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THE DISTRIBUTION AND ABUNDANCE OF HERRING LARVAE TO THE WEST OF SCOTLAND

In 1974

by

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Summary

The results of the herring larval surveys carried out to the west of Scotland in the autumn of 1974 are described. For the September and early October surveys larval densities in 1974 were similar to those of the corresponding surveys in 1973. Larval densities in the late October surveys were considerably higher than those in 1965 and 1971, when comparable surveys were last carried out.

The results are discussed in terms of numbers of larvae and in relation to the adult stock size in the area.

Introduction

This report gives the results of the fifth of a series of annual surveys 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 the 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), Saville and McKay (1974b) and McKay (1975).

Materials and Methods

During the autumn of 1974 three countries participated in the surveys, with the following research vessels: England, RV 'Scotia', Netherlands RV 'Tridens', Scotland, RV 'Explorer'. Two complete and three partial surveys of the spawning area of herring in Area VIa were carried out, the timing of each survey being given in Table 1. Sampling was carried out using a modified Gulf III sampler towed in a double oblique haul fishing the whole water column to within 5 m of the sea bed. A more detailed description of the gear and sampling techniques is given by Saville (1970). From August to October a total of 390 stations were sampled. Abundancies of larvae, as numbers beneath one square metre of surface were plotted and planimeted and total abundances estimated as described by Saville and McKay (1974a).

Results

The results from the various surveys in 1974 are given in Figs 1-13. On the first survey covering only the area north of 58°N larvae <10 mm long were located in a patch extending from north of the Butt of Lewis to north of Cape Wrath with a maximum density of 294 larvae/m² surface being found north of Cape Wrath. The estimated number of larvae <10 mm long in the surveyed area was 364 x 10⁹ (Table 2). Larvae in the 10-15 mm length range were found in much the same area as the < 10 mm long larvae but at generally lower densities. The number of larvae in the 10-15 mm length range was estimated to be 205 x 10⁹ (Table 2). No larvae >15 mm long were taken during this survey.

The second survey sampled the area north of 56°30'N but that part of it to the west of the Outer Hebrides was poorly sampled except for small areas north east of the Flannan Islands and west of Barra Head. Larvae <10 mm long were found in several patches; the major one being located to the north east of the Flannan Islands with a maximum density of 744 larvae/m² surface. Secondary patches of <10 mm long larvae were found to the west of Barra Head, density up to 198/m² surface, west of Cape Wrath, density up to 125/m² surface, west of Skye, density up to 143/m² surface and north of Coll Island, density up to 98/m² surface. Such concentrations of larvae have not been observed in either of the latter two areas on any of the previous September surveys. The total number of larvae <10 mm long was estimated to be 1051 x 10⁹ (Table 2). Larvae in the 10-15 mm length range were also widely distributed with the main concentrations being located in an almost continuous belt from the Flannan Islands north and east to the eastern limit of the survey at 4°W. Highest densities of 226 larvae/m² surface and 131 larvae/m² surface respectively were obtained to the north of the Butt of Lewis and to the east of the Flannan Islands. The estimated number of larvae in the 10-15 mm length range for the whole survey area was 832 x 10⁹ (Table 2). Larvae >15 mm long were rather scarce being located in scattered patches in the northern part of the survey area with an estimated total number of 23 x 10⁹ (Table 2).

The third survey was of rather limited extent being confined to the area north and east of Cape Wrath with a few additional stations in the North Minch. On this survey a major patch of <10 mm long larvae was located inshore between Cape Wrath and Strathy Point with the maximum density of 482 larvae/m² surface being located immediately west of Strathy Point. Because of its limited extent no estimates of abundances have been made for this survey. Larvae in the 10-15 mm length range were found in a similar area to the < 10 mm long larvae with the maximum density of 119 larvae/m² surface being located north of Cape Wrath. Densities of larvae in the 10-15 mm length range in the Minch were much higher than those for the < 10 mm long larvae, with a maximum density of 65 larvae/m² surface being encountered off Tiupan Head.

On the first complete survey of the spawning area <10 mm long larvae were located in two main areas, to the west of the Outer Hebrides and to the north and west of Ireland. To the west of the Outer Hebrides the major concentration was located west of North and South Uist with a maximum density of 623 larvae/m² surface. In the area north and west of Ireland the major concentration, maximum density of 1331 larvae/m² surface was located to the west of Aran Island with a subsidiary patch, maximum density 154 larvae/m² surface to the northwest of Malin Head. The total number of larvae < 10 mm long was estimated to be 2389 x 10⁹ (Table 2). Larvae in the 10-15 mm length range were also widely distributed but at

lower densities than the < 10 mm long larvae. The major concentration of larvae in the 10-15 mm length range was in the area west of the Outer Hebrides with a maximum density of 98 larvae/m² surface being observed in the area of St. Kilda. The total number of larvae in the 10-15 mm length range was estimated to be 1383×10^9 (Table 2).

The final survey covered the whole spawning area and larvae < 10 mm long were again found to the west of the Outer Hebrides and off the north west coast of Ireland. In the former area the maximum concentration was located west of Lewis with a maximum density of 196 larvae/m² surface. In the area north and west of Ireland the major concentration was off Malin Head with a maximum density of 625 larvae/m² surface with a second patch to the west and north of Aran Island with a maximum density of 193 larvae/m² surface. The total number of larvae < 10 mm long was estimated to be 1515×10^9 (Table 2). Larvae in the 10-15 mm length range were generally distributed throughout the survey area with the major concentrations in the same areas as the < 10 mm long larvae. The total number of larvae in the 10-15 mm length range was 2061×10^9 (Table 2). Larvae > 15 mm long were generally distributed at low densities over the whole survey area giving an estimated total abundance of 351×10^9 larvae (Table 2).

Discussion

In making comparisons between larval abundances in 1974 and those of previous surveys (Wood, 1971 and 1973; Saville and McKay, 1974b and McKay 1975) it is necessary to group the estimates into comparable time periods and survey areas. These data are given in Tables 3 and 4 for the areas north and south of 56°30'N. This grouping of data is necessary in Area VIa as it would appear that hatching of larvae in the north of the area is completed significantly earlier than in the south. In 1974 the hatching of larvae in the Cape Wrath/Butt of Lewis area was almost totally finished by the beginning of October whereas significant numbers of larvae were still being produced on the more southerly spawning grounds during the last survey in late October.

September surveys

Because of the incomplete nature of the September surveys in 1974 direct comparison of the larval abundances in these surveys with those of previous years is rather misleading as these would indicate that the larval production in 1974 was considerably lower than in previous years. Much of this difference may however be due to the smaller area of the surveys. The survey lasting from 11-18 September gives total larval abundances approximately half of those for the corresponding survey in 1973 (McKay, 1975), but the 1974 survey did not adequately cover the spawning areas to the west of the Outer Hebrides. If the larval distributions for the two surveys are compared Figs 3 and 14, it is apparent that for the area surveyed in the two years the larval distributions and densities are very similar. It is therefore reasonable to assume that the larval abundance over the whole area during mid September in 1974 is likely to be similar to that in 1973.

Because of their limited extent and the lack of comparable surveys in previous years the remaining surveys carried out in September 1974 are of little value when considering changes in spawning population size. They do however, provide data which may be extremely valuable in the future design of these surveys. Comparison of the limited survey carried out in the Cape Wrath area during the period 16-18 September with the survey of the area during the period 11-18 September shows considerably different larval densities. During the 11-18 September survey the stations in the Cape Wrath

area were sampled on the 11-13 September and therefore there was a gap of five days between the sampling on the two surveys. During these five days the maximum density of <10 mm long larvae to the east of Cape Wrath had increased from 25 larvae/m² surface to 482 larvae/m² surface whereas that to the west of Cape Wrath had fallen from 125 larvae/m² surface to seven larvae/m² surface. This would indicate that in this area rapid changes in larval densities are likely and therefore the timing of surveys in the area could cause considerable changes in total larval abundances, which could easily mask long term variations in spawning intensity. An example of slight differences in timing giving apparently large changes in larval abundances are the early September surveys in 1972 (Saville and McKay, 1974b) and 1974. In 1972 when the survey of the area was carried out in the period 5-8 September very high larval abundances, 7,691 x 10⁹ for larvae <10 mm long, were observed whereas the abundance of larvae on the survey during the period 30 August - 2 September 1974 was an order of magnitude less at 364 x 10⁹ larvae. There was a gap between the timing of the surveys of approximately 7 days and as this is at the beginning of the hatching period such a build up of small larvae could easily occur in such a time period.

