INVESTIGATIONS ON CAPELIN LARVAE OFF NORTHERN NORWAY AND IN THE BARENTS SEA IN 1981-84.

By

Oddgeir Alvheim

Institute of Marine Research,
P.O. Box 1870, N-5011 Bergen,Nordnes
Norway

ABSTRACT

This report gives a detailed description of the sampling technique, employing the Gulf III plankton sampler. The collected data are displayed on distribution maps, which show both the total abundance of capelin larvae and the abundance for each of four length groups. A relative index is given for the number of capelin larvae.

1. METHODS

1.1 Sampling with Gulf III plankton sampler

Samples of capelin larvae and plankton were collected with a Gulf III plankton sampler (Zijlstra 1970) in oblique hauls from surface to 60 meters depth and back. Cruising speed during the haul was 5 knots, and the wire speed was 0.5 meters per second. To obtain a maximum depth of 60 meters, approximately 250-260 meters wire were given out, making the duration of the haul about 17 minutes.

In order to check the depth of the Gulf III, a Benthos depth recorder was connected to the sampler in some of the hauls in 1981. In 1982 and 1984 an echo transduser was attached to the tail fin of the Gulf III (Fig. 1). The towing cable transmitted signals from the transducer to a recorder, allowing depth to be traced during the haul. When the sampler reached a depth of 60 meters, it was hoisted. In 1983 a wireless Scanmar depth censor was connected to the Gulf III, which allowed the depth to be traced continuously onboard the vessel during the haul. Unfortunately a malfunction of the depth censor made the readings uncertain. The transducer method used in 1982 and 1984 seems to be preferable.

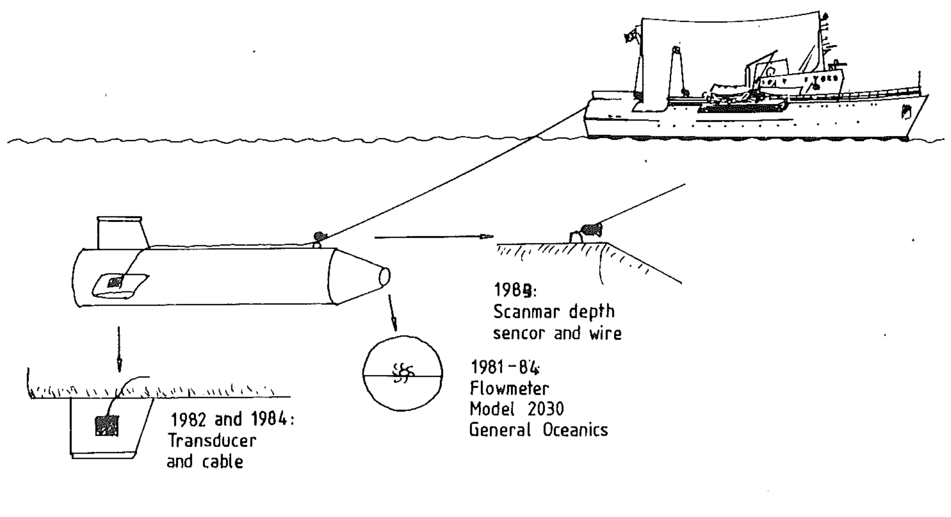

Fig. 1. Arrangement of the transducer (1982 and 1984), the Scanmar depth censor (1983) and the flowmeter (1981-84).

A flowmeter, Model 2030 General Oceanics, was mounted in the opening of the Gulf III. The number of revolutions per haul was taken as the counter difference before and after hauling.

1.2 Mesh size of the net

The mesh size of the net in the plankton sampler was 273μ, measured as indicated by the arrows in Fig. 2.

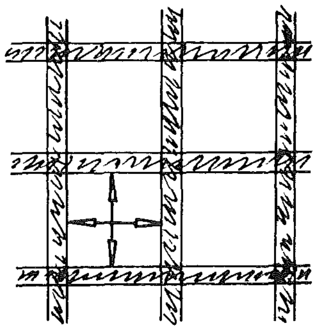

Fig. 2. Measurement of the mesh size in the plankton net.

