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STRATEGIES IN ASSESSMENT OF POTENTIAL OIL POLLUTION EFFECTS ON THE FISH RESOURCES

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INTRODUCTION

The Norwegian continental shelf is an important fishing area as well as the spawning area for many of the most economical important fish species in the North-east Atlantic. The eggs and larvae are transported northwards by the currents to the nursery grounds along the Norwegian coast, in the Barents Sea and off West-Spitsbergen. The main currents in the area are described by SÆTRE and LJØEN (1971).

Norwegian oil exploration on the continental shelf north of 62^{0}N started in 1980. In the prosess leading up to the political decision of opening theese biological sensitive areas, much work were done in describing the potential risks of damaging marine life and the fish resources in particular.

One of the main conclusions from this work is that an oil pollution can never destroy a complete year-class of a fishspescies, but sever reductions may occure if an oil pollution takes place in an area where fish-eggs and larvae are found.

A further consequence of the opening for oil exploration north of 62^{0}N is that the fisheries authorities have asked the Institute of Marine Research to provide more reliable and detailed data for the potential reductions in the main fish stocks. In 1983 we presented a five-year "Plan for intensive mapping of fish-eggs and larvae distributions and additional consquens estimations of potential oil-spills' possible damage to the main fish-stocks north of 62^{0}N." The Plan was accepted by the Government late 1985 and we started our work in February 1986.

A realistic calculation of the potential damage on the fish resources must be based on the following:

1. Data on the amount of oil, needed in a watermass, necessary to damage fish - eggs and larvae.
2. A realistic oil drift model, describing both vertical and horizontal oil distribution.
3. Detailed knowledge of the distribution of fish - eggs and larvae both in space and time.

The two first conditions are fairly well documented while the third is only partly fullfilled and therefor will be the main task for the program. This paper will give a presentation of the work allready done in sampling fish- eggs and larvae and also a brief presentation of our thoughts about how to make assesments of oil pollution on the fish stocks with the basis in the above three statements.

MATERIALS AND METHODS

The Institute of Marine Research has since 1948 been sampling fish eggs and larvae at different localities along the Norwegian coast (e.g. WIBORG, 1960; HOGNESTAD, 1969; DRAGESUND, 1970; GJØSÆTER and SÆTRE, 1974; ELLERTSEN, SOLEMDAL, STRØMME, SUNDBY, TILSETH, WESTGÅRD and ØIESTAD, 1981; BJØRKE, 1981, 1984; SUNDBY and SOLEMDAL 1984; SUNDBY and BRATLAND 1986). The sampling has taken place during the spring and summer seasons and has partly been aimed at the study of single species, such as herring and cod.

After 1966 a closer sampling grid was introduced from Stad to Vestfjorden and the sampling was aimed at the study of the herring larvae only. From 1976, due to the plans of moving the oil exploration north of 62^{d}N, it was decided to identify and record all fish eggs and larvae caught with zooplankton gears in the area. Fig. 1, presents the stations sampled, by our insttute, in March-April during the periode 1976-85. If more than one sample is taken within one square nautical mile, only one point is plotted and this point represent the average value of the samples when isolines are drawn.

Table 1 shows the recorded number of samples caught with different type of gears. The Bongo-20 cm sampler is described by POSGAY, MARAK and HENNEMUTH (1968), the Clarke-Bumpus sampler by CLARKE and BUMPUS(1950), The Otter Surface Sampler by SAMEOTO and JAROSZYNSKI (1969), the Isaacs-Kidd midwater trawl by ANON. (1977), the Gulf-III by ZIJLSTRA (1970), the Juday net by JUDAY (1916), the Egg net by ELLERTSEN, FOSSUM, SOLEMDAL, SUNDBY and TILSETH (1984) and the Mocness sampler by WIEBE, BURT, BOYD and MORTON (1976).

Only fish larvae younger than 6 months are recorded, and standard length is measured to the nearest mm. The fish eggs are identified when possible and are recorded according to easy recognizable stages of development. Unidentifiable eggs were recorded according to diameter and wether or not oil globulus are present. Each class interval include eggs within 0.19 mm; for example eggs without oil globules and with diameter from 1.0 to 1.19 mm are recorded in the same class interval.

Table 1. Total number of samples samled with different gears recorded up to July 1986.

Bongo-20 cm	C-B	O.S.S.	IKMT	Pel.-trawl	Gulf-III	Juday-36 cm	Juday-80 cm	Egg-net	Mocness
154	1853	397	477	1300	4103	3987	273	501	192

The data are recorded in a data base system developed for the NORD-computer by KVAM DATA. This system makes it possible to choose among any sets of parameters in the data base and list the results. It is, for example, possible to list the number of herring larvae per m^2 surface smaller than 9 mm caught with Gulf III in March/April from 62^0 to 64^0N during the period 1976-1985. Larvae smaller than 9 mm are newly hatched and the distribution of these indicate spawning areas for the Atlanto Scandian herring. From this list plots can be made, by a computer programme (WESTGAARD 1984), and isolines of choosen values can be drawn if wanted as shown in some of the figures.

The most vulnerable part in a fish life is the periode when the fish is trapped in a certain watermass, a watermass which may be contaminated by pollutants. As a general rule, when a fish is able to swim freely it is not likely to be affected by an oil pollution and we can therefore consentrate on the impact on the youngest life stages, namely eggs and larvae. We have at our Institute setteled on a pragmatic figure for an oil consentration below which no lethal effects are likely to occure, FØYN, 1984. This figure is set to 50 µg oil pr. litre seawater and is based on a litterature survey of reported toxic effects of oil on marine fish, eggs and larvae. Studies at our Institute (SOLBERG et al.,1984 and TILSETH et al.,1984) confirm this limit for crude oil, but the work demonstrate sub-lethal effects pronounced as reduced feeding ability, due to malformation of the front part of the upper jaw, at lower levels of oil and specially for illuminated oil.

