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THE DISTRIBUTION AND ABUNDANCE OF HERRING LARVAE TO THE WEST OF  
SCOTLAND IN 1973.

by

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Summary

This paper describes the results of the herring larval surveys carried out to the west of Scotland in the autumn of 1973. These gave larval densities similar to the corresponding surveys in 1972. The results are discussed in terms of numbers of larvae and in relation to the adult stock size in the area.

In addition comparisons are made between surveys carried out in early September by the RV 'Corella' and RV 'Scotia' and the possible reasons for the differences are discussed.

Introduction

This report gives the results of the fourth survey of herring larvae to the west of Scotland. Following an initial survey in 1965 a regular series began in 1971 following a recommendation by the ICES Herring Assessment Working Group (Anon 1971). They are intended to provide measures of changes in herring spawning stock size which are independent of catch per unit effort data.

The results of previous surveys have been reported by Wood (1971, 1973) and Saville and McKay (1974<sub>b</sub>).

Material and Methods

The spawning area of autumn-spawning herring in area VIa as delineated by Wood (1971, 1973) was surveyed completely on two occasions. The surveys were carried out by the RV 'Scotia' of the Marine Laboratory, Aberdeen, the first survey taking place during the period 11 to 20 September 1973 and the second during the period 27 September to 8 October 1973. On 9 October, nine stations were sampled to the north of Ireland as the beginning of a third survey. During the period 12 to 16 September 1973 the area north of 58°N was surveyed independently by the RV 'Corella' of the Fisheries Laboratory, Lowestoft.

Samples were collected and analysed in the same ways as in the North Sea herring larval surveys (Saville 1970). Densities of larvae, in numbers beneath one square metre of surface were plotted and planimeted and total abundances estimated as described by Saville and McKay (1974<sub>a</sub>) for the North Sea surveys in 1972.

## Results

The results of the two complete surveys carried out by RV 'Scotia' are given in Figures 1-5. On the first survey larvae <10 mm long were located in a broad belt extending from St Kilda north and east to 4°W the eastern boundary of the survey area with an area of high density, up to 715 larvae/m<sup>2</sup> surface, being found to the south-west of the Flannan Isles and extending north towards the Butt of Lewis. Secondary patches of newly hatched larvae were found north of Malin Head and west of Aran Island with maximum densities of 70 and 247 larvae/m<sup>2</sup> surface respectively. The estimated numbers of larvae <10 mm long in the whole survey area was  $2\ 210 \times 10^9$  with  $2\ 016 \times 10^9$  (Table 1) being located north of 56°30'N. Larvae in the 10-15 mm length range were found in two major patches, one to the west of the Isle of Lewis and the other larger patch extending north and east from the Butt of Lewis to the survey boundary at 4°W. The number of larvae in the 10-15 mm length range was estimated to be  $2\ 962 \times 10^9$ . Larvae >15 mm long were only found in very small numbers at one or two stations and no valid estimate could be made of their abundance.

On the second survey high density patches of larvae <10 mm long were located in two areas, to the west of the Outer Hebrides and to the north and west of Ireland. The patches to the west of the Outer Hebrides were found from the Flannan Isles to the Butt of Lewis with a maximum density of 314 larvae/m<sup>2</sup> surface and to the west of North and South Uist with a maximum density of 226 larvae/m<sup>2</sup> surface. In the area to the north and west of Ireland patches of newly hatched larvae were located to the north of Malin Head with a maximum density of 389 larvae/m<sup>2</sup> surface and west of Aran Island, with a maximum density of 130 larvae/m<sup>2</sup> surface. Both patches were incompletely defined with the Aran Island patch being open to both the south and west and the Malin Head patch being open to the east. The total number of larvae <10 mm long was estimated to be  $2\ 189 \times 10^9$ , with  $1\ 665 \times 10^9$  being north of 56°30'N. Larvae in the 10-15 mm length range were also widely distributed with the major concentrations being located west of the Outer Hebrides. Maximum densities of 363 larvae/m<sup>2</sup> surface and 296 larvae/m<sup>2</sup> surface, respectively, were obtained from patches to the east and west of the Flannan Isles. The estimated number of larvae in the 10-15 mm length range for the whole survey area was  $2\ 010 \times 10^9$ . Larvae >15 mm long were rather scarce, being found mainly north and east of the Butt of Lewis, with an estimated total number of  $145 \times 10^9$  (Table 1).

