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An assessment of the cod stock in NAFO Division 3M

by

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INTRODUCTION

An analysis of the cod stock in Division 3M was presented last year (Vazquez et al. 1995), where the recent history of the Flemish Cap cod fishery is fully described till 1994.

The 1995 cod fishery has been carried out as usual by Portuguese stern trawlers and gillnetters, Spanish pair-trawlers and longliners from Faroes. Most of the catches were taken during the first half of the year. Since then catch rates drop and the trawl fleets moved out or directed their fishing effort to other species. The 1995 catch level of cod catches is estimated to be around 10,000 tons (Table 1), which represents a substantial decline from the 1994 estimated level of 30,000 tons.

MATERIAL AND METHODS

**Commercial fishery data**

The 3M catch and effort data series for Portugal and Spain have been reconstructed for the 1988-1994 period by an extended revision of skippers log-books from each component of the national fleets (Vazquez et al. 1995).

**Spanish catch and effort data for 1995**

All Spanish cod catches were made by pair-trawlers in the first half of the year, most of them taken in June. Catch and effort data were derived from Spanish STATLANT 21B.

**Portuguese catch and effort data for 1995**

Observed catch and effort data from three trawlers and three gillnetters were reviewed on a haul by haul basis. These data, covering respectively 21% and 63% of the 1995 total fishing effort on Flemish Cap for Portuguese trawl and gillnet fleets, were used to calculate raw catch rates, mean number of hours trawling and mean number of nets hauled per fishing day, by month. The nominal effort of each fleet in fishing days was then multiplied by the correspondent mean catch per fishing day to give an estimate of the monthly catch. Around 85% of the estimated 1995 3M cod catches from trawl were taken during the first quarter of the year. Since the cod catch rates dropped and redfish, as well as on a lesser scale Greenland halibut, replaced cod as the main target species for trawl on Flemish Cap. The gillnet estimated cod catches were mainly taken in March (30%) and August/September (40%).

The catch of the three former Portuguese trawlers, with non-Contracting parties flags, sighted on 1995 in the NAFO Regulatory Area was calculated with the mean number of days that a Portuguese trawler spent fishing in Division 3M and the rational described above, using annual mean values for cod catch rate and number of hours trawling per fishing day.

Observed catches were derived from the conversion factors used in each vessel applied to its processed landings.

#### Sampling catch

Sampling of commercial catches was in 1995 only available for Portugal (Godinho et al. 1996). Portuguese catches were sampled on board for trawl on February and March and for gillnets on May and July. For both gears sampling included length frequencies of the total catch of the hauls and the stratified subsamples of otoliths. Mean weight in the catch and mean weight at age were calculated using 3M cod length-weight relationship obtained from EU bottom trawl survey on Flemish Cap in July 1995 (Vazquez 1996).

#### Data files for Extended Survivors Analysis (XSA)

The 1995 Portuguese catch estimates for trawl and gillnets were included in the landings data files of the present assessment together with the Spanish nominal catches of pair-trawlers, and the catches of Belize and Sierra Leone given by courtesy (NAFO 1996). The Faroese longline catch as well as non-reported catches from non-contracting parties were taken from inspections forms of Canadian Surveillance (NAFO 1996).

The catch figures for cod from Spanish pair-trawlers, Belize and Sierra Leone were considered to have a structure similar to the Portuguese trawl catch, and were broken down in numbers at age using the mean weight in the catch and the age composition of this catch fraction. The same rationale was applied to the Faroese longline catch as regards gillnet catches. The total number for 1995 were then incorporated in the catch-at-age data file (Table 2).

The mean weights at age used to update the catch weight-at-age data file were derived from Portuguese trawl and gillnet data combined. The stock weight at age were calculated using the EU survey data (Table 3).

Natural mortality was assumed at 0.2.

Abundance at age indices as calculated in the EU survey (Vazquez 1996) were used to tuning the Analysis (Table 4). Abundance at age indices for 1989 were recalculated in accordance to a revision of the ageing of the otoliths from 1989 survey samples. No effort/catch at age matrices from commercial CPUE series were used in the present analysis due to the discrepancy observed between survey biomass and CPUE trends over the time period considered (Avila de Melo and Alpoim, 1996).