Oil-drift models have mostly been based on wind drift and mean data for the residual component of the main current systems. Work is however in progress in Norway, both at the Norwegian Meteorological Institute (DNMI) and at the Oceanographic Center, Sintef Group, to refine the present models giving them a better dissolution.

DISCUSSION

The events taking place in the open ocean during an oil-spill must be simulated in detail. But when assesments are done the various inputs to the model must be considered realistic to each other. There is no real meaning in establishing lethal consentrations of oil to fish larvae to a great accuracy when we are not able to determin the accuracy of the larvae distribution better than to the nearest square nautical mile. In other words there is no need to put much work into establishing figures saying that for example 46,7 µg or 55,3 µg is the lethal concentration of oil in seawater to a certain larvae-species, as long as the other parts of the assement model are based on much less accuracy. What is needed however is to establish in which dimension, i.e. 25, 50, 100 or 500 µg oil pr.litre seawater, the lethal effects are observed.

At the Institute of Marine Research we have worked with consequensanalyzes of potential oil-pollution (ANON 1978), and we based our original approach to the problem on a worst case consept. We defined the potential reduction of a certain year-class of a fish-species to be correlated to the percentage of larvae covered by 15 days or younger oil. By use of simulated oil-drift plotted against observed larvae data, we were able to give some realistic aspects of the magnitude of damage an oil pollution may cause to a certain year-class. For the purpose of visualizing potential oil pollution examples a worst case situations were presented to a Government commision (ANON,1980). One of thees examples is given in Fig. 2, where a simulated oil-drift is plotted against observed herring-larvae in April 1976. An estimation of the overlapped area indicates that one-third of the 1976 year-class of norwegian spring spawning herring could have been destroyed.

As Fig. 2 illustrates, the oil-covered area is rather big and certainly do not represent an approximate right picture of events taking place if a real blow-out had taken place. The refining of the oil-drift models have progressed and the present models will give a far more realistic approach to the real events. Detailed knowledge of the distribution of larvae for the use in consquensmodels is, however, still lacking.

Our aim is to link the various time series of observations together with the help of transport-models, using lenght distributions for the larvae as a tool to explain the dynamics of the larvae-distributions. Fig. 3 shows the normal way of presentation where all length groups are together, while Figs. 4, 5, 6 and 7 demonstrates how we, by splitting the data for the observed larvae in length groups, may introduce dynamics into the distribution pattern. With the help of ARGOS - drifters and a more intensified observation scheme, where both vertical and horizontal distribution will be observed, the input to the transport-models will be of a quality good enough to present time variable and reliable presentations.

The possible conflict between fisheries interest and the oil exploration is demonstrated in Figs. 8 and 9 where oil-blocks are marked on the map together with the distributions of newly hatched herring larvae. Fig. 8 present the area usually ivestigated while Fig. 9 shows a smaller part of the area. The figures demonstrates the necessity of working with details when our aim is to give realistic assessments of potential oil pollution effect on the fish resources.

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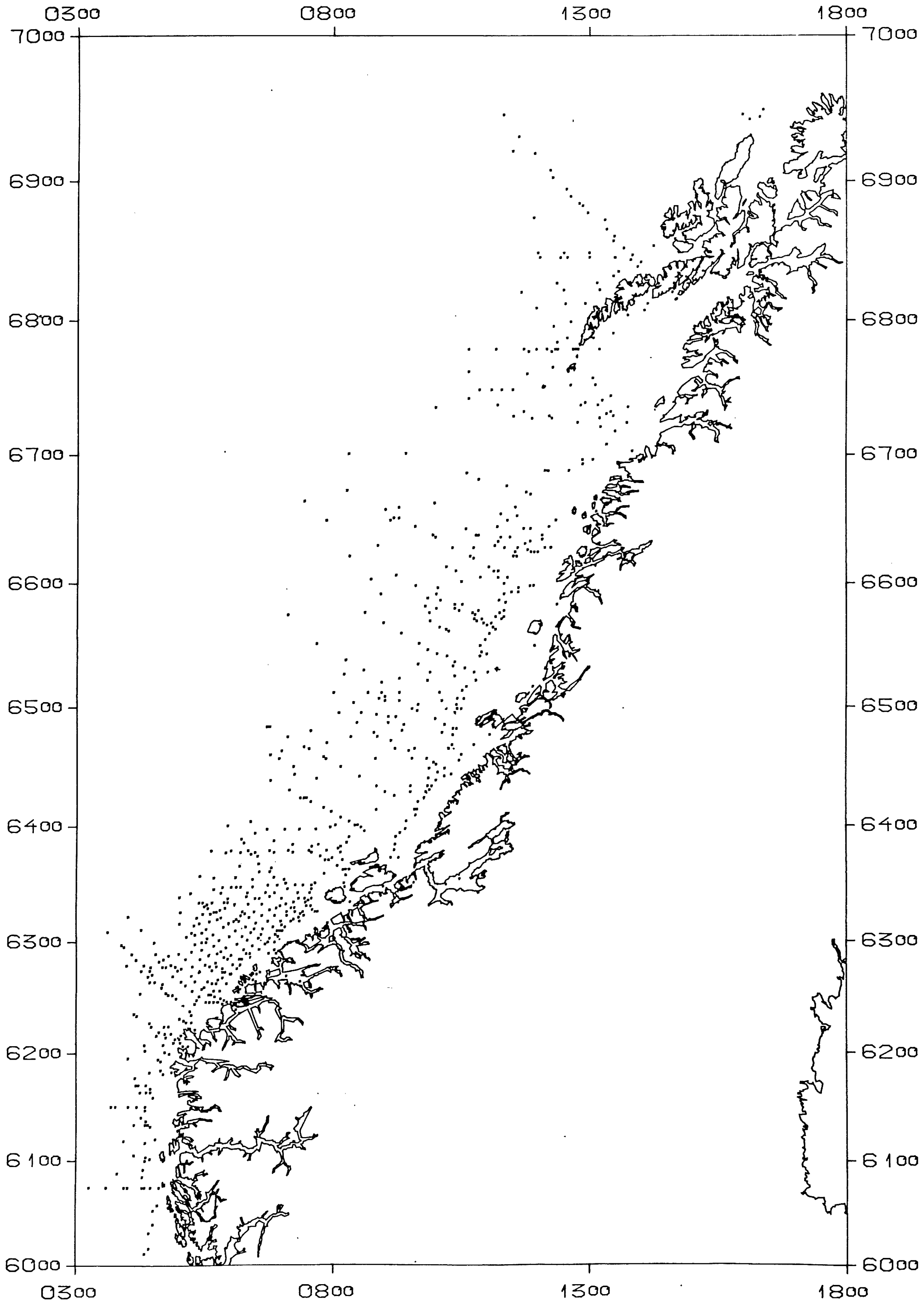

