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An Assessment of the American Plaice Stock in Division 3M

by

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American Plaice in Division 3M (SCR Doc. 93/16, 19; SCS Doc. 93/10, 14, 15)

a) Introduction

Since 1974, when this stock started to be regulated, reported catches ranged from 600 tons in 1981 to the highest value of 5 600 tons in 1987. From 1989 to 1990 reported catches declined drastically from 3 500 tons to 800 tons and after that stayed below the TAC (Fig. 1). Nominal catches for 1992 are 763 tons including 10 tons reported by South Korea. Estimated overall catch derived from Canadian Surveillance is at 900 ton.

Recent TACs and catches ('000 tons) are as follows:

	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
TAC	2	2	2	2	2	2	2	2	2	2	2
Catch	1.9	1.3	1.7	3.8	5.6	2.8	3.5[1]	0.8[1]	1.6[1]	0.8[1]	

[1] Provisional.

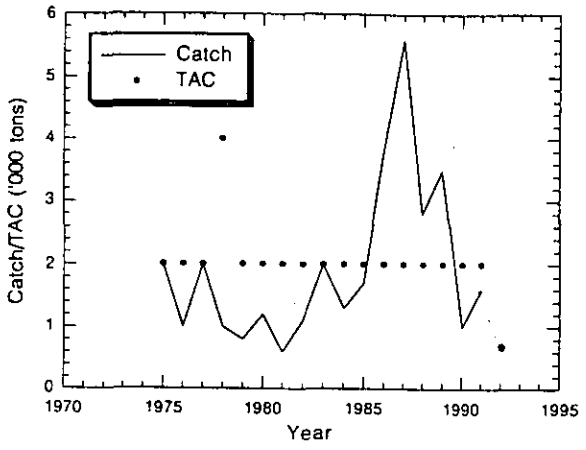

Fig. 1. American plaice in Div. 3M: catches and TACs.

b) Input Data

i) Commercial fishery data

There was no directed fishery for American plaice in Div. 3M during 1992.

Biological information is available for Spain and Portugal by-catches. For the Spanish small freezer fishery lengths ranged from 28 cm to 52 cm with two modes at 38 cm and 48 cm. For

Portuguese trawlers the information available, although weak, indicated age 6 as the most abundant for both sexes. For the gillnet fishery sampled from June to October, length distributions are quite different for each sex, males ranging mainly from 26 cm to 42 cm with a mode at 38 cm while females concentrate on the 38-54 cm range. Ages 6, 5 and 4 were the most abundant for males while age 13 (48 cm mean length) was the best represented in the gillnet fishery, followed by the 6 one.

Catch-at-age were estimated for the 1988-92 period (Table 1). Evolution of mean weight-at-age for the 3-10 age group, presented in Table 2, Fig. 2, suggest a slight decrease for the older ages, from 1991 to 1992.

ii) Research survey data

Research surveys were conducted in 1992 by EEC in July and Russia in April. Russian surveys showed high variability in the biomass in recent years. In 1992 estimated biomass decreased from 14 000 tons to 1 000 tons. Biomass from EEC surveys showed a continuous decrease from 11 868 tons in 1988 to 6 492 tons in 1992 (Table 3, Fig. 3). The same occurred with the abundance which decreased from 21.2 mill. indiv. in 1988 to 10.4 mill. in 1992 (Table 4). The 1986 year-class still appeared as the most abundant in the EEC survey. There is some indication that the 1990 year-class can be more abundant than the previous ones but only about one-third of the 1986 strong one at age 2.

A maturation ogive is available for the 1992 research cod tagging survey. L_{50} is estimated to be about 42 cm. Spawning stock biomass (age 5+) of American plaice, that increased slightly last year, decreased from 5 700 tons in 1991 to 3 600 tons in 1992, despite the full recruitment of the (strong) 1986 year-class to the spawning stock. Spawning biomass (age 5+) estimated from EEC surveys on Flemish Cap are as follows:

Year	1988	1989	1990	1991	1992
Biomass[1]	8.5	5.8	5.3	5.7	3.6

[1] 1992 estimate using abundance from EEC surveys and mean weight-at-age in the catch.

c) Assessment of parameters

An analytical assessment, not available until now, was attempted for the period 1988-92. A catch matrix was constructed using the following information:

1988 - Length composition for the Spanish freezer catches (SCS Doc. 89/15); age-length keys from the 1988 EEC research survey (SCR Doc. 89/60).