### RESULTS AND DISCUSSION

An Extended Survivor Analysis (Darby and Flatman, 1994) was carried out for ages 1 to 8+ and years 1988 to 1995 (Table 5). Due to high levels of catches at age 2 observed in some years, ages 1 and 2 were considered in the present analysis although an increase is generally observed in the survey abundance indices from ages 1 to 3 for most of the 1988/1993 cohorts. Due to high  $t$  values on the regression analysis of catchability for some of the younger ages, catchability was considered independent of age at age 6, the penultimate true age considered in the analysis.

Total biomass from XSA and Spawning Stock Biomass (SSB) are compared with survey biomass in Figure 1. According to most recent analysis, cod spawned at a younger age in the last years than in the past: age at first maturity traditionally occurs at age 5, but it was observed at age 4 in 1994 and 1995 (Junquera and Saborido-Rey 1996).

Total biomass from XSA results decline from a higher level between 70,000 and 85,000 tons recorded in 1988-1990 period to an intermediate level around 50,000 tons observed between 1991 and 1994 (Figure 2). This decline seems to be related with the overexploitation of the abundant 1985 and 1986 cohorts. During this period fishing mortalities greater than one are observed throughout the age range of the exploited population. In 1994 the population was already basically restrained to the survivors of the abundant 1991 and 1990 year-classes but fishing mortalities on the correspondent age groups were still kept in the vicinity of 1 in 1994 and 1995. This fishing strategy lead to a further decline of the biomass in 1995 to a level near 30,000 ton, the lowest recorded in the time series. Biomass indices from EU surveys generally agree with XSA results, despite the year effects detected in some of these indices.

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Table 1 - Total cod catch on Flemish Cap. Reported nonimal catches and actual estimation. (tons)

| year | total<br>esti-<br>mated | reported |       |       |       |       |       |       |    |        | total |
|------|-------------------------|----------|-------|-------|-------|-------|-------|-------|----|--------|-------|
|      |                         | Faro.    | Japan | Korea | Norw. | Port. | Russ. | Spain | UK | others |       |
| 1988 | 28899                   | 1100     | 5     | 6     |       | 421   | 39    | 141   |    | 6      | 1718  |
| 1989 | 48373                   |          | 38    | 321   |       | 170   | 10    | 378   |    |        | 917   |
| 1990 | 40827                   | 1262     | 24    | 815   |       | 551   | 22    | 87    |    | 1      | 2762  |
| 1991 | 16229                   | 2472     | 54    | 82    | 795   | 2838  | 1     | 1416  | 26 | 1196   | 8989  |
| 1992 | 25089                   | 747      | 2     | 18    |       | 2201  | 1     | 4215  | 5  |        | 7226  |
| 1993 | 15958                   | 2075     |       | 3     |       | 3130  |       | 2249  |    |        | 7458  |
| 1994 | 29916                   |          |       |       |       | 2587  |       | 1952  |    |        | 4539  |
| 1995 | 10372                   | 1125     | 2     |       |       | 1670  |       | 563   |    | 445    | 3805  |

Table 2 - Catch in numbers. ('000)

| year | age: |       |       |       |       |      |      |     |
|------|------|-------|-------|-------|-------|------|------|-----|
|      | 1    | 2     | 3     | 4     | 5     | 6    | 7    | 8+  |
| 1988 | 1    | 3500  | 25593 | 11161 | 1399  | 414  | 315  | 162 |
| 1989 | 0    | 52    | 15399 | 23233 | 9373  | 943  | 220  | 205 |
| 1990 | 7    | 254   | 2180  | 15740 | 10824 | 2286 | 378  | 117 |
| 1991 | 1    | 561   | 5196  | 1960  | 3151  | 1688 | 368  | 76  |
| 1992 | 0    | 23425 | 15102 | 7055  | 4448  | 3061 | 1322 | 571 |
| 1993 | 0    | 2657  | 14530 | 3547  | 931   | 284  | 426  | 213 |
| 1994 | 0    | 1216  | 24692 | 7647  | 261   | 99   | 9    | 119 |
| 1995 | 0    | 0     | 264   | 6553  | 2750  | 651  | 135  | 232 |