Fig. 1. Stations sampled in March-April during the period 1976-85.

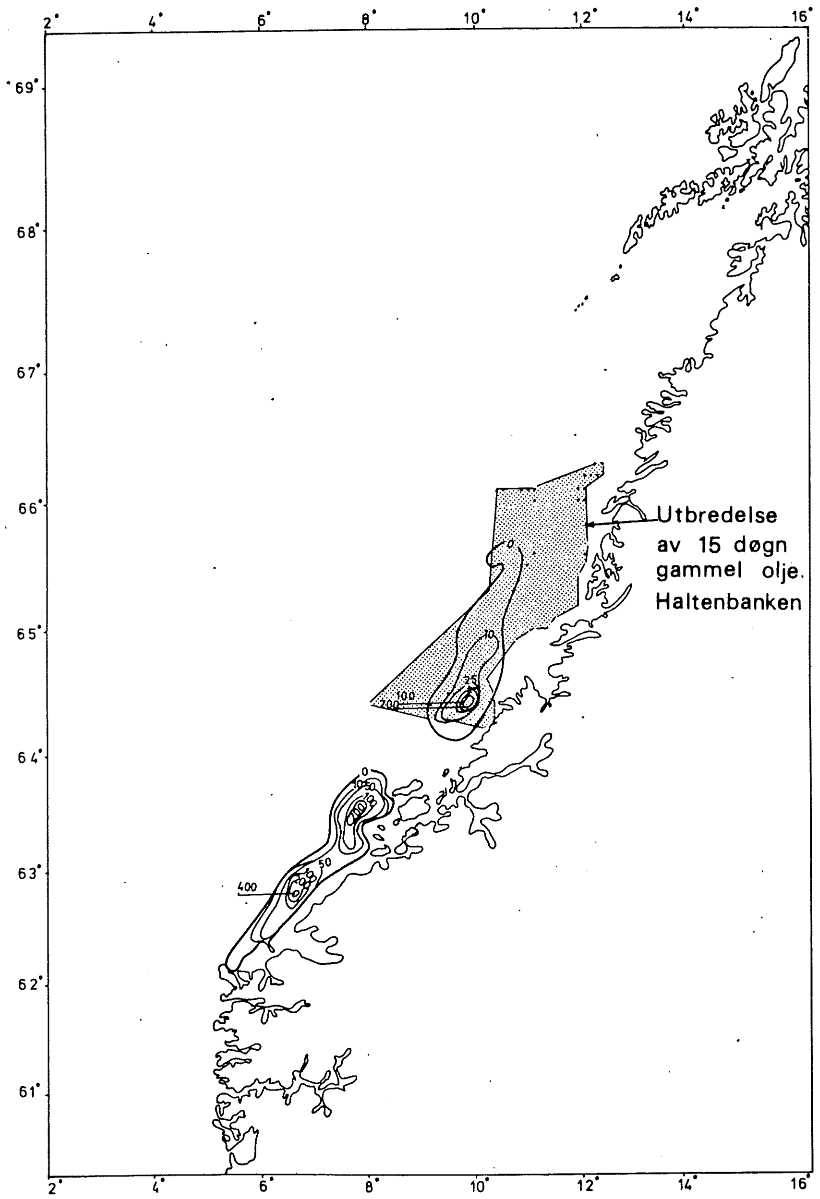

Fig. 2. Herring larvae distribution in April 1976 plotted against 15 days and younger oil.