From the nine stations sampled on 9 October by the RV 'Scotia' (Figures 6 and 7) very high densities, up to 1 882 larvae/m<sup>2</sup> surface, were obtained north of Malin Head. Due to the very limited coverage of the area no estimate of total larval abundance for this survey has been made.

The results from the RV 'Corella' survey are given in Figures 8 and 9. A broad belt of larvae <10 mm long was located extending from the Flannan Isles north and east to the eastern boundary of the survey at 4°W with areas of very high density being found in the vicinity of the Flannan Isles, maximum density 832 larvae/m<sup>2</sup> surface, and north of Cape Wrath, maximum density 812 larvae/m<sup>2</sup> surface. A patch of newly hatched larvae was also located in the North Minch, with a maximum density of 308 larvae/m<sup>2</sup> surface. The estimated number of larvae <10 mm long was high at  $3\ 584 \times 10^9$ . Larvae in the 10-15 mm length range were present at lower densities over a similar area to the <10 mm long larvae with concentrations being found to the west of the Isle of Lewis and in the North Minch. The estimated number of larvae in the 10-15 mm length range was  $813 \times 10^9$  (Table 2). No larvae >15 mm long were collected.

## Discussion

### (a) Annual variations in larval abundance and estimates of spawning stock size.

In making comparisons between larval abundances in 1973 and those of previous surveys (Wood 1971, 1973 and Saville and McKay 1974b) it is necessary to group the estimates into comparable time periods and survey areas. These data are given in Tables 3 and 4 for areas north and south of 56°30'N. From these data it is apparent that the larval abundance estimates for the northern part of VIa in late September early October 1973 were very similar to those in 1972. If, however, the mean number of newly hatched larvae per survey is calculated for both years the 1972 figure,  $3\ 822 \times 10^9$ , is almost twice that of 1973,  $2\ 200 \times 10^9$ . This is largely due to the survey in the first week of September 1972, which gave very high larval abundances and for which there was no comparable survey in 1973. Every effort should be made in the future to obtain a measure of larval production in the northern part of VIa in early September.

The most marked difference between the 1973 surveys and those of previous years occurred in the southern part of VIa (Table 4). In this area abundances of newly hatched herring larvae in both the 1973 surveys were an order of magnitude higher than those in corresponding surveys in 1972. The September abundance estimates in 1973 were of the same order as the October ones in 1965 and 1971 (Wood 1971, 1973). There were indications from the limited sampling carried out on 9 October that production of herring larvae in this area could be considerably higher than in 1965 and 1971 as the larval densities obtained in some of these samples were considerably higher than larval densities obtained in this area on any previous survey.

By comparing larval abundance data from VIa with the larval production and spawning potential of the stocks in the North Sea, Saville and McKay (1974b) were able to produce estimates for the spawning stock size in VIa in 1965 and 1971. Using the data on larval production and spawning potential for North Sea stocks given by Saville and McKay (1974b) estimates of stock sizes in VIa have been produced for those years for which there are larval abundance data (Table 5). For comparison estimates are given of the biomass of the spawning stock in each of these years, derived from the virtual population analysis of Saville and Morrison (1973 and personal communication) by calculating the number of survivors of the stock at 1 January to the time of spawning, and multiplying by the mean weight per age group at spawning.

The estimates from the virtual population analysis and those from the comparison of larval abundances in VIa and in the Northern/Central North Sea are as close as could be expected from the nature of the data. Both sets of data show an increase in the spawning stock size from 1965 to 1972 with a decrease in 1973. The size of the decrease in the estimates from larval abundance data may be greater than actually occurred because of the lack of an early September survey in 1973. If this early 1972 survey is omitted from the calculation of mean larval abundance the stock size estimates obtained for the 1972 stock with both comparisons are 630 100 and 417 800 tonnes, indicating that the stock in VIa in 1973 was slightly higher than that of 1972.

### (b) Inter-ship variability

As already stated, two surveys of the area north of 58°N were carried out during the period 11-16 September 1973. These surveys were carried out by the RV 'Corella' and RV 'Scotia' and give rather different estimates of larval abundance (Table 2). It is apparent from these data

that although both surveys gave rather similar estimates of total larval abundance the estimates for the component size groups of larvae show considerable differences. The RV 'Corella' caught considerably larger numbers of <10 mm larvae than the RV 'Scotia' with the difference being most marked in the Cape Wrath area, while the RV 'Scotia' caught more 10-15 mm long larvae than the RV 'Corella' with the difference again being most marked in the Cape Wrath area.

