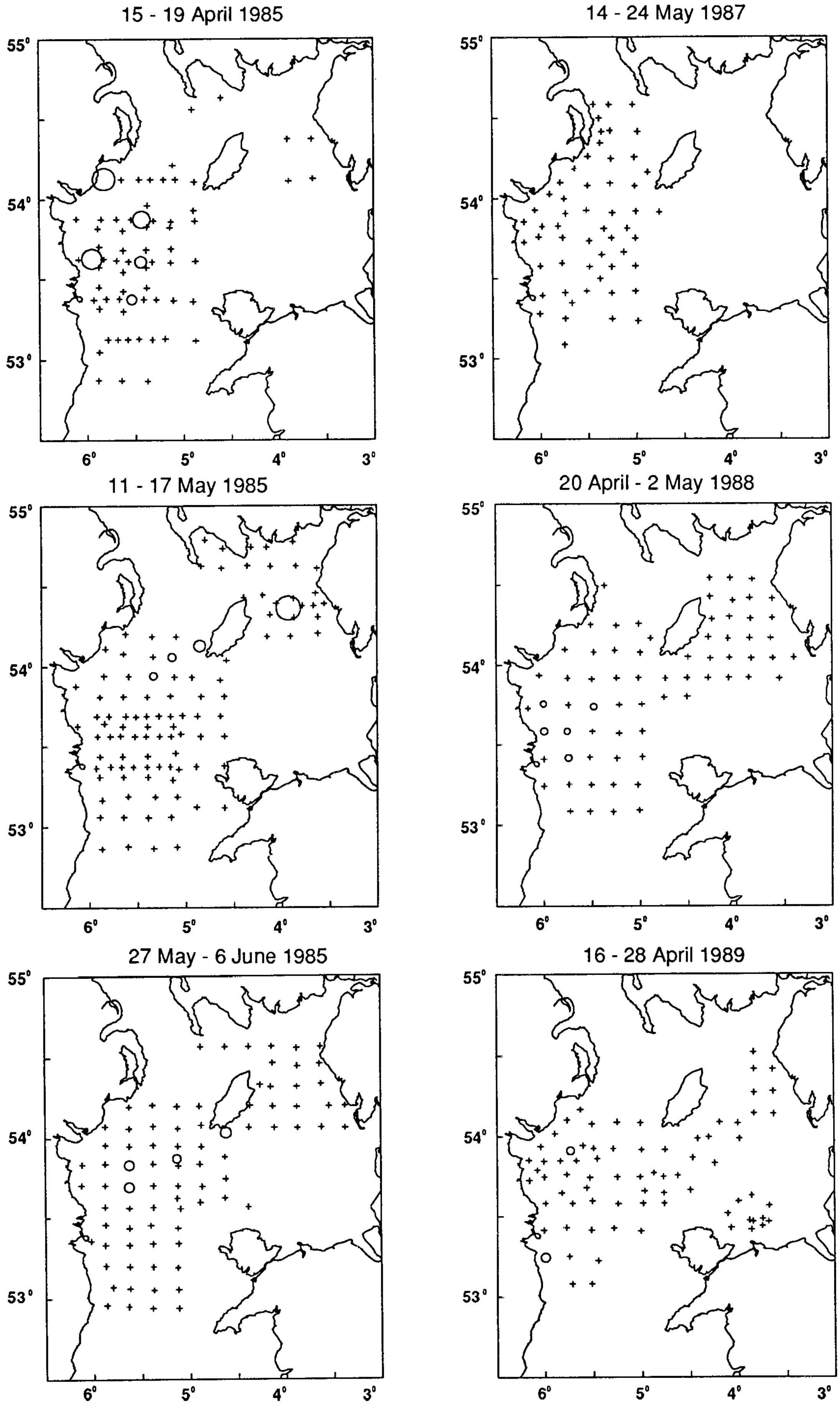

Figure 44 continued

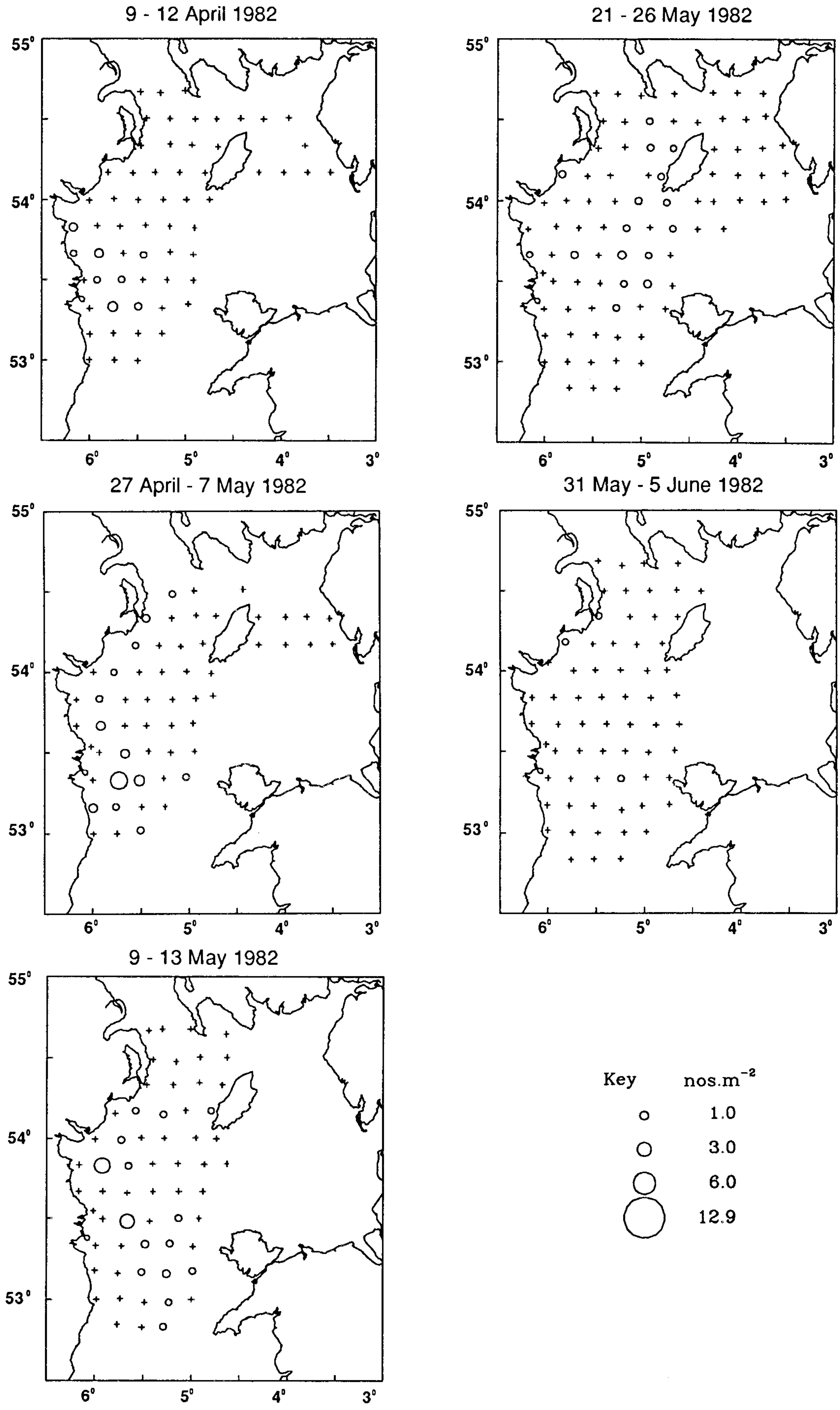

Figure 45. Total witch (Glyptocephalus cynoglossus) larvae concentrations (nos.m^{-2}) for the surveys in 1982, 1985, 1987, 1988 and 1989