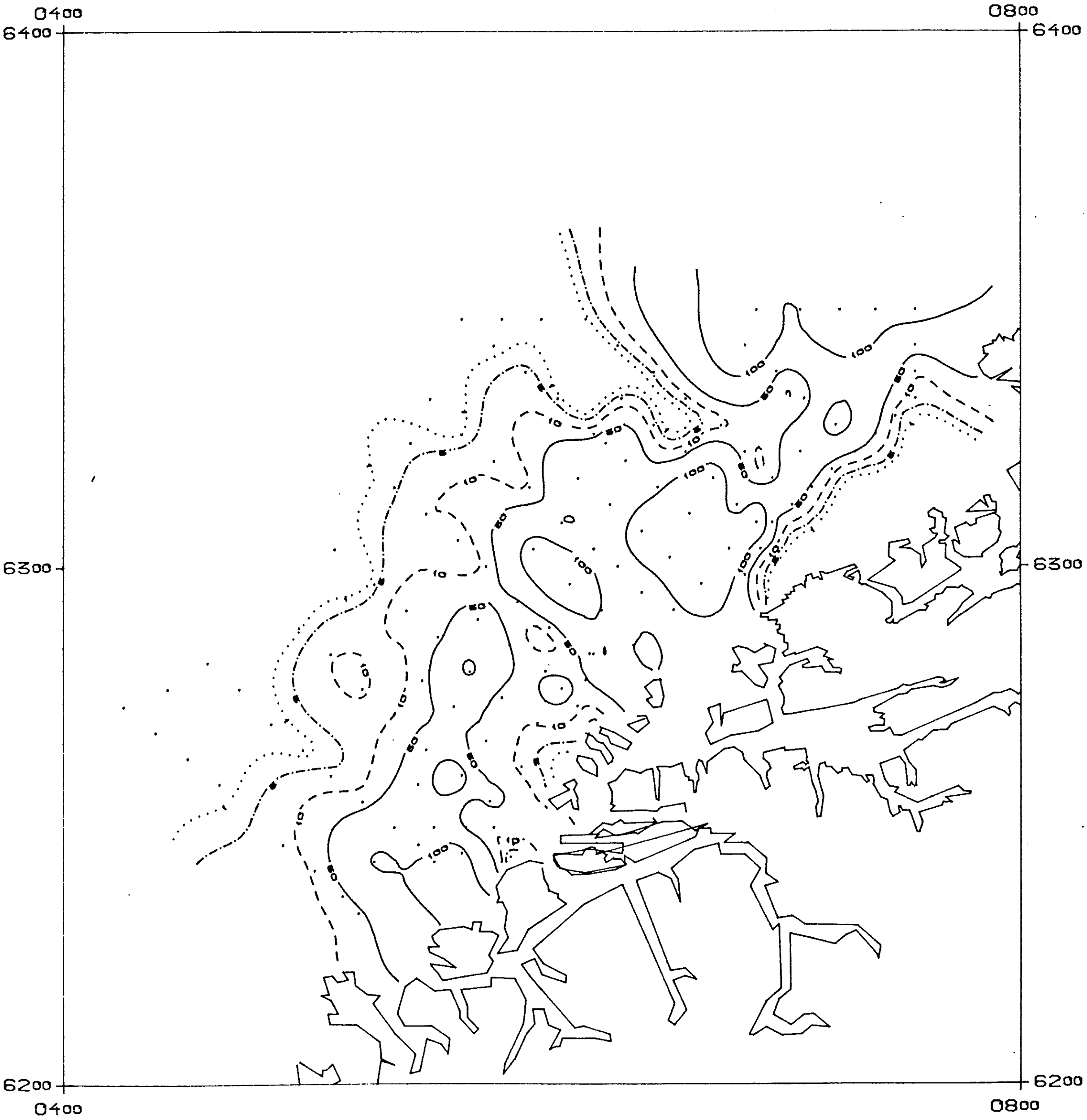

Fig. 3. Distribution of herring larvae in 1985 (no/m^2 surface). All length groups. Dots indicate station grid.