It was first thought that this was simply due to there being a time difference in sampling of the same area of the survey by the two ships but examination of the order of sampling the stations within the survey area has shown that the ships had a very similar pattern of operation. Further examination of the data has shown that the size distributions of the larvae caught by the two ships were markedly different with the RV 'Corella' catching considerable numbers of larvae in the 5-7 mm length range while the RV 'Scotia' caught very few larvae at 7 mm long and none  $\leq 6$  mm long. It was thought that this could be associated with slight differences in the towing speeds with the RV 'Scotia' towing one knot faster at 6 knots than the RV 'Corella'. Considering the difference in numbers of very small larvae and the discrepancy in towing speeds it was thought that the smallest larvae could have been extruded through the meshes of the sampler used by the RV 'Scotia'.

To test this the smallest categories of larvae were omitted from the RV 'Corella's' catches and the larval densities were plotted in Figure 10. Comparison of this with Figure 1 shows that the amended larval densities obtained by the RV 'Corella' have even less similarity with those of the RV 'Scotia' than those data given in Figure 8. It would therefore appear that although extrusion may occur it is not at a high enough level to explain the differences in the data.

It would therefore appear that the differences in larval abundances and size distributions were due to differences in sampling techniques or in the methods used to measure the larval lengths. To explain the discrepancies in larval size distributions fairly major differences in sampling techniques and larval distributions would be necessary whereas only small errors in the larval length measurements might cause such a difference.

In view of the differences and the fact that these ships and gears are widely used for herring larval surveys it would appear that comparative tests of the various sampling gears and the length measuring techniques should be carried out as soon as possible.

## References

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**Table 1** Estimated abundances of herring larvae on each complete survey in VIA in 1973. (Totals for N and S of 56°30'N given separately.)

Date	Survey area	Number of larvae x10 <sup>-9</sup>			
		<10 mm	10-15 mm	>15 mm	Total
11-20/9/73	N of 56°30'N	2 016	2 553	-	4 569
	S of 56°30'N	194	47	-	241
	55°N-59°30'N	2 210	2 600	-	4 810
27/9-8/10/73	N of 56°30'N	1 665	1 779	142	3 586
	S of 56°30'N	524	231	3	758
	55°N-59°30'N	2 189	2 010	145	4 344

**Table 2** Estimated abundances of herring larvae N of 58°N during the period 11-16/9/1973 by R.V. "Scotia" and R.V. "Corella".

Date	Survey ship	Number of larvae x10 <sup>-9</sup>		
		<10 mm	10-15 mm	Total
11-16/9/73	"Scotia"	1 917	2 503	4 420
12-16/9/73	"Corella"	3 584	813	4 397

**Table 3** Estimated abundances of herring larvae N of 56°30'N in VIA in 1965, 1971, 1972 and 1973 in standard time periods. (After Wood (1971,1973) and Saville and McKay (1973b).)

Time period	Estimated abundances x10 <sup>-9</sup>											
	<10 mm				10-15 mm				Total			
	1965	1971	1972	1973	1965	1971	1972	1973	1965	1971	1972	1973
1-10/9	N.S.	N.D.	7 691	N.S.	N.S.	N.D.	669	N.S.	N.S.	3 267 <sup>1)</sup>	8 360	N.S.
11-25/9	N.S.	N.S.	1 334	2 016	N.S.	N.S.	1 350	2 553	N.S.	N.S.	2 773	4 569
26/9-10/10	N.S.	N.S.	2 388	1 665	N.S.	N.S.	2 122	1 779	N.S.	N.S.	4 586	3 586
10-25/10	415 <sup>2)</sup>	319	N.S.	N.S.	N.D.	N.D.	N.S.	N.S.	1 330 <sup>2)</sup>	1 037	N.S.	N.S.

N.S. - no survey  
N.D. - no data

1) incomplete survey including yolk sac larvae  
2) including Minches

**Table 4** Estimated abundances of herring larvae S of 56°30'N in VIa in 1965, 1971, 1972 and 1973 in standard time periods. (after Wood (1971, 1973) and Saville and McKay (1973b).)