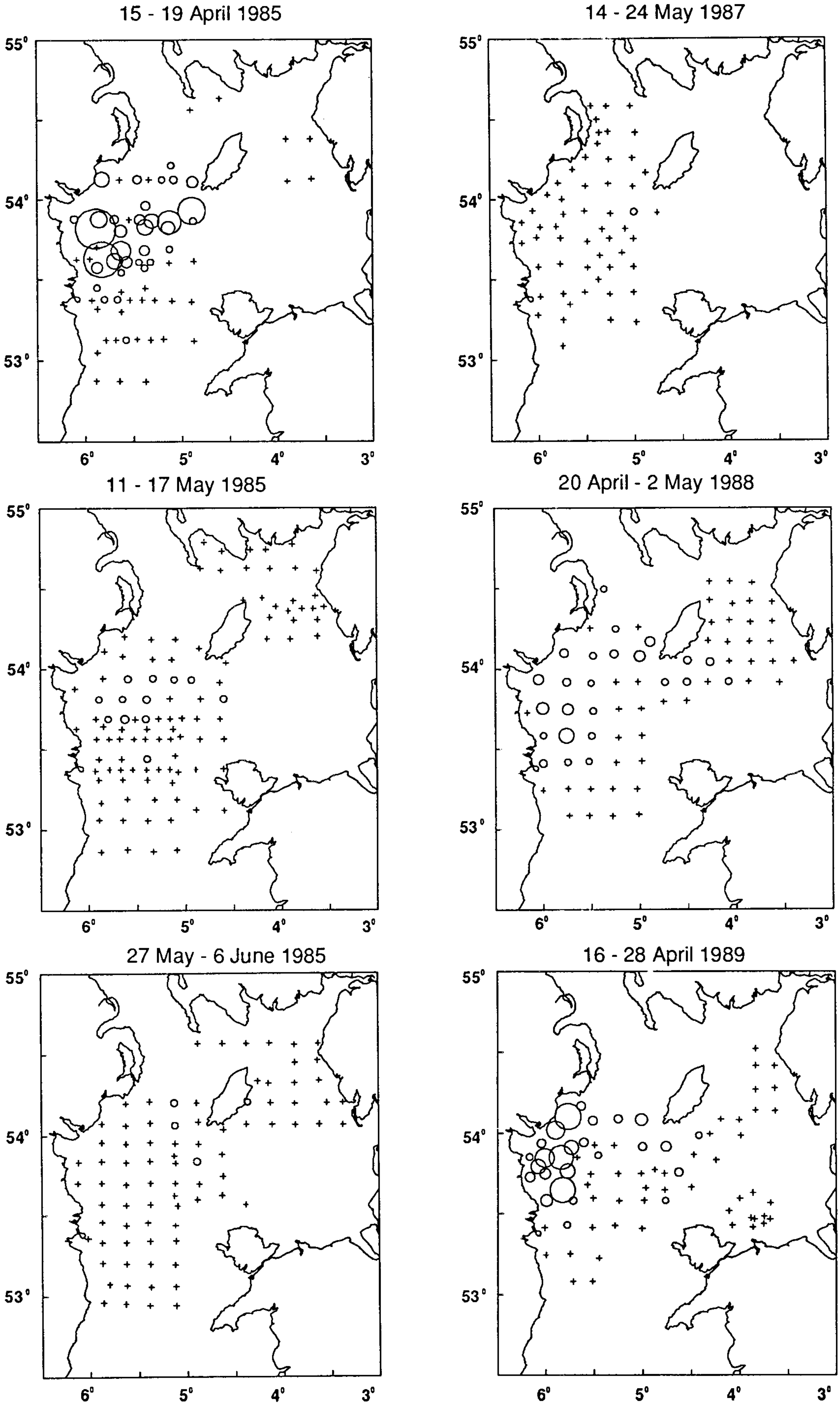

Figure 45 continued

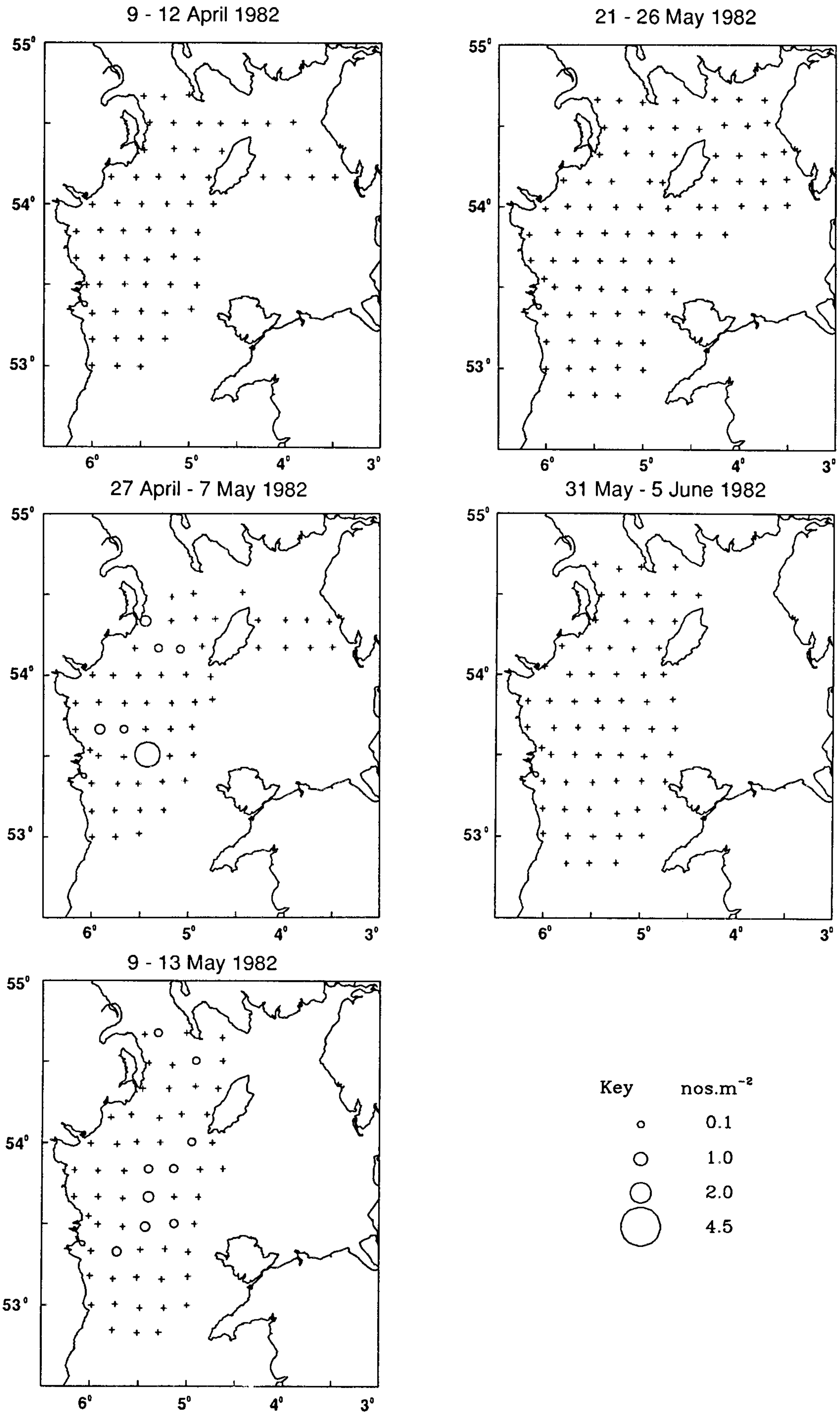

Figure 46.** **Total long rough dab (Hippoglossoides platessoides) larvae concentrations (nos.m^{-2}) for the surveys in 1982, 1985, 1987, 1988 and 1989