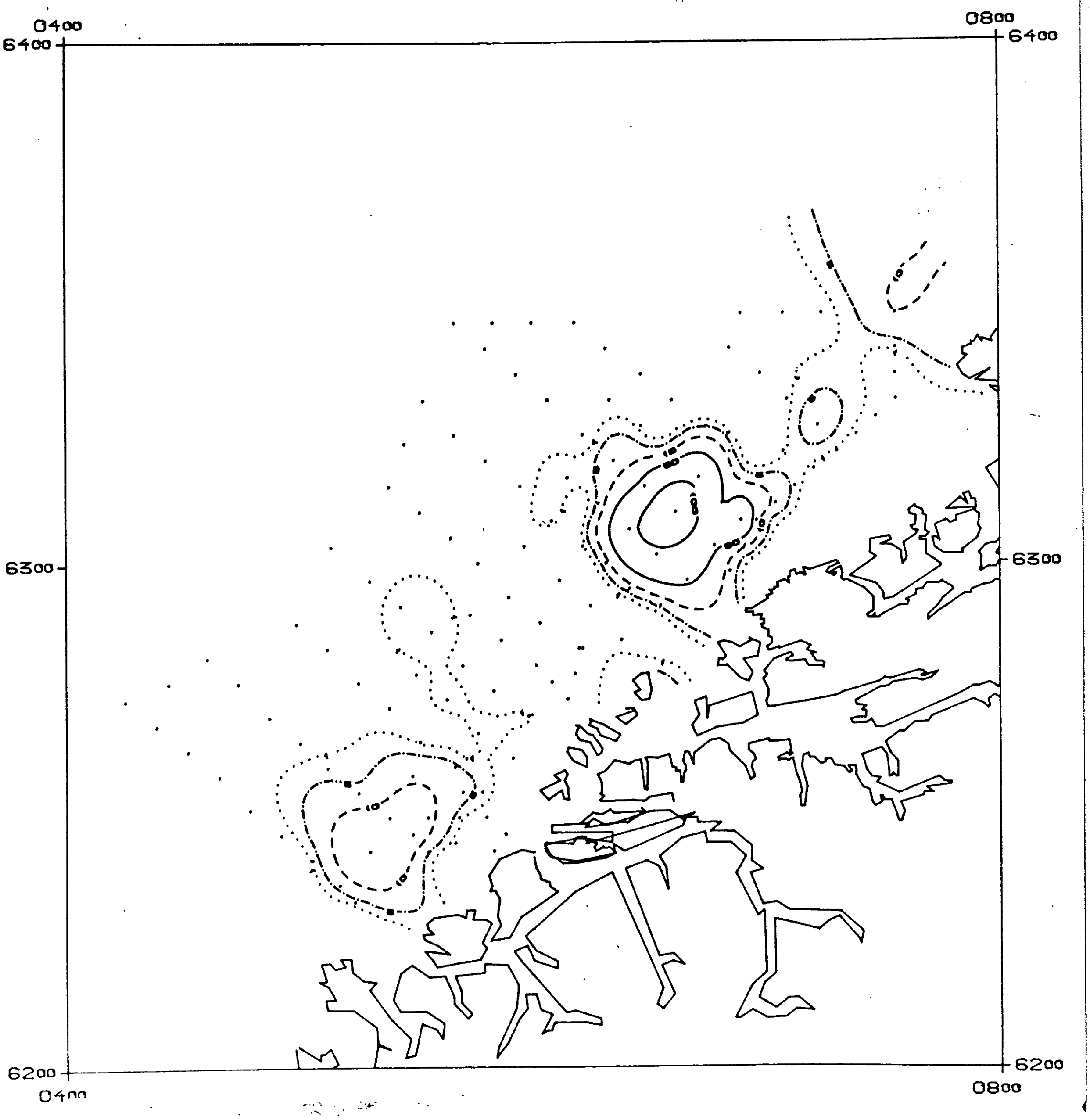

Fig. 4. Distribution of herring larvae less than 9 mm in 1985 (no/m^2 surface). Dots indicate station grid.

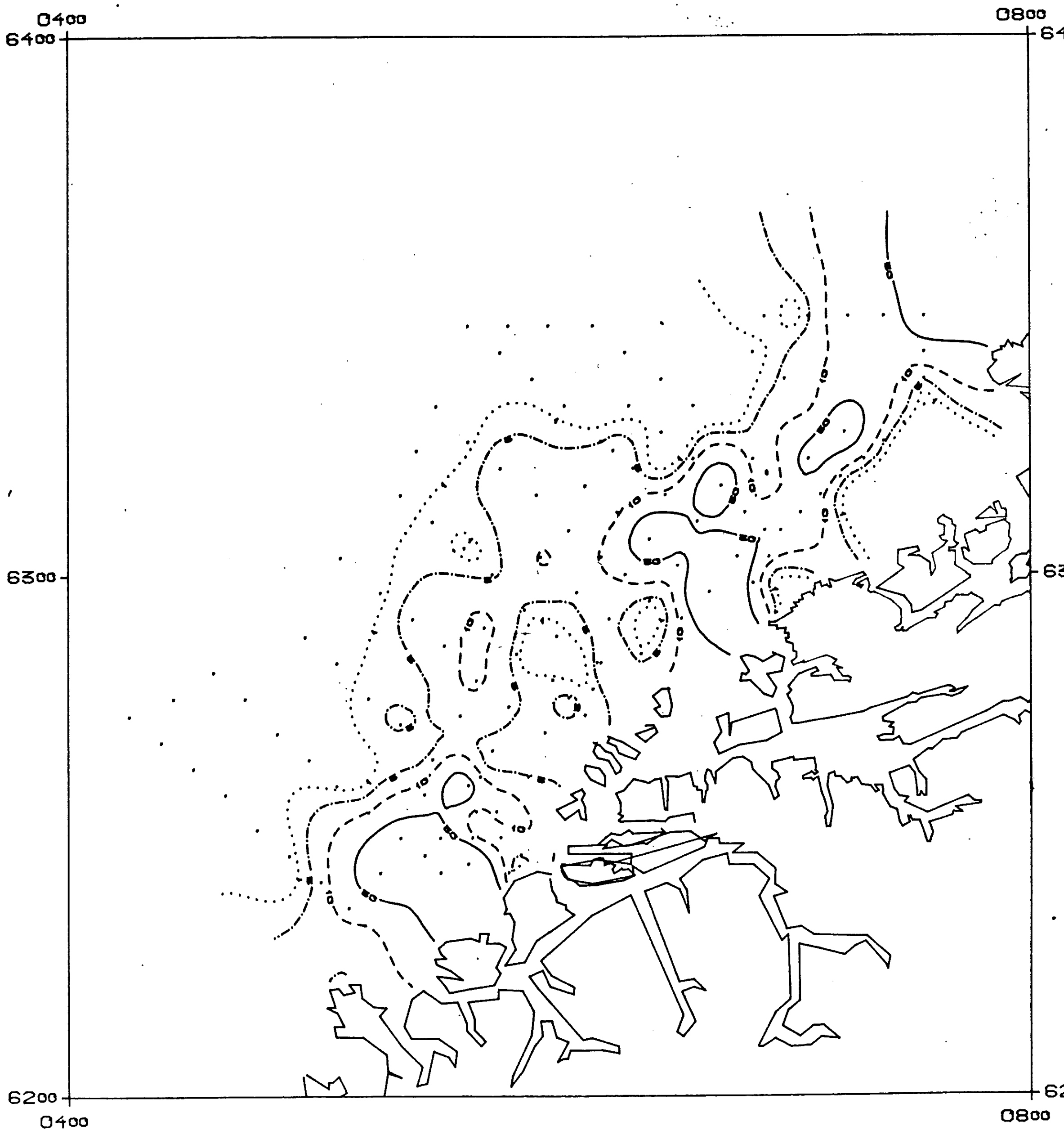

Fig. 5. Distribution of herring larvae 9-10 mm long in 1985 (no/m^2 surface). Dots indicate station grid.