1989 - Age composition for Spanish freezer catch (SCS Doc. 90/13); length composition for the 1989 Portuguese trawl catches (SCS Doc. 90/12); age length keys for 1989 EEC research survey (SCR Doc. 90/68).

1990 - Age composition for Spanish freezer catches (SCS Doc. 91/16); length composition for Portuguese trawl catches (SCS Doc. 91/15); age length keys from EEC survey (SCR 91/28).

1991 - Age composition for Spanish freezer catches (SCS Doc. 92/13); age composition of Portuguese gillnet catches (SCS Doc. 92/14).

1992 - Length composition for Spanish freezer catches (SCS Doc. 93/14); age length keys from EEC surveys (SCR 93/19); age composition for Portuguese trawl and gillnet catches (SCS Doc. 93/15).

Mean length and mean weight-at-age in the catch are presented in Table 2.

The catch matrix, presented in Table 1, shows some inconsistencies, namely for age 3 in 1988 and subsequent years. The same occurs with ages 4 and 5 also in 1988. This may reflect some problems with sampling or age readings.

A L/S was attempted using the EEC survey data to calibrate the analysis. The obtained results are given in Table 5. Results indicate a decrease in fishing mortality on the last year that is consistent with the fact that part of the trawl fleet shift to the Greenland halibut fishery. However, the statistics of the analysis indicate that standard error of q is bigger than q in all the cases. A separate VPA was attempted with ages below 10 to find the exploitation pattern. A full recruitment was chosen at age 6, $\bar{F}$ = 0.7 and final S at 1. The results show a tendency in the residuals for the last two years that implies a change in the exploitation pattern. However, one can see that this fishery is fully recruited at age 8.

L_n of catch-at-age in numbers were plotted versus age for the period 1988-90 (Fig. 4). We can see that fully recruited age is about age 8. That is consistent with the result from separate analysis. From this curve we have estimated F for that period for ages 8-11 as 0.53.

Taking into account that the survey was conducted in July, it is assumed that it can be considered as an index of B_c so:

$$C = \bar{F} \cdot q \cdot \bar{B}.$$

We can do for ages 8-11 and for the period 1988-90

$q = \dfrac{C_{88} + C_{89} + C_{90}}{B_{88} + B_{89} + B_{90}} \cdot \dfrac{1}{F}$ being the catchability of the survey.

With q known we can assess the level of F for 1992, that was estimated to be below 0.1. This result is similar to the one obtained by the L/S.

d) Prognosis

STACFIS noted that, despite the high variability in the Russian research survey results, it appears that the stock has steadily decline in recent years. It is believed that this decline is due to excessive fishing mortality at least in the period 1988-90. In order to halt the decline of the stock, STACFIS advises that a TAC of 1 000 tons should be set for 1994. This corresponds to the expected by-catch in non-directed fisheries.

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TABLE 1. 3M American plaice catch-at-age for 1988-92.

CATCH AGE MATRIX

	1988	1989	1990	1991	1992
3	35	198	12	22	11
4	208	158	193	162	22
5	855	533	60	868	62
6	1185	1048	100	459	204
7	806	1094	177	657	53
8	1024	524	240	579	107
9	295	469	163	354	96
10	95	224	72	100	45
11	25	177	11	11	26
12	53	42	2	4	14
13	56	21	2	0	16
14	14	8	1	0	0
15	28	0	0	0	0
Catch	2800	3500	800	1600	800

TABLE 2. 3M American plaice mean length-at-age and mean weight-at-age in the catch for 1988-92.

