Other ways of counting fish

Most analytical assessments carried out by the International Council for the Exploration of the Seas (ICES) provide information on historic trends in stock abundance to assess the effect of fishing. They use indices of relative abundance obtained from research surveys and catch and effort data from commercial fisheries. Acoustic surveys can be used to produce abundance indices over the distribution of an entire stock, and they are particularly valuable for fish such as herring and blue whiting which aggregate in large single-species shoals. However, with increasing emphasis on managing fisheries sustainably, it is also important to be able to estimate the actual abundance of reproductively active fish. Maintaining a healthy spawning stock is crucial to sustainability.

The most direct way to estimate the numbers of spawning fish in a stock is to use an egg-production method, which estimates the eggs produced by the females during a single spawning season. The number of eggs is then divided by the average fecundity (the number of eggs spawned per female) to calculate the number of spawning females. This is then divided by the sex ratio (the proportion of females in the adult population) to calculate the total number or weight of spawning fish. Most of the biological information required for this method is obtained from research vessel surveys.

Between January and May 2000, egg production data were obtained for plaice, cod and haddock in the Irish Sea. Research vessels were used to carry out a series of nine plankton surveys, each collecting up to 105 samples of fish eggs and measuring water temperature throughout the sampling grid shown in Figure 1. These plankton

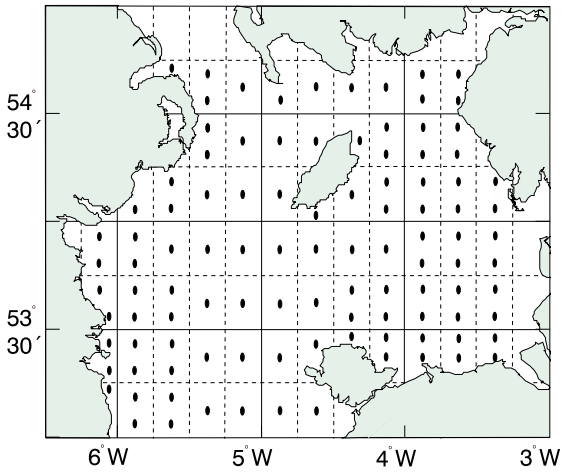

Figure 1. The plankton sampling grid used to estimate egg production of plaice, cod and haddock in the Irish Sea in January – May 2000.

samples were preserved and returned to the laboratory, where individual eggs of the three species are sorted to species and allocated a development stage according to their size and internal structure.

Species identification becomes easier as the embryos develop in older eggs, but newly spawned eggs of some fish species, such as cod, are not visually distinguishable, and genetic methods are being developed to identify them. Eggs develop faster at higher temperatures, but development rates differ between species and development stage and have to be measured experimentally. Real-time measurements of water temperature can then be used to calculate the average age of each development stage. Estimates of the total numbers of eggs of each species from the whole series of plankton surveys are used in an inter-relational data base to calculate the total production of eggs spawned, either in the Irish Sea as a whole, or at a particular spawning location (Figure 2).

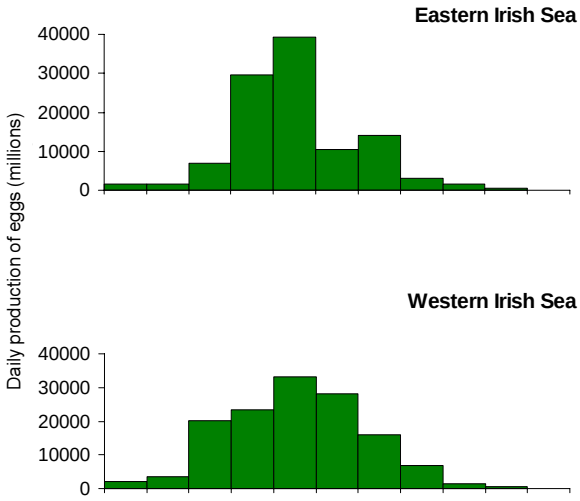

Figure 2. The seasonal production of cod eggs in the east and west Irish Sea in 1995.

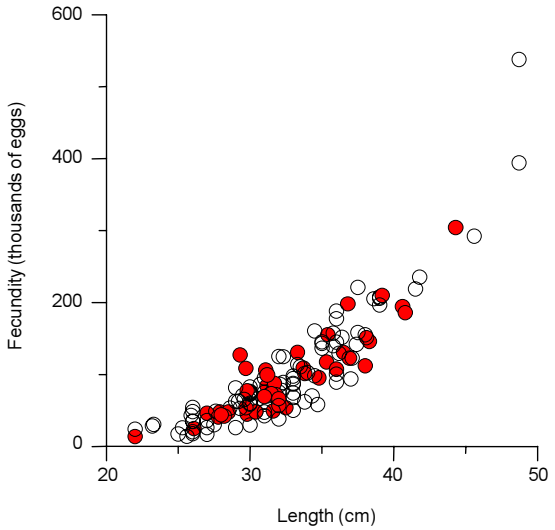

Figure 3. The relationship between fecundity and size of female plaice off the Cumbrian coast in 1950 (●) and 1995 (○).

Samples of adult fish obtained from fishing surveys and commercial catches in the spawning area are used to determine the size of spawning females and to collect unspawned roes. Fecundity is estimated by counting the number of maturing eggs in each ovary, using histological techniques to distinguish eggs that will eventually be spawned from those which will be resorbed by the fish. Fecundity is related to the size of the fish: for example, a three year-old female plaice of 30 cm spawning for the first-time will have around 60 thousand eggs, whereas a 7 or 8 year old female of 50 cm will have nearly half a million eggs (Figure 3).

In the annual egg-production method, the number of spawning females is calculated by dividing the fecundity of an average-sized female into the estimate of the total number of eggs produced by the stock over the spawning period. The proportions of males and females at each age actually involved in spawning are determined by fishing surveys carried out towards the start of the spawning season. With this information, we can calculate the total biomass of the spawning stock, which can then be compared directly with the results of analytical stock assessments, and against the biological reference levels implicit in sustainable fishing.

CEFAS
The Centre for Environment, Fisheries & Aquaculture Science

The Centre for Environment, Fisheries & Aquaculture Science
Lowestoft Laboratory, Pakefield Road,
Lowestoft, Suffolk NR33 0HT UK
Tel: +44 (0) 1502 562244
Fax: +44 (0) 1502 513865
www.cefas.co.uk