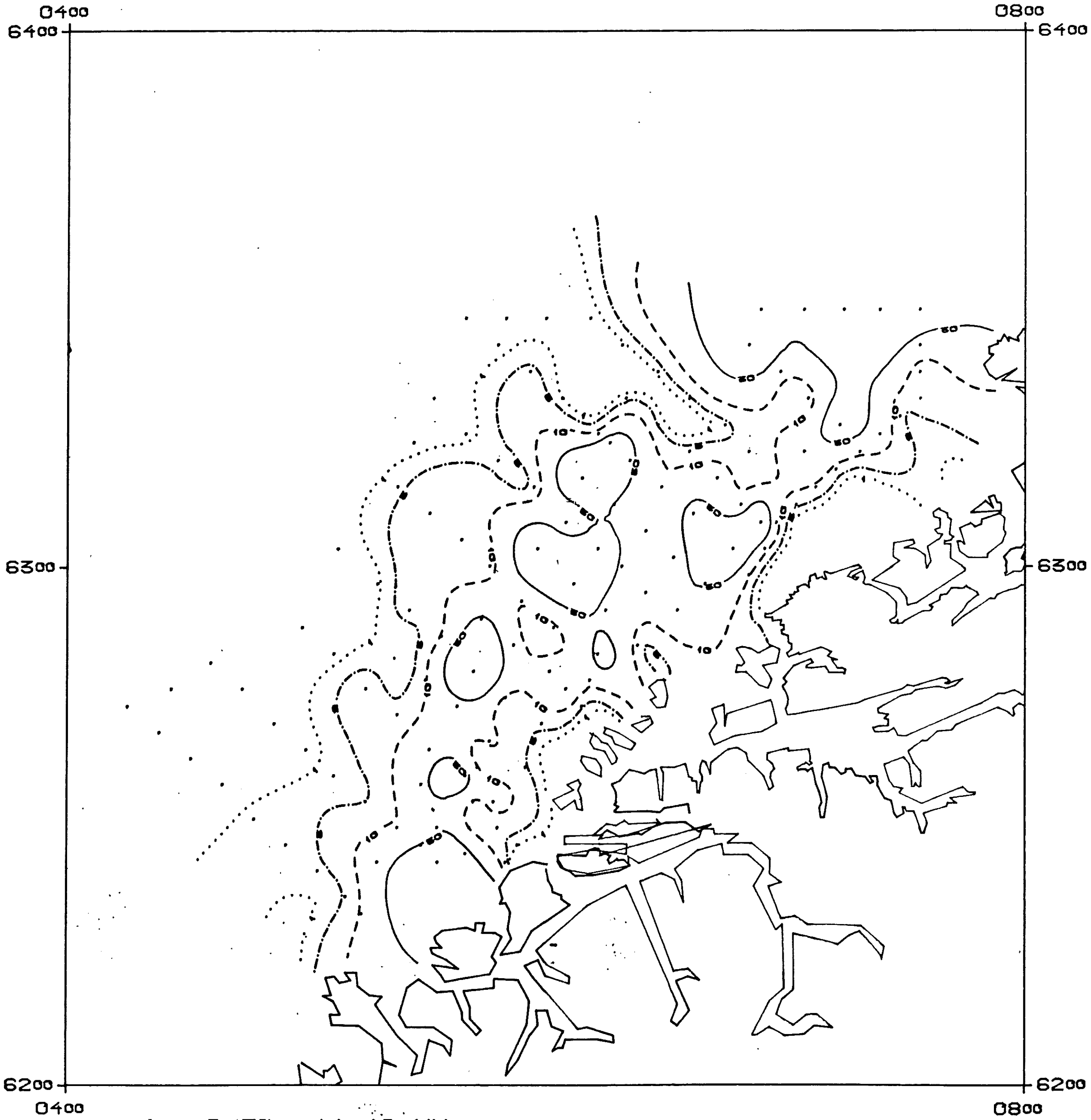

Fig. 6. Distribution of herring larvae 11-12 mm long in 1985 (no/m^2 surface). Dots indicate station grid.