MEAN LENGTH AT AGE

	1988	1989	1990	1991	1992
3	26.66	29.38	29.00	23.29	27.57
4	29.99	33.30	32.92	31.31	30.91
5	30.97	35.31	36.24	35.87	35.49
6	35.21	40.15	38.20	38.99	39.57
7	39.00	43.26	42.93	43.35	41.44
8	43.22	44.64	45.10	46.09	44.91
9	45.23	47.28	46.58	48.81	47.62
10	47.81	44.60	46.89	49.94	48.68
11	48.23		56.05	51.00	51.14
12	51.28		55.00	52.98	52.72
13	54.26		53.51		55.97
14	53.00		53.81		
15	53.78				

Table 2. (cont'd)

MEAN WEIGHT AT AGE

	1988	1989	1990	1991	1992
3	0.181	0.247	0.237	0.117	0.201
4	0.264	0.371	0.358	0.304	0.292
5	0.293	0.449	0.488	0.472	0.456
6	0.445	0.681	0.579	0.619	0.649
7	0.619	0.867	0.845	0.873	0.754
8	0.864	0.960	0.992	1.064	0.978
9	1.001	1.156	1.101	1.282	1.183
10	1.198	0.957	1.125	1.380	1.271
11	1.233		2.006	1.477	1.491
12	1.504		1.887	1.671	1.645
13	1.806		1.726		1.997
14	1.674		1.758		2.000
15	1.755				2.000

TABLE 3. 3M American plaice total biomass estimated from EEC surveys (1) and USSR/Russia surveys (2).

year	EEC[1]	Russia[2]
1983 -		8,900
1984 -		7,500
1985 -		7,800
1986 -		20,200
1987 -		9,300
1988 -	11,868	6,500
1989 -	10,533	5,000
1990 -	9,101	1,200
1991 -	7,565	14,400
1992 -	6,492	1,000

tons

(1) Vazquez, 1993
(2) Rikhter *et al.*, 1991; Borovkov *et al.*, 1992, Borovkov *et al.*, 1993.

TABLE 4. 3M American plaice abundance by age-group estimated from EEC surveys (Vazquez, 1993).

age	year: 1988	1989	1990	1991	1992
2 -	2284	454	359	309	736
3 -	625	6847	775	911	679
4 -	3034	1500	7083	1877	910
5 -	1975	3238	897	4461	1471
6 -	3020	3006	2475	1836	3423
7 -	4154	2868	1717	2009	913
8 -	4258	1691	1657	1566	1090
9 -	1492	587	1030	675	624
10 -	207	261	485	232	289
11 -	109	34	90	8	138
12 -	61	14	15	48	74
13 -	-	-	31	-	16
14 -	-	-	17	-	-
total	21219	20500	16631	13932	10363
biomass	11868	10533	9101	7565	6492
SOP		9726	8827	7682	6111
N 6+	13301	8461	7517	6374	6567

(x 1000)

TABLE 5.

VPA Version 3.0 (MSDOS)

At 8/06/1993 13:24

3M AMERICAN PLAICE S-1

CPUE data from file bacsurfl.dat

Disaggregated Qs
Log transformation
No trend in Q (mean used)

Terminal Fs estimated using Laurec-Shepherd

Tuning converged after 20 iterations

Total of the absolute F residuals for all ages in the last year, between iterations 19 and 20 = .000

Regression weights
, 1.000, 1.000, 1.000, 1.000, 1.000

Oldest age F = 1.000*average of 3 younger ages.

Fishing mortalities

Age,	1988,	1989,	1990,	1991,	1992
3,	.014,	.029,	.004,	.018,	.008
4,	.059,	.080,	.036,	.069,	.022
5,	.208,	.210,	.040,	.225,	.034
6,	.323,	.423,	.055,	.470,	.075
7,	.354,	.558,	.116,	.602,	.089
8,	.747,	.411,	.225,	.665,	.181
9,	.394,	.964,	.215,	.601,	.214
10,	.361,	.591,	.367,	.198,	.138
11,	.331,	3.038,	.050,	.087,	.072
12,	1.000,	1.555,	.335,	.023,	.152
13,	.564,	1.728,	.251,	.103,	.121