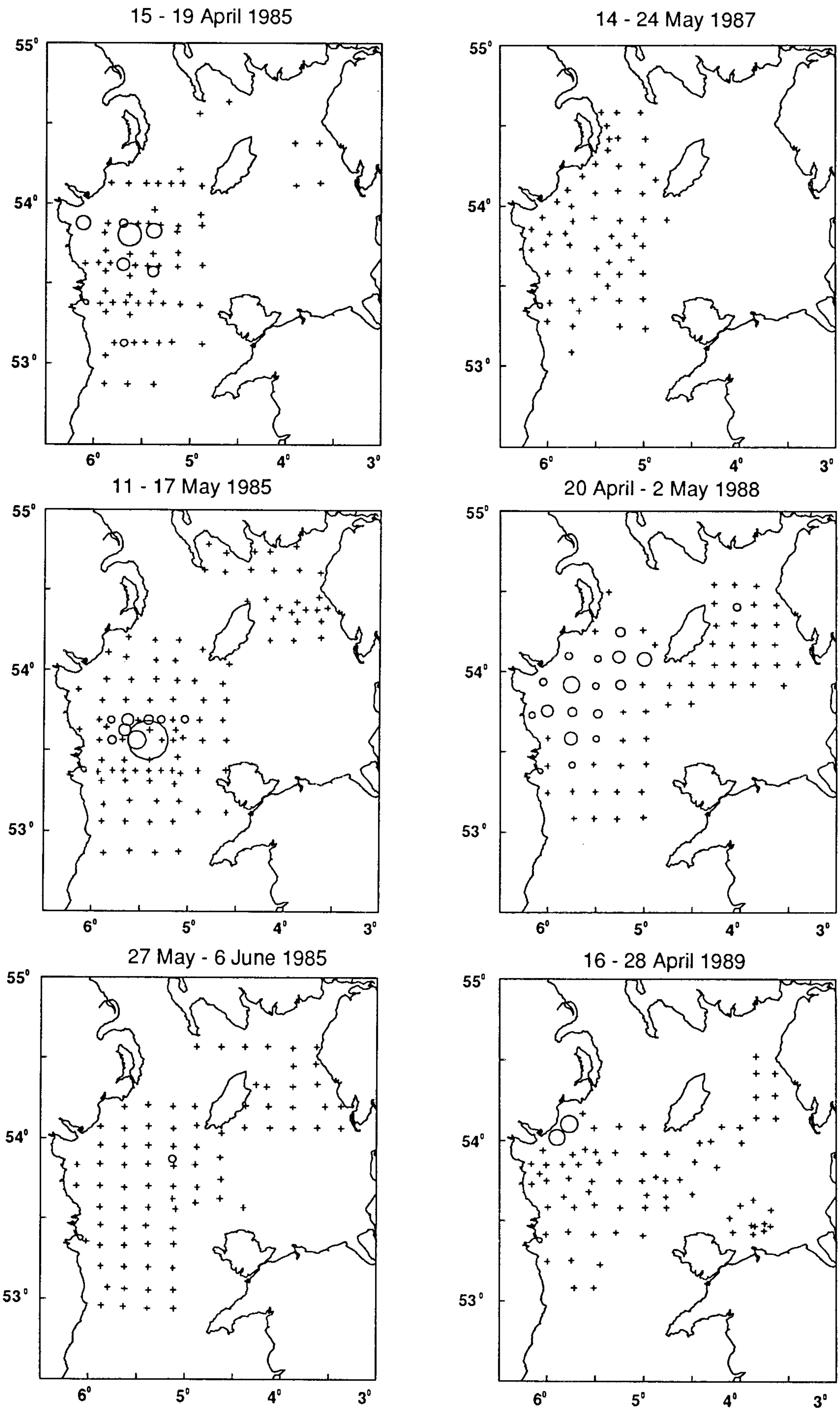

Figure 46 continued

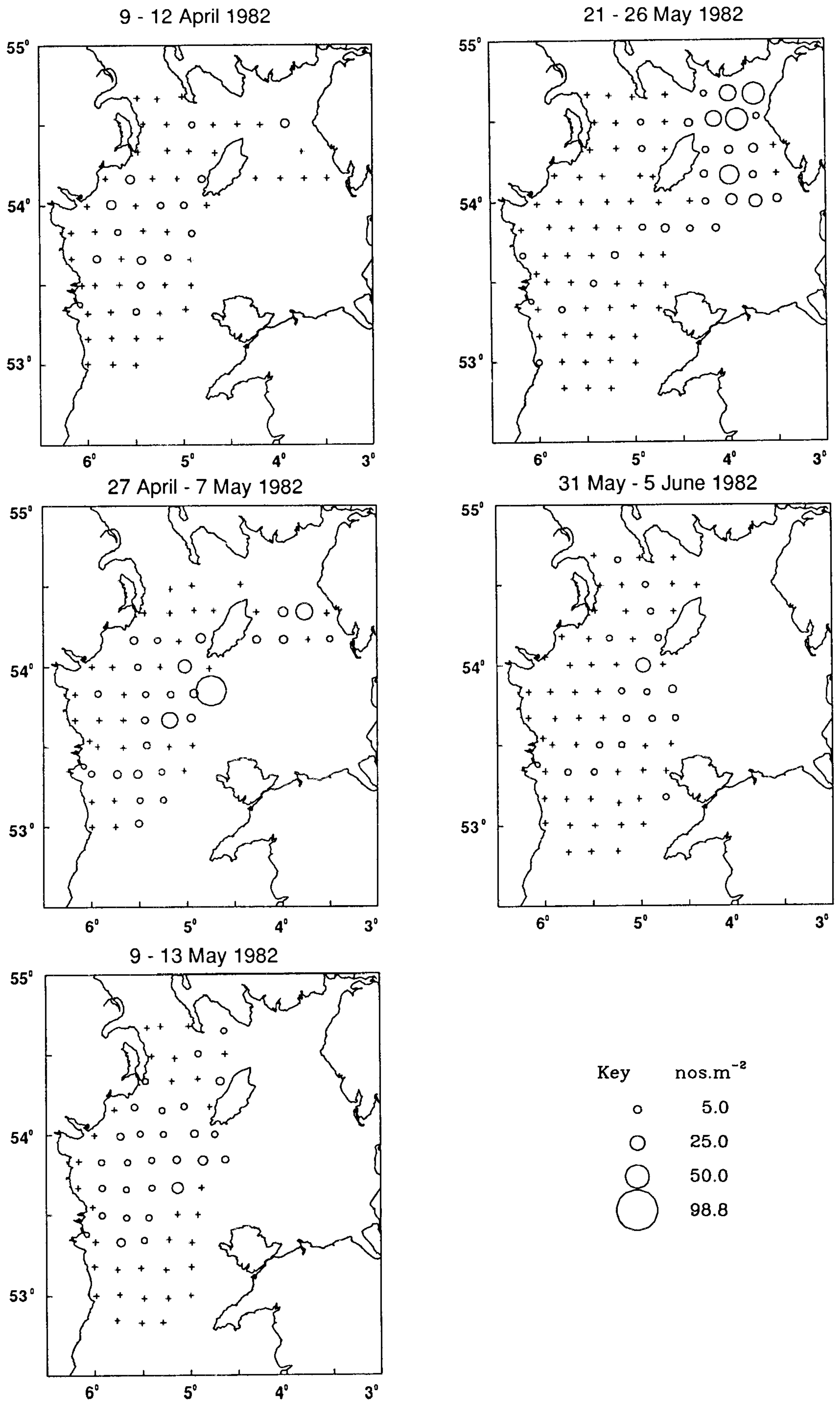

***Figure 47.** Total sole (Solea solea) egg concentrations (nos.m^{-2}) for the surveys in 1982, 1985, 1987, 1988 and 1989*