Table 3 - Weights at age in both catch and stock. (Kg)

**catch**

| year | age:  |       |       |       |       |       |       |       |
|------|-------|-------|-------|-------|-------|-------|-------|-------|
|      | 1     | 2     | 3     | 4     | 5     | 6     | 7     | 8+    |
| 1988 | 0.058 | 0.198 | 0.442 | 0.821 | 2.190 | 3.386 | 5.274 | 7.969 |
| 1989 | 0.000 | 0.209 | 0.576 | 0.918 | 1.434 | 2.293 | 4.721 | 7.648 |
| 1990 | 0.080 | 0.153 | 0.500 | 0.890 | 1.606 | 2.518 | 3.554 | 7.166 |
| 1991 | 0.118 | 0.229 | 0.496 | 0.785 | 1.738 | 2.622 | 3.474 | 6.818 |
| 1992 | 0.000 | 0.298 | 0.415 | 0.593 | 1.084 | 1.702 | 2.615 | 3.851 |
| 1993 | 0.000 | 0.210 | 0.509 | 0.894 | 1.829 | 2.233 | 3.367 | 4.841 |
| 1994 | 0.142 | 0.289 | 0.511 | 0.798 | 1.559 | 2.246 | 1.465 | 3.115 |
| 1995 | 0.000 | 0.000 | 0.415 | 0.790 | 1.447 | 2.266 | 3.960 | 5.500 |

**stock**

| year | age:  |       |       |       |       |       |       |       |
|------|-------|-------|-------|-------|-------|-------|-------|-------|
|      | 1     | 2     | 3     | 4     | 5     | 6     | 7     | 8+    |
| 1988 | 0.031 | 0.103 | 0.308 | 0.678 | 1.973 | 3.594 | 5.772 | 6.926 |
| 1989 | 0.035 | 0.214 | 0.628 | 1.260 | 2.062 | 3.779 | 4.269 | 6.930 |
| 1990 | 0.039 | 0.170 | 0.342 | 0.846 | 1.501 | 2.426 | 4.083 | 5.635 |
| 1991 | 0.054 | 0.166 | 0.495 | 0.855 | 1.611 | 2.606 | 4.255 | 7.692 |
| 1992 | 0.054 | 0.246 | 0.490 | 1.377 | 1.702 | 2.633 | 3.133 | 6.685 |
| 1993 | 0.043 | 0.222 | 0.655 | 1.209 | 2.270 | 2.371 | 3.449 | 5.890 |
| 1994 | 0.060 | 0.211 | 0.624 | 1.241 | 1.974 | 3.940 | 4.034 | 6.282 |
| 1995 | 0.046 | 0.235 | 0.466 | 0.961 | 1.850 | 3.159 | 5.555 | 8.480 |

Table 4 - EU survey abundances at age used for tuning XSA  
(8+ group not used). ('0000)

| age    | year : |        |       |       |       |       |       |      |
|--------|--------|--------|-------|-------|-------|-------|-------|------|
|        | 1988   | 1989   | 1990  | 1991  | 1992  | 1993  | 1994  | 1995 |
| 1 :    | 458    | 2418   | 237   | 13780 | 7118  | 438   | 314   | 155  |
| 2 :    | 7196   | 6062   | 1179  | 2560  | 3706  | 13274 | 385   | 1137 |
| 3 :    | 4037   | 6964   | 467   | 1548  | 475   | 2852  | 4710  | 123  |
| 4 :    | 1085   | 2819   | 1588  | 192   | 203   | 102   | 844   | 361  |
| 5 :    | 128    | 227    | 1453  | 622   | 33    | 127   | 18    | 90   |
| 6 :    | 22     | 33     | 394   | 173   | 127   | 17    | 9     | 1    |
| 7 :    | 28     | 12     | 32    | 25    | 21    | 50    | 0     | 2    |
| 8 :    | 11     | 8      | 24    | 6     | 2     | 10    | 19    | 2    |
| B 1+ : | 33038  | 100067 | 51155 | 37049 | 22780 | 55170 | 42773 | 8763 |
| B 2+ : | 32896  | 99220  | 51063 | 29608 | 18937 | 54982 | 42584 | 8692 |
| B 3+ : | 25484  | 86248  | 49059 | 25358 | 9820  | 25513 | 41772 | 6020 |
| B 4+ : | 13050  | 42514  | 47461 | 17696 | 7493  | 6833  | 12382 | 5447 |
| B 5+ : | 5694   | 6994   | 34027 | 16054 | 4697  | 5599  | 1908  | 1977 |
| B 6+ : | 3169   | 2314   | 12217 | 6034  | 4136  | 2717  | 1552  | 312  |
| B 7+ : | 2378   | 1067   | 2659  | 1525  | 792   | 2314  | 1198  | 281  |
| B 8+ : | 762    | 554    | 1352  | 462   | 134   | 589   | 1194  | 170  |