Log catchability residuals

Fleet : EEC survey

Age ,	1988,	1989,	1990,	1991,	1992
3 ,	-.63,	.77,	-.59,	.45,	.00
4 ,	-.06,	-.18,	.37,	-.13,	.00
5 ,	-.52,	.46,	-.31,	.36,	.00
6 ,	-.43,	-.04,	.08,	.40,	.00
7 ,	.17,	-.05,	-.31,	.18,	.00
8 ,	.52,	-.33,	-.17,	-.02,	.00
9 ,	.36,	-.14,	-.02,	-.19,	.00
10 ,	-.12,	-.25,	1.03,	-.66,	.00
11 ,	1.32,	.42,	.06,	-1.81,	.00
12 ,	.36,	-.44,	1.14,	-1.07,	.00

SUMMARY STATISTICS FOR AGE 3

Fleet ,	Pred. q ,	SE(q),	Partial F ,	Raised, F ,	SLOPE ,	SE Slope ,	INTRCPT, Intrcpt	SE
1 ,	-.76 ,	.681,	.4690 ,	.0076,	.944E-01,	.220E+00,	-.757,	.278

Fbar	SIGMA(int.)	SIGMA(ext.)	SIGMA(overall)	Variance ratio
.008	.681	0.000	.681	0.000

TABLE 5. (continued).

SUMMARY STATISTICS FOR AGE 4

Fleet	Pred. q	SE(q)	Partial F	Raised F	SLOPE	SE Slope	INTRCPT Intrcpt	SE
1	-.09	.241	.9134	.0221	.165E-01	.797E-01	-.091	.098

Fbar	SIGMA(int.)	SIGMA(ext.)	SIGMA(overall)	Variance ratio
.022	.241	0.000	.241	0.000

SUMMARY STATISTICS FOR AGE 5

Fleet	Pred. q	SE(q)	Partial F	Raised F	SLOPE	SE Slope	INTRCPT Intrcpt	SE
1	-.22	.460	.8056	.0340	.933E-01	.144E+00	-.216	.188

Fbar	SIGMA(int.)	SIGMA(ext.)	SIGMA(overall)	Variance ratio
.034	.460	0.000	.460	0.000

SUMMARY STATISTICS FOR AGE 6

Fleet	Pred. q	SE(q)	Partial F	Raised F	SLOPE	SE Slope	INTRCPT Intrcpt	SE
1	.24	.324	1.2660	.0754	.130E+00	.777E-01	.236	.132

Fbar	SIGMA(int.)	SIGMA(ext.)	SIGMA(overall)	Variance ratio
.075	.324	0.000	.324	0.000

SUMMARY STATISTICS FOR AGE 7

Fleet	Pred. q	SE(q)	Partial F	Raised F	SLOPE	SE Slope	INTRCPT Intrcpt	SE
1	.43	.221	1.5323	.0890	-.119E-01	.734E-01	.427	.090

Fbar	SIGMA(int.)	SIGMA(ext.)	SIGMA(overall)	Variance ratio
.089	.221	0.000	.221	0.000

SUMMARY STATISTICS FOR AGE 8

Fleet	Pred. q	SE(q)	Partial F	Raised F	SLOPE	SE Slope	INTRCPT Intrcpt	SE
1	.61	.351	1.8411	.1807	-.740E-01	.109E+00	.610	.143

Fbar	SIGMA(int.)	SIGMA(ext.)	SIGMA(overall)	Variance ratio
.181	.351	0.000	.351	0.000

SUMMARY STATISTICS FOR AGE 9

Fleet	Pred. q	SE(q)	Partial F	Raised F	SLOPE	SE Slope	INTRCPT Intrcpt	SE
1	.33	.237	1.3910	.2140	-.770E-01	.653E-01	.330	.097

Fbar	SIGMA(int.)	SIGMA(ext.)	SIGMA(overall)	Variance ratio
.214	.237	0.000	.237	0.000

TABLE 5. (continued).