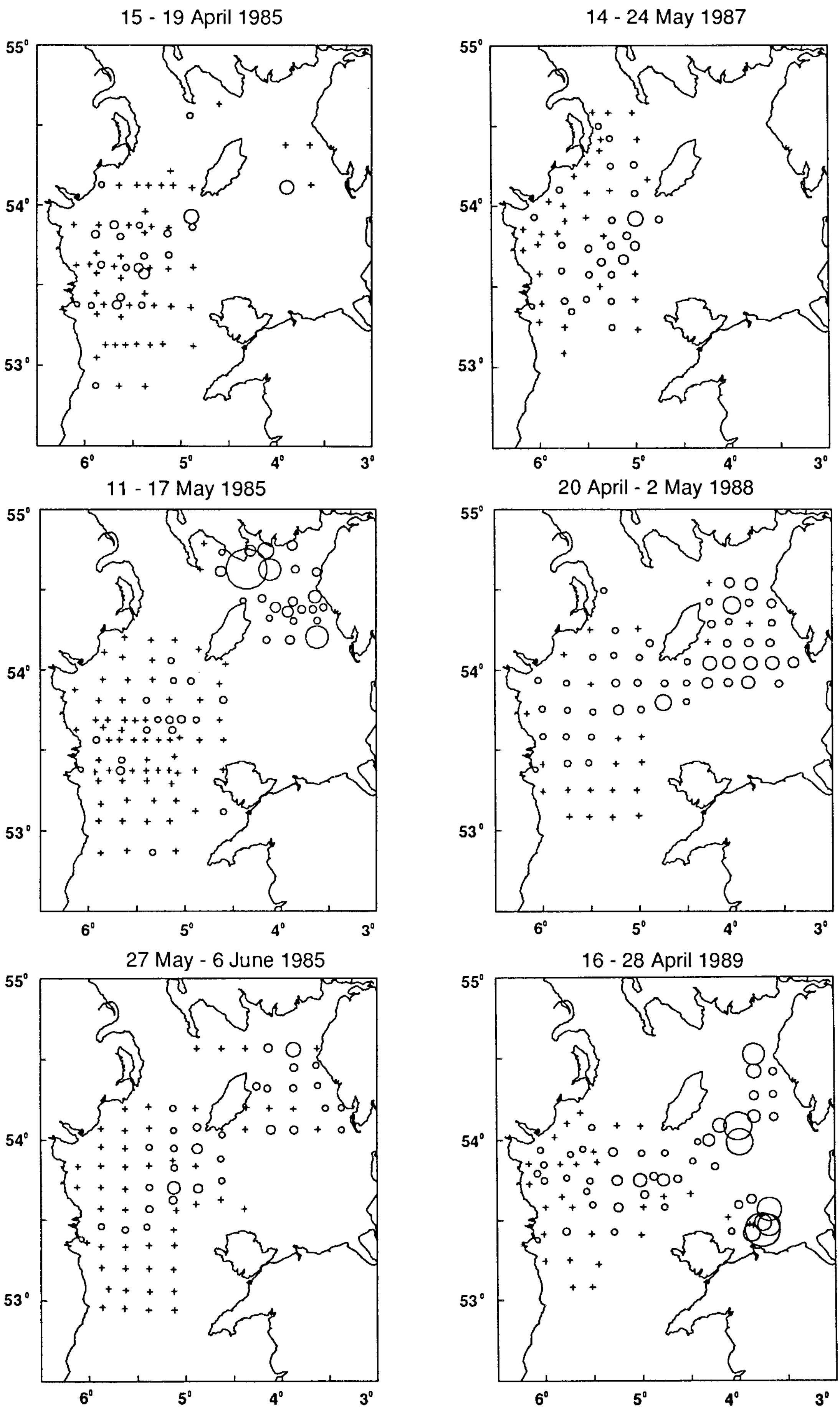

Figure 47 continued

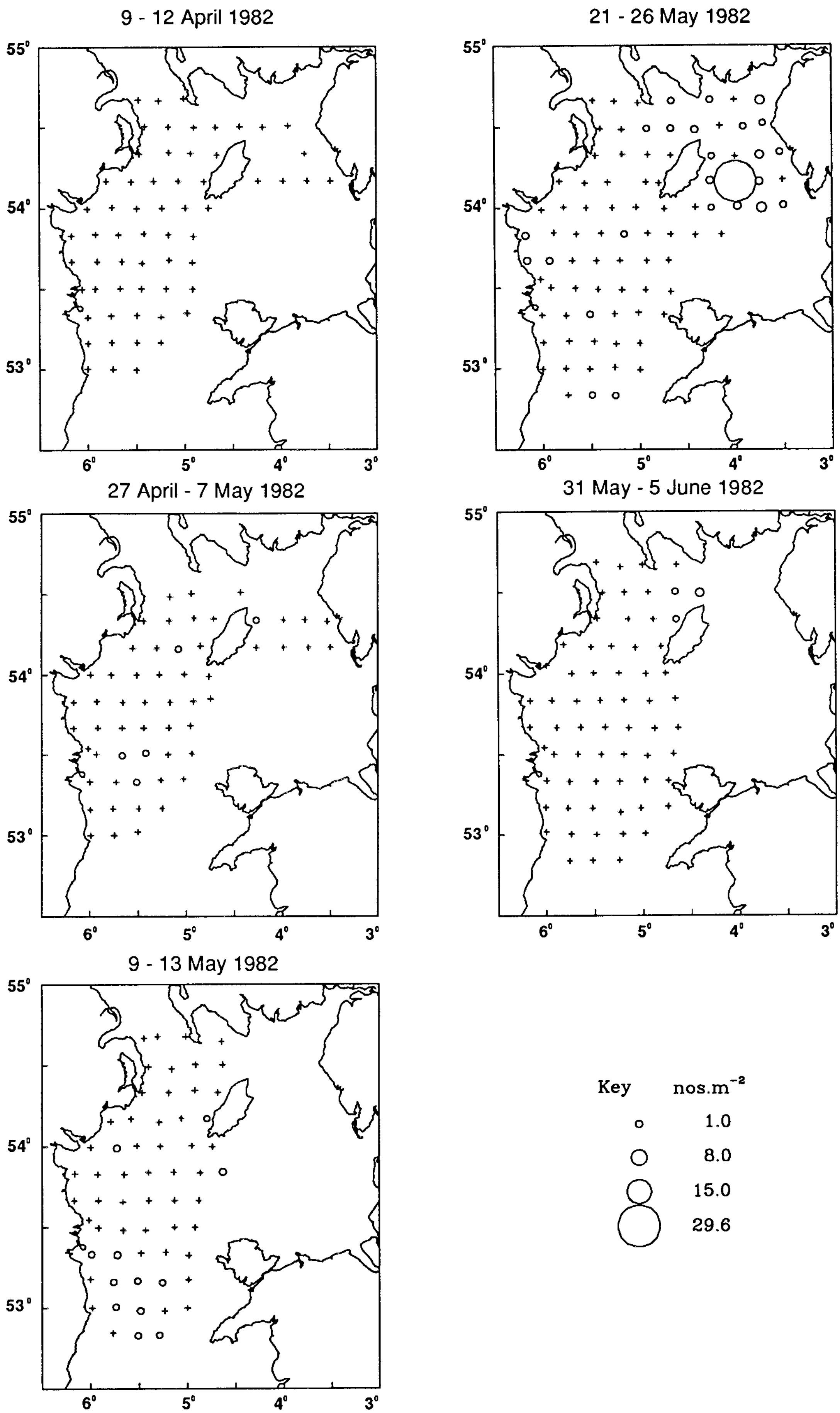

Figure 48. Total sole (Solea solea) larvae concentrations (nos.m^{-2}) for the surveys in 1982, 1985, 1987, 1988 and 1989