Time period	Estimated abundances x10 <sup>-9</sup>											
	<10 mm				10-15 mm				Total			
	1965	1971	1972	1973	1965	1971	1972	1973	1965	1971	1972	1973
11-25/9	N.S.	N.S.	21	194	N.S.	N.S.	29	47	N.S.	N.S.	51	241
26/9-10/10	N.S.	N.S.	31	524	N.S.	N.S.	21	231	N.S.	N.S.	57	758
10-25/10	504	677	N.S.	N.S.	N.D.	N.D.	N.S.	N.S.	807	940	N.S.	N.S.

**Table 5** Estimated spawning stock sizes in tonnes in VIa in 1965, 1971, 1972 and 1973.

Year	Period/Area comparison	Estimated spawning stock size in VIa (tonnes)	
		From larval abundances	From V.P.A.
1965	Central/Northern North Sea 1957-60	227 500*	231 700
1965	Central/Northern North Sea 1961-64	150 800*	
1971	Central/Northern North Sea 1957-60	371 000*	330 200
1971	Central/Northern North Sea 1961-64	220 500*	
1972	Central/Northern North Sea 1957-60	1 276 300	825 000
1972	Central/Northern North Sea 1961-64	846 100	
1973	Central/Northern North Sea 1957-60	734 600	583 000
1973	Central/Northern North Sea 1961-64	487 100	

\*Estimates from Saville and McKay (1974b)

