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ESTIMATING THE YEAR CLASS STRENGTH OF COD IN THE IRISH SEA

by

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A major problem in predicting the stock size of fast growing heavily
fished species is to obtain estimates of the strength of incoming year-classes.
At the present time such predictions are made in the first quarter of the year
in order to determine total allowable catches (TAC) for the following year.

Table 1 gives the percentage by weight of different ages of Irish Sea cod
in the Fleetwood trawl catch over the period 1969-73. On average 66% by weight
of the catch consists of fish less than 4 years old. At the time that the predic-
tions are made the latest information available is for the previous year, when
these fish are aged 1, 0 and -1 (ie not yet born). An idea of the timing and
distributions of catch weight at different ages is given in Figure 1. This shows
the progress of the year-classes through the fishery from 1974 to 1976, the year
currently being predicted. The age groups which will be 1, 2 and 3 years old in
1976 are the 1975, 1974 and 1973 year-classes. At the time when the predictions
are made (March 1975) data from the commercial catches are available for 1974, but
these can only be used to estimate the strength of the 1973 year-class. Nevertheless
the ability to evaluate this year-class (which will be 3 years old in 1976) will
greatly improve the prediction.

Table 2 gives the catch rate (No/100 h motor trawl effort by Milford Haven
and Fleetwood trawlers) of one-year-old cod in the last quarter of the year and of
the same year-class as 3 year olds in the first quarter 2 years later. The first
quarter was chosen because this is when the major cod fishery takes place and the
abundance is best estimated. The number of fish surviving to age 3 is of course
determined by the amount of fishing to which they are subjected in the interim,
but for the period under consideration (1964-1972) this has been fairly constant.
The values for the two ports are plotted in Figure 2a and b. As indicated in Table 2,
the values prior to 1967 are estimated from length frequency analysis, using a
maximum likelihood procedure to fit normal distributions. The estimates of one-
year-old abundance using this method are accurate, but the 3-year-old abundances
for the years before 1967 by this method may be less so. The later years (1967
onwards) are estimated from age/length keys. Functional regressions have been
fitted for the later years (Ricker, 1973) and the correlation coefficients, both
of which are significant, are indicated.

If estimates or guesses of the fishing mortalities in 1974 and 1975 are available, then predictions can be made for 1976, starting from the absolute abundance of the different year-classes in 1974 as estimated from an updating of Virtual Populations. Table 3 gives the catch per effort of one-year-olds in the last quarter for the whole Irish Sea (mean of the values for Fleetwood and Milford Haven in Table 2) and the Virtual Population of one-year-olds at the beginning of the fourth quarter as estimated from the international catch at age. As before, the values prior to 1967 are from length frequency analysis and they are plotted, with the functional regression, in Figure 3. The correlation coefficient is 0.93 for 3 df, which is significant, and the line passes reasonably close to the origin.

From these regressions it appears that a very good estimate of year-class strength can be made from the catch rate of one-year-old fish in the last quarter. In the case of the prediction for 1976 this means that we have a good idea of the 1973 year-class which, as 3-year-olds would normally be likely to account for 30% by weight of the catch in 1976. The 1974 year-class cannot be estimated from commercial catches, except possibly in the small mesh fisheries for Nephrops and industrial fish along the Irish coast. A 0-group survey in 1974 or young fish survey in January or February 1975 may give some indication of it. Hillis (1974) has attempted such estimates for whiting, but obviously several years data are required to establish the correlation. The 1975 year-class cannot be estimated in time to set 1976 TACs, as it is not spawned until March.

Thus, if an attempt is to be made to improve our predictions, it would seem that the effort would be best spent in trying to estimate the 1974 year-class in our example (ie the class spawned two years prior to the year being predicted). The record of attempts to estimate year-class strength by 0-group research survey is not particularly encouraging to date, and it would certainly be worthwhile to investigate the use of catch-rates from the small mesh commercial fisheries as well. The advantage of research surveys is that the unit of effort applied can be kept constant, but this is offset by the more limited coverage available. With any fast growing heavily fished species it will obviously be an advantage if the setting of TAC can be left as late in the year as possible, since this will allow the most recent information to be used.

Any 0-group or young fish survey could cover other species as well, but the problem is less acute with plaice and sole for example, since they grow into the fishery more slowly and are present in it over a greater age span.

REFERENCES

HILLIS, J. P. (1974). Relative brood strength and landings in Irish Sea whiting. I.C.E.S., C.M. 1974/F:42.

RICKER, W. E. (1973). Linear regressions in fishery research. J. Fish. Res. Board Can. 30: 409-434.