October surveys

Although the abundance of larvae <10 mm long in VIa during the early part of October 1974 (2389 x 10⁹) was similar to that in 1972 and 1973 (2419 x 10⁹ and 2189 x 10⁹ respectively) (Saville and McKay 1974b and McKay 1975) the larval distributions were rather different. Whereas in previous years the area to the west of the Outer Hebrides, ie north of 56°30'N had contributed the majority of the larvae, almost all in 1972 and 75% in 1973, in 1974 the larval production in this area was only slightly higher than that in the southern part of VIa. The period from 1972 to 1974 would appear to have been marked by a gradual decline in the early October larval abundances in the northern part of VIa and a substantial increase in the southern part of VIa (Tables 3 and 4).

In late October the abundances of larvae were rather higher than those observed by Wood (1971 and 1973) in 1965 and 1971. This increased larval abundance was observed over the whole of VIa but was most marked in the northern area where abundances of larvae in all size groups were about twice that in 1965 and 1971 (Table 3). In the southern part of VIa the total larval abundance in 1974 was about 40% higher than that for 1965 and 1974 with the biggest increase being in the size groups <10 mm long. As the survey in 1974 covered a smaller area with no sampling being carried out in Donegal Bay area it is probable that the increase in larval abundances between 1965 and 1971 and 1971 is even greater than shown in Table 4.

Stock size estimates

Saville and McKay (1974b) and McKay (1975) have attempted to estimate the size of the spawning stock in VIa by comparing the abundance estimates for <10 mm long larvae for VIa with those of other stocks for which both larval abundance and stock size data are available. The relationship used is

$$S_{VIa} = \frac{S_{N.S.} \times F_{N.S.} \times L_{VIa}}{F_{VIa} \times L_{N.S.}}$$

where S = spawning stock size in tonnes, F = fecundity per tonne, L = larval abundance, and the subscripts VIa and N.S. (North Sea) refer to the areas. The spawning stock size and larval abundance data for the North Sea are given by

Saville and McKay (1974b). Using this method the size of the spawning stock in VIa in 1974 was estimated to be of the order of 400,000-600,000 tonnes (Table 5). Whereas in previous years the estimates obtained by this method have been in reasonable agreement with that from the virtual population analysis (Saville and Morrison, 1973), in 1974 it would appear that this method of estimation gives a spawning stock size about twice that from virtual population analysis (Anon. 1975).

References

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| Anon., | 1971 | Report on the state of herring stocks around Ireland and north west of Scotland. ICES Coop. Res. Rep., Ser. A, No. 21: 1-29. |
| Anon, | 1975 | Report of the Herring Assessment Working Group for the area south of 62°N. ICES C.M. 1975 H:2 (mimeo). |
| McKay, D. W., | 1975 | The distribution and abundance of herring larvae to the west of Scotland. ICES Coop. Res. Rep. No. 48: 41-54. |
| Saville, A., | 1970 | Report on the international surveys of herring larvae in the North Sea in 1967. ICES Coop. Res. Rep. Ser. A. No. 19: 2-17. |
| Saville, A., and D. W. McKay. | 1974a | Report on the international surveys of herring larvae in the North Sea and adjacent waters in 1972/73. ICES Co-op. Res. Rep. No. 41: 1-39. |
| Saville, A., and D. W. McKay, | 1974b | Herring larvae to the west of Scotland in the autumn of 1972. ICES Coop. Res. Rep. No. 41: 40-60. |
| Saville, A., and J. A. Morrison, | 1973 | A reassessment of the herring stock to the west of Scotland. ICES, C.M. 1973 H:24 (mimeo). |
| Wood, R. J., | 1971 | Autumn spawning grounds of herring to the west of Scotland. Rapp. p.-v Reun. Cons. int. Explor. Mer., 160: 65-73. |
| Wood, R. J. | 1973 | Herring larvae to the west of Scotland in the autumn of 1971. ICES Coop. Res. Rep. No. 34, 41-54. |

Table 1 Surveys carried out in 1974

Country	Area	Period	No. of stations sampled
Scotland	N of 58°N	30 Aug - 2 Sept	56
Netherlands	N of 56°30'N	11-18 Sept	80
England	Cape Wrath area	15-18 Sept	35
Scotland	55°N - 59°N	2-9 Oct	104
Scotland	55°N - 59°N	17-24 Oct	105

Table 2 Estimated abundances of herring larvae on each survey in VIa in 1974
 (Total for N and S of 56°30'N given separately)

Dates	Survey area	Number of larvae x10 ⁻⁹			Total
		<10 mm	10-15 mm	>15 mm	
30 Aug - 2 Sept	North of 58°N	364	205	-	569
11-18 Sept	North of 56°30'N	1 051	832	23	1 906
2-9 Oct	North of 56°30'N	1 376	1 234	222	2 832
	South of 56°30'N	1 013	149	10	1 172
	55°N-59°N	2 389	1 383	232	4 004
17-24 Oct	North of 56°30'N	788	1 321	257	2 366
	South of 56°30'N	727	740	94	1 561
	55°-59°N	1 515	2 061	351	3 927

Table 3 Estimated abundances of herring larvae N of 56°30'N in VIa in 1965, 1971, 1972, 1973, and 1974 in standard time periods. (After Wood (1971, 1973), Saville & McKay (1974b), and McKay (1975).

Time Periods	Estimated abundances x10 ⁻⁹														
	<10 mm					10-15 mm					Total				
	65	71	72	73	74	65	71	72	73	74	65	71	72	73	74
1-10 Sept	NS	ND	7 691 ¹⁾	NS	364 ¹⁾	NS	ND	669 ¹⁾	NS	205 ¹⁾	NS	3 267 ²⁾	8 360	NS	569 ¹⁾
11-25 Sept	NS	NS	1 334	2 016	1 051	NS	NS	1 350	2 553	832 ¹⁾	NS	NS	2 773	4 569	1 906 ¹⁾
26 Sept - 10 Oct	NS	NS	2 388	1 665	1 376	NS	NS	2 122	1 779	1 234	NS	NS	4 586	3 586	2 832
10-25 Oct	415 ³⁾	319	NS	NS	788	ND	ND	NS	NS	1 321	1 330 ³⁾	1 037	NS	NS	2 366

NS - No survey

ND - No data given

1) incomplete survey

2) incomplete survey including yolk sac larvae

3) including Minches

Table 4 Estimated abundances of herring larvae S of 56°30'N in VIa in 1965, 1971, 1972, 1973, and 1974 in standard time periods. (After Wood 1971, 1973), Saville & McKay (1974b), McKay (1975).

Time periods	Estimated abundances x10 ⁻⁹														
	<10 mm					10-15 mm					>15 mm				
	65	71	72	73	74	65	71	72	73	74	65	71	72	73	74
11-25 Sept	NS	NS	21	194	NS	NS	NS	29	47	NS	NS	NS	51	241	NS
26 Sept - 10 Oct	NS	NS	31	524	1 013	NS	NS	21	231	149	NS	NS	57	758	1 172
10-25 Oct	504	677	NS	NS	727	ND	ND	NS	NS	740	807	940	NS	NS	1 561

NS - No survey

ND - No data given

Table 5 Estimated spawning stock size in tonnes in VIa from comparison with Central/Northern N Sea in 1957-60, and 1961-64 and from V.P.A.

Estimated spawning stock size in VIa (tonnes)

Year	By comparison with local surveys		
	Central/Northern	Central/Northern	From VPA
	N. Sea 1957-60	N. Sea 1961-64	
1965	227 500		
1965	227 500 ¹⁾	150 800 ¹⁾	231 700 ³⁾
1971	371 000 ¹⁾	220 500 ¹⁾	330 200 ³⁾
1972	1 276 300 ²⁾	846 100 ²⁾	825 000 ³⁾
1973	734 600 ²⁾	487 100 ²⁾	583 000 ³⁾
1974	651 800	432 200	220 000 ⁴⁾

- 1) Figures from Saville & McKay (1974b)
- 2) Figures from McKay (1975)
- 3) Figures from Saville & Morrison (1973).
- 4) Figures from Anon (1975).