Table 5 - Results of the Extended Survivors Analysis.

Lowestoft VPA Version 3.1

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Extended Survivors Analysis

BACALAO 3M 1996, 8+

CPUE data from file \VPA\data\COD96.Tun

Catch data for 8 years. 1988 to 1995. Ages 1 to 8.

| Fleet,  | First,  | Last, | First, | Last, | Alpha, | Beta |
|---------|---------|-------|--------|-------|--------|------|
|         | year,   | year, | age,   | age   |        |      |
| EU-SURV | , 1988, | 1995, | 1,     | 7,    | .500,  | .600 |

Time series weights :

Tapered time weighting applied  
Power = 3 over 20 years

Catchability analysis :

Catchability dependent on stock size for ages < 6

Regression type = C  
Minimum of 5 points used for regression  
Survivor estimates shrunk to the population mean for ages < 6

Catchability independent of age for ages >= 6

Terminal population estimation :

Survivor estimates shrunk towards the mean F  
of the final 5 years or the 5 oldest ages.

S.E. of the mean to which the estimates are shrunk = .500

Minimum standard error for population  
estimates derived from each fleet = .300

Prior weighting not applied

Tuning converged after 14 iterations

Regression weights

, .877, .921, .954, .976, .990, .997, 1.000, 1.000

Fishing mortalities

Age, 1988, 1989, 1990, 1991, 1992, 1993, 1994, 1995

|    |       |        |        |       |        |        |        |       |
|----|-------|--------|--------|-------|--------|--------|--------|-------|
| 1, | .000, | .000,  | .000,  | .000, | .000,  | .000,  | .000,  | .000  |
| 2, | .060, | .004,  | .013,  | .021, | .491,  | .055,  | .538,  | .000  |
| 3, | .404, | .404,  | .205,  | .394, | 1.219, | .654,  | 1.041, | .209  |
| 4, | .507, | .804,  | .970,  | .287, | 1.616, | 1.151, | .900,  | .901  |
| 5, | .474, | 1.129, | 1.212, | .511, | 2.557, | 1.049, | .216,  | 1.025 |
| 6, | .540, | .692,  | .977,  | .597, | 1.570, | 2.632, | .276,  | 1.328 |
| 7, | .406, | .625,  | .669,  | .394, | 1.519, | 1.042, | .692,  | .752  |

F 3/5 : 0.433 0.667 0.869 0.397 1.503 0.739 0.985 0.875

XSA population numbers (Thousands)