1.3 Calculation of number of larvae per square meter surface

Number of larvae per square meter surface is calculated by the following formula:

$$N = \frac{n \cdot I}{a \cdot d' \cdot R}$$

N = number of larvae per square meter surface
n = total number of larvae caught
I = depth interval (0-60 meters = 60)
a = area of front opening of Gulf III sampler in square meters
($\pi \cdot r^2 = \pi \cdot 0.095^2 = 0.0283529$)
d'= calibration constant = 0.316 (see next section)
R = number of flowmeter revolutions

Example: Station 59, date 1.6.1983:
n = 44
I = 60
R = 11634

$$N = \frac{n \cdot I}{a \cdot d' \cdot R} = \frac{44 \cdot 60}{0.0283529 \cdot 0.316 \cdot 11634} = 25.3$$

i.e. number per square meter surface = 25.3

1.4 Calibration of the flowmeter

Calibration of the flowmeter can be made either in a tank or in the field. Calibration in tank is done by reading off the counter, towing the flowmeter a known distance and reading the number of revolutions. From the following formula the calibration constant can be calculated:

$$d' = \frac{\text{distance}}{\text{no. of revolutions}}$$

Tank calibrations of the flowmeter used in these investigations gave: d' = 0.316.

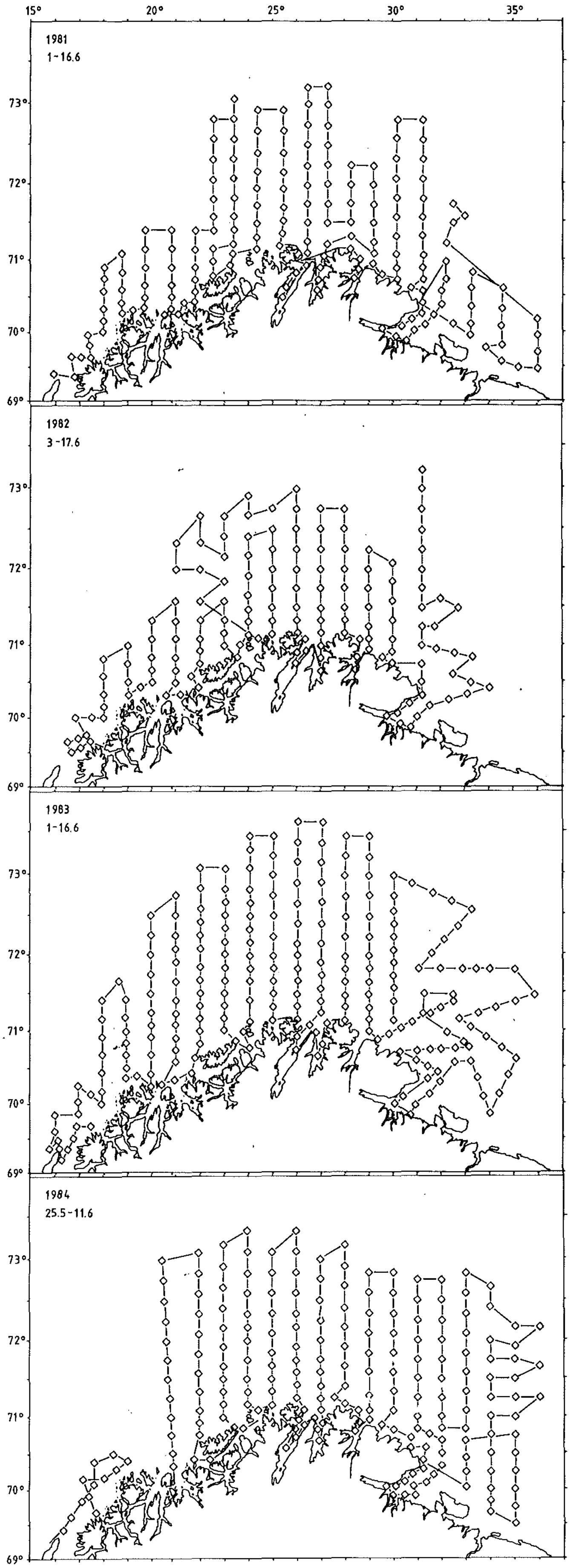

Fig. 3. Cruise tracks and grid of stations for the capelin larval cruises in 1981-84.