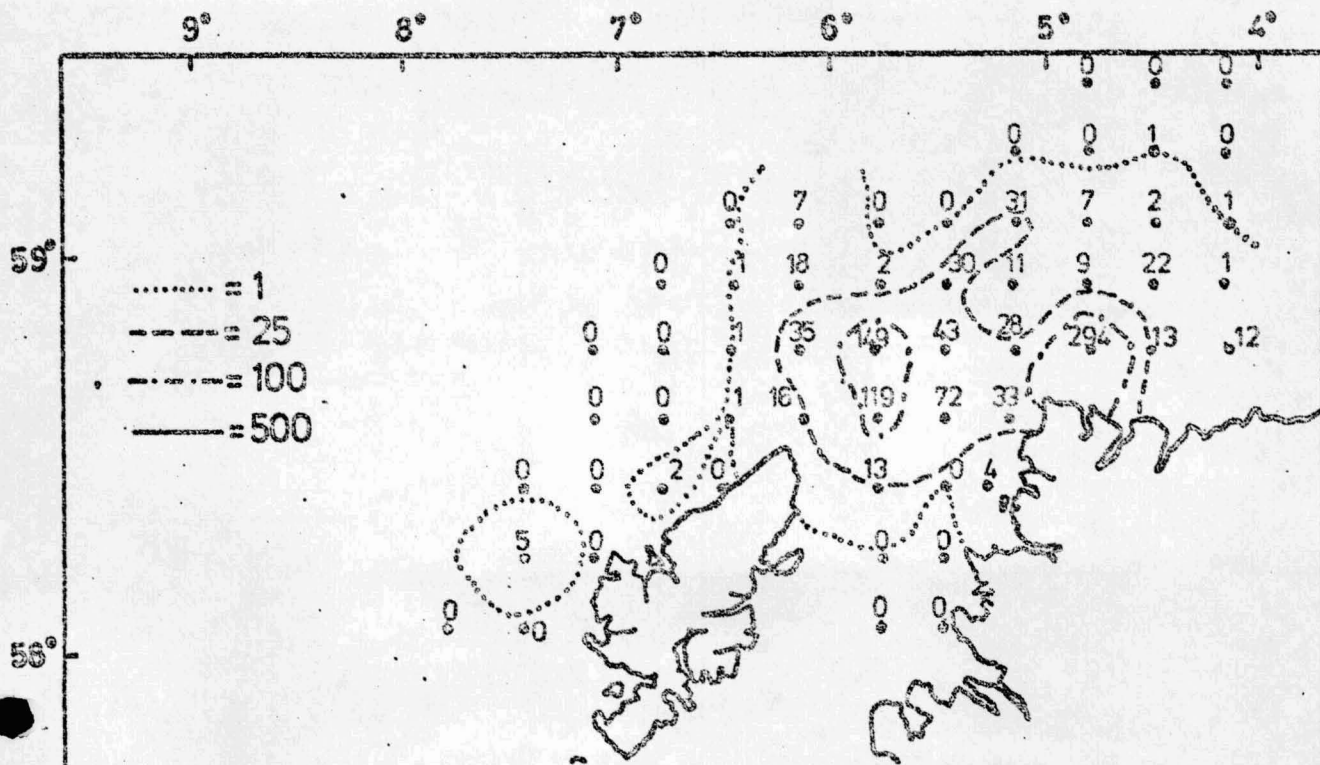


Fig.1 Numbers of larvae <10mm below 1sq metre W. of Scotland
30 August - 2 September 1974 Scottish survey

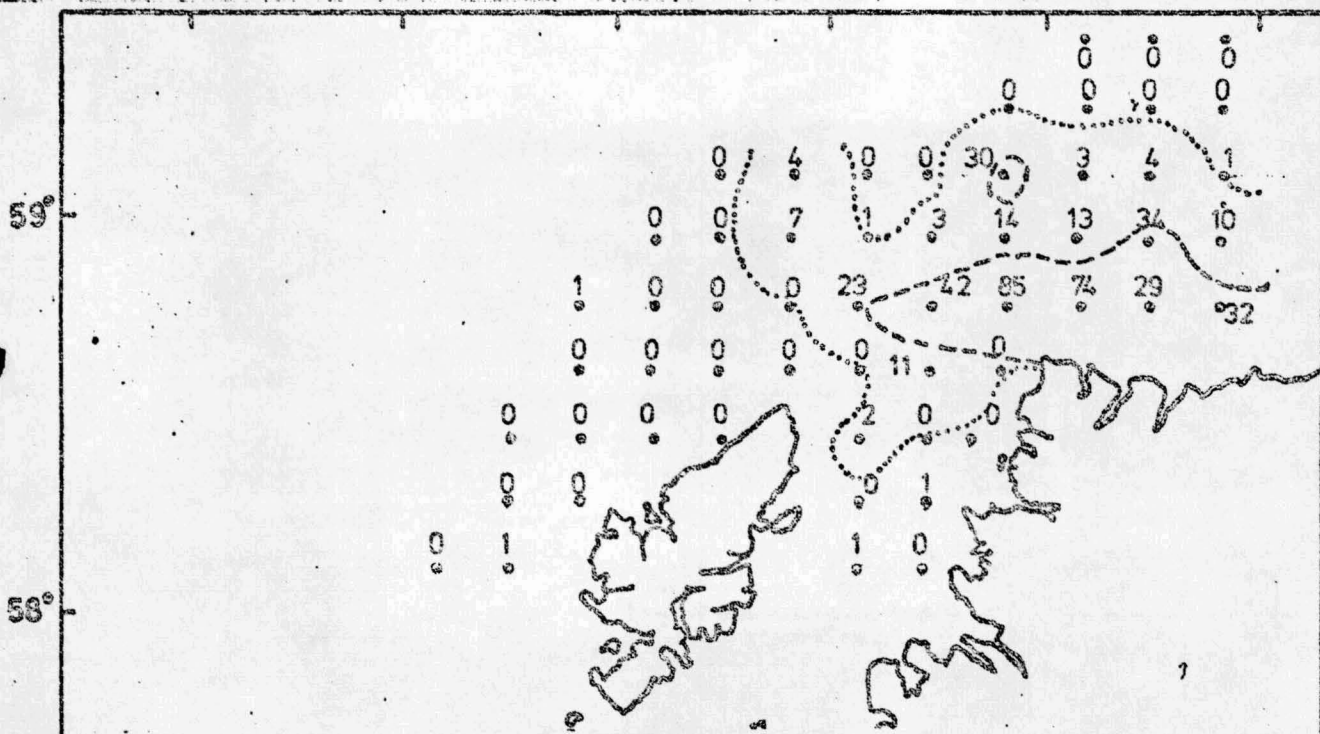


Fig.2 Numbers of larvae 10-15mm below 1sq metre W. of Scotland
30 August - 2 September 1974 Scottish survey