| age    | year : |        |       |       |       |       |       |       | term  |
|--------|--------|--------|-------|-------|-------|-------|-------|-------|-------|
|        | 1988   | 1989   | 1990  | 1991  | 1992  | 1993  | 1994  | 1995  |       |
| 1 :    | 19500  | 26600  | 36100 | 81500 | 66500 | 3950  | 12700 | 13400 | 0     |
| 2 :    | 66500  | 15900  | 21800 | 29600 | 66700 | 54500 | 3230  | 10400 | 11000 |
| 3 :    | 85100  | 51200  | 13000 | 17600 | 23700 | 33500 | 42200 | 1550  | 8530  |
| 4 :    | 31000  | 46500  | 28000 | 8670  | 9730  | 5730  | 14200 | 12200 | 1030  |
| 5 :    | 4100   | 15300  | 17000 | 8700  | 5330  | 1580  | 1480  | 4740  | 4060  |
| 6 :    | 1100   | 2090   | 4050  | 4150  | 4270  | 338   | 454   | 979   | 1390  |
| 7 :    | 1040   | 523    | 856   | 1250  | 1870  | 727   | 20    | 282   | 212   |
| B 1+ : | 72728  | 136757 | 72085 | 55589 | 71184 | 48034 | 50189 | 28935 |       |
| B 2+ : | 72124  | 135826 | 70677 | 51188 | 67593 | 47864 | 49427 | 28319 | 20629 |
| B 3+ : | 65274  | 132423 | 66971 | 46274 | 51184 | 35765 | 48746 | 25875 | 18044 |
| B 4+ : | 39064  | 100269 | 62525 | 37562 | 39571 | 13823 | 22413 | 25152 | 14070 |
| B 5+ : | 18046  | 41679  | 38837 | 30149 | 26173 | 6895  | 4791  | 13428 | 13080 |
| B 6+ : | 9956   | 10131  | 13320 | 16134 | 17102 | 3309  | 1869  | 4659  | 5569  |
| B 7+ : | 6003   | 2233   | 3495  | 5319  | 5859  | 2507  | 80    | 1567  | 1178  |

Estimated population abundance at 1st Jan 1996

, 0.00E+00, 1.10E+04, 8.53E+03, 1.03E+03, 4.06E+03, 1.39E+03, 2.12E+02,

Taper weighted geometric mean of the VPA populations:

, 2.25E+04, 2.28E+04, 2.13E+04, 1.52E+04, 5.14E+03, 1.48E+03, 4.99E+02,

Standard error of the weighted Log(VPA populations) :

, .9954, 1.0580, 1.2337, .7177, .9225, 1.0242, 1.4514,

Log catchability residuals.

Fleet : EU-SURV

| Age | 1988 | 1989 | 1990  | 1991 | 1992 | 1993 | 1994  | 1995  |
|-----|------|------|-------|------|------|------|-------|-------|
| 1   | -.44 | .62  | -1.60 | .94  | .60  | 1.12 | -.33  | -.96  |
| 2   | .01  | 1.20 | -.96  | -.38 | -.48 | .90  | .01   | -.27  |
| 3   | -.49 | .52  | -.68  | .20  | -.76 | .25  | .67   | .23   |
| 4   | -.35 | -.01 | .17   | -.32 | .09  | -.01 | .40   | -.01  |
| 5   | -.09 | -.67 | .72   | .42  | -.52 | 1.11 | -.73  | -.27  |
| 6   | -.34 | -.50 | 1.48  | .42  | .62  | 1.72 | -.50  | -2.89 |
| 7   | -.13 | -.16 | .35   | -.43 | -.39 | 1.16 | -1.64 | -1.27 |

Mean log catchability and standard error of ages with catchability independent of year class strength and constant w.r.t. time

| Age        | 6       | 7       |
|------------|---------|---------|
| Mean Log q | -3.1596 | -3.1596 |
| S.E(Log q) | 1.4698  | .9561   |

Regression statistics :

Ages with q dependent on year class strength

| Age | Slope | t-value | Intercept | RSquare | No Pts | Reg s.e | Mean Log q |
|-----|-------|---------|-----------|---------|--------|---------|------------|
| 1   | .83   | .420    | 4.28      | .51     | 8      | 1.06    | -3.08      |
| 2   | 1.13  | -.464   | .90       | .69     | 8      | .78     | -1.96      |
| 3   | .91   | .455    | 2.97      | .83     | 8      | .60     | -2.31      |
| 4   | .67   | 2.285   | 5.04      | .89     | 8      | .27     | -2.79      |
| 5   | .79   | .677    | 4.11      | .64     | 8      | .75     | -2.92      |

Ages with q independent of year class strength and constant w.r.t. time.

| Age | Slope | t-value | Intercept | RSquare | No Pts | Reg s.e | Mean Q |
|-----|-------|---------|-----------|---------|--------|---------|--------|
| 6   | .81   | .400    | 3.95      | .43     | 8      | 1.27    | -3.16  |
| 7   | .71   | 2.049   | 4.26      | .90     | 8      | .52     | -3.48  |