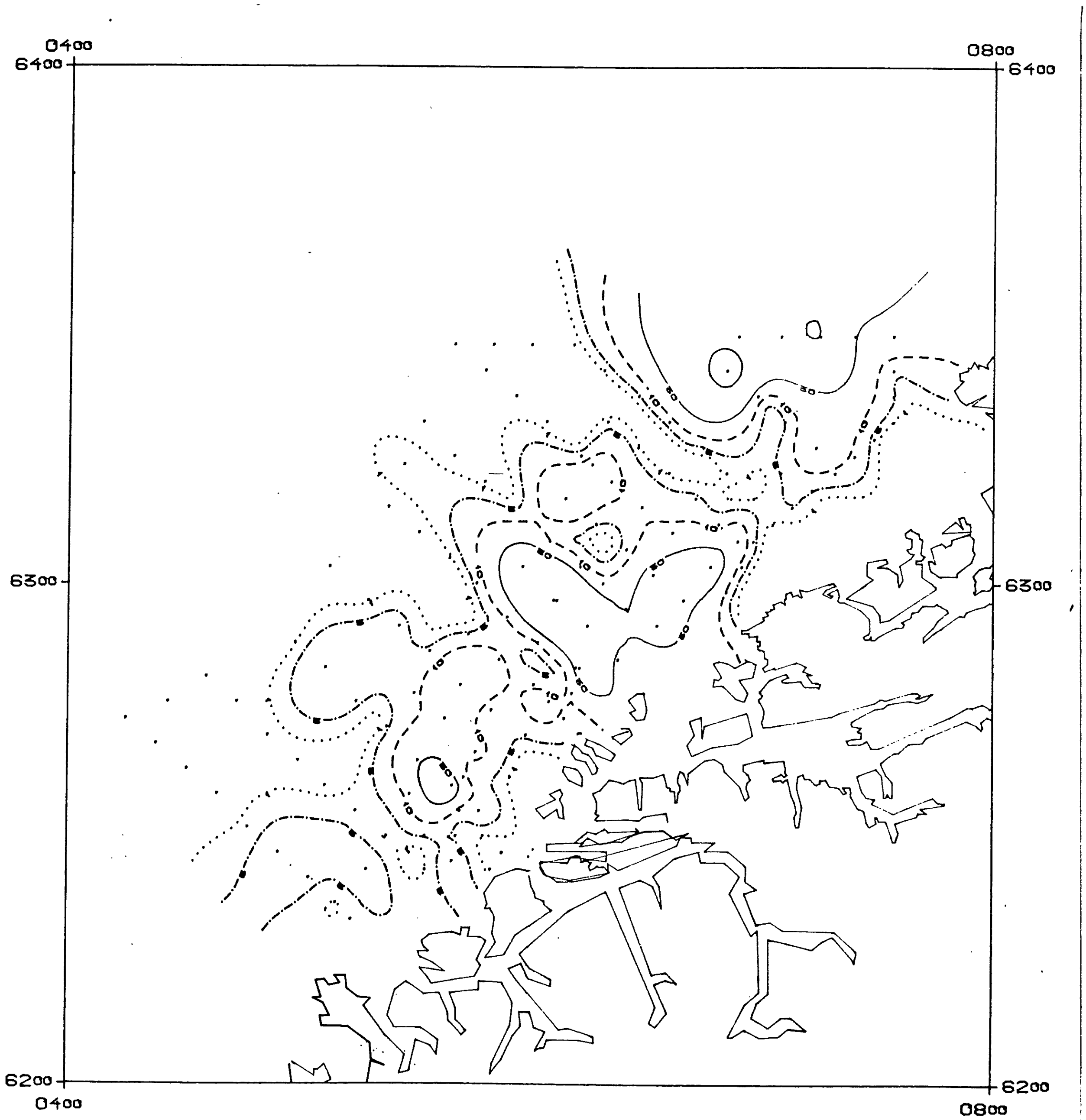

Fig. 7. Distribution of herring larvae > 13 mm long in 1985 (no/m^2 surface). Dots indicate station grid.