TABLE 1

Percentage by weight at age of Irish Sea cod in the Fleetwood trawl catch

| Age | Year | | | | | Mean |
	1969	1970	1971	1972	1973	1969-1973
1	5	10	15	6	9	9
2	26	24	33	42	10	27
3	36	17	26	29	44	30
4	24	19	12	12	20	17
5	5	18	7	4	9	9
6	2	8	5	3	4	4
7	2	3	2	3	2	2
8	+	1	+	+	1	+
9	+	+	+	+	+	+

TABLE 2 CATCH RATE (NO/100 h) OF IRISH SEA COD AT 1 YEAR
OLD (4TH QUARTER) AND 3 YEAR OLD (1ST QUARTER).
(VALUES ABOVE THE DOTTED LINE ARE ESTIMATED BY LENGTH
FREQUENCY ANALYSIS, THOSE BELOW BY AGE-LENGTH KEY.)

		FLEETWOOD		MILFORD HAVEN	
YEAR CLASS	AGE	1	3	1	3
1963		904.4	636.2	652.9	159.8
1964		632.1	409.1	495.9	103.0
1965		1480.9	567.2	1062.4	292.3
1966		652.4	961.5	275.5	124.9
1967		355.0	158.9	138.0	141.8
1968		439.9	376.3	1090.8	305.0
1969		849.5	449.6	470.9	130.6
1970		1546.5	698.2	1012.2	423.0
1971		551.2	301.1	228.6	57.5
1972		789.7		897.5	

TABLE 3 CATCH RATE (NO/100 h) OF IRISH SEA COD AT 1
YEAR OLD (4th QUARTER) AND VIRTUAL POPULATION
OF 1 YEAR OLDS AT THE START OF THE 4th QUARTER
(VALUES ABOVE THE LINE ARE ESTIMATED BY LENGTH
FREQUENCY ANALYSIS, THOSE BELOW BY AGE-LENGTH
KEY)

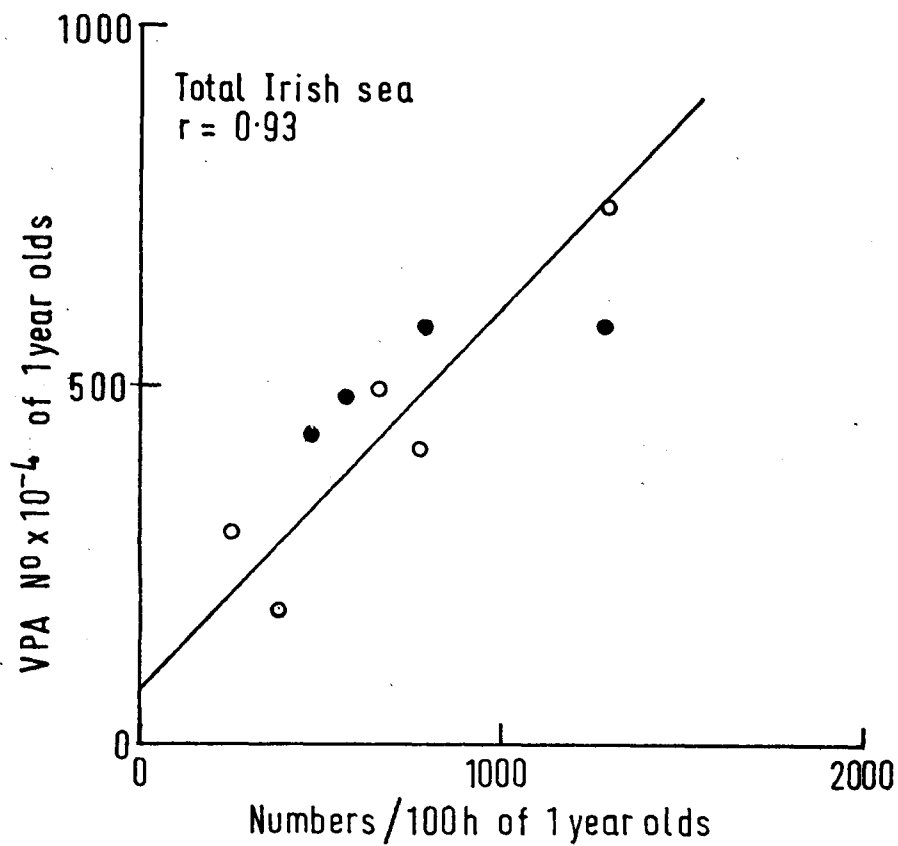| YEAR CLASS	CATCH RATE	VIRTUAL POPULATION ($\times 10^{-4}$)
1963	778.7	582.9
1964	564.0	485.2
1965	1271.7	583.7
1966	464.0	431.1
1967	246.5	300.0
1968	765.4	415.8
1969	660.2	494.6
1970	1279.3	754.1
1971	389.9	190.0
1972	843.6	
1973	(324)	

Fig. 3   Plot of abundance of one-year-old cod estimated by catch-per-effort against abundance estimated by virtual population analysis for the Irish Sea. The period 1964-67 shown by (●) and 1968-72 by (O).