

the data of the commercial fishery he estimated the density of sand eels on the North Sea fishing ground to be 13/m². Twenty-two van Veen grab samples yielded a total of 13 sand eels corresponding to a density of 2–4/m². He also informed me that during winter sand eels occur on tidal flats, buried deep in the substrate.

Comparing the observations from Disko with the above-mentioned results and the sand eel fishery in the North Sea, it is suggested that a large unexploited stock of sand eels might be found in Disko Bugt. Hitherto a small experimental sand eel fishery has only been carried out off Godthåb in 1969 (Bertelsen and Hansen 1970, p. 86). A sand eel fishery along the east coast of Disko with bottom trawl at 2–8 m depths might be remunerative in Disko Bugt during November. Here the bottom is suitable and the sand eel presumably hibernates in shoals and will probably stay buried during the days, which are very dark and short in November. The sea ice will prevent a fishery in December.

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The use of trawling in conjunction with plankton surveys as an aid to fish egg identification in the west central North Sea

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The eggs of cod (*Gadus morhua*) and those of haddock (*Melanogrammus aeglefinus*) cannot be distinguished until pigmentation has developed on the tail of the developing larva inside the egg (Russell, 1976). This has handicapped the description of cod and haddock spawning areas where both species occur together and, in particular, precludes the estimation of egg mortality rates.

Cod and haddock occur together off the northeast coast of England and, since both species are currently being studied by the Ministry of Agriculture, Fisheries and Food, it seemed useful to explore the extent to which cod and haddock eggs could be distinguished in plankton samples on the basis of a comparison of the distribution of eggs with the distribution of mature fish as shown by trawling.

The plankton and trawl surveys were carried out between 27 February and 7 March 1975 from RV "Corella". The plankton survey preceded the trawl survey and was completed on 2 March.

Plankton samples were collected using the 50 cm diameter version of the Lowestoft multipurpose high-speed plankton sampler (Beverton and Tungate, 1967) fitted with a 20.3 cm diameter nose-cone and a net of 23.6 meshes/cm (60 mpi). The sampler was towed at five knots in a "double oblique" haul (surface to bottom to surface) at each station of a regularly spaced grid of 38 stations. Fish eggs and larvae were staged, identified as far as possible and expressed as numbers/m² using the flowmeter readings and the calibration constant of the flowmeter calculated from hauls without the net. The stage

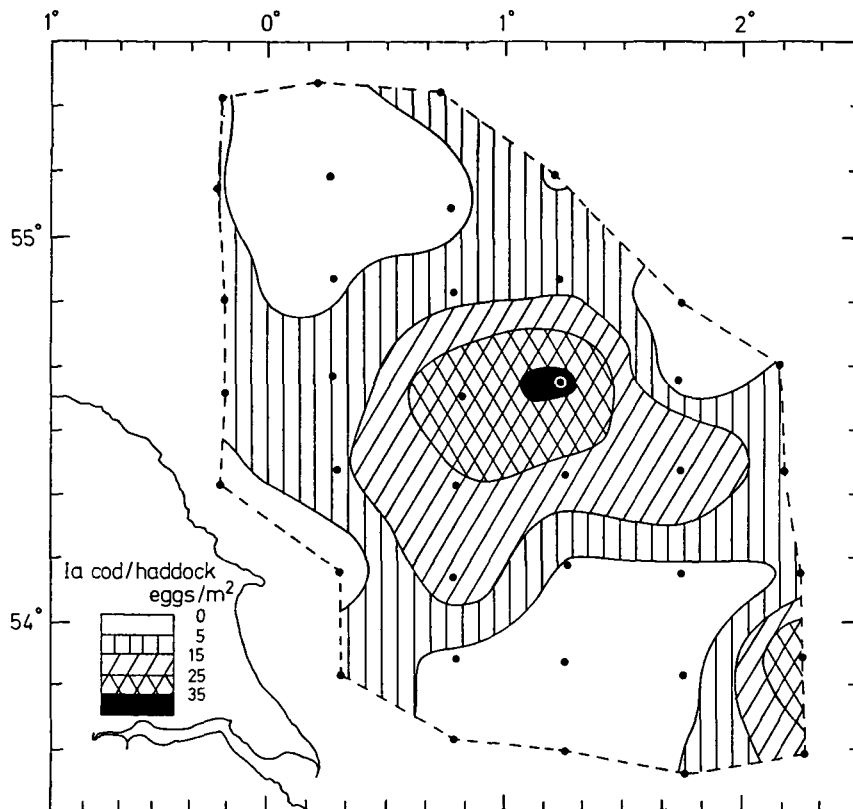


Figure 1. Distribution of stage 1a cod/haddock eggs between 27 February and 2 March 1975. Contours at 5, 15, 25 and 35 eggs/m² intervals.

criteria have been described by Harding et al (1974).