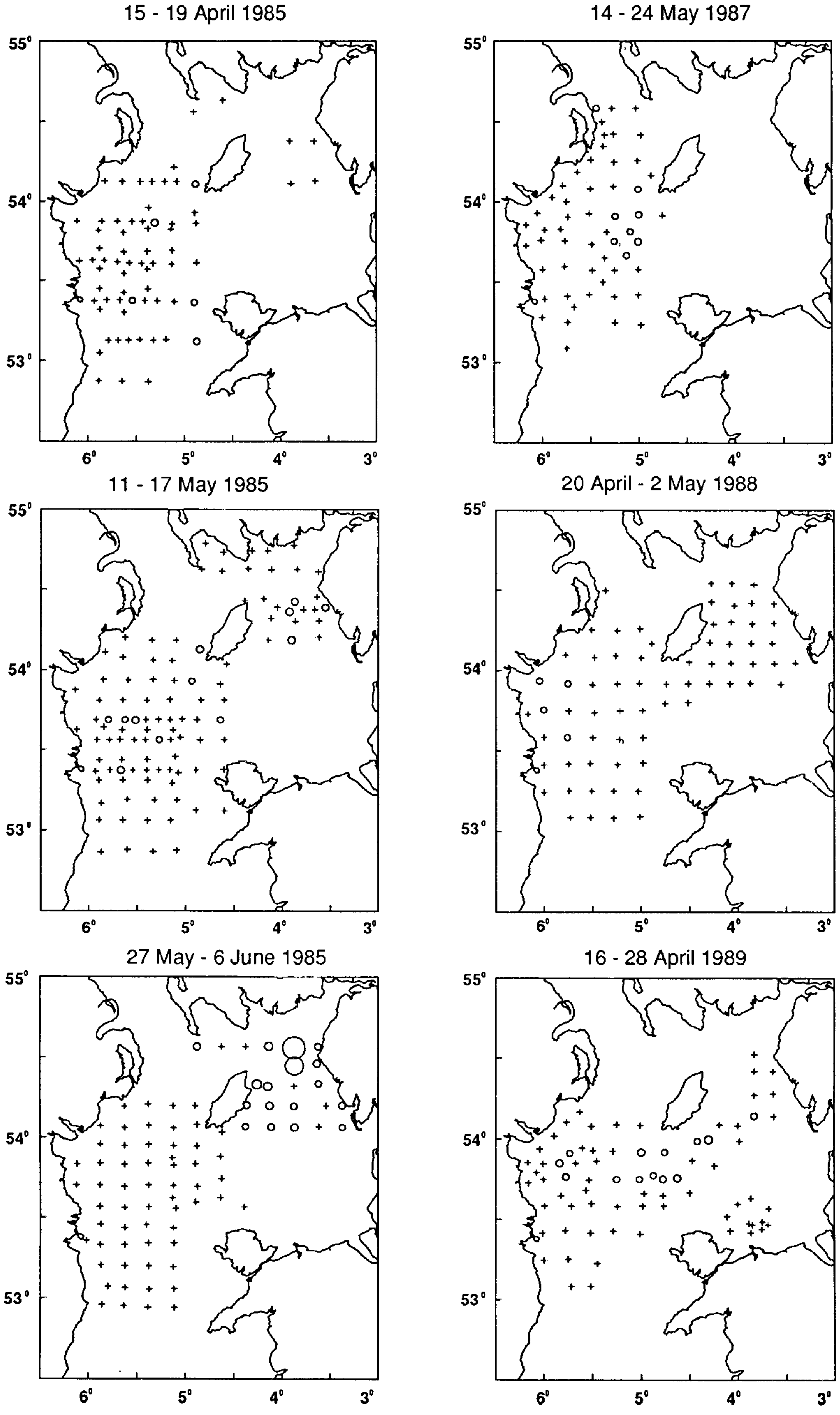

Figure 48 continued

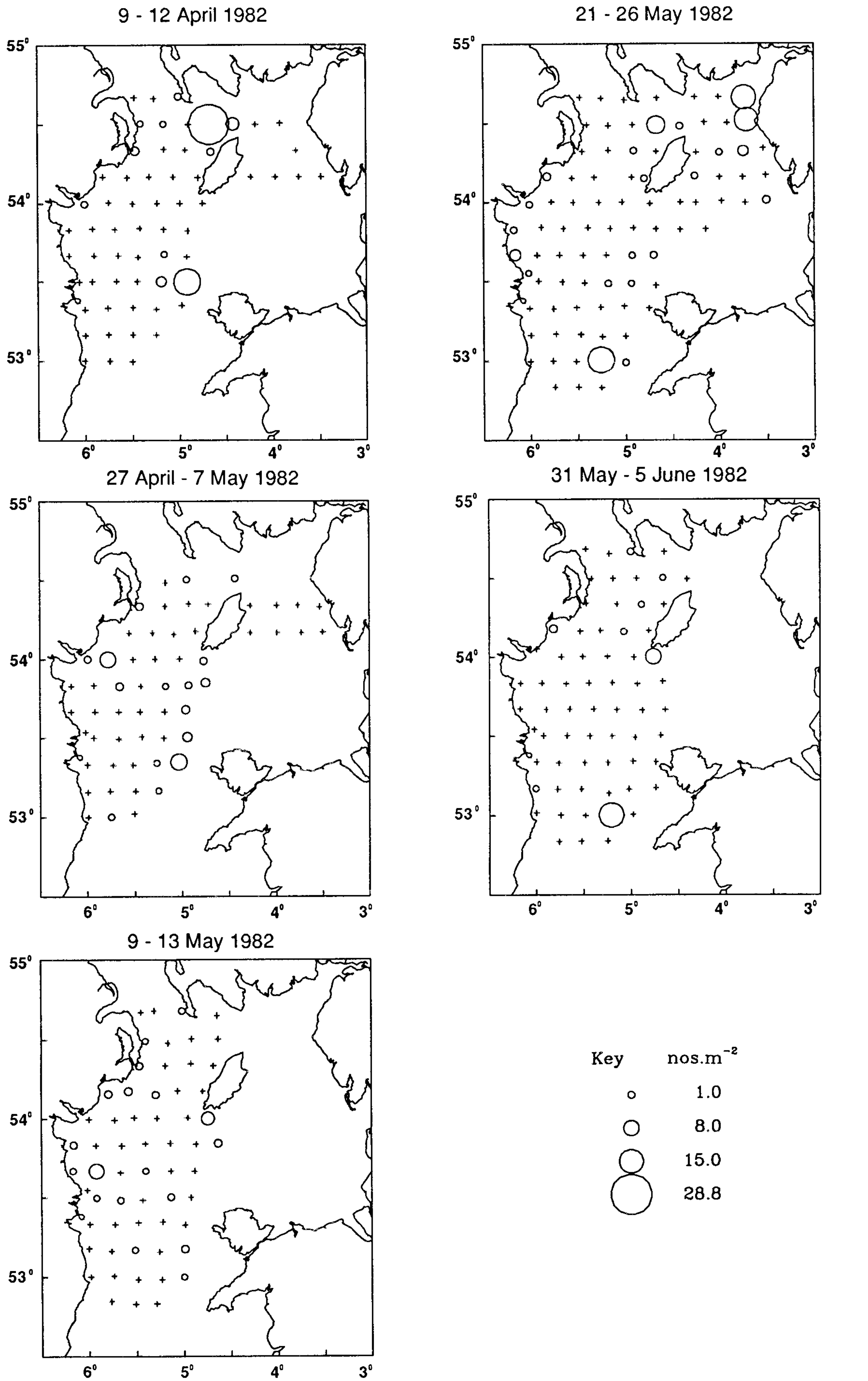

Figure 49. ***Total solenette (Buglossidium luteum) egg concentrations (nos.m^{-2}) for the surveys in 1982, 1985, 1987, 1988 and 1989***

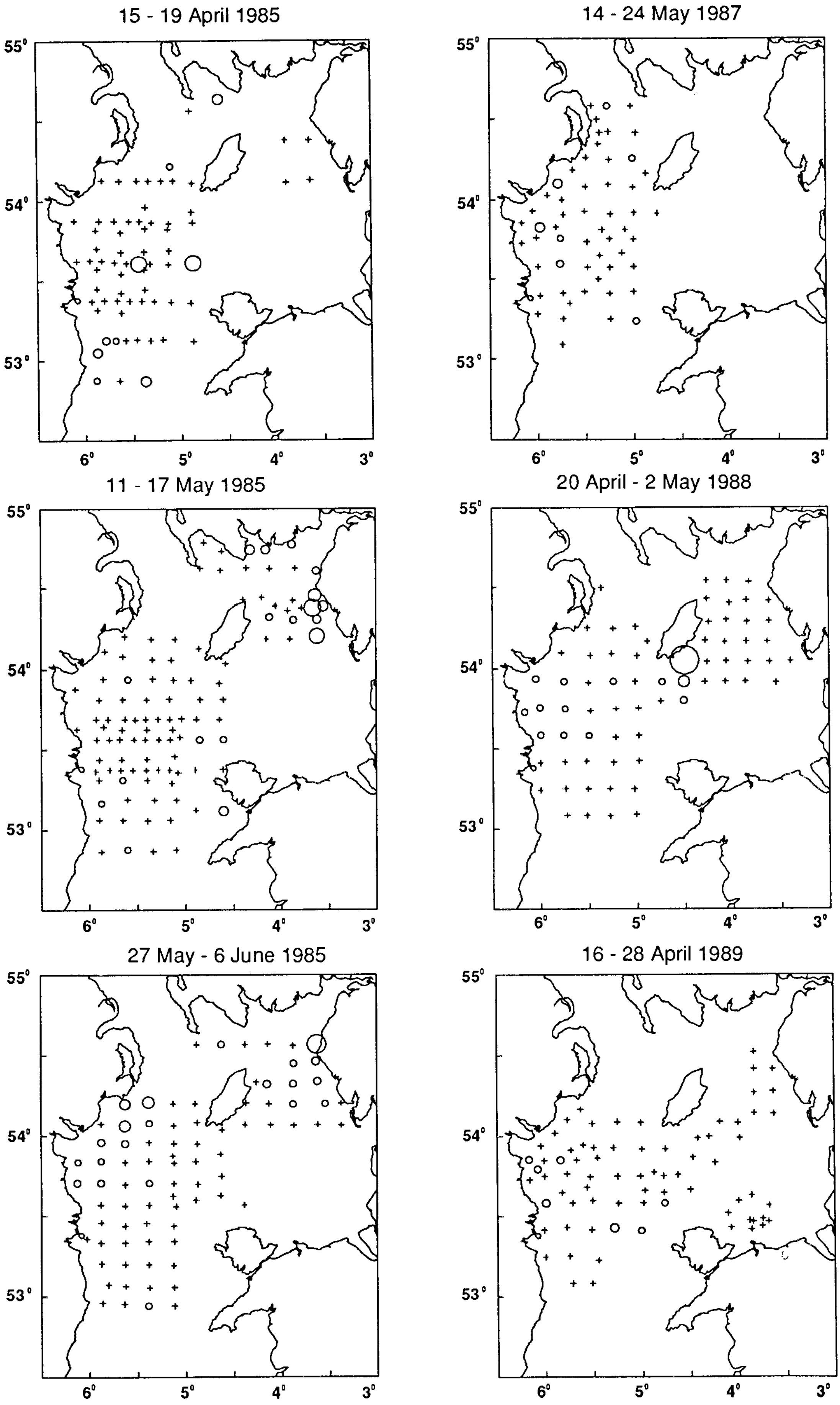

Figure 49 continued

Table 2(a). List of species occurring as eggs, the frequency of their occurence and maximum concentration on each of five surveys in the Irish Sea in 1982. Species marked * have been plotted

Species	% Positive stations					Maximum concentration (nos. m^{-2})				
	9 - 12 April	27 April - 7 May	9 - 13 May	21 - 26 May	31 May - 5 June	9 - 12 April	27 April - 7 May	9 - 13 May	21 - 26 May	31 May - 5 June
Clupeidae	-	-	-	-	-	-	-	-	-	-
*Sprattus sprattus**	80.0	87.7	73.3	72.9	61.5	485.9	683.8	754.5	5075.4	1081.2
Sardina pilchardus	-	-	1.7	1.2	-	-	-	0.5	0.2	-
Argentinidae spp.	-	-	1.7	-	-	-	-	4.2	-	-
*Argentina sphyraena**	3.3	5.3	5.0	-	3.1	1.2	3.4	0.3	-	0.2
Gadidae spp.	-	-	-	-	-	-	-	-	-	-
*Gadus morhua**	91.7	87.7	56.7	7.1	-	600.6	46.9	19.3	1.1	-
Gadiculus argenteus	-	-	-	-	-	-	-	-	-	-
Melanogrammus aeglefinus	-	1.8	-	-	-	-	0.2	-	-	-
Merlangius merlangus	-	-	-	-	-	-	-	-	-	-
Micromesistius poutassou	-	-	-	-	-	-	-	-	-	-
Trisopterus minutus	-	-	-	-	-	-	-	-	-	-
Trisopterus esmarkii	-	-	-	-	-	-	-	-	-	-
Trisopterus luscus	-	-	-	-	-	-	-	-	-	-
Pollachius pollachius	-	-	-	-	-	-	-	-	-	-
Pollachius virens	-	-	-	-	-	-	-	-	-	-
Onos spp.	83.3	86.0	96.7	88.2	92.3	247.0	129.4	86.0	45.9	79.0
*Molva molva**	-	-	30.0	5.9	12.3	-	8.1	2.5	7.7	8.8
Merluccius merluccius	-	-	3.3	-	1.5	-	-	1.2	-	0.3
*Triglidae**	25.0	52.6	63.4	48.2	50.8	21.5	28.5	24.9	18.5	7.9
Dicentrarchus labrax	1.7	5.3	6.7	-	-	0.2	5.1	1.5	-	-
Trachurus trachurus	-	1.8	1.7	10.6	3.1	-	0.2	2.2	4.3	0.2
Trachinus vipera	-	-	1.7	5.9	-	-	-	1.5	1.6	-
Chirolophis ascanii	-	-	-	-	-	-	-	-	-	-
Callionymiidae spp.*	68.3	75.4	70.0	67.1	53.8	250.5	159.1	242.4	267.1	122.7
*Scomber scombrus**	46.7	38.6	16.7	36.5	30.8	14.8	36.3	5.8	997.4	6.2
Bothidae spp.	-	-	-	-	-	-	-	-	-	-
Scophthalmus rhombus	-	-	-	-	-	-	-	-	-	-
Scophthalmus maximus	13.3	14.0	15.0	18.8	21.5	3.5	3.4	3.3	3.1	1.2
Lepidorhombus whiffiagonis	-	-	3.3	-	-	-	-	1.3	-	-
Phrynorhombus norvegicus	-	-	-	-	4.6	-	-	-	-	0.5
Zeugopterus punctatus	-	-	-	1.2	-	-	-	-	0.1	-
Pleuronectidae spp.	-	-	-	-	-	-	-	-	-	-
*Pleuronectes platessa**	51.7	17.5	1.7	-	-	26.2	1.2	1.8	-	-
Platichthys flesus	-	-	-	-	-	-	-	-	-	-
Limanda limanda	-	-	-	-	-	-	-	-	-	-
Microstomus kitt	-	3.5	5.0	1.2	-	-	0.3	0.3	0.2	-
Glyptocephalus cynoglossus	-	-	-	-	-	-	-	-	-	-
Hippoglossoides platessoides	1.7	-	-	-	-	6.6	-	-	-	-
Soleidae	-	1.8	-	-	4.6	-	0.2	-	-	3.6
*Solea solea**	23.3	45.6	45.0	32.9	26.2	10.0	68.4	14.7	45.9	23.4
*Buglossidium luteum**	18.3	28.1	30.0	24.7	12.3	28.8	8.9	7.6	16.9	15.4
Microchirus variegatus	5.0	-	1.7	4.7	13.8	1.8	-	0.2	9.8	16.1
Unidentified spp.	90.0	100.0	91.7	83.5	84.6	-	296.2	257.7	92.6	61.5
Total number of stations worked	60	57	60	85	65	60	57	60	85	65