Calibration in the field can be accomplished by attaching an additional flowmeter with a known calibration constant to the tailfin of the sampler. Both flowmeters are read before and after the haul, whose distance can be calculated from the calibrated flowmeter reading. Using the formula given above, the calibration constant for the flowmeter in the sampler's mouth may be calculated. To avoid clogging, the plankton net should be removed from the sampler before such a calibration haul. During the capelin larval cruise in 1984 three calibration hauls were carried out. The mean value of the three calibration constants gave a d'=0.316.

1.5 Surveying the distribution area

Stations along north-south transects were usually taken at intervals of one degree (Fig. 3). However, the distance between stations in areas with high densities of larvae, (more than 50), was 10 nautical miles. In areas with low densities, the distance between the stations was extended to 15 nautical miles. Stations were also sampled along the coast near known spawning grounds.

1.6 Calculation of number of capelin larvae

The total number of capelin larvae (Fig. 4) and the number of larvae in four different length groups (Figs. 5-8) per square meter surface have been plotted on charts for each year. Then isolines were drawn and, by area integration, the total number of larvae and number of larvae in each length group was found (Table 1).

2. RESULTS

2.1 Total distribution of capelin larvae

Fig. 4 shows the total distribution of capelin larvae observed on the cruises in 1981-84. In 1981 and 1982 the areas of distribution were similar and relatively small, whereas in 1984 the area of distribution was extended to the east by about 60 nautical miles. The most widespread distribution was found in 1983.

The highest concentrations of capelin larvae were usually found near the coastal spawning grounds. The cruise in 1981 gave the highest values in these areas, (more than 1000 larvae per square meter surface), a magnitude occasionally attained in 1982 and 1984. 1983 resulted in a different distribution pattern, with the highest coastal concentrations of capelin larvae less than 500. Conversely, in an area of open sea (72^{o}10'N, 23^{o}E) one patch of more than 500 capelin larvae per square meter surface was found.

In 1982 and 1984 relatively few capelin larvae were found along the coast in the western part of the investigated area, and few larvae were found in the eastern part during 1981-84. The number of capelin larvae in the Varangerfjord area was extremely low in 1983, mostly below 50 larvae per square meter surface.