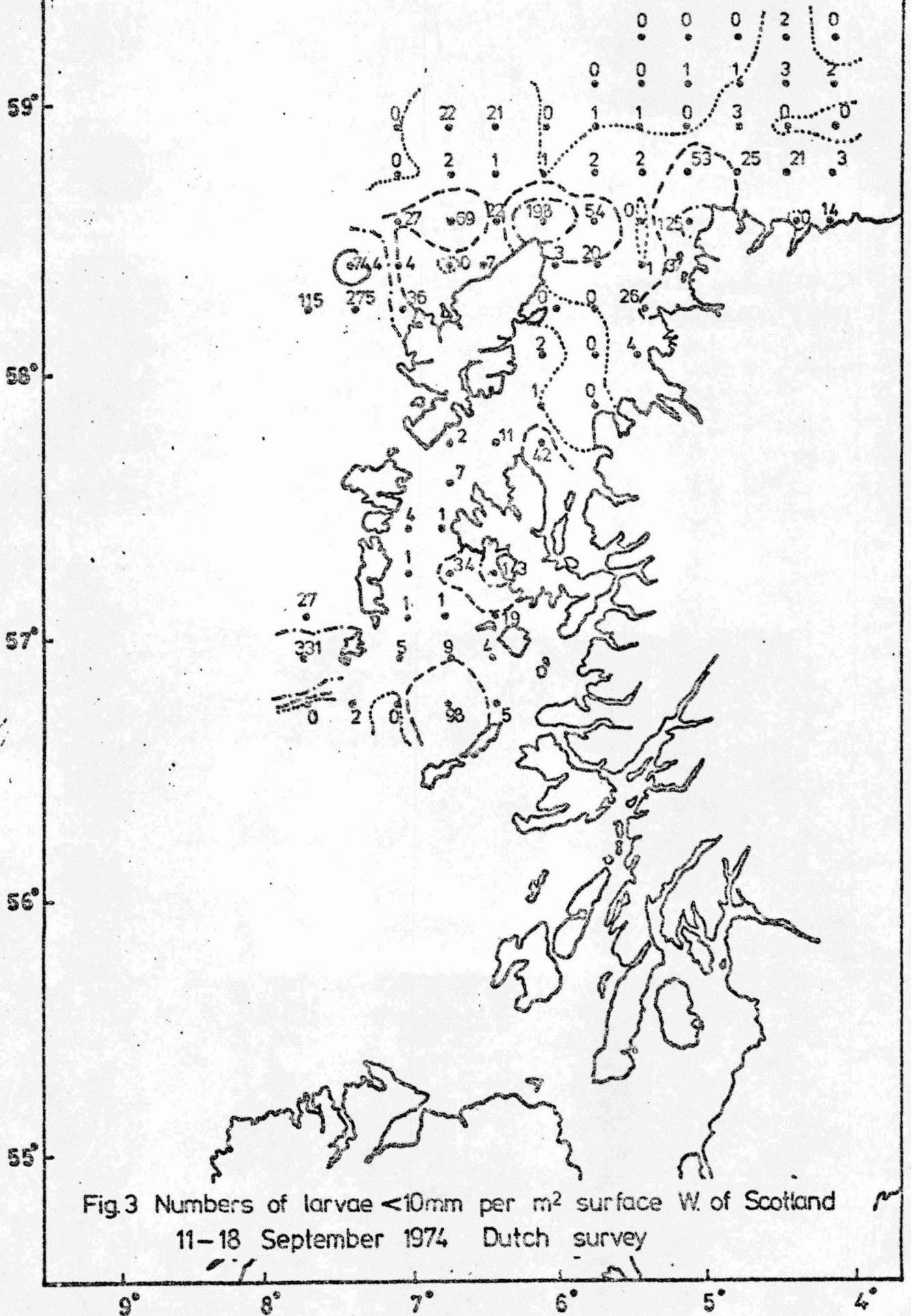


Fig.3 Numbers of larvae <math>< 10\text{mm}</math> per
 11-18 September 1974 Dutch survey

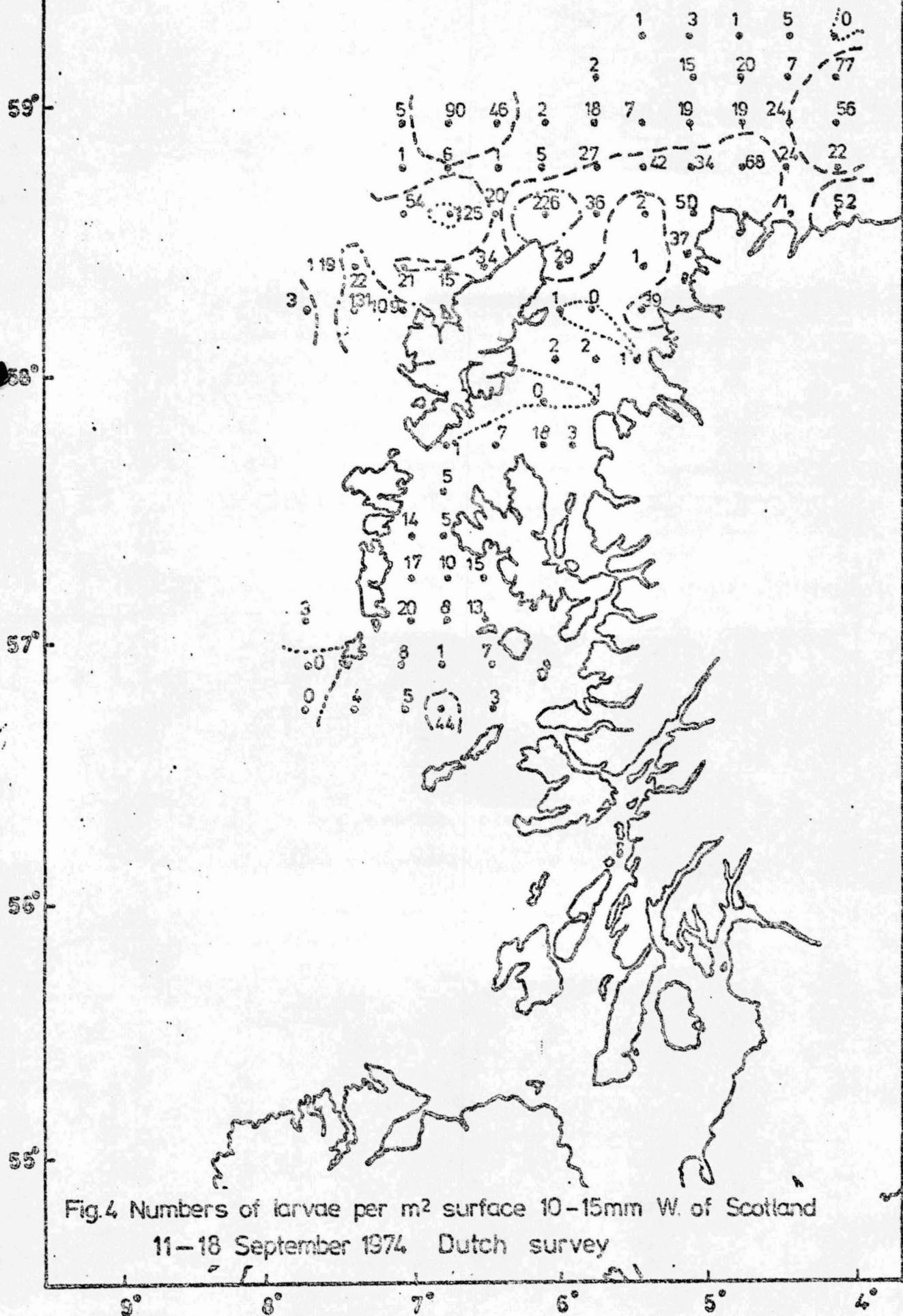


Fig.4 Numbers of larvae per m² surface 10-15mm W. of Scotland
11-18 September 1974 Dutch survey