Table 2(b). List of species occurring as larvae, the frequency of their occurrence and maximum concentration on each of five surveys in the Irish Sea in 1982. Species marked * have been plotted

Species	% Positive stations					Maximum concentration (nos. m⁻²)				
	9 - 12 April	27 April - 7 May	9 - 13 May	21 - 26 May	31 May - 5 June	9 - 12 April	27 April - 7 May	9 - 13 May	21 - 26 May	31 May - 5 June
Clupeidae	3.3	22.8	98.3	97.6	98.5	129.9	70.3	273.8	158.1	217.5
Clupea harengus	18.3	12.3	-	-	-	2.5	1.6	0.7	-	-
*Sprattus sprattus**	60.0	78.9	-	-	-	215.1	187.8	86.7	-	-
Sardina pilchardus	-	3.5	3.3	-	-	-	0.2	1.1	-	-
Argentinidae spp.	-	-	-	-	-	-	-	-	-	-
*Argentina sphyraena**	1.7	14.0	15.0	2.4	4.6	0.1	0.6	1.3	0.4	0.3
Gobiesocidae spp.	-	-	-	4.7	12.3	-	-	-	1.4	5.2
Apletodon microcephalus	-	-	-	-	-	-	-	-	-	-
Diplecogaster bimaculata	-	-	-	2.4	-	-	-	-	0.8	-
Lepadogaster lepadogaster	-	-	-	-	-	-	-	-	-	-
Lophius piscatorius	-	-	-	-	-	-	-	-	-	-
Gadidae spp.	-	56.1	73.3	74.1	60.0	-	20.5	11.6	21.5	3.5
*Gadus morhua**	76.7	89.5	90.0	57.6	33.8	38.5	47.0	21.4	2.2	0.9
Gadiculus argenteus	-	1.8	-	-	-	-	0.2	-	-	-
*Melanogrammus aeglefinus**	-	1.8	1.7	2.4	-	-	0.2	0.3	1.6	-
*Merlangius merlangus**	65.0	91.2	95.0	96.5	80.0	11.4	60.1	78.8	35.8	19.0
Micromesistius poutassou	3.3	8.8	3.3	2.4	-	0.3	1.7	0.4	0.2	-
Trisopterus minutus	3.3	-	-	1.2	4.6	1.1	-	-	0.5	2.1
Trisopterus esmarkii	1.7	1.8	1.7	2.4	1.5	0.4	0.6	0.8	1.6	1.6
*Trisopterus luscus**	16.7	43.9	58.3	56.5	27.7	1.4	2.3	7.6	5.6	2.0
*Pollachius pollachius**	10.0	45.6	53.3	40.0	9.2	3.6	2.0	1.8	2.3	0.7
Pollachius virens	-	3.5	-	1.2	1.5	-	0.2	-	0.2	0.4
Onos spp.*	63.3	96.5	93.3	90.6	83.1	10.5	21.9	39.1	29.3	6.6
*Molva molva**	3.3	22.8	43.3	17.6	3.1	0.3	1.2	1.4	0.6	0.6
Merluccius merluccius	-	-	-	-	-	-	-	-	-	-
Triglidae*	-	12.3	36.7	25.9	12.3	-	4.1	3.2	1.5	0.6
Cottidae spp.*	35.0	36.8	26.7	20.0	24.6	2.1	8.6	2.8	1.2	1.3
Triglops murrayi	1.7	-	-	1.2	-	-	-	-	-	-
Myoxocephalus scorpius	16.7	10.5	6.7	1.2	-	3.5	0.4	0.5	0.1	-
Taurulus bubalis	-	1.8	8.3	-	-	3.1	2.1	2.2	0.2	-
Taurulus lilljeborgi	-	-	1.7	3.5	-	-	-	0.3	3.3	-
Agonus cataphractus	16.7	1.8	3.3	2.4	-	0.9	0.1	0.2	0.2	-
Cyclopterus lumpus	-	-	1.7	-	-	-	-	0.2	-	-
Liparis spp.*	45.0	63.2	55.0	43.5	24.6	9.5	5.2	12.2	3.2	0.9
Liparis liparis	1.7	1.8	5.0	2.4	-	5.3	0.7	0.3	1.0	-
Dicentrarchus labrax	3.3	1.8	-	2.4	-	0.8	0.8	-	0.2	-
Trachurus trachurus	-	1.8	-	-	-	-	0.2	-	-	-
Labridae spp.	-	-	-	1.2	-	-	-	-	0.2	-
Trachinus vipera	-	-	-	-	-	-	-	-	-	-
Chirolophis ascanii	16.7	10.5	3.3	2.4	1.5	1.0	0.6	0.3	0.2	0.3
Lumpenus lampretaeformis	10.0	3.5	3.3	-	-	5.2	0.3	1.8	-	-
*Pholis gunnellus**	50.0	61.4	40.0	37.6	24.6	35.2	12.2	14.2	5.8	3.0
Ammodytidae spp.*	96.7	82.5	81.7	47.1	40.0	70.3	18.1	8.3	25.2	11.9
Callionymiidae spp.*	13.3	73.7	88.3	89.4	86.2	29.8	39.7	55.5	77.8	53.5
Gobiidae spp.*	60.0	87.7	96.7	100.0	100.0	26.8	37.6	103.5	79.9	82.0
Crystallogobius linearis	-	-	-	-	-	-	-	-	-	-
Lebetus scorpioides	-	-	-	-	-	-	-	-	-	-
Scomber scombrus	-	1.8	-	-	1.5	-	0.1	-	-	0.2
Bothidae spp.	-	-	-	-	-	-	-	-	-	-
Scophthalmus rhombus	-	-	-	-	-	-	-	-	-	-
Scophthalmus maximus	-	-	-	-	-	-	-	-	-	-
Lepidorhombus whiffiagonis	-	5.3	-	-	-	-	0.3	-	-	-
*Phrynorhombus norvegicus**	-	1.8	13.3	7.1	21.5	-	1.3	0.6	4.6	3.8
Zeugopterus punctatus	-	1.8	5.0	5.9	1.5	-	0.2	1.0	1.0	0.4
Pleuronectidae spp.	-	21.1	3.3	-	-	-	12.8	2.8	-	-
*Pleuronectes platessa**	48.3	8.8	15.0	5.9	-	6.4	0.9	0.6	3.8	-
*Platichthys flesus**	46.7	71.9	70.0	45.9	9.2	57.4	28.8	4.6	8.7	1.8
*Limanda limanda**	46.7	61.4	90.0	87.1	81.5	106.6	198.2	48.6	82.5	11.3
*Microstomus kitt**	-	10.5	23.3	11.8	7.7	-	2.2	1.5	2.0	0.4
*Glyptocephalus cynoglossus**	13.3	22.8	25.0	18.8	4.6	1.4	4.1	3.6	0.8	0.3
*Hippoglossoides platessoides**	-	10.5	15.0	1.2	-	-	2.6	0.6	2.2	-
Soleidae	-	-	-	-	-	-	-	-	-	-
*Solea solea**	1.7	8.8	20.0	29.4	3.1	0.2	0.3	0.8	29.6	2.1
Buglossidium luteum	1.7	5.3	13.3	2.4	6.2	2.0	0.5	0.7	0.4	0.7
Microchirus variegatus	-	-	-	-	-	-	-	-	-	-
Unidentified spp.	56.7	71.9	76.7	58.8	46.2	28.4	20.5	15.4	11.2	2.3
Total number of stations worked	60	57	60	85	65	60	57	60	85	65