Trawling was carried out with a Granton otter trawl of 25 m headline length, fitted with 27.4 m bridles and 30.8 cm rubber bobbins on the footrope. The codend was 70 mm mesh size blinded with shrimp-netting of 19 mm mesh size. The trawl was fished for one hour at an average of 3.65 knots through the water and 3.09 knots over the ground at each of 20 stations within the area of the plankton grid. All cod and haddock were measured at each station and length stratified samples were examined for maturity stage. Estimates of the total number of mature fish were derived from these samples and expressed as number/hour of fishing.

Figure 1 shows the distribution of stage 1a cod/haddock eggs, which, at the prevailing sea surface temperature of 5.4 to 6.7°C, were between 1.2 and 1.4 days old. Figures 2a and b show the distributions of mature cod and mature haddock respectively, as shown by the trawl survey. It is clear that the distributions of mature cod and of eggs coincided and that the centre of each distribution occurred at 54°35'N

1°00'E. A second patch of cod/haddock eggs was identified in the southeast corner of the plankton grid at 53°50'N 2°15'W. Few mature haddock were caught within the 15 eggs/m² contour although high concentrations of mature haddock were found 35 km northeast and also 80 km northwest by west of the main centre of the stage 1a egg distribution. No haddock larvae or stage V haddock eggs were identified in any of the plankton samples although cod larvae and stage V cod eggs were present.

Each trawl station was located within a square of four plankton stations. The mean number of stage 1a eggs/m² per square (y) was calculated using the following formula:

$$y = \exp \left[\frac{\sum \ln(l + y)}{n} \right] - 1$$

where y is the observed number of eggs/m² at a station and n is the number of stations per square. This procedure is equivalent to calculating the geometric mean of the observations and allows one to include observations with zero value. Figure 3 shows