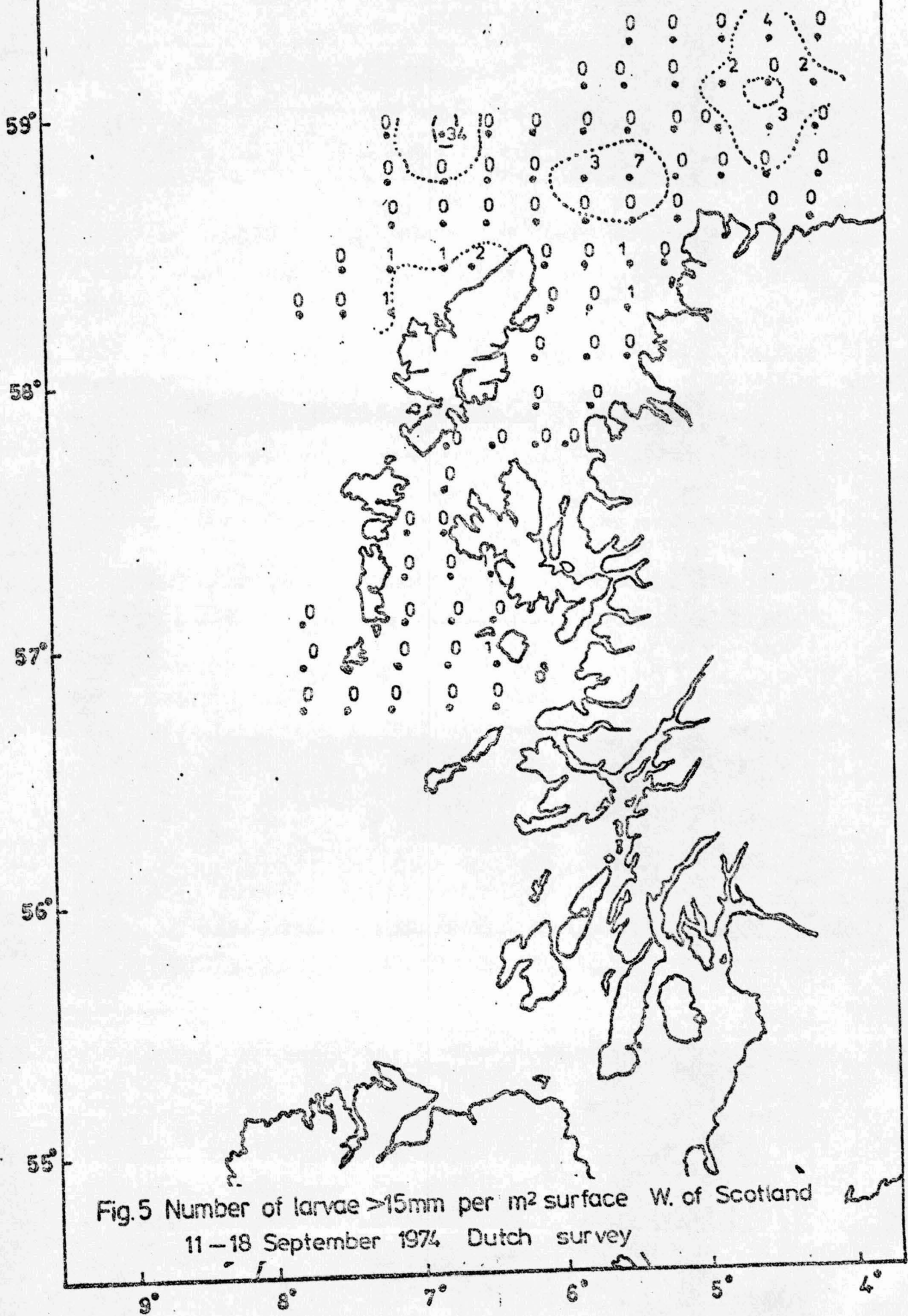


Fig.5 Number of larvae >15mm per m² surface W. of Scotland
 11-18 September 1974 Dutch survey

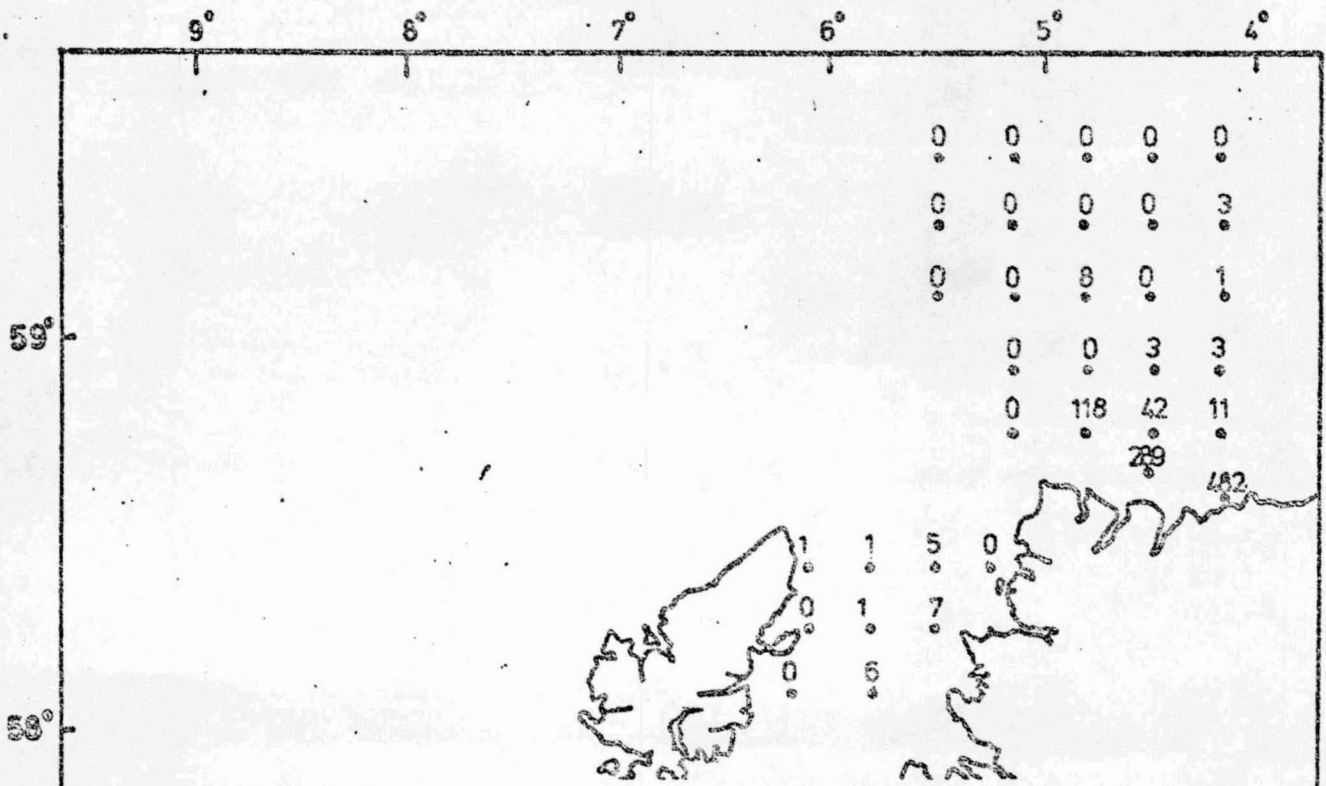


Fig.6 Numbers of larvae <10mm below 1sq metre W. of Scotland
16-18 September 1974 English survey

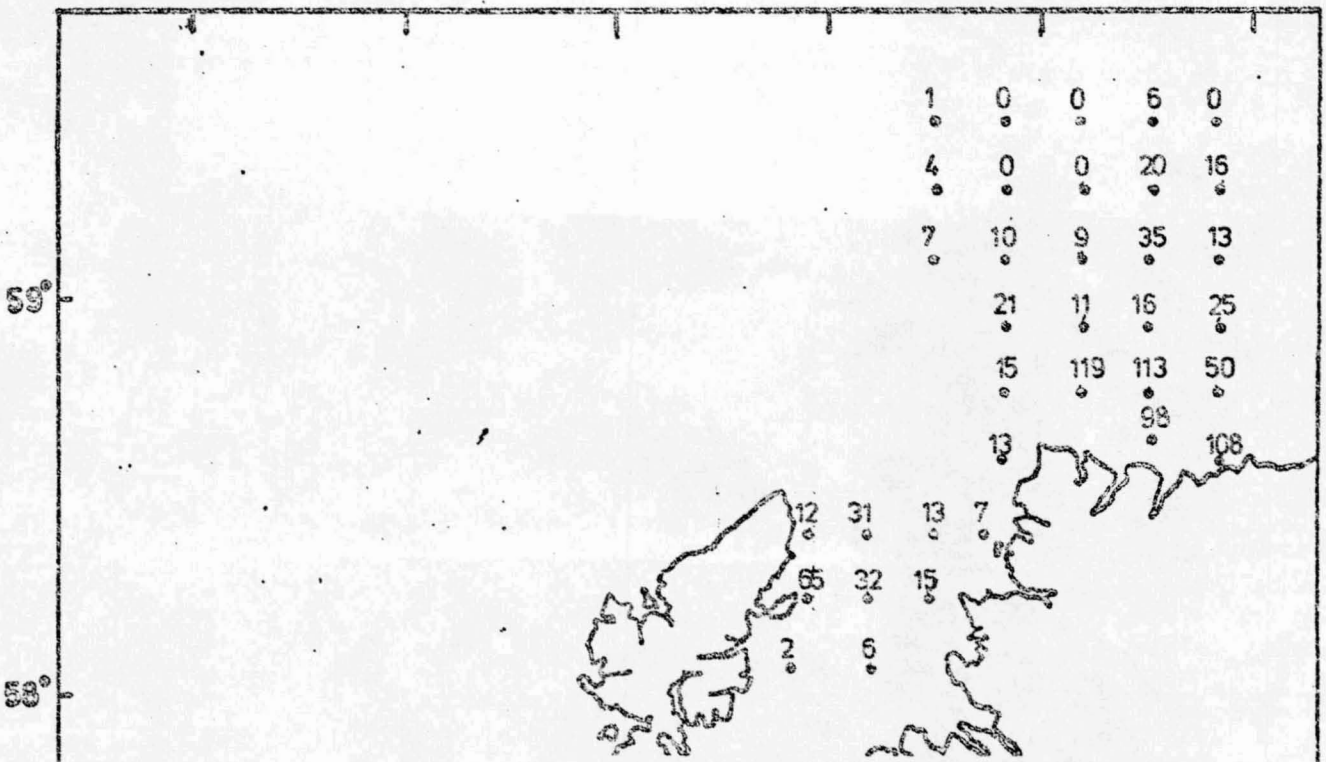


Fig.7 Numbers of larvae 10-15mm below 1sq metre W. of Scotland
16-18 September 1974 English survey