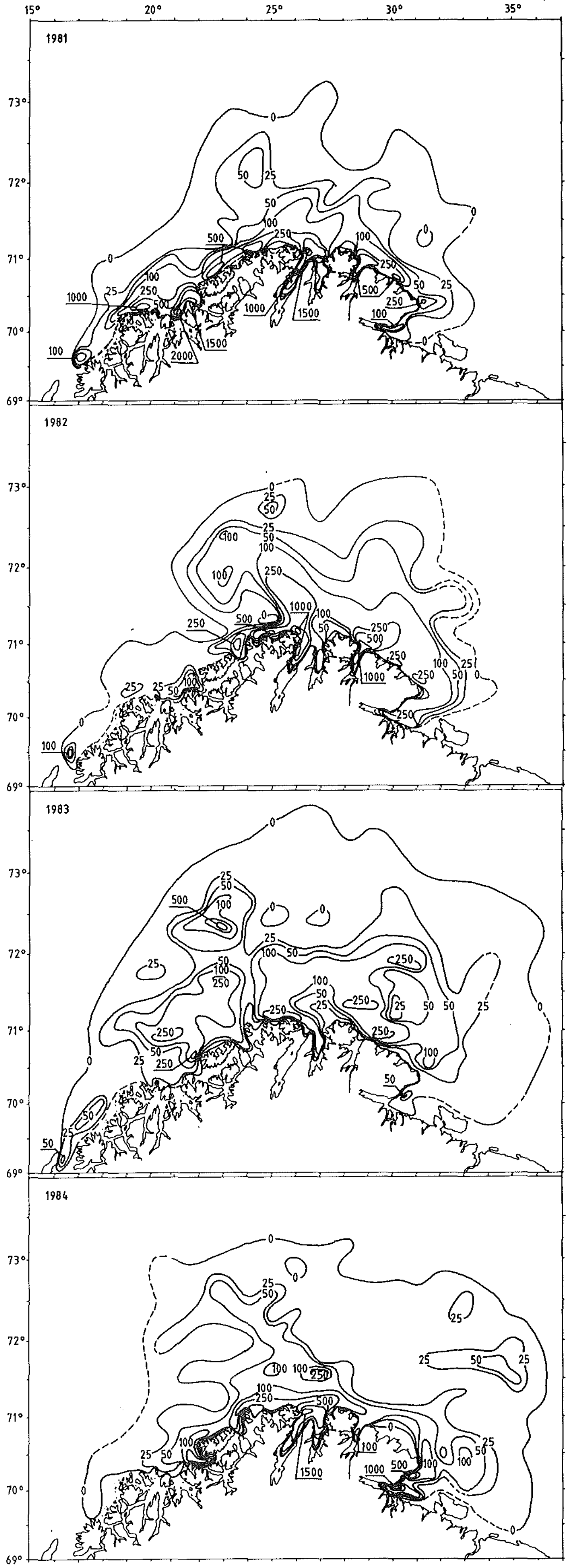

Fig. 4. Total number of capelin larvae per square meter surface in 1981-84.

2.2 Distribution of capelin larvae on length groups

Figs. 5-8 show the distribution of capelin larvae in the length groups 5-9 mm, 10-14 mm, 15-19 mm and >20 mm. typically, the highest concentrations of larvae of 5-9 mm are found near the coast, which thin out until about 100 nautical miles from the coast.

The figures show clearly an increasing area of distribution with increasing length of the larvae. Most of the larvae are transported away from the spawning grounds to the open ocean by the current, but some still remain in coastal waters and fjords.

2.3 Total number of capelin larvae

The number of larvae observed during the cruises 1981-84 is given in Table 1. The total number observed is remarkably constant for this period. Larvae in the two smallest length groups constitute the majority, while the number of larvae >20 mm is very low. The number of larvae per sub-area varies from year to year but was generally low in the eastern section. This corresponds well with the observed spawning areas, as these years only minor spawning took place off Eastern Finnmark.

Table 1. Calculated number of capelin larvae (x 10^{-12}) for the years 1981-84.

Year	Length in mm	West of 20 E	20-25 E	25-28 E	28-31 E	East of 31 E Varang.f.	Sum
1981	5- 9	0.52	1.08	0.15	0.26	0.06	2.07
	10-14	0.53	2.44	1.77	0.74	0.26	5.74
	15-19	0.09	0.71	0.46	0.42	0.11	1.79
	20	0.01	0.04	0.02	0.03	0.01	0.11
	Total	1.15	4.27	2.40	1.45	0.44	9.71
1982	5- 9	0.02	0.31	1.80	1.69	0.50	4.32
	10-14	0.09	0.84	1.14	1.30	1.13	4.50
	15-19	0.01	0.35	0.25	0.29	0.13	1.03
	20	+	0.01	0.01	0.01	+	0.03
	Total	0.12	1.51	3.20	3.29	1.76	9.88
1983	5- 9	0.17	0.85	0.34	0.48	0.19	2.03
	10-14	0.30	1.50	0.92	1.30	0.71	4.73
	15-19	0.13	0.98	0.37	0.43	0.34	2.25
	20	0.02	0.43	0.16	0.14	0.18	0.93
	Total	0.62	3.76	1.79	2.35	1.42	9.94
1984	5- 9	0.01	0.32	1.51	0.22	0.12	2.18
	10-14	0.02	0.94	1.26	0.15	1.14	3.51
	15-19	0.01	0.52	0.55	0.07	0.53	1.68
	20	0.02	0.39	0.18	0.04	0.15	0.78
	Total	0.06	2.17	3.50	0.48	1.94	8.15