Table 2(c). List of species occurring as eggs, the frequency of their occurrence and maximum concentration on each of three surveys in the Irish Sea in 1985. Species marked * have been plotted

Species	% Positive stations			Maximum concentration (nos. m^{-2})		
	15 - 19 April	11- 17 May	27 May - 6 June	15 - 19 April	11- 17 May	27 May - 6 June
Clupeidae	-	-	-	-	-	-
*Sprattus sprattus**	79.4	73.3	70.7	349.0	579.2	3369.1
Sardina pilchardus	-	-	1.2	-	-	0.3
Argentinidae spp.	-	-	-	-	-	-
*Argentina sphyraena**	16.2	2.9	1.2	4.4	0.5	0.9
Gadidae spp.	-	-	-	-	-	-
*Gadus morhua**	88.2	48.6	-	220.4	5.0	-
Gadiculus argentus	-	-	-	-	-	-
Melanogrammus aeglefinus	4.4	-	-	0.4	-	-
Merlangius merlangus	-	-	-	-	-	-
Micromesistius poutassou	-	-	-	-	-	-
Trisopterus minutus	-	-	-	-	-	-
Trisopterus esmarkii	-	-	-	-	-	-
Trisopterus luscus	-	-	-	-	-	-
Pollachius pollachius	-	-	-	-	-	-
Pollachius virens	-	-	-	-	-	-
Onos spp.*	80.9	63.8	89.0	90.6	71.2	573.0
*Molva molva**	44.1	29.5	15.9	17.5	6.0	10.5
Merluccius merluccius	-	-	-	-	-	-
Triglidae*	42.6	50.5	45.1	62.9	9.0	14.8
Dicentrarchus labrax	1.5	-	-	0.4	-	-
Trachurus trachurus	-	-	2.4	-	-	0.3
Trachinus vipera	-	-	-	-	-	-
Chirolophis ascanii	-	-	-	-	-	-
Callionymiidae spp.*	64.7	72.4	78.0	327.8	246.9	116.9
*Scomber scombrus**	7.4	1.9	20.7	8.0	0.9	58.7
Bothidae spp.	-	-	-	-	-	-
Scophthalmus rhombus	2.9	1.0	-	5.9	0.2	-
Scophthalmus maximus	1.5	10.5	8.5	2.0	3.0	1.1
Lepidorhombus whiffiagonis	-	-	1.2	-	-	0.1
Phrynorhombus norvegicus	1.5	6.7	14.6	2.7	1.3	6.3
Zeugopterus punctatus	5.9	-	7.3	6.9	-	0.9
Pleuronectidae spp.	-	-	-	-	-	-
*Pleuronectes platessa**	25.0	-	-	17.7	-	-
Platichthys flesus	-	-	-	-	-	-
Limanda limanda	-	-	-	-	-	-
Microstomus kitt	2.9	-	2.4	0.8	-	3.7
Glyptocephalus cynoglossus	7.4	-	1.2	4.4	-	0.6
Hippoglossoides platessoides	1.5	-	-	0.3	-	-
Soleidae	1.5	-	-	2.3	-	-
*Solea solea**	30.9	38.1	37.8	24.2	98.8	24.2
*Buglossidium luteum**	13.2	17.1	25.6	8.2	8.9	10.5
Microchirus variegatus	-	2.9	17.1	-	0.4	11.1
Unidentified spp.	100.0	98.1	92.7	823.9	404.2	121.1
Total number of stations worked	68	105	82	68	105	82

Table 2(d). List of species occurring as larvae, the frequency of their occurrence and maximum concentration on each of three surveys in the Irish Sea in 1985. Species marked * have been plotted

Species	% Positive stations			Maximum concentration (nos. m^{-2})		
	15 - 19 April	11- 17 May	27 May - 6 June	15 - 19 April	11- 17 May	27 May - 6 June
Clupeidae	76.5	79.0	85.4	89.0	96.4	145.1
Clupea harengus	1.5	1.0	-	0.2	0.2	-
*Sprattus sprattus**	-	1.0	1.2	-	23.2	0.2
Sardina pilchardus	-	-	-	-	-	-
Argentinidae spp.	-	-	-	-	-	-
*Argentina sphyraena**	4.4	-	-	2.5	-	-
Gobiesocidae spp.	-	-	1.2	-	-	0.5
Apletodon microcephalus	-	-	1.2	-	-	1.9
Diplecogaster bimaculata	-	-	2.4	-	-	0.6
Lepadogaster lepadogaster	-	-	1.2	-	-	0.8
Lophius piscatorius	-	-	-	-	-	-
Gadidae spp.	72.1	61.9	64.6	38.7	8.8	7.4
*Gadus morhua**	88.2	50.5	19.5	57.3	13.9	4.0
Gadiculus argenteus	-	-	-	-	-	-
*Melanogrammus aeglefinus**	16.2	2.9	1.2	5.1	0.2	0.2
*Merlangius merlangus**	77.9	69.5	64.6	53.8	13.0	12.7
Micromesistius poutassou	-	-	-	-	-	-
Trisopterus minutus	-	-	-	-	-	-
Trisopterus esmarkii	-	-	-	-	-	-
*Trisopterus luscus**	35.3	18.1	12.2	7.6	1.7	1.5
*Pollachius pollachius**	22.1	7.6	8.5	3.9	1.8	0.5
Pollachius virens	-	-	-	-	-	-
Onos spp.*	77.9	77.1	64.6	25.7	6.9	3.6
*Molva molva**	19.1	2.9	3.7	3.1	0.2	0.3
Merluccius merluccius	-	-	-	-	-	-
Triglidae*	5.9	7.6	7.3	0.8	0.4	0.7
Cottidae spp.*	10.3	23.8	18.3	2.3	3.2	2.9
Triglops murrayi	-	-	-	-	-	-
Myoxocephalus scorpius	20.6	-	-	2.7	-	-
Taurulus bubalis	1.5	1.0	2.4	0.3	0.1	6.5
Taurulus lilljeborgi	-	-	-	-	-	-
Agonus cataphractus	13.2	7.6	2.4	1.3	1.3	1.2
Cyclopterus lumpus	-	-	-	-	-	-
Liparis spp.*	33.8	37.1	17.1	8.0	2.4	1.0
Liparis liparis	-	-	2.4	-	-	2.9
Dicentrarchus labrax	-	-	-	-	-	-
Trachurus trachurus	-	-	-	-	-	-
Labridae spp.	-	1.0	-	-	0.1	-
Trachinus vipera	-	-	-	-	-	-
Chirolophis ascanii	10.3	2.9	-	1.6	0.4	-
Lumpenus lampretaeformis	8.8	-	-	4.3	-	-
*Pholis gunnellus**	42.6	38.1	23.2	29.3	46.4	4.2
Ammodytidae spp.*	94.1	93.3	69.5	193.0	55.7	5.8
Callionymiidae spp.*	51.5	58.1	70.7	47.1	7.9	29.8
Gobiidae spp.*	52.9	54.3	62.2	12.9	6.6	28.8
Crystallogobius linearis	-	-	1.2	-	-	0.3
Lebetus scorpioides	-	-	-	-	-	-
Scomber scombrus	-	-	-	-	-	-
Bothidae spp.	1.5	-	-	0.1	-	-
Scophthalmus rhombus	1.5	-	-	1.1	-	-
Scophthalmus maximus	-	-	-	-	-	-
Lepidorhombus whiffiagonis	-	-	-	-	-	-
*Phrynorhombus norvegicus**	2.9	19.0	36.6	4.3	2.2	4.0
Zeugopterus punctatus	1.5	-	1.2	2.1	-	0.2
Pleuronectidae spp.	-	-	-	-	-	-
*Pleuronectes platessa**	25.0	1.9	2.4	12.0	0.2	0.3
*Platichthys flesus**	58.8	44.8	25.6	43.6	8.2	10.0
*Limanda limanda**	85.3	85.7	91.5	175.7	102.4	27.6
*Microstomus kitt**	5.9	3.8	4.9	1.6	1.3	0.5
*Glyptocephalus cynoglossus**	50.0	11.4	4.9	12.9	0.8	0.5
*Hippoglossoides platessoides**	10.3	8.6	1.2	2.4	4.5	0.2
Soleidae	-	2.9	-	-	2.2	-
*Solea solea**	7.4	11.4	20.7	1.1	1.3	13.7
Buglossidium luteum	-	-	-	-	-	-
Microchirus variegatus	-	1.0	2.4	-	1.5	0.6
Unidentified spp.	85.3	76.2	43.9	40.0	8.2	3.5
Total number of stations worked	68	105	82	68	105	82