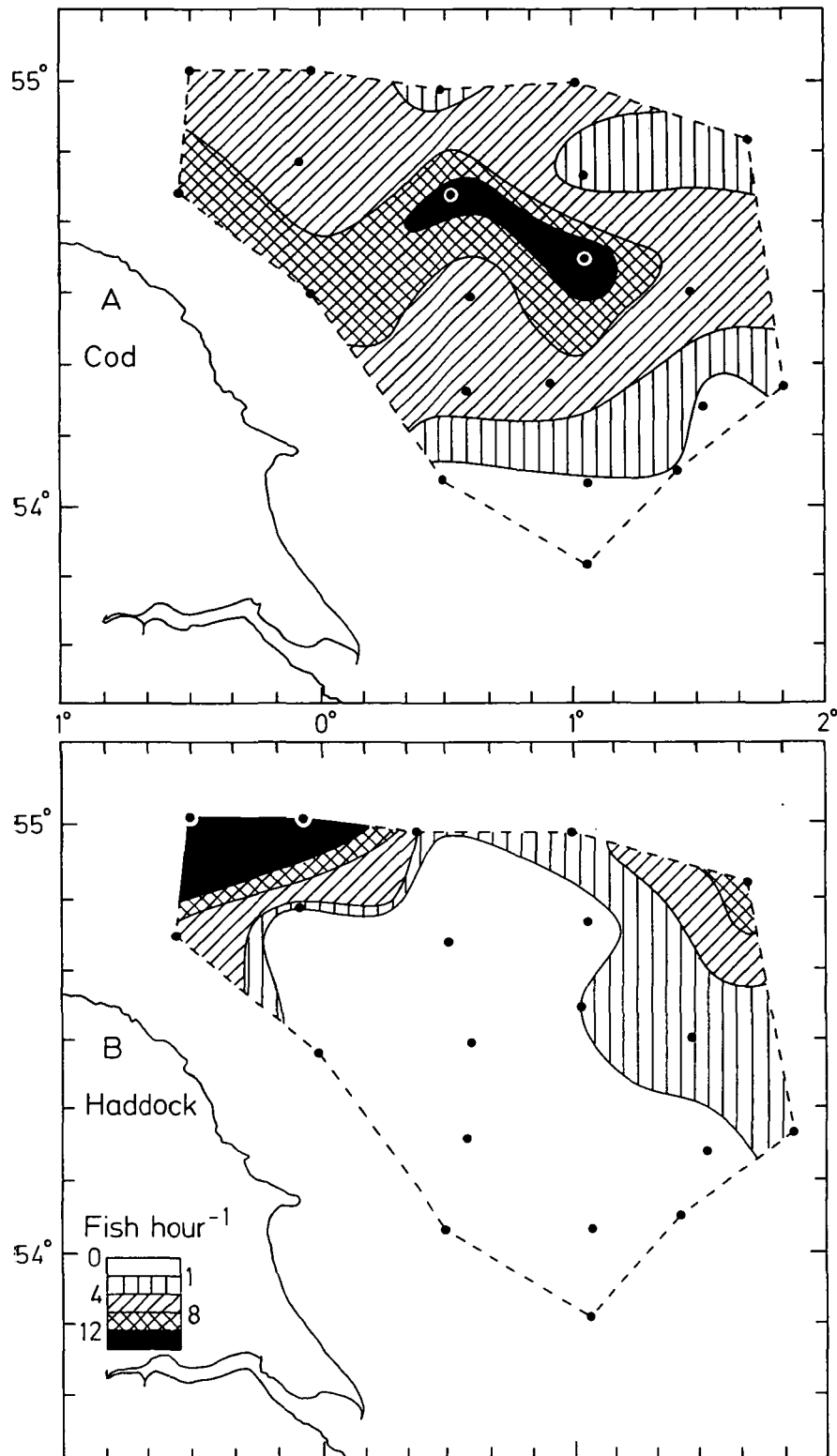


Figure 2. a. Distribution of mature cod between 2 and 7 March 1975. Contours at 1, 4, 8 and 12 fish per hour's fishing. b. Distribution of mature haddock between 2 and 7 March 1975. Contours at 1, 4, 8 and 12 fish per hour's fishing.

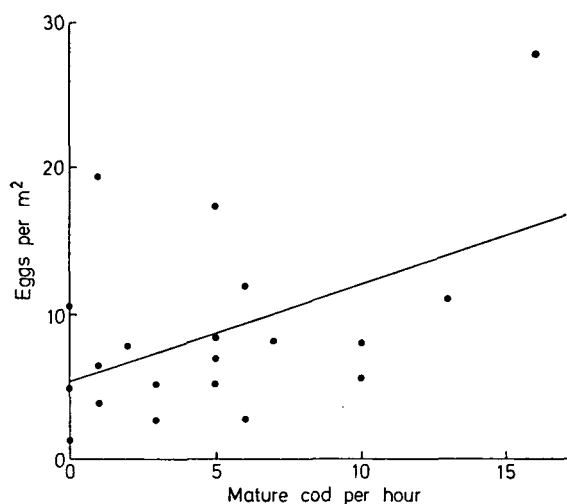


Figure 3. Relationship between the mean number of stage 1a cod/haddock eggs per m^2 and number of mature cod per hour's fishing. $r = 0.47$ for 18 degrees of freedom, $P < 0.05$.

the relationship between the mean number of eggs/ m^2 and the number of mature cod. The correlation coefficient was significantly different from zero for cod ($r = 0.47$, 18 d.f. $P < 0.05$) but was not significantly different for haddock ($r = 0.28$, 18 d.f., $P > 0.1$).

Even though a clear correspondence between the distribution of mature cod and of stage 1a cod/haddock eggs was found, concentrations of mature haddock were found in sufficiently close proximity to suggest that the patch of eggs could, in fact, have been haddock eggs which had drifted at least 35 km southwest during the 1.2 to 1.4 days since they were fertilised or 80 km to the southeast by east (assuming the same rate of development as the cod). This explanation would require a rate of residual drift of 25 km/day whereas observations with moored current meters in the vicinity have shown a maximum

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Colour of the ocean as an indicator in photosynthetic studies

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Spectral analysis of the daylight backscattered from the sea yields information about the optical properties of the upper layer and ultimately about its content of suspended particles and coloured dissolved

drift in February and March 1971-74 of 15-90 km/day at JONSIS station 2 at 54°23'N 1°06'E (Ramster, personal communication).

A further objection might be that the trawl survey took place between four and nine days after the time of fertilisation of the stage 1a eggs observed on the plankton survey and that the eggs were derived from a patch of mature cod or haddock not described by the trawl survey. The fact that later stage eggs and larvae of cod but not of haddock were found in the area of the patch of stage 1a eggs is evidence against the objection. It would, of course, have been desirable to have carried out the trawl survey before the plankton survey. If the technique is to be used routinely then this procedure would have to be followed as far as it is practicable to do so.

There is thus strong evidence that the patch of cod or haddock eggs found on the plankton survey was, in fact, a patch of cod eggs. The results confirm the notion, which was put forward by Graham (1923) on the basis of the presence of large cod in March, that cod spawn in the area off Flamborough. It is likely that the technique of trawling in conjunction with plankton surveys is a useful method of identifying fish eggs when it is not possible to distinguish them anatomically and when the spawning of the two species is to some extent separated spatially.

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substances. Generally the spectral character of the colour of the upwelling light can be investigated by employing a two channel system. Thus a colour index is defined as the ratio of nadir radiance in the