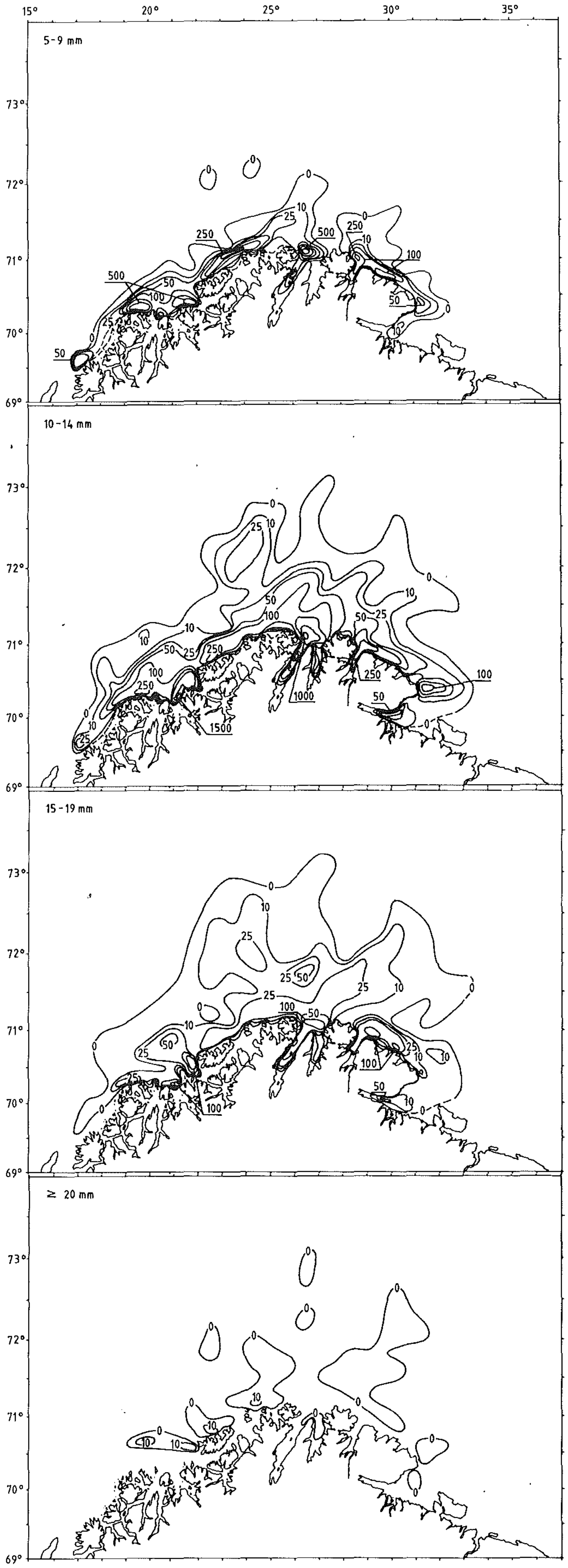

Fig. 5. Number of capelin larvae per square meter surface for different length groups in 1981.