Terminal year survivor and F summaries :

Age 1 Catchability dependent on age and year class strength

Year class = 1994

| Fleet            | Estimated Survivors | Int, s.e. | Ext, s.e. | Var, Ratio | N, Scaled Weights | Estimated F |
|------------------|---------------------|-----------|-----------|------------|-------------------|-------------|
| EU-SURV          | 4193.               | 1.212     | .000      | .00        | 1, .432           | .000        |
| P shrinkage mean | 22844.              | 1.06      |           |            | .568              | .000        |
| F shrinkage mean | 0.                  | .50       |           |            | .000              | .000        |

Weighted prediction :

| Survivors,<br>at end of year, | Int,<br>s.e. | Ext,<br>s.e. | N, | Var,<br>Ratio, | F    |
|-------------------------------|--------------|--------------|----|----------------|------|
| 10975.,                       | .80,         | 1.28,        | 2, | 1.602,         | .000 |

Age 2 Catchability dependent on age and year class strength

Year class = 1993

| Fleet,           | Estimated,<br>Survivors, | Int,<br>s.e. | Ext,<br>s.e. | Var,<br>Ratio, | N, Scaled,<br>Weights, | Estimated<br>F |
|------------------|--------------------------|--------------|--------------|----------------|------------------------|----------------|
| EU-SURV          | 6400.,                   | .692,        | .029,        | .04,           | 2, .761,               | .000           |
| P shrinkage mean | 21253.,                  | 1.23,,,      |              |                | .239,                  | .000.          |
| F shrinkage mean | 0.,                      | .50,,,       |              |                | .000,                  | .000           |

Weighted prediction :

| Survivors,<br>at end of year, | Int,<br>s.e. | Ext,<br>s.e. | N, | Var,<br>Ratio, | F    |
|-------------------------------|--------------|--------------|----|----------------|------|
| 8529.,                        | .60,         | .42,         | 3, | .689,          | .000 |

Age 3 Catchability dependent on age and year class strength

Year class = 1992

| Fleet,           | Estimated,<br>Survivors, | Int,<br>s.e. | Ext,<br>s.e. | Var,<br>Ratio, | N, Scaled,<br>Weights, | Estimated<br>F |
|------------------|--------------------------|--------------|--------------|----------------|------------------------|----------------|
| EU-SURV          | 1413.,                   | .545,        | .252,        | .46,           | 3, .278,               | .156           |
| P shrinkage mean | 15185.,                  | .72,,,       |              |                | .236,                  | .016           |
| F shrinkage mean | 231.,                    | .50,,,       |              |                | .486,                  | .709           |

Weighted prediction :

| Survivors,<br>at end of year, | Int,<br>s.e. | Ext,<br>s.e. | N, | Var,<br>Ratio, | F    |
|-------------------------------|--------------|--------------|----|----------------|------|
| 1027.,                        | .33,         | .86,         | 5, | 2.584,         | .209 |

Age 4 Catchability dependent on age and year class strength

Year class = 1991

| Fleet,           | Estimated,<br>Survivors, | Int,<br>s.e. | Ext,<br>s.e. | Var,<br>Ratio, | N, Scaled,<br>Weights, | Estimated<br>F |
|------------------|--------------------------|--------------|--------------|----------------|------------------------|----------------|
| EU-SURV          | 4342.,                   | .273,        | .135,        | .49,           | 4, .495,               | .861           |
| P shrinkage mean | 5141.,                   | .92,,,       |              |                | .115,                  | .767           |
| F shrinkage mean | 3473.,                   | .50,,,       |              |                | .390,                  | .996           |

Weighted prediction :

| Survivors,<br>at end of year, | Int,<br>s.e. | Ext,<br>s.e. | N, | Var,<br>Ratio, | F    |
|-------------------------------|--------------|--------------|----|----------------|------|
| 4058.,                        | .26,         | .10,         | 6, | .384,          | .901 |