KEY

- ..... 1
- 25
- - - - - 100
- 500

55°  
58°  
57°  
56°  
55°

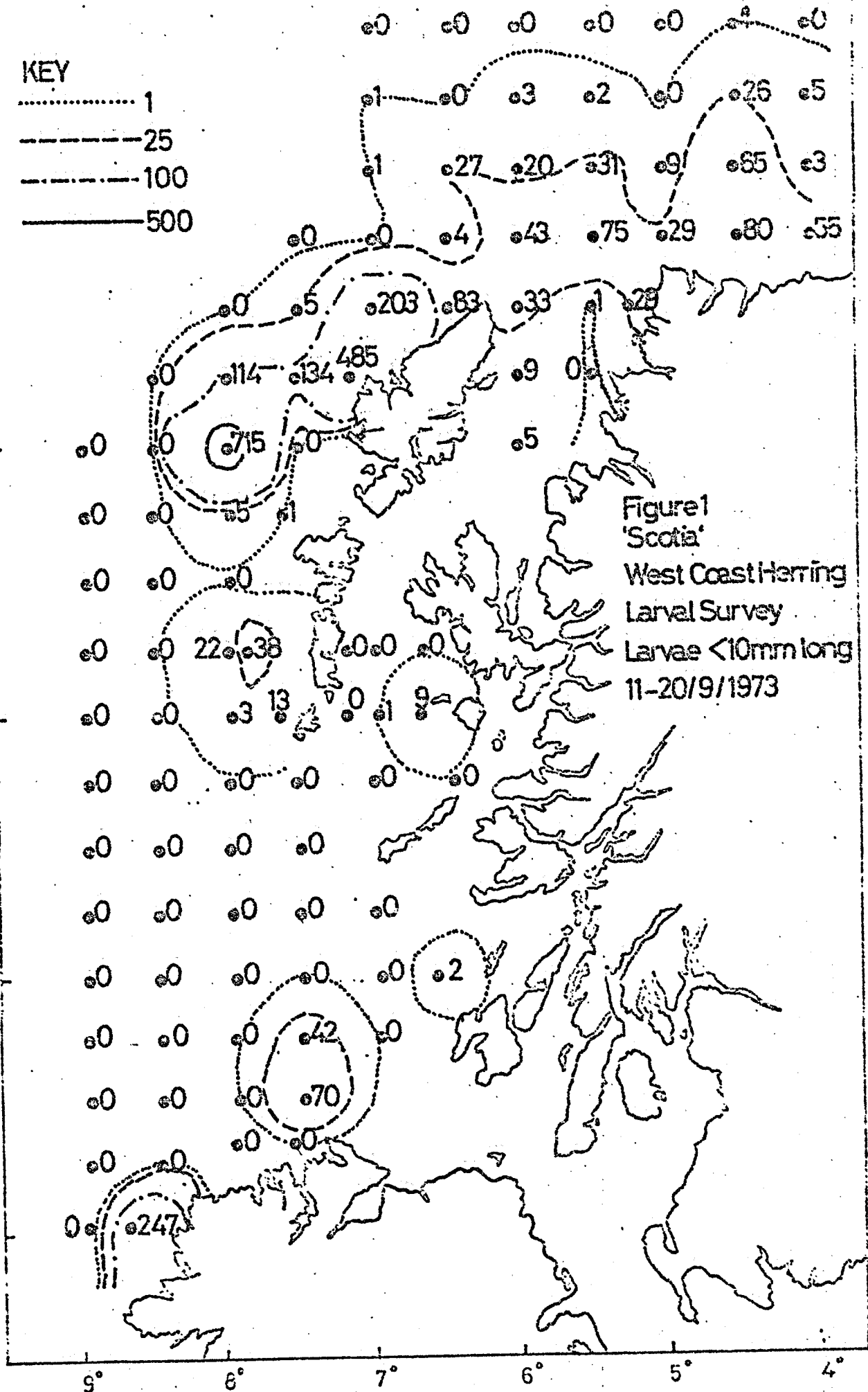


Figure 1  
'Scotia'  
West Coast Herring  
Larval Survey  
Larvae <10mm long  
11-20/9/1973