SUMMARY STATISTICS FOR AGE 10

Fleet	Pred. q	SE(q)	Partial F	Raised F	SLOPE	SE Slope	INTRCPT	SE Intrcpt
1	-.12	.684	.8859	.1379	-.164E-01	.228E+00	-.121	.279

Fbar	SIGMA(int.)	SIGMA(ext.)	SIGMA(overall)	Variance ratio
.138	.684	0.000	.684	0.000

SUMMARY STATISTICS FOR AGE 11

Fleet	Pred. q	SE(q)	Partial F	Raised F	SLOPE	SE Slope	INTRCPT	SE Intrcpt
1	-.96	1.248	.3840	.0723	-.487E+00	.306E+00	-.957	.509

Fbar	SIGMA(int.)	SIGMA(ext.)	SIGMA(overall)	Variance ratio
.072	1.25	0.000	1.25	0.000

SUMMARY STATISTICS FOR AGE 12

Fleet	Pred. q	SE(q)	Partial F	Raised F	SLOPE	SE Slope	INTRCPT	SE Intrcpt
1	-.22	.910	.8024	.1518	-.135E+00	.293E+00	-.220	.371

Fbar	SIGMA(int.)	SIGMA(ext.)	SIGMA(overall)	Variance ratio
.152	.910	0.000	.910	0.000

Title : 3M AMERICAN PLAICE

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Separable analysis
from 1988 to 1992 on ages 3 to 10
with Terminal F of .200 on age 6 and Terminal S of 1.0000

Initial sum of squared residuals was 52.361 and
final sum of squared residuals is 4.176 after 56 iterations

Matrix of Residuals

Years, Ages	1988/89	1989/90	1990/91	1991/92	WTS
3/ 4,	.015,	.013,	.004,	-.024,	.008, 1.000,
4/ 5,	-.314,	.084,	.207,	.031,	.007, .080,
5/ 6,	.072,	.459,	-.671,	.147,	.007, .037,
6/ 7,	.049,	.257,	-.810,	.511,	.007, .031,
7/ 8,	.289,	-.104,	-.216,	.038,	.007, .082,
8/ 9,	.454,	-.654,	.413,	-.207,	.007, .034,
9/10,	-.365,	-.328,	1.011,	-.312,	.007, .026,
WTS ,	.023, 1.000,	.005, 1.000,	-.007, 1.000,	-.012, 1.000,	.049,

TABLE 5. (continued).