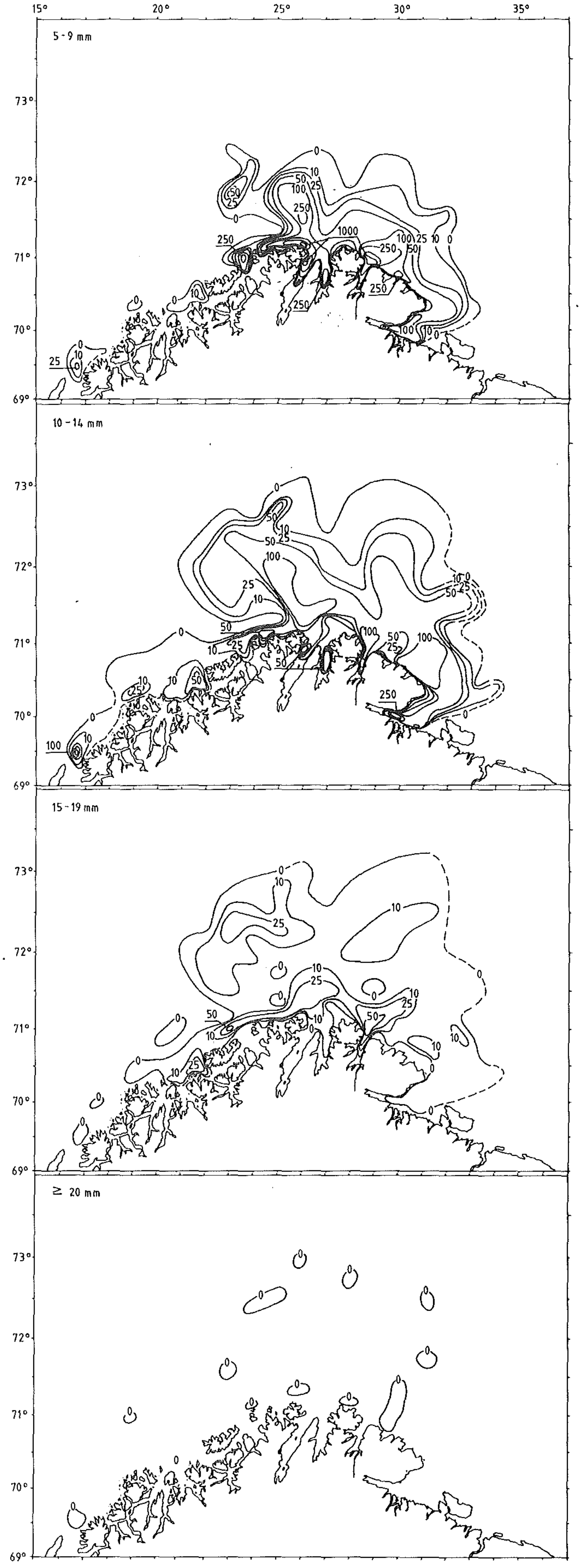

Fig. 6. Number of capelin larvae per square meter surface for different length groups in 1982.