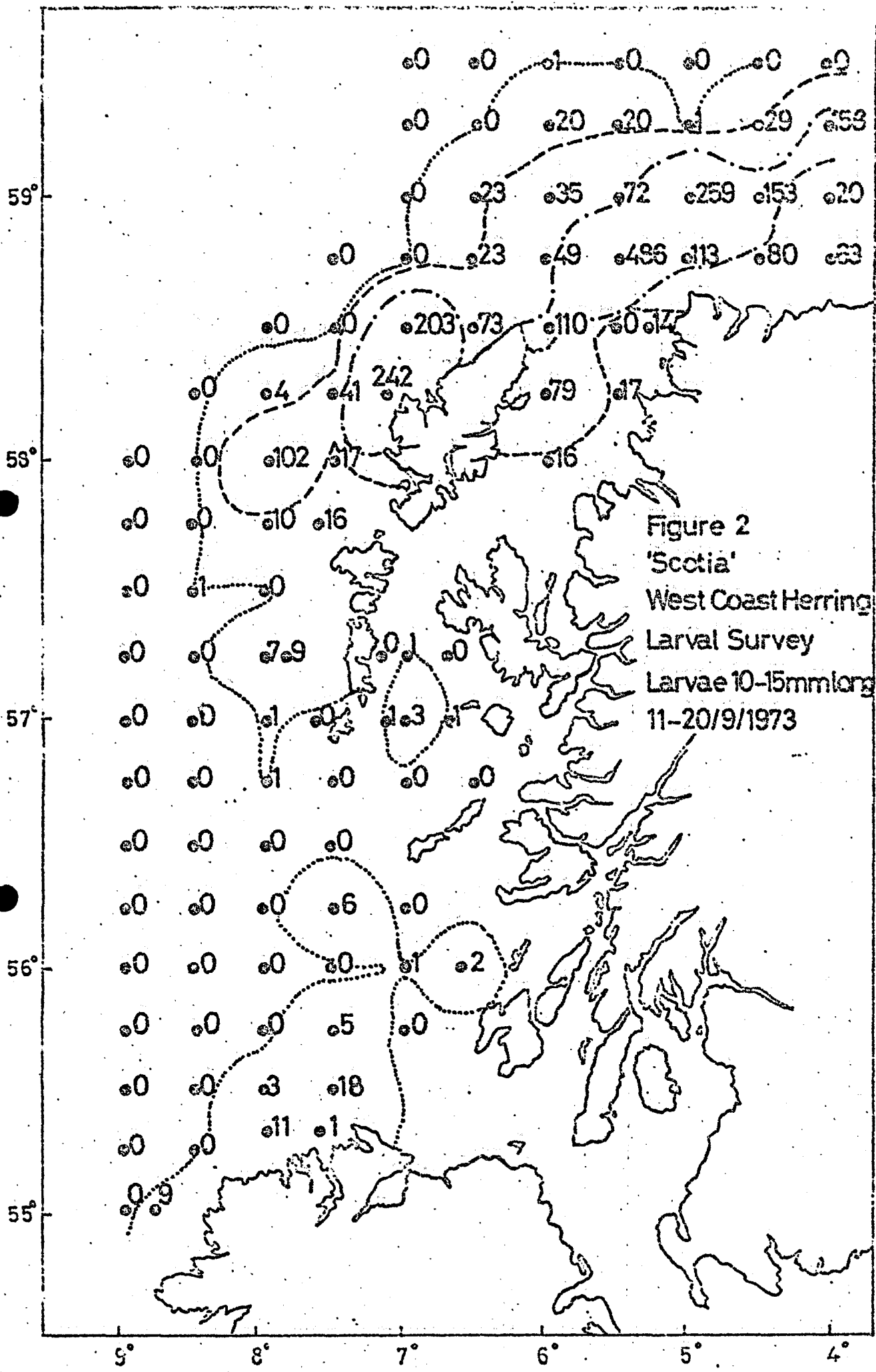


Figure 2  
 'Scotia'  
 West Coast Herring  
 Larval Survey  
 Larvae 10-15mm long  
 11-20/9/1973

59°

58°

57°

56°

55°

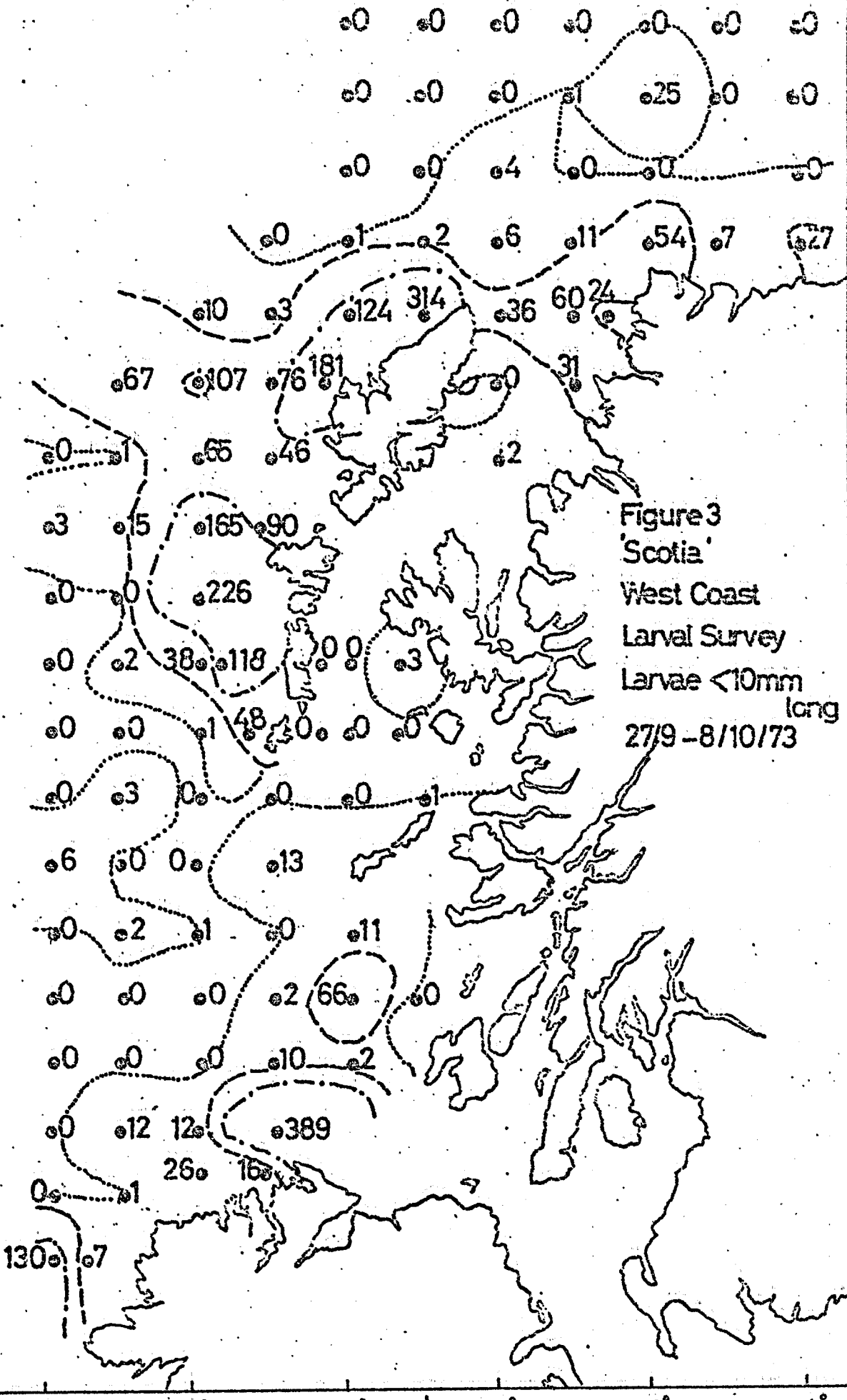


Figure 3  
 'Scotia'  
 West Coast  
 Larval Survey  
 Larvae < 10mm long  
 27/9 - 8/10/73