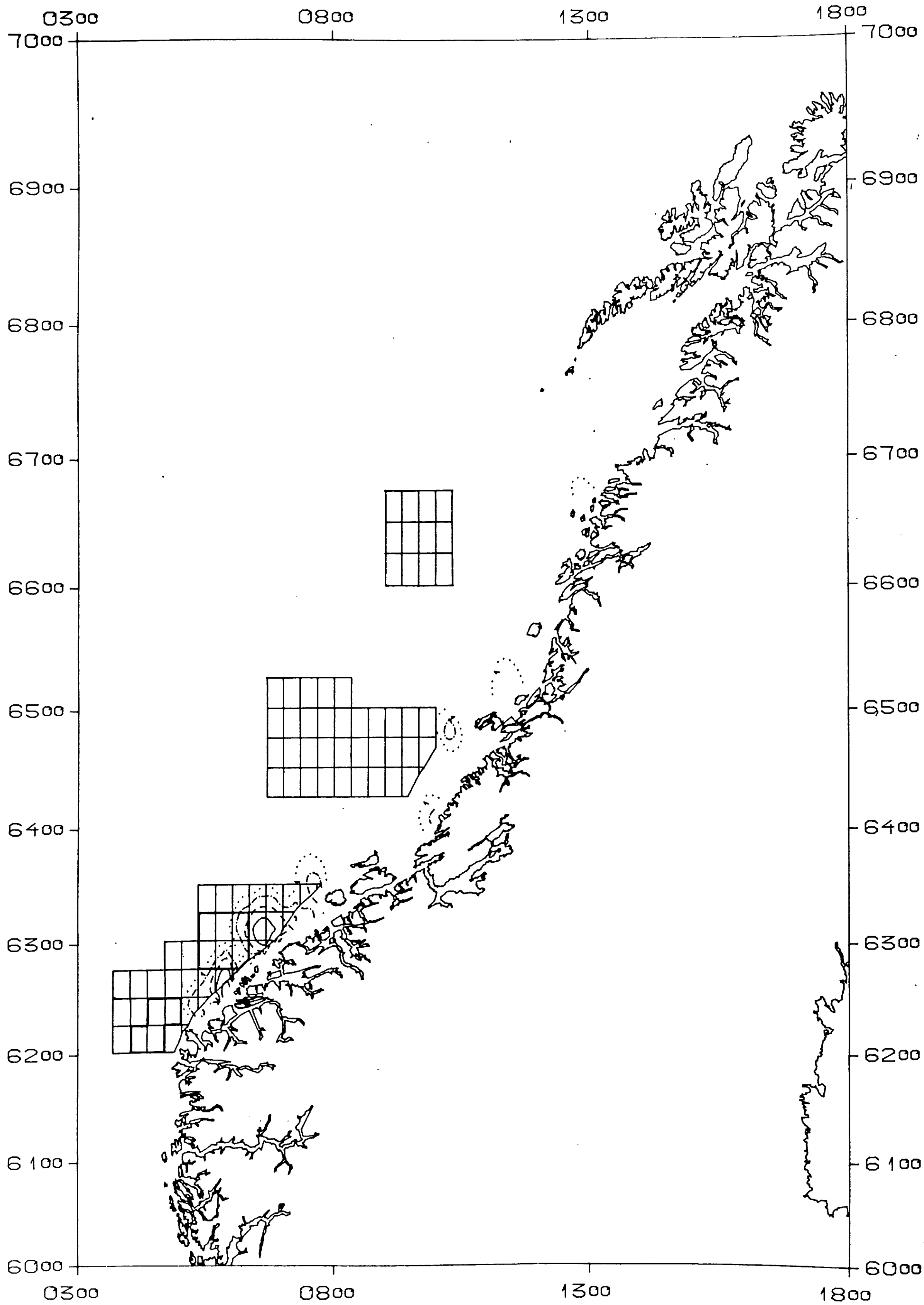

Fig. 8. Distribution of newly hatched herring larvae caught in March-April during the period 1976-85. Grids show oilblocks.

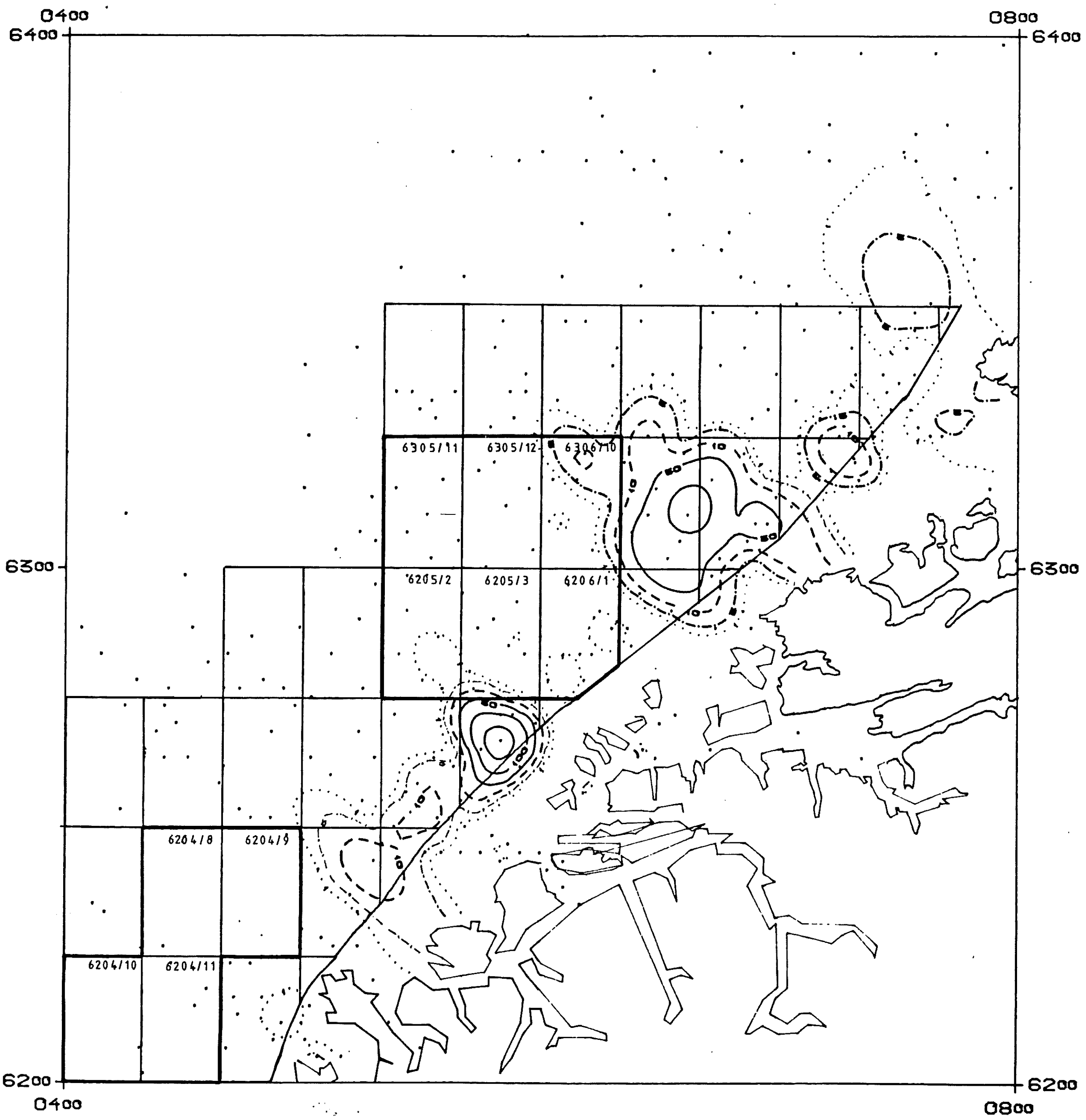

Fig. 9. Distribution of newly hatched herring larvae caught in March-April during the period 1976-85 at Møre. Grid show oilblocks.