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      Fishing Mortalities (F)
                  1988,   1989,   1990,   1991,   1992,
     F-values     .3126,  .4670,  .1433,  .6474,  .2000,
      Selection-at-age (S)
                     3,      4,      5,      6,      7,      8,
  9,     10,
     S-values     .0867,  .3565,  .6697, 1.0000, 1.2136, 1.4297,
1.4618, 1.0000,
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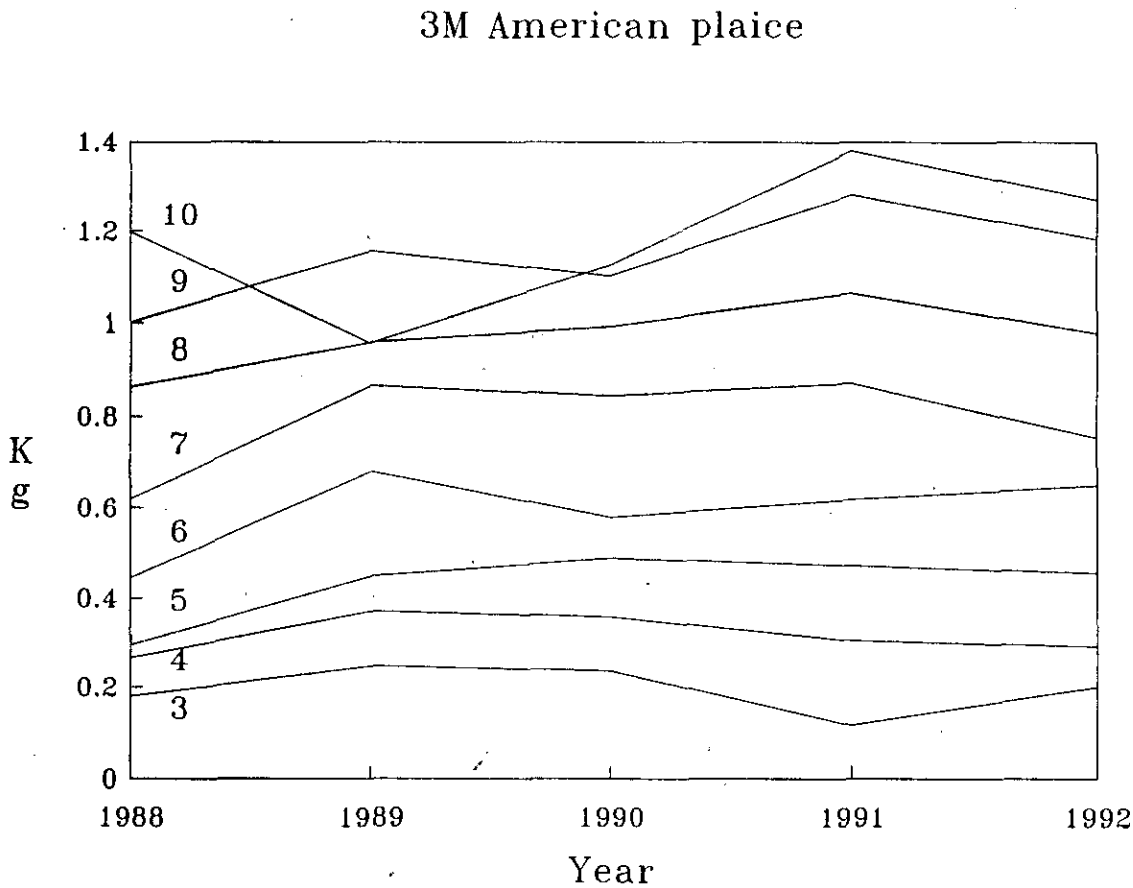

Fig. 2. Evolution of mean weight-at-age.