Age 5 Catchability dependent on age and year class strength

Year class = 1990

| Fleet,           | Estimated,<br>Survivors, | Int,<br>s.e, | Ext,<br>s.e, | Var,<br>Ratio, | N, Scaled,<br>, Weights, | Estimated<br>F |
|------------------|--------------------------|--------------|--------------|----------------|--------------------------|----------------|
| EU-SURV          | 1734.,                   | .275,        | .155,        | .56,           | 5, .331,                 | .890           |
| P shrinkage mean | 1481.,                   | 1.02, , , ,  |              |                | .129,                    | .986           |
| F shrinkage mean | 1201.,                   | .50, , , ,   |              |                | .540,                    | 1.122          |

Weighted prediction :

| Survivors,<br>at end of year, | Int,<br>s.e, | Ext,<br>s.e, | N,<br>, | Var,<br>Ratio, | F     |
|-------------------------------|--------------|--------------|---------|----------------|-------|
| 1393.,                        | .31,         | .13,         | 7,      | .427,          | 1.025 |

Age 6 Catchability constant w.r.t. time and dependent on age

Year class = 1989

| Fleet,           | Estimated,<br>Survivors, | Int,<br>s.e, | Ext,<br>s.e, | Var,<br>Ratio, | N, Scaled,<br>, Weights, | Estimated<br>F |
|------------------|--------------------------|--------------|--------------|----------------|--------------------------|----------------|
| EU-SURV          | 128.,                    | .320,        | .381,        | 1.19,          | 6, .219,                 | 1.724          |
| F shrinkage mean | 245.,                    | .50, , , ,   |              |                | .781,                    | 1.225          |

Weighted prediction :

| Survivors,<br>at end of year, | Int,<br>s.e, | Ext,<br>s.e, | N,<br>, | Var,<br>Ratio, | F     |
|-------------------------------|--------------|--------------|---------|----------------|-------|
| 212.,                         | .40,         | .29,         | 7,      | .719,          | 1.328 |

Age 7 Catchability constant w.r.t. time and age (fixed at the value for age) 6

Year class = 1988

| Fleet,           | Estimated,<br>Survivors, | Int,<br>s.e, | Ext,<br>s.e, | Var,<br>Ratio, | N, Scaled,<br>, Weights, | Estimated<br>F |
|------------------|--------------------------|--------------|--------------|----------------|--------------------------|----------------|
| EU-SURV          | 76.,                     | .477,        | .360,        | .75,           | 7, .223,                 | .958           |
| F shrinkage mean | 121.,                    | .50, , , ,   |              |                | .777,                    | .699           |

Weighted prediction :

| Survivors,<br>at end of year, | Int,<br>s.e, | Ext,<br>s.e, | N,<br>, | Var,<br>Ratio, | F    |
|-------------------------------|--------------|--------------|---------|----------------|------|
| 109.,                         | .40,         | .22,         | 8,      | .547,          | .752 |