Table 2(e). List of species occurring as eggs, frequency of occurrence and maximum concentration on each of the surveys of the Irish Sea in 1987, 1988 and 1989. Species marked * have been plotted

Species	% Positive stations			Maximum concentration (nos. m⁻²)		
	14 - 24 May 1987	20 April - 2 May 1988	16 - 28 April 1989	14 - 24 May 1987	20 April - 2 May 1988	16 - 28 April 1989
Clupeidae	-	-	-	-	-	-
*Sprattus sprattus**	78.2	81.2	88.9	263.7	434.5	226.9
Sardina pilchardus	-	-	-	-	-	-
Argentinidae spp.	1.8	-	-	0.1	-	-
*Argentina sphyraena**	5.5	5.8	2.8	0.3	1.3	0.2
Gadidae spp.	-	-	-	-	-	-
*Gadus morhua**	54.5	79.7	76.4	14.2	133.9	54.4
Gadiculus argenteus	-	-	-	-	-	-
Melanogrammus aeglefinus	-	-	-	-	-	-
Merlangius merlangus	-	-	-	-	-	-
Micromesistius poutassou	-	-	-	-	-	-
Trisopterus minutus	-	-	-	-	-	-
Trisopterus esmarkii	-	-	-	-	-	-
Trisopterus luscus	-	-	-	-	-	-
Pollachius pollachius	-	1.4	1.4	-	-	-
Pollachius virens	-	-	-	-	-	-
Onos spp.*	89.1	89.9	87.5	53.8	64.9	110.9
*Molva molva**	47.3	44.9	33.3	5.1	15.5	18.9
Merluccius merluccius	1.8	-	-	0.2	-	-
Triglidae*	63.6	58.0	43.1	8.5	7.4	12.1
Dicentrarchus labrax	1.8	-	-	0.3	-	-
Trachurus trachurus	-	2.9	1.4	-	0.4	0.2
Trachinus vipera	-	-	-	-	-	-
Chirolophis ascanii	-	-	-	-	-	-
Callionymiidae spp.*	90.9	78.3	73.6	193.8	171.0	256.0
*Scomber scombrus**	5.5	2.9	2.8	1.7	0.1	0.5
Bothidae spp.	14.5	-	-	4.4	-	-
Scophthalmus rhombus	-	-	-	-	-	-
Scophthalmus maximus	20.0	15.9	33.3	3.1	2.9	3.8
Lepidorhombus whiffiagonis	-	-	-	-	-	-
Phrynorhombus norvegicus	49.1	40.6	36.1	12.3	18.1	11.2
Zeugopterus punctatus	-	2.9	-	-	0.3	-
Pleuronectidae spp.	-	1.4	-	-	0.4	-
*Pleuronectes platessa**	-	15.9	23.6	-	2.5	20.7
Platichthys flesus	-	1.4	-	-	-	-
Limanda limanda	-	-	-	-	-	-
Microstomus kitt	3.6	1.4	-	1.4	0.9	-
Glyptocephalus cynoglossus	-	10.1	2.8	-	1.0	0.2
Hippoglossoides platessoides	-	2.9	-	-	15.7	-
Soleidae	-	-	-	-	-	-
*Solea solea**	45.5	68.1	63.9	25.5	32.2	79.4
*Buglossidium luteum**	12.7	18.8	9.7	3.1	18.4	1.9
Microchirus variegatus	5.5	1.4	6.9	0.2	-	3.8
Unidentified spp.	98.2	98.6	98.6	93.8	299.3	1403.1
Total number of stations worked	55	69	72	55	69	72

Table 2(f). List of species occurring as larvae, the frequency of the occurrence and maximum concentration on each of the surveys of the Irish Sea in 1987, 1988 and 1989. Species marked * have been plotted

Species	% Positive stations			Maximum concentration (nos. m^{-2})		
	14 - 24 May 1987	20 April - May 1988	16 - 28 April 1989	14 - 24 May 1987	20 April - 2 May 1988	16 - 28 April 1989
Clupeidae	58.2	81.2	80.6	1.4	113.0	118.0
Clupea harengus	-	1.4	-	-	0.1	-
*Sprattus sprattus**	1.8	1.4	6.9	0.2	46.1	55.8
Sardina pilchardus	-	-	-	-	-	-
Argentinidae spp.	-	-	-	-	-	-
*Argentina sphyraena**	1.8	2.9	2.8	0.2	0.1	0.2
Gobiesocidae spp.	1.8	-	-	0.3	-	-
Apletodon microcephalus	-	-	-	-	-	-
Diplecogaster bimaculata	-	-	-	-	-	-
Lepadogaster lepadogaster	-	-	-	-	-	-
Lophius piscatorius	1.8	-	-	0.3	-	-
Gadidae spp.	10.9	46.4	11.1	0.6	2.4	1.6
*Gadus morhua**	21.8	69.6	62.5	0.8	10.1	17.2
Gadiculus argenteus	-	-	-	-	-	-
*Melanogrammus aeglefinus**	-	8.7	1.4	-	0.2	0.2
*Merlangius merlangus**	18.2	65.2	70.8	0.3	8.5	19.0
Micromesistius poutassou	-	-	-	-	-	-
Trisopterus minutus	3.6	2.9	-	0.6	<0.1	-
Trisopterus esmarkii	-	-	-	-	-	-
*Trisopterus luscus**	3.6	18.8	47.2	0.3	1.0	1.8
*Pollachius pollachius**	9.1	14.5	25.0	0.3	0.5	2.8
Pollachius virens	-	1.4	-	-	0.1	-
Onos spp.*	47.3	81.2	91.7	1.1	8.9	23.5
*Molva molva**	3.6	14.5	33.3	0.4	0.7	2.9
Merluccius merluccius	-	-	1.4	-	-	0.7
Triglidae*	3.6	2.9	23.6	0.2	0.2	2.9
Cottidae spp.*	12.7	36.2	16.7	0.7	2.4	2.0
Triglops murrayi	-	-	-	-	-	-
Myoxocephalus scorpius	-	18.8	4.2	-	0.8	1.9
Taurulus bubalis	1.8	4.3	-	0.8	0.5	-
Taurulus lilljeborgi	-	-	-	-	-	-
Agonus cataphractus	9.1	21.7	9.7	0.3	0.7	0.7
Cyclopterus lumpus	1.8	-	-	0.2	-	-
Liparis spp.*	47.3	46.4	23.6	2.1	3.3	1.5
Liparis liparis	-	10.1	1.4	-	2.9	0.5
Dicentrarchus labrax	-	-	-	-	-	-
Trachurus trachurus	-	-	-	-	-	-
Labridae spp.	-	-	-	-	-	-
Trachinus vipera	-	-	-	-	-	-
Chirolophis ascanii	1.8	10.1	9.7	0.3	0.3	0.5
Lumpenus lampretaeformis	3.6	18.8	6.9	0.3	1.2	4.5
*Pholis gunnellus**	38.2	59.4	34.7	2.9	9.5	9.2
Ammodytidae spp.*	81.8	97.1	93.1	6.0	40.9	19.7
Callionymiidae spp.*	29.1	65.2	76.4	0.7	14.3	24.6
Gobiidae spp.*	69.1	82.6	75.0	6.2	8.4	12.7
Crystallogobius linearis	-	-	-	-	-	-
Lebetus scorpioides	-	-	1.4	-	-	0.2
Scomber scombrus	-	-	-	-	-	-
Bothidae spp.	-	-	1.4	-	-	1.4
Scophthalmus rhombus	-	-	-	-	-	-
Scophthalmus maximus	-	-	1.4	-	-	0.1
Lepidorhombus whiffiagonis	-	-	-	-	-	-
*Phrynorhombus norvegicus**	16.4	8.7	19.4	0.3	0.2	4.8
Zeugopterus punctatus	-	8.7	8.3	-	0.4	0.9
Pleuronectidae spp.	-	1.4	-	-	0.3	-
*Pleuronectes platessa**	-	7.2	8.3	-	0.5	0.3
*Platichthys flesus**	10.9	66.7	58.3	0.6	13.2	15.5
*Limanda limanda**	61.8	84.1	84.7	6.5	68.2	193.8
*Microstomus kitt**	-	7.2	2.8	-	0.1	0.2
*Glyptocephalus cynoglossus**	1.8	34.8	36.1	0.3	3.4	7.7
*Hippoglossoides platessoides**	-	24.6	2.8	-	1.4	1.5
Soleidae	-	-	1.4	-	-	0.1
*Solea solea**	14.5	5.8	18.1	0.8	0.2	1.7
Buglossidium luteum	-	-	-	-	-	-
Microchirus variegatus	-	-	1.4	-	-	0.7
Unidentified spp.	27.3	71.0	73.6	4.0	5.5	13.6
Total number of stations worked	55	69	72	55	69	72

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