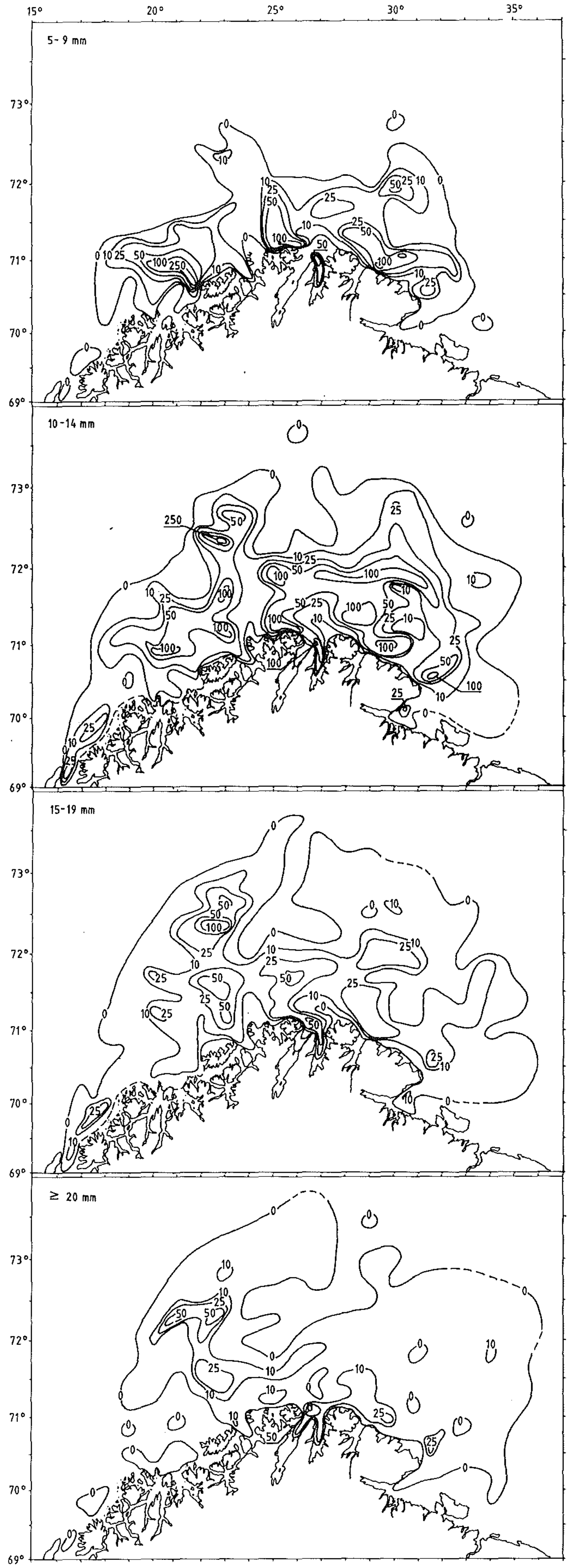

Fig. 7. Number of capelin larvae per square meter surface for different length groups in 1983.