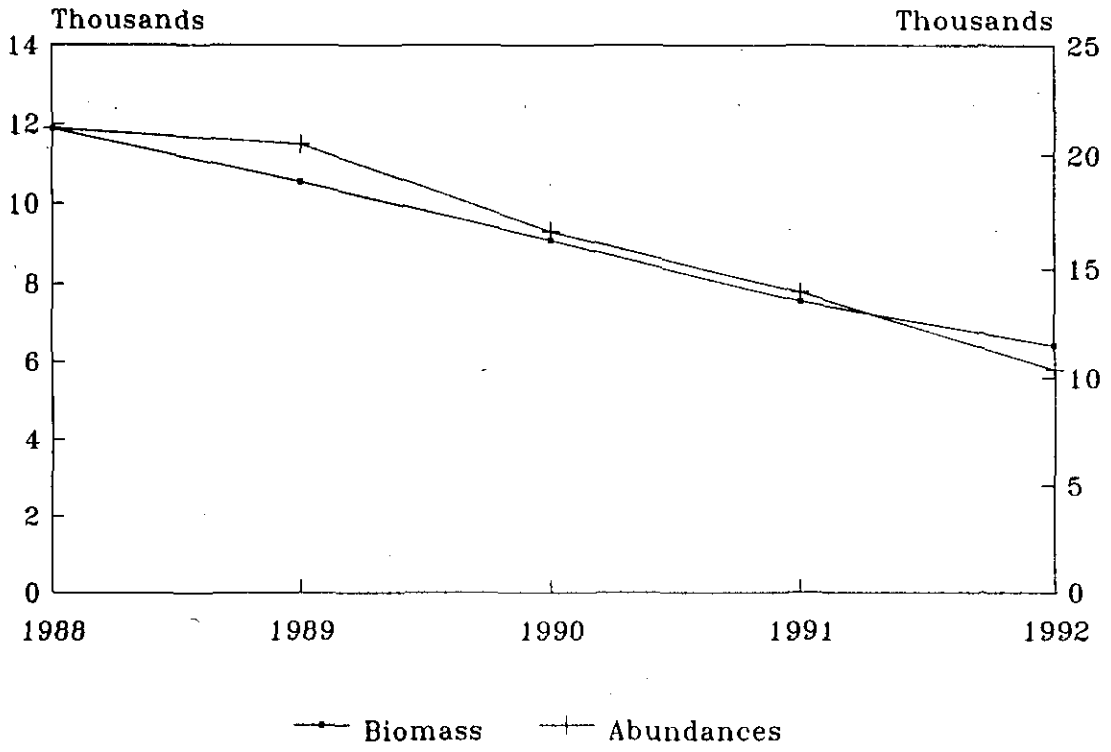

Fig. 3. 3M American plaice biomass and abundance estimated from the EEC bottom trawl surveys for 1988-92 (Vazquez, 1993).

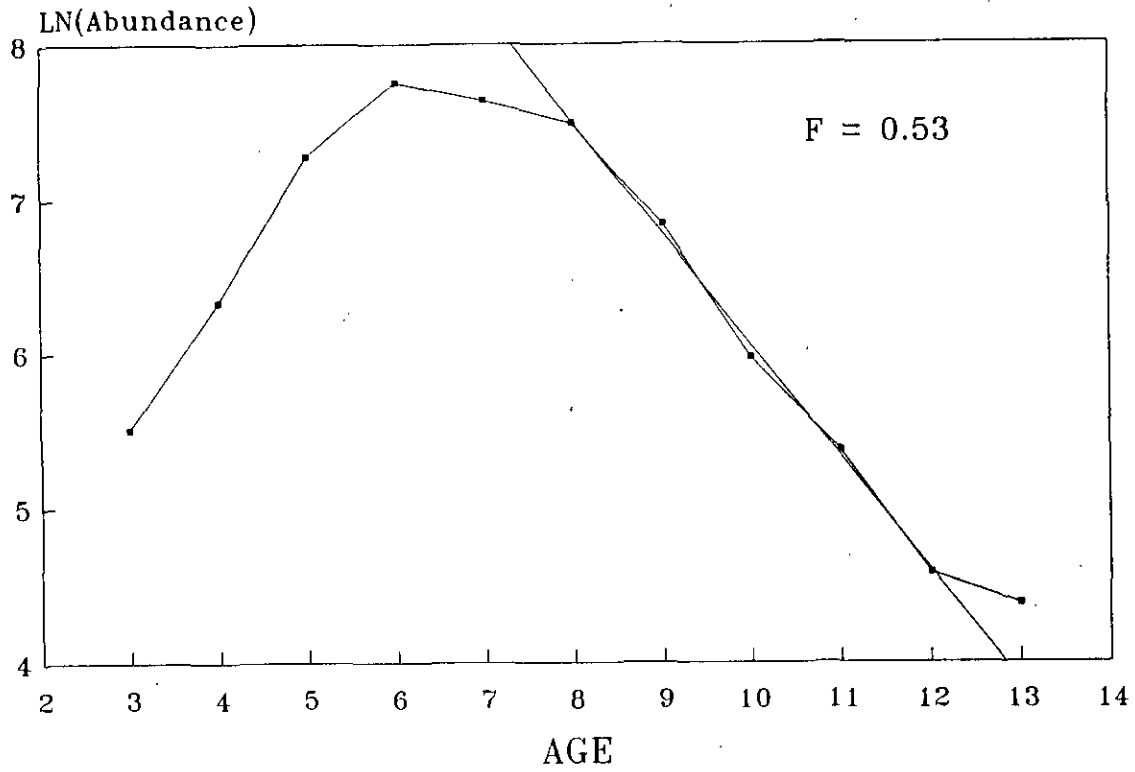

Fig. 4. Catch curve for the period 1988-90 for 3M American plaice.