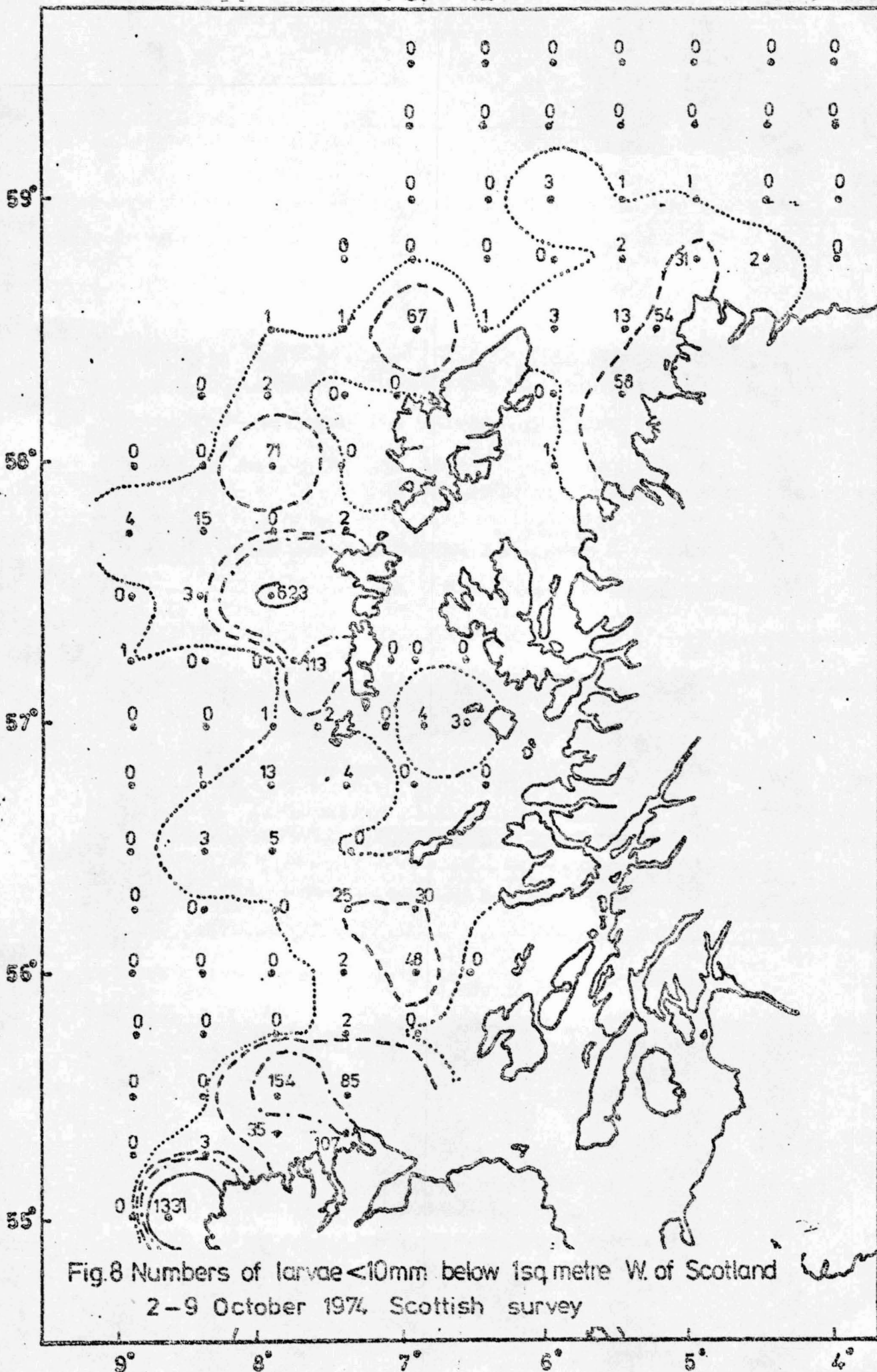


Fig.8 Numbers of larvae <10mm below 1sq metre W. of Scotland
2-9 October 1974. Scottish survey

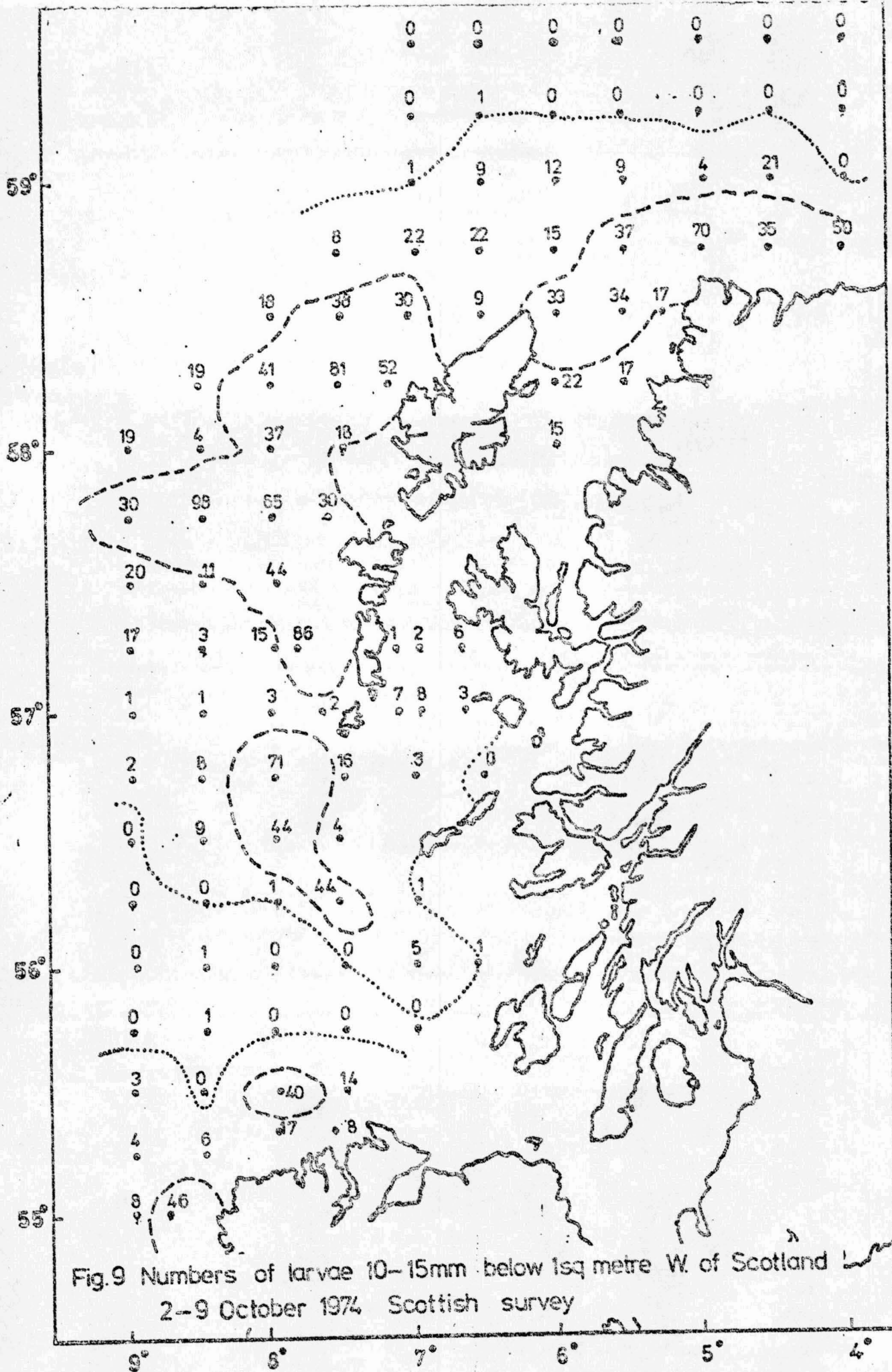


Fig.9 Numbers of larvae 10-15mm below 1sq metre W. of Scotland
2-9 October 1974 Scottish survey