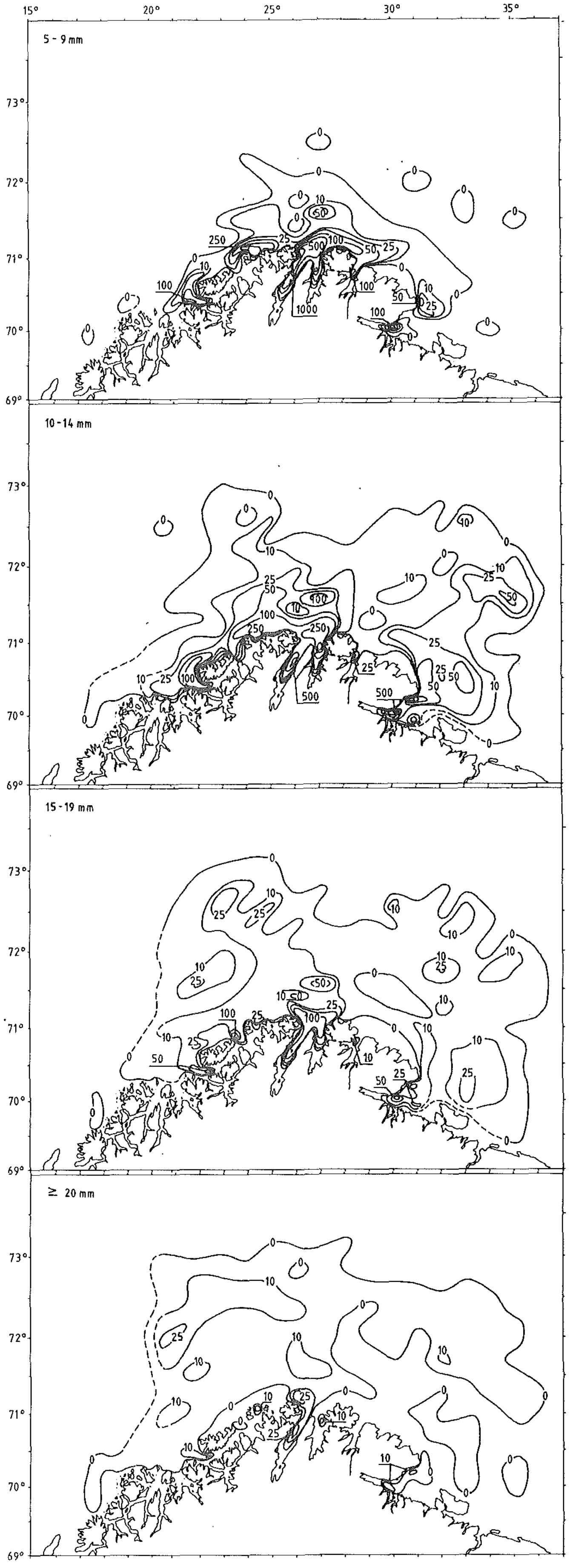

Fig. 8. Number of capelin larvae per square meter surface for different length groups in 1984.

3. DISCUSSION

3.1 Sampling technique

During the period of investigations the sampling technique has remained nearly unchanged from year to year, apart from the systems of reading the sampling depth. These do not affect the haul itself.

If the maximum depth per haul should be increased, correspondingly greater time would be needed for each cruise. Greater accuracy cannot be guaranteed in the results. No thorough investigations have been done so far, but in 1977 a capelin larval cruise was carried out, using Clarke Bumpus Plankton Samplers (CLARKE and BUMPUS 1950). Three CBPS were attached to the wire (Dragesund 1970) to sample at 5-25, 30-50 and 55-75 meters. The catch showed a trend of decreasing numbers with increasing depth (9% of the total in the last depth interval) and supports the practice of hauling only to 60 meters.

3.2 Coverage of the distribution area

To be able to cover the whole distribution area with one vessel within a reasonable short time period, a relatively open sampling grid is necessary. As a consequence of this, the accuracy of the area integration may be low in areas with strong gradients in the larval density. In most years such gradients may be found close to the coast, primarily affecting the smallest length group. An assessment of the resulting effect on the calculated larval index has not been attempted, but one may speculate that in some cases the effect could be substantial.

3.3 Time of spawning - time of larval cruise

The main spawning period for the Barents Sea capelin is March-April, while minor spawning takes place from the end of February until the summer. A dense concentration of spawning capelin was found in end of February 1984 along the coast of Troms (70° 20'N, 18° E) (TORESEN 1984). One month later a dense concentration of newly hatched capelin larvae was found in the same area (DOMMASNES,A., pers. comm.), but that year's larval cruise found very few larvae in this area. A mass mortality may have occurred to these larvae, but most likely they were transported to the north-east by the current. The patch of larvae at position 72°N, 20°E seen in the lower map on Fig.8 probably came from this spawning area. This illustrates the difficulties of obtaining a detailed picture of the early life of capelin larvae, based on only one cruise a year.

The larvae experience a high and probably unpredictable mortality at the earliest life stages. Consequently the larval index is not only dependent on number of larvae hatched, but also on the time lag between hatching and larval cruise covering. The long spawning period adds to this source of variance.

It seems though that the larval cruise in June is carried out well after the main hatching, and probably after the period of most intense larval mortality. Consequently the larval abundance index can be regarded as a tentative index of year class strength. While too rough for a forecast of spawning stock biomass two or three years ahead, it may give information on major changes taking place in the success of spawning, hatching and survival through the earliest life stages of the capelin.

4. REFERENCES

CLARKE, A. L. and BUMPUS, D. F. 1950. The plankton sampler - an instrument for quantitative plankton investigations. Spec.Publs Am.Soc.Limnol.Oceanogr.,5:1-8.

DRAGESUND, O. 1970. Factors influencing year-class strength of Norwegian spring spawning herring (Clupea harengus L.). Fisk Dir.Skr.Ser.HavUndres.,15:381-450.

TORESEN, R. 1984. To hovedinnsig av lodde vinteren-84. Fiskets Gang, 70:365. (In Norwegian)

ZIJLSTRA, J. J. 1970. Herring larvae in the central North Sea. North Sea.Ber.Dt.Wiss.Komm.Meeresforsch.,21:92-115.