59°

59°

57°

56°

55°

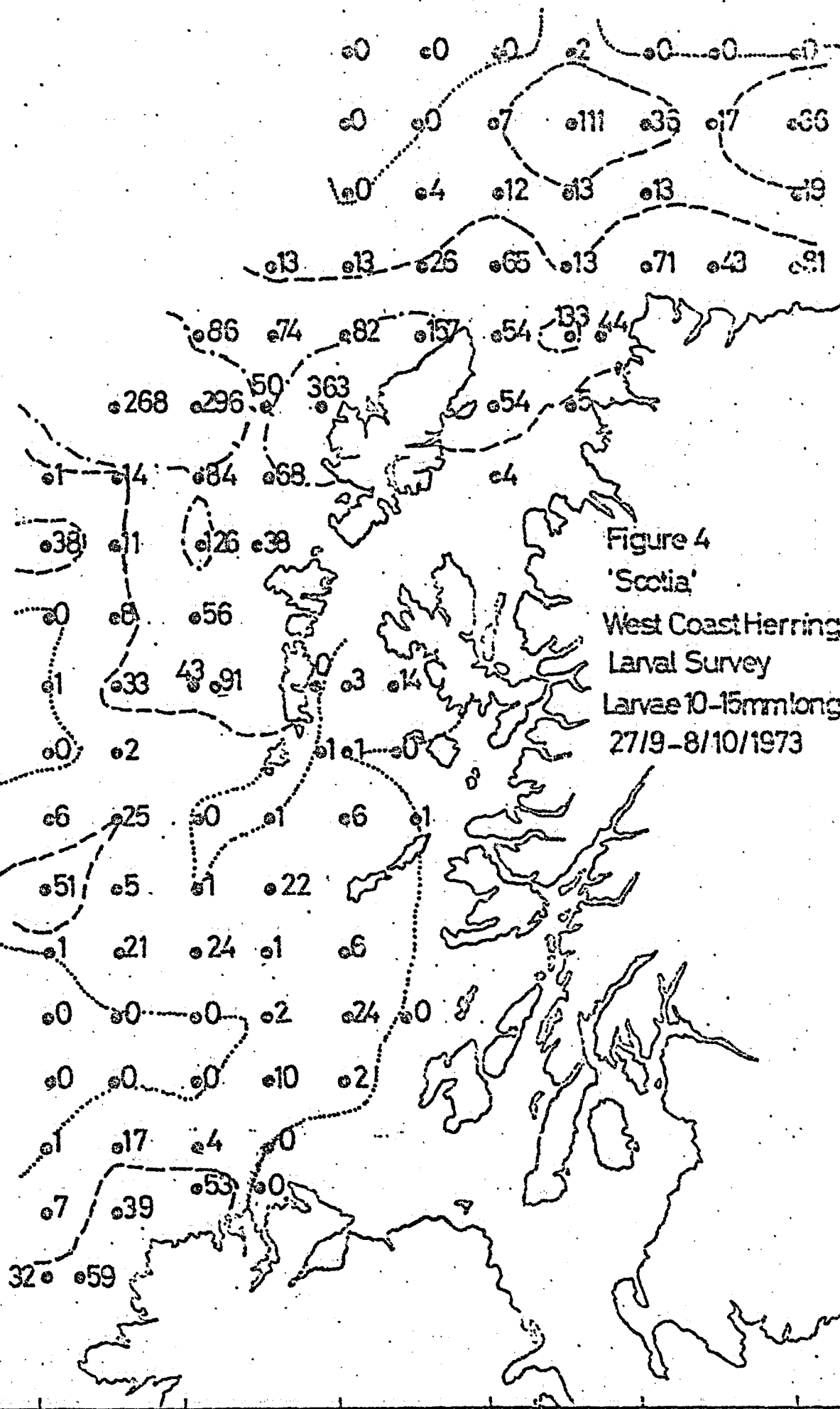


Figure 4  
 'Scotia'  
 West Coast Herring  
 Larval Survey  
 Larvae 10-15mm long  
 27/9-8/10/1973