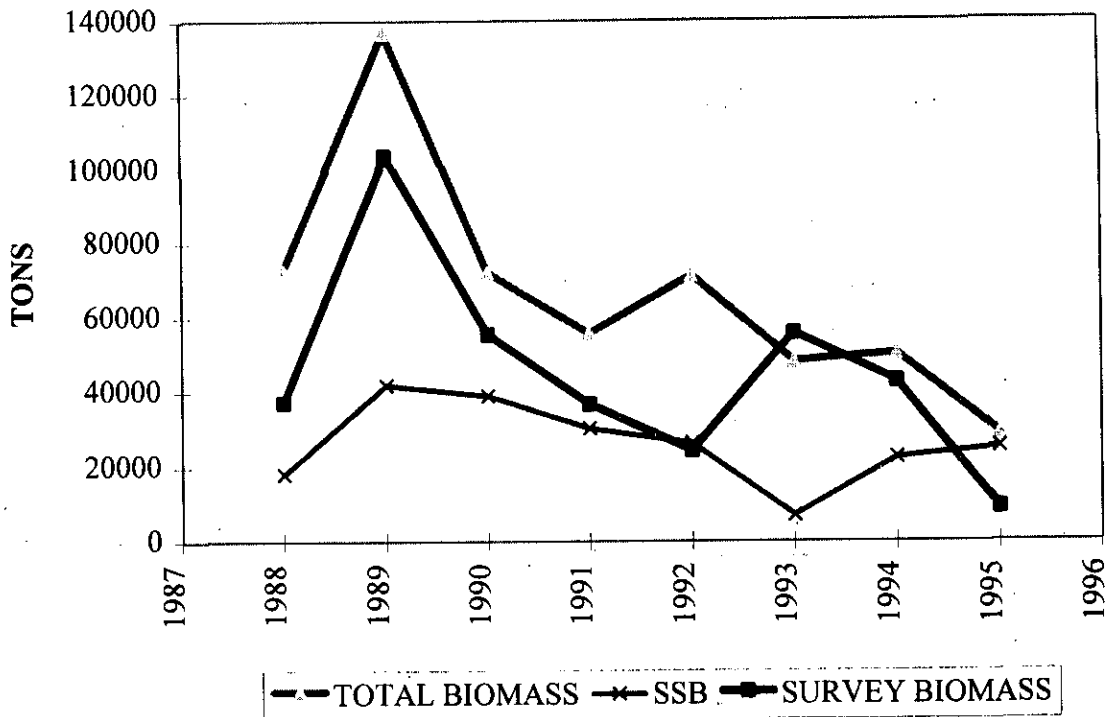


Figure 1 - Total cod biomass according EU survey and total biomass and spawning stock biomass estimate according XSA results.

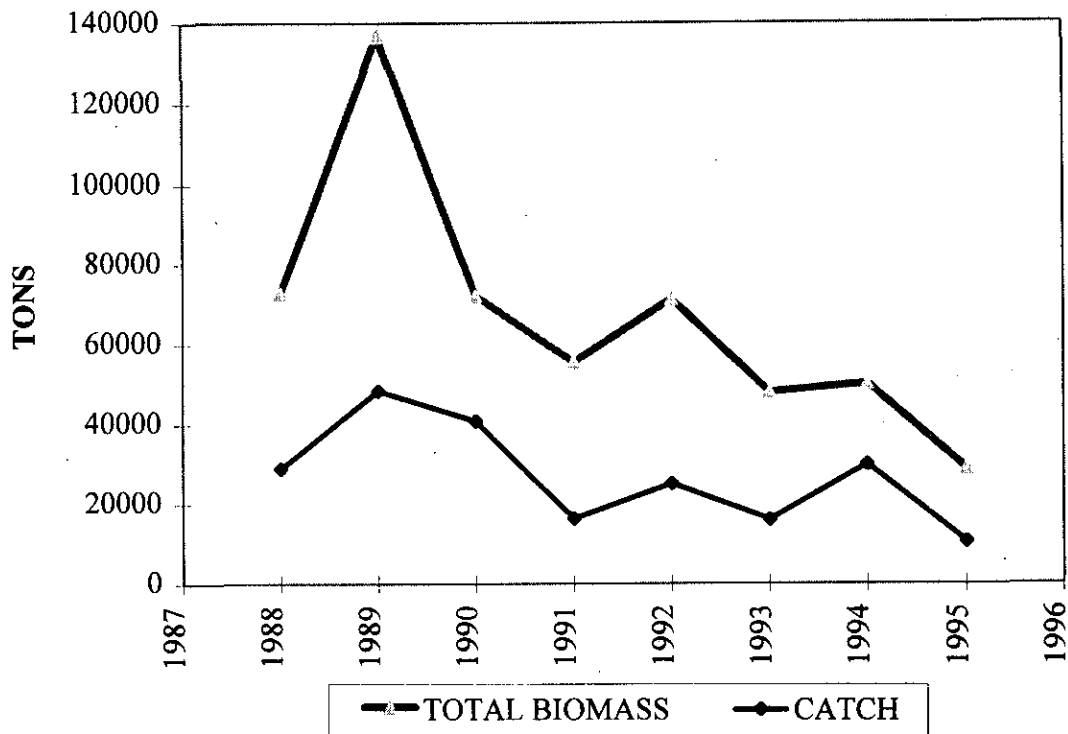


Figure 2 - Total annual cod catch compared with total biomass according to XSA results.