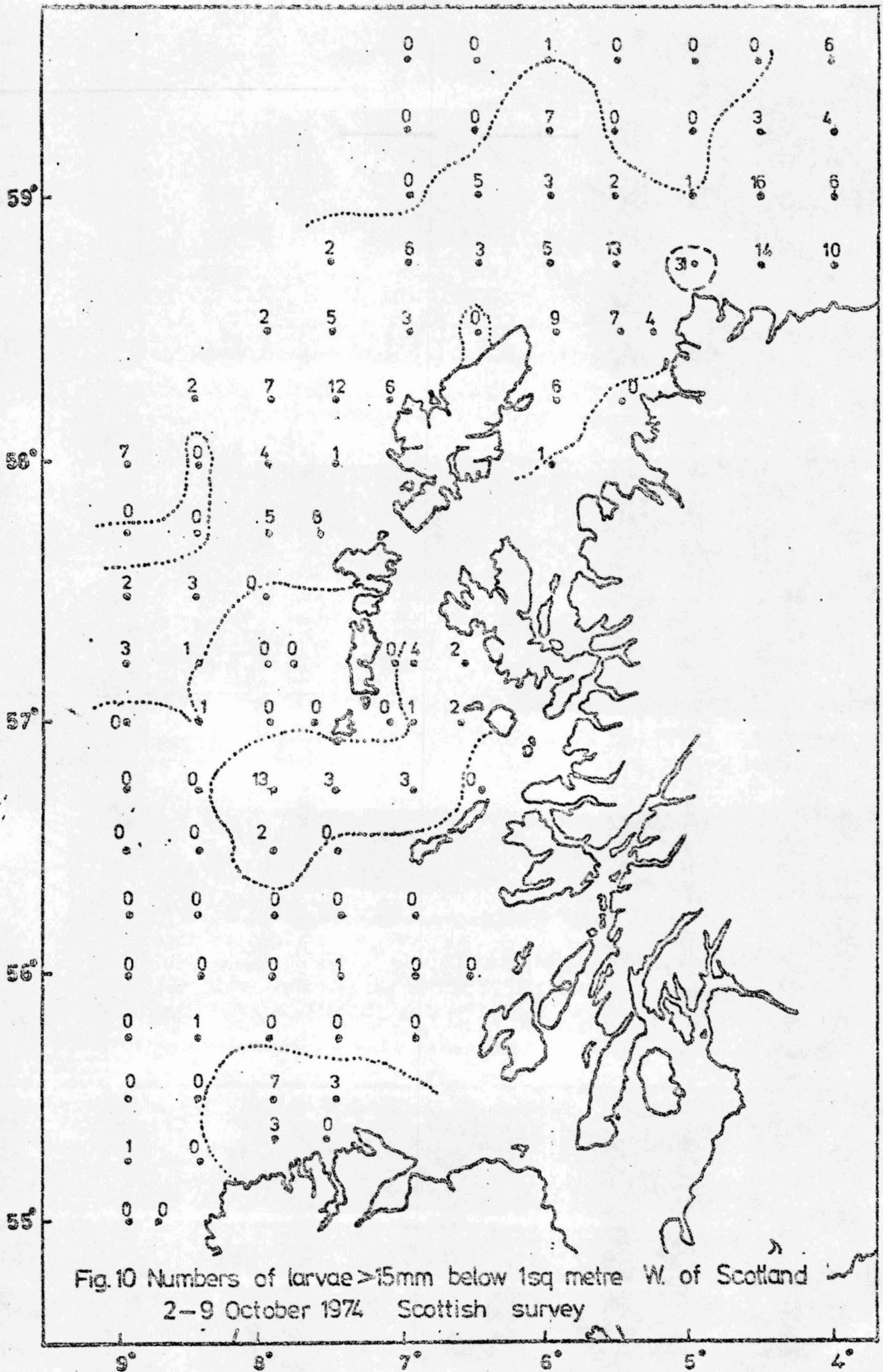


Fig.10 Numbers of larvae >15mm below 1sq metre W. of Scotland
2-9 October 1974 Scottish survey

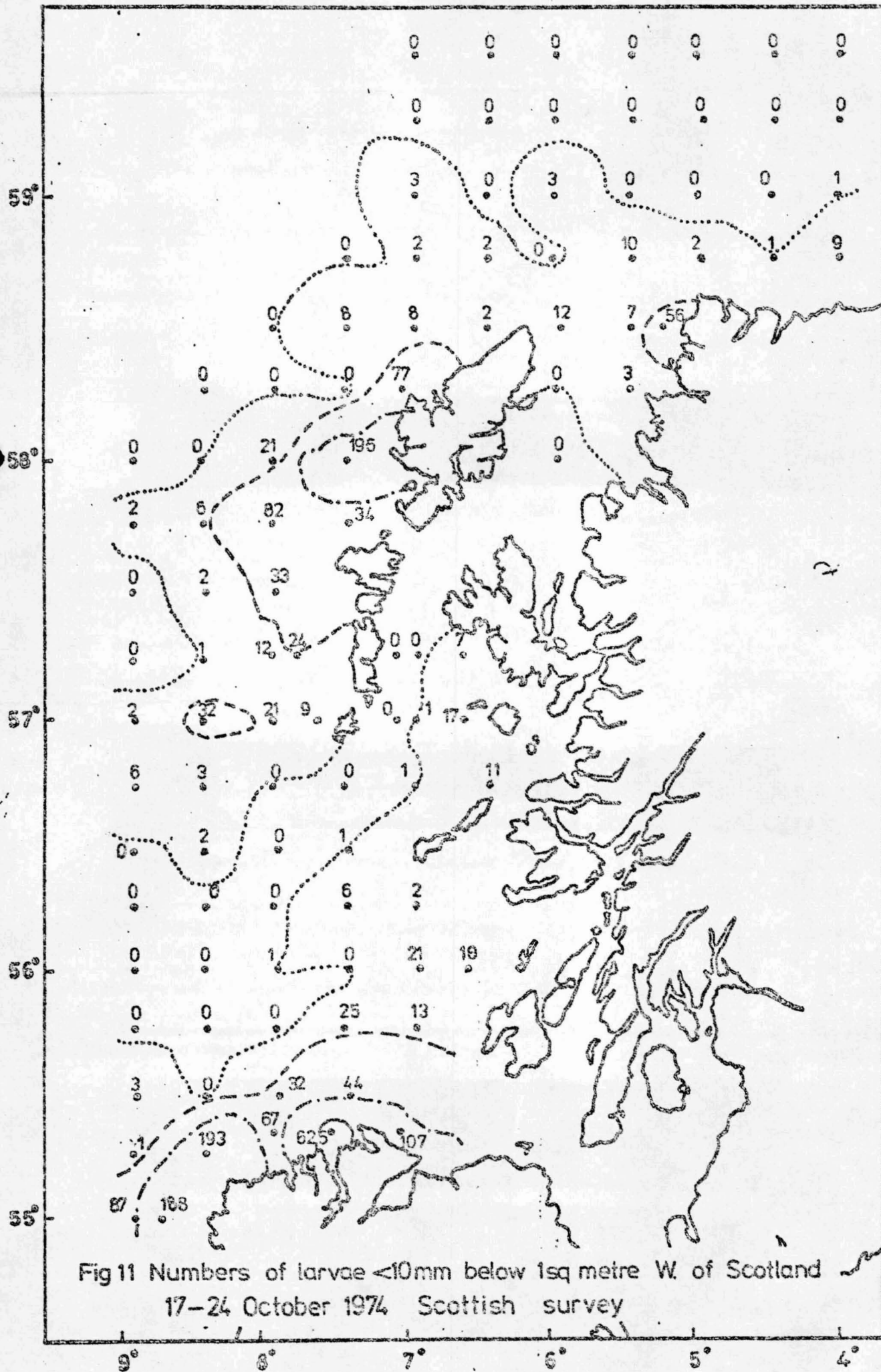


Fig 11 Numbers of larvae <10mm below 1sq metre W. of Scotland
17-24 October 1974 Scottish survey