59°

58°

57°

56°

55°

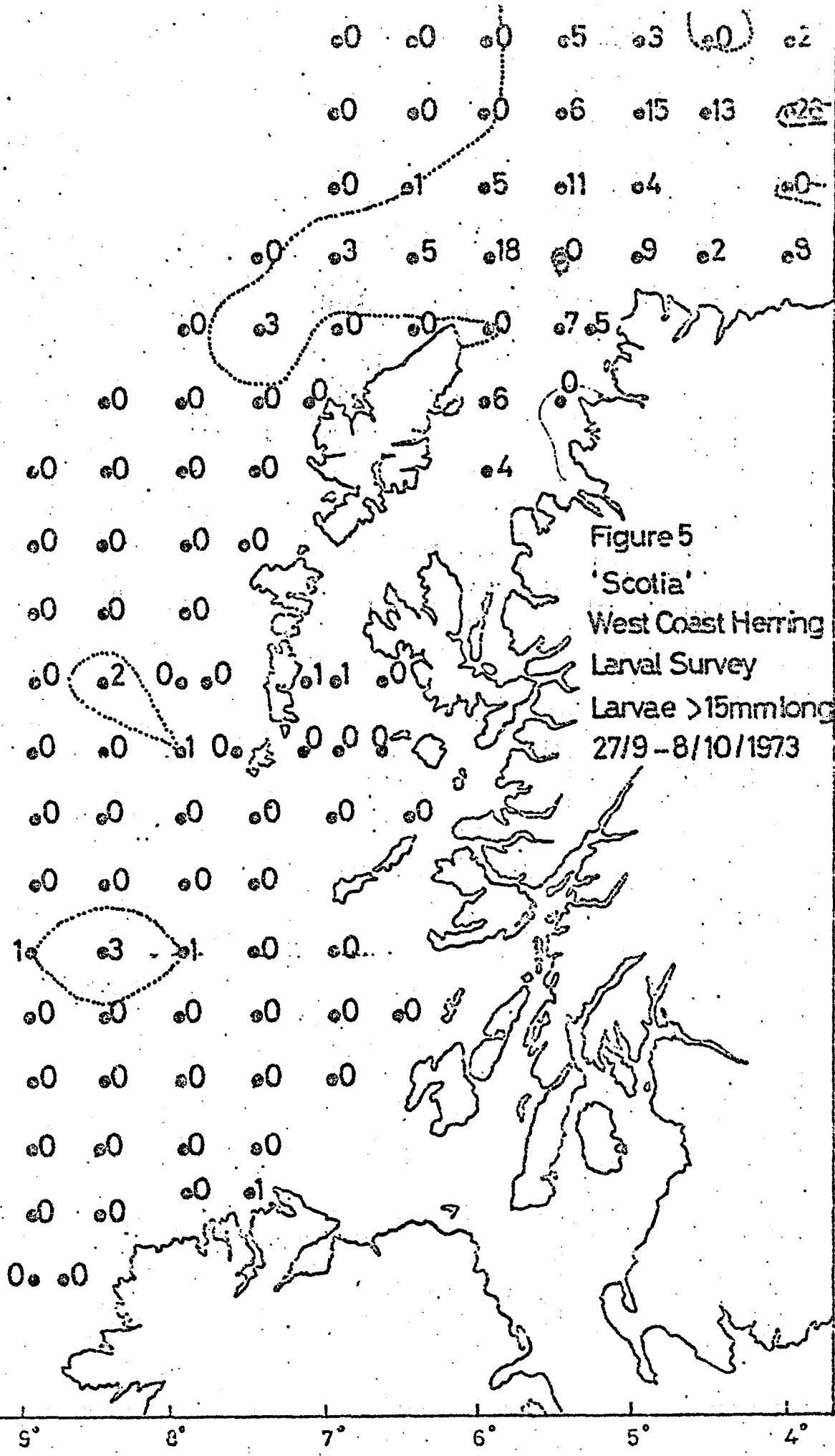


Figure 5  
 'Scotia'  
 West Coast Herring  
 Larval Survey  
 Larvae >15mm long  
 27/9 - 8/10/1973