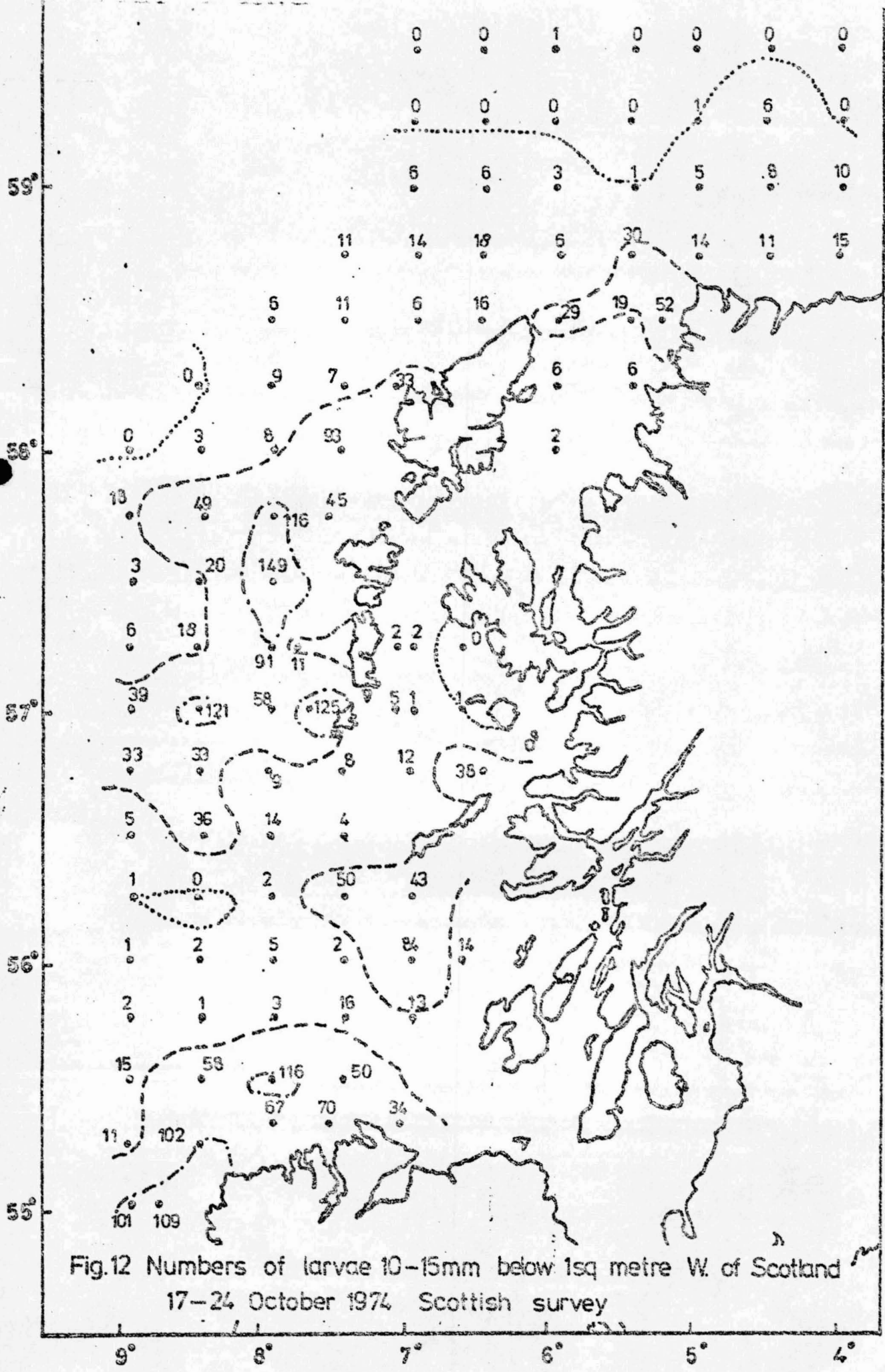


Fig.12 Numbers of larvae 10-15mm below 1sq metre W. of Scotland
17-24 October 1974 Scottish survey

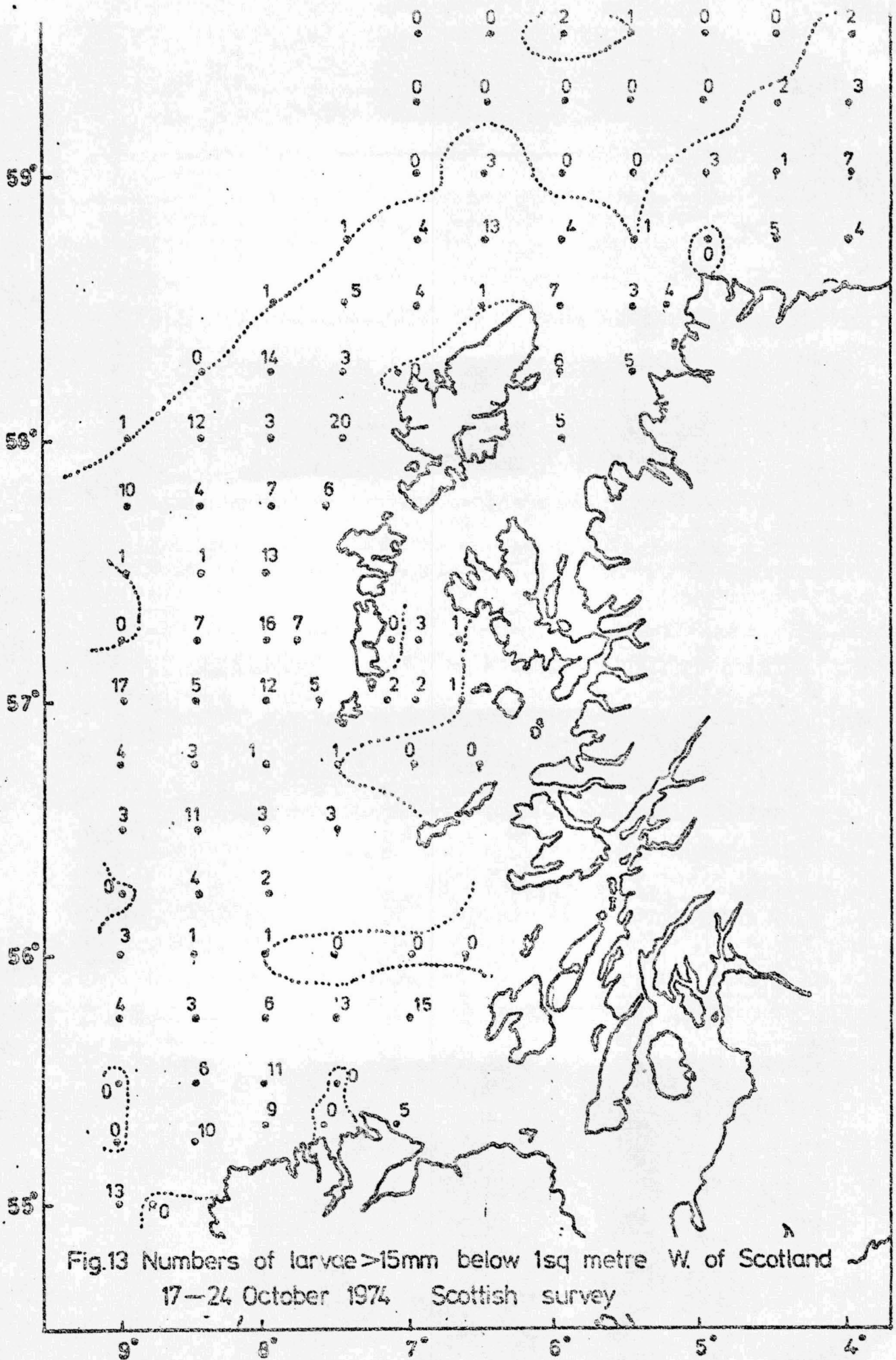


Fig.13 Numbers of larvae >15mm below 1sq metre W. of Scotland
17-24 October 1974 